Consultation on proposals for the levels of banded support under the Renewables Obligation for the period 2013-17 and the Renewables Obligation Order 2012

URN 11D/876: October 2011

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The consultation documents can be found on DECC's website:
www.decc.gov.uk/en/content/cms/consultations/cons_ro_review/cons_ro_review.aspx

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Ministerial Foreword

As part of our commitment to being the greenest government ever, I am pleased to launch the Renewables Obligation Banding Review.

The package proposed in this document will create and support the green jobs necessary to rebuild our economy, securing the UK's position as a global leader in the renewable energy sector.

It will ensure we keep on track to meet our 2020 renewable energy target, in line with our vision for renewables, published in July's UK Renewable Energy Roadmap, whilst at the same time minimising the cost to consumers.

To do so, we are proposing to reduce support where it can be done without significantly affecting deployment, and maximise deployment of the cheapest renewable technologies, such as coal-to-biomass conversions and co-firing. We are targeting only the most cost effective onshore wind farm deployment, recognising that it is one of the more mature, and cheaper, technologies, and paving the way for an expansion in sustainable biomass generation, as one of the most reliable and cost effective sources of renewable energy.

The result is that, over the course of the Banding review, this package will cost consumers less, and result in higher levels of renewable generation, than if we were to leave the bands unchanged.

I am also pleased to reiterate the Coalition's agreement to promote Marine technologies, providing additional support to bring this vital sector to commercial-scale deployment, as well as continuing to support offshore wind deployment, securing billions of pounds of private sector investment in these two key areas.

Chris Huhne

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General information

Purpose of this consultation

This consultation sets out the Government's proposals for levels of banded support under the Renewables Obligation for the period 2013-17, a number of other matters relating to the Renewables Obligation and a draft Renewables Obligation Order 2012. DECC invites interested parties to submit comments and evidence in response to these proposals. This consultation is relevant to energy generators, energy suppliers, energy consumers and their representatives, Consumer Focus, network operators, Ofgem, environmental and energy efficiency organisations, energy service companies, installers, the construction sector, finance institutions and other stakeholders with an interest in the renewable energy business.

Issued: **20 October 2011**

Respond by: **12 January 2012**

Enquiries to:
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Consultation reference: URN 11D/876 – Consultation on Renewables Obligation Banding Review and Renewables Obligation Order 2012

Territorial extent:
This consultation is on the Renewables Obligation, which applies to England and Wales only. The Scottish Government and Northern Ireland Executive will consult separately on banding proposals in relation to the Scottish Renewables Obligation and the Northern Ireland Renewables Obligation.

How to respond:
Your response will most useful if it is framed in direct response to the questions posed and the specific calls for evidence invited, though further comments and evidence are also welcome. Reasoning and evidence to support your answers will be particularly helpful. If including any long reports as part of your evidence, please identify the relevant sections.

- Online responses are preferred and can be submitted via DECC's consultation hub: https://econsultation.decc.gov.uk/office-for-renewable-energy-deployment-ored/ro-banding-rev

- If you are unable to submit your response online, please send it in an email to: robr@decc.gsi.gov.uk. Please use the template provided to record your response, which is available on the consultation page:

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

- Alternatively, hard copy replies should be sent to the Renewables Obligation Team at the above address (see '**Enquiries to**').

Additional copies:
You may make copies of this document without seeking permission. An electronic version can be found at:

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

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

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

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

Quality assurance:
This consultation has been carried out in accordance with the Government's Code of Practice on consultation, which can be found here:
http://www.bis.gov.uk/files/file47158.pdf

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

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

Executive Summary

UK Renewables

The Coalition Government has made clear its commitment to increasing the deployment of renewable energy across the UK in the sectors of electricity, heat and transport. This will provide long-term energy security, protect consumers from fossil fuel price fluctuations, and drive investment in new jobs and businesses in the renewable energy sector, as well as keeping us on track to meet our carbon reduction objectives for the coming decades. Renewables are key to the decarbonisation of the energy sector by 2030, alongside new nuclear, carbon capture and storage, and improvements in energy efficiency.

We want the UK to be the location of choice for inward investment and a world class centre of energy expertise. The support levels set out in this consultation will enable us to maximise the deployment of our most cost effective renewables, provide energy security, opportunities for jobs and wealth creation, and contribute to efforts to reduce emissions of harmful greenhouse gases.

The Renewables Obligation

The Renewables Obligation is currently the main mechanism by which we enable renewable electricity generation to compete effectively with fossil fuel generation. It aims to provide support in addition to the electricity price, such that it is economic to deploy the renewable capacity that we need.

Our long term goal is to achieve around 108TWh/y of large-scale renewable electricity generation in 2020, with the remainder of the 234TWh/y overall renewable energy target coming from small-scale renewable electricity, renewable heat and transport. With the support levels proposed in this consultation, we expect large scale renewable electricity to generate around 70-75TWh/y by the end of the banding period in 2017, in line with the deployment trajectory set out in the UK Renewable Energy Roadmap[1], published on 12 July 2011.

Aims of the Banding Review

The RO has undergone a number of reforms and improvements since it was introduced in 2002. The most significant of these was the introduction of banding in April 2009. This moved the RO from a mechanism which offered a single level of support for all renewable technologies, to one where support levels vary by technology, according to a number of factors including their costs, relative maturity and potential for future deployment.

The enabling primary legislation for RO banding requires the Secretary of State to carry out a review of the bands before new bands are set. The Renewables Obligation Order

[1] UK Renewable Energy Roadmap, DECC, July 2011, URN 11D/698.
http://www.decc.gov.uk/en/content/cms/meeting_energy/renewable_ener/re_roadmap/re_roadmap.aspx

2009 provides that a banding review may be commenced in October 2010 and then at four yearly intervals thereafter.

Bands need to be reviewed periodically to ensure that support levels are set as cost-effectively as possible and that they help to bring forward renewable technologies at the capacity needed in an affordable way, delivering value for money for consumers.

Methodology

In conducting this review, we commissioned Arup to provide us with an independent view of the current costs of each technology, and the expected cost trajectory as we see greater levels of deployment. Arup also provided us with their view of the potential of each technology to contribute to the UK's electricity generation mix.

We published the Arup report on 10 June 2011, and in developing the banding proposals in this document have taken on board a number of the comments we subsequently received. An updated version of the Arup report is being published alongside this consultation and is available on the main consultation page.

We have taken the Arup cost and deployment data, and input this to Pöyry's models of the electricity and Renewable Obligation Certificate (ROC) markets. We have cross-checked the output from the modelling with our own data of project timelines, to ensure that we are capturing real world data on deployment, particularly projects which are in, or about to start, construction.

Minimising impact on consumer bills

As announced in this year's budget, the RO is subject to the Levy Control Framework, which sets an overall cap on the amount that can be spent over the current Comprehensive Spending Review (CSR) period – 2011-2015. This helps to ensure that we are supporting renewable electricity generation cost effectively. The Pöyry modelling suggests that, on current levels of support, the levy envelope for the RO would be exceeded by around £130m and £290m in 2013/14 and 2014/15 respectively, mainly due to a surge in coal to biomass conversions which are significantly over rewarded at current ROC rates, whilst overall deployment would not be on track to meet our legally binding 2020 target.

In order to reduce excessive impacts on consumers bills and incentivise a sufficient level of deployment, we will need to reduce rents in the current banding levels, make use of the relatively cheap co-firing and conversion technologies, and drive down the costs of our marginal technology, offshore wind.

By setting support for the cheapest technologies at a level that ensures high deployment, we are able to minimise the amount of generation needed from our most expensive technologies. By bringing down support for the most expensive technologies in line with the reducing costs of offshore wind, we ensure that we are not paying more than is necessary to get the deployment we need to meet our legally binding target.

Maximising cheaper generation - Biomass Conversions

Converting existing coal generating stations to biomass is a cheap and effective way of achieving renewables deployment. It uses existing infrastructure, and helps maintain security of supply, especially where it prolongs the generation life of coal stations that might otherwise be taken offline.

Current legislation allows coal generators to convert to biomass and receive the same level of support (1.5ROCs) as a new build dedicated biomass generator. This leads to a significant over-subsidy, and was never the policy intention of the dedicated biomass band. The support level is not grandfathered, and as such may be deterring investment.

We believe that we can **reduce support by 33% (to 1ROC)** and still achieve significant deployment. This saves at least £1bn over the banding period (to 2017), so **we are proposing to create a new band, 'biomass conversions'**, which would aim to adequately support these projects.

We propose that generators which convert before 1 April 2013, (including those which have already converted), should also be transferred to this new band. They would receive 1.5ROCs/MWh for any generation up to 31 March 2013 and 1ROC/MWh for any generation from 1 April 2013. We would then adopt a policy of grandfathering support at 1 ROC from this date.

Increased support for biomass co-firing

We also propose to **create a new 'enhanced co-firing' band** so that some of the larger coal generators are able to partly switch to biomass. This would also be set at 1ROC, recognising the requirement for capital investment and allowing generators who decide to do so, to gradually move to full conversion. In order to benefit from this level of support, generators would need to be co-firing at least 15% of their generation. As from 1 April 2013, we would adopt a policy of grandfathering support under the enhanced co-firing band.

In recognition of the need to expand the level of co-firing, we propose to **remove the co-firing cap** from 1 April 2013.

Reducing support where possible

We have considered carefully whether support for any other technology could be reduced, and are proposing to reduce support for **hydro-electricity, standard pyrolysis and gasification, energy from waste with Combined Heat and Power (CHP),** and **landfill gas**. According to our modelling, reducing support for these technologies does not significantly impact deployment. We are reducing rents, whilst maintaining maximum deployment of the cheapest technologies.

We are also proposing to **reduce support for onshore wind by 10% to 0.9ROCs/MWh**, in order to reflect long term cost movements, and to deter poorly sited projects which are more expensive to develop. On our analysis, this prevents the least cost-effective 350-

490MW from being deployed, whilst only reducing the contribution from large-scale onshore wind generation towards the 2020 renewables target by 0.9-1.3TWh/y]

The marginal cost of meeting the target – offshore wind

To support the renewable generation that we need to meet the 2020 target, the most expensive technology we need to deploy is offshore wind. This technology needs 2ROC/MWh to deploy, and therefore this level of support is the marginal cost of meeting the target – i.e. **if a technology costs less than 2ROCs we should maximise deployment of it; if it costs more, we should not set higher bands to incentivise deployment unless there are other compelling arguments to do so**.

As announced on 12 October 2011, we have established an industry-led task force which will set out a path and action plan to reduce the costs from development, construction and operations of offshore wind to £100/MWh by 2020. Bringing down costs over time should enable us to reduce the support for offshore wind over the banding review period without impacting deployment levels, and see up to 18GW of offshore wind deployed by 2020.

We are therefore proposing that for new offshore wind generating stations accredited in 2015/16 we reduce support to 1.9ROCs, and for new accreditations in 2016/17 we reduce it further to 1.8ROCs, in line with our cost evidence which projects offshore wind costs to fall. As offshore wind remains the marginal technology, we would reduce the maximum ROC level for all technologies in line with the reductions for offshore wind – i.e. in 2016/17 no new accreditations should receive more than 1.8ROC. The exception to this approach is for wave and tidal stream technologies as set out below and in chapter 6.

Wave & Tidal Technologies

We recognise that wave and tidal stream technologies are not currently ready for commercial-scale deployment, but that there is significant potential for these technologies to help meet our longer term decarbonisation goals. Without investment now, we will lose the opportunity to tap into these technologies cost effectively in the future. So we are proposing support at 5 ROCs for capacity up to 30MW per generating station in order to help bring this technology into mainstream deployment. Support at this level would only be available for capacity that is **accredited and operational before 1 April 2017**.

Bioliquids

We are proposing that bioliquids, including fossil derived bioliquids, should be supported at the same number of ROCs as other biomass. Analysis suggests that support at this level is unlikely to bring widespread deployment. But for further assurance that bioliquids are not significantly diverted from other uses of greater priority, such as transport, **we are proposing to set a cap on the use of bioliquids** by electricity suppliers to meet their renewables obligation. The cap will be set at 4% of each supplier's renewables obligation, broadly equivalent to around 2TWh/yr of ROCs from electricity generated from bioliquids under the RO in 2017. With these controls in place, we then propose to treat bioliquids in the same way as other biomass for the purposes of our grandfathering policy from 1 April 2013. In line with a European Commission decision, we are proposing to increase the information that must be included in the annual bioliquid sustainability audit report.

Advanced Conversion Technologies (ACT)

We are proposing to replace the current standard and advanced gasification and pyrolysis bands with two new bands. The aim is to distinguish between the more proven means of generating electricity using steam cycle technologies, and those more innovative methods of generating electricity which use more efficient engines or gas turbines. We are seeking further evidence on costs, including gate fees, and deployment potential to inform our decision in relation to these proposed new bands.

CHP uplift

Generators of Combined Heat and Power (CHP) plants receive additional support under some of the current RO bands. The introduction of the Renewable Heat Incentive presents an opportunity to differentiate support for heat and electricity. We are proposing to end the CHP uplift for new stations accredited on or after 1 April 2015 and support new build CHP from then on through a combination of the RO and RHI. New accreditations or additional capacity added between 1 April 2013 and 31 March 2015 will have a choice between power-only RO bands plus the RHI or the RO CHP band. We propose to adopt a policy of grandfathering support for CHP technologies under the RO from 1 April 2013.

Energy Crops

We are proposing to narrow the definition of “energy crops” to cover only a defined list of non-food crops, and to adopt a policy of grandfathering the energy crop uplift (as amended) from 1 April 2013.

Grandfathering

We are proposing that support for most types of generating stations accredited before 1 April 2013, and support for additional capacity added by those stations before that date, will be grandfathered. There are some exceptions to this approach which are set out in chapter 18.

Grace Periods

We are proposing to offer limited grace periods for projects installing technologies where support is being reduced from 1 April 2013 to allow for unavoidable delays concerning **grid connection** and **implementation of radar solutions**. The grace periods will apply if a developer had expected to complete their project in order to be eligible for current ROC bands, but grid connection or a radar solution are delayed by the network operator or radar installer respectively. A grace period would last six months from 1 April 2013.

Implementation

Subject to the responses received to this consultation, our aim is to implement these proposals via a Renewables Obligation (Amendment) Order 2012 (ROO 2012), which would be legislated for next year, and come into force on 1 April 2013. The proposals will be contingent on obtaining State Aid approval from the European Commission and subject to Parliamentary process.

Devolution

The Renewables Obligation works on the basis of three complementary obligations – the Renewables Obligation (RO) in England and Wales, the Scottish Renewables Obligation in Scotland (SROCs) and the NI Renewables Obligation in Northern Ireland (NIRO).

For investors, particularly those with large portfolios across the UK, it is important that the three mechanisms are as consistent as possible. We are committed to working closely with the Devolved Administrations, and have worked together with the same data and modelling evidence to inform our banding proposals. Scottish and Northern Ireland Ministers will make separate announcements of their Banding Review proposals.

1. Banding review methodology

Introduction

1.1 The Renewables Obligation (RO) is currently the Government's main mechanism for incentivising deployment of large scale renewable electricity. It requires electricity suppliers to submit a number of renewables obligation certificates ("ROCs") in respect of each megawatt hour of electricity they supply, or pay a buyout price. The proceeds from the buyout payments are recycled to suppliers in proportion to the number of ROCs they submit. The RO is administered by Ofgem who issue ROCs to accredited renewable electricity generators in respect of their eligible renewable output.

1.2 Since its introduction in 2002, the RO has succeeded in more than tripling the level of renewable electricity in the UK from 1.8% to 6.64% and is currently worth around £1.4 billion a year in support to the renewable electricity industry. In April 2010, the end date of the RO was extended from 2027 to 2037 for new projects, in order to provide greater long-term certainty for investors and to ensure continued deployment of renewables to meet our 2020 renewables target.

1.3 The Coalition Government is committed to maintaining a banded RO alongside other support mechanisms, including Feed-in-Tariffs and the new measures that will be introduced through Electricity Market Reform, with the aim of securing a significant increase in renewable electricity generation.

Devolution

1.4 The RO system works on the basis of three complementary obligations, one covering England and Wales, and one each for Scotland and Northern Ireland. Decisions regarding the details of the Obligations in Scotland and Northern Ireland are for the Scottish Government and the Northern Ireland Executive respectively. Both Scotland and Northern Ireland will publish their own consultations and introduce any changes through their own secondary legislation. The Scottish Government and the Northern Ireland Executive will announce their timetables in due course. However, the Government and the Devolved Administrations understand the benefits of a consistent approach across the UK and are working together to deliver this where possible. The independent study commissioned from Arup (see below) on UK generation costs and deployment potential of renewable electricity technologies, is intended to provide a common starting point to help facilitate as much commonality as possible on banding levels across the UK.

The need for a banding review

1.5 The RO has undergone various reforms and improvements since it was introduced in 2002. The most significant of these was the introduction of banding in April 2009 which moved the RO from a mechanism which offered a single level of support for all renewable technologies to one where support levels vary by technology according to a number of factors, including their costs and level of development.

1.6 Bands need to be reviewed periodically to ensure that support levels are set as cost-effectively as possible and that they help both to bring forward renewable technologies at the capacity needed to achieve the UK's 2020 renewables target while delivering good value for money for the taxpayer. The enabling primary legislation[2] for the RO requires the Secretary of State to carry out a review of the bands before new bands are set. The Renewables Obligation Order 2009 provides that a banding review may be commenced in October 2010 and then at four yearly intervals thereafter.

1.7 Before making any changes to the levels of support under the RO, the Secretary of State is required to have regard to a range of matters listed in section 32D of the Electricity Act 1989 as detailed in Chapter 4 below and must also consult a range of persons listed in section 32L of that Act.

Banding review process and methodology

1.8 In March 2010, the previous Government published details of the process and timetable for the 2013-17 banding review. The original timetable set out in the Renewables Obligation Banding Review Process document[3] indicated that the Government would launch a statutory consultation on new banding proposals in Spring 2012 and announce its decision on banding levels by Autumn 2012. However, this meant that investors would not have known for certain what support they could expect to receive until late 2012 at the earliest. The Coalition Government was concerned that this might delay early investment in certain technologies.

1.9 To address these concerns, the Government decided to accelerate the banding review process. We believe that accelerating the banding review will give investors and developers greater certainty and confidence to help bring forward the scale of renewable electricity deployment needed to deliver the renewable energy goals and other important energy and climate change objectives.

1.10 The RO banding review started in October 2010 with the appointment of Arup, with their sub-contractors Ernst & Young, to review the market costs of generation and deployment potential of renewable electricity technologies. Arup's report, published on DECC's website on 10 June, forms a key part of the evidence base for the banding review. An updated version of Arup's final report is available alongside this consultation at: **www.decc.gov.uk/en/content/cms/consultations/cons_ro_review/cons_ro_review.aspx**.

1.11 The approach and methodology undertaken by Arup is described in detail in the report, but can be summarised here. Their study was divided into two parts:

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[2] Electricity Act 1989 as amended by the Energy Act 2008

[3] Renewables Obligation Banding Review Process – DECC, March 2010. http://www.decc.gov.uk/en/content/cms/meeting_energy/renewable_ener/renew_obs/renew_obs.aspx

- Part A was an analysis of the non-financial constraints to renewables deployment informing the development of low, medium and high deployment scenarios by technology, and

- Part B examined generation costs, excluding fuel, of renewable technologies, differentiating by size and key characteristics as appropriate.

1.12 The following technologies were examined by Arup during this phase of the review:

Technology family	**Subcategories by:**
	Technological/ fuel/ geography/ resource
Onshore wind	Larger (>5MW) and smaller (<5MW)
Offshore wind	Round 2, Round 3, Scottish Territorial Waters
Hydro	Larger (>5MW) and smaller (<5MW)
Wave	Nearshore, offshore
Tidal stream	Shallow, deep
Tidal range	Tidal barrages, tidal lagoons, tidal reefs
Geothermal	With/without CHP
Solar PV	Larger (>5MW) and smaller (<5MW)
Dedicated Biomass (Solid) All sources	Regular biomass; energy crops, virgin wood (e.g. forestry residues) , Waste wood , Perennial energy crops (e.g. SRC willow, miscanthus), biomass fuel type including torrification / pre-treatment of biomass Larger (>50MW) and smaller (<50MW)
Biomass co-firing All sources	
Dedicated Biomass (Solid) Powerstation conversion	
Dedicated Bioliquids All sources	Made from: food crops waste, e.g. cooking oil dedicated bioliquid crops
Energy from Waste	Solid Recovered Fuel (SRF) derived from wastes such as Municipal Solid Waste (MSW)
Anaerobic digestion	Feedstock: food waste; whole food crops (with sustainability levels); manures and slurries
Dedicated Biogas	Sewage gas
	Landfill gas
Advanced Conversion Technologies	Gasification
	Pyrolysis
Renewable combined heat and power	On all biomass/bioliquid technologies listed
	Waste combustion with combined heat and power (RO definition)

Part A - Renewables Deployment Scenarios

1.13 Arup's methodology for assessing potential renewables deployment to 2020, 2030 and beyond was as follows:

- Evidence gathering: - review of existing renewables industry literature and data and consultation with key stakeholders in the renewables industry e.g. Renewables UK, The Crown Estate;
- Analysis of evidence and application of logic models to derive renewables deployment scenarios;

1.14 The following non-financial constraints to deployment were considered:

- Supply chain (fuel supply (where applicable – including competing uses), equipment and materials, skilled labour availability and installation capacity);
- Planning (Government consent, local authority planning approval for power plant);
- Grid constraints (construction of and connection to the transmission network; and reinforcement of the transmission network);
- Other constraints (physical constraints, including availability of suitable sites) and any other relevant constraints (technical, legal, etc), which could limit the deployment or maximum feasible potential.

1.15 Three scenarios of renewables deployment were developed based on the analysis of the above constraints:

- **Low scenario**: the maximum amount of capacity that could be built per year (i.e. MW/year) *per renewable technology* between now and 2030 in the UK given current constraints;
- **Medium scenario**: the maximum amount of capacity that could be built per year (i.e. MW/year) *per renewable technology* between now and 2030 in the UK if some of the constraints are relaxed;
- **High scenario**: the maximum amount of capacity that could be built per year (i.e. MW/year) *per renewable technology* between now and 2030 in the UK if additional constraints are relaxed.

1.16 A qualitative consideration was made regarding deployment trends beyond 2030 for each technology. It is important to note that these scenarios are not financially constrained. They are therefore treated as ***maximum*** build rates, and deployment in each technology would be expected to be correspondingly lower than them, except where RO support is set high enough to incentivise even the most expensive potential renewable projects in a given technology.

Part B - Generation costs

1.17 Arup (and Ernst & Young who were sub-contracted for work on onshore wind, offshore wind, dedicated biomass and solar PV technologies costs), used the following methodology to derive capex, opex, load factors, efficiencies and financial hurdle rate information for renewable technologies from now to 2030.

1.18 They reviewed the industry data to gather benchmark data on project costs for comparison; consulted with approximately 200 industry stakeholders (of which 70 reported back) with a standardised questionnaire with separate sections for detailed individual technology questions; and followed up as appropriate with stakeholders to ensure their own understanding, validate the data and ensure consistency. This provided project cost datasets for projects around financial close in late 2010. Arup and Ernst & Young then used these datasets to derive, high (90^{th} percentile), median and low (10^{th} percentile) estimates of the different cost elements and technical parameters.

1.19 DECC calculated the levelised costs for each of the technologies which appear in the relevant technology chapter of Arup's report. These are also included in Annex A of this consultation document for ease of reference. The levelised cost of generation is the discounted lifetime cost of a generation asset (including all the costs over its lifetime, such as initial investment, operations and maintenance, cost of fuel, gate fees, avoided costs of alternative means of heat generation for CHP, cost of capital) divided by the discounted lifetime generation, giving a electricity unit cost in £/MWh. Following this methodology, the levelised costs were calculated using the DECC levelised cost model[4], for consistency with the Parsons Brinckerhoff report (2011)[5] on the generation costs of non-renewable power technologies and the Mott Macdonald (2010)[6] report.

1.20 The following input data was used to calculate the levelised costs, using the DECC levelised cost model:

- Capex – from Arup/Ernst & Young;
- Opex – from Arup/Ernst & Young;
- Load factors – from Arup/Ernst & Young;
- Efficiencies for fuelled technologies – from Arup/Ernst & Young;

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[4] Levelised cost defined as:

Sum of discounted lifetime capex, opex, heat revenue and fuel costs divided by sum of discounted lifetime electricity generation in MWh

where discounting goes back to the point of 'project start', at the beginning of pre-development, and discount rate used is the hurdle rate, i.e. the target rate of return for the project.
Costs include the cost of delivering the electricity as far as the first land-based sub-station, but no further. They do not therefore include onshore transmission and distribution costs, or power system balancing costs.

[5] Electricity Generation Cost Model – 2011 Update, 2011, to be found at www.decc.gov.uk/assets/decc/11/meeting-energy-demand/nuclear/2153-electricity-generation-cost-model-2011.pdf

[6] UK Electricity Generation Cost Update, 2010, to be found at www.decc.gov.uk/assets/decc/statistics/projections/71-uk-electricity-generation-costs-update-.pdf

- Financial hurdle rates – from Arup/Ernst and Young, and in some cases from the Oxera (2011)[7] survey of hurdle rates for the Committee on Climate Change;
- DECC heat revenue assumptions for Combined Heat and Power technologies;
- Fuel costs and gate fees – based on AEA (2011)[8], the WRAP 2010 gate fees report[9], and industry knowledge from Defra;

1.21 The resulting levelised costs and further details of the underlying assumptions are set out in Annexes A and B.

Modelling of the banding levels

1.22 DECC commissioned Pöyry to model the potential deployment of renewables technologies and resulting impacts under different RO banding levels scenarios using UK electricity market modelling.

1.23 Using Arup's work on current and projected costs and deployment potential, we have constructed annual stepped supply curves for each technology.[10]

1.24 This supply curve data was provided to Pöyry consultants, alongside similar data for non-renewables technologies, in order to input it into their electricity market model to assess the impacts of different RO banding scenarios from 1 April 2013 to 31 March 2017 on renewables deployment, resource costs[11], carbon, security of supply and subsidy costs.

1.25 In addition, using the same central assumptions as given to Pöyry (and the electricity prices that come out of their model), we have calculated the minimum ROC bands required to bring on deployment at the low, central and high ends of the supply curves for each technology in 2014/15.[12] This is done by comparing generation costs

[7] Oxera, 2011, *Discount rates for low-carbon and renewable generation technologies*, available at: http://hmccc.s3.amazonaws.com/Renewables%20Review/Oxera%20low%20carbon%20discount%20rates%20180411.pdf

[8] AEA, 2011, *UK and Global Bioenergy Resource – Final report*, available at: http://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

[9] WRAP, 2010, *Gate fees report 2010 – Comparing the cost of alternative waste treatment options,* available at: http://www.wrap.org.uk/downloads/2010_Gate_Fees_Report.d6857e4e.9523.pdf

[10] As Arup's medium cost estimates represent the median, the cost data takes into account cost skewedness, i.e. if the median equals the mean, costs are symetrically distributed, while a median above (below) the mean implies costs are concentrated 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 at lower support levels, if costs are skewed to the left (i.e. less distance between low, low-medium and medium costs), while it assumes less deployment at lower support levels if costs are skewed to the right.

[10] 2014/15 is the middle year of three in which the new RO bandings are assumed to have an impact. In the last year of the period, 2016/17, it is assumed that projects choose the new FiT CfD support scheme instead (due to the risk of construction overrun leading to missing the RO end-date). In reality, some projects may choose CfDs before this date, and some may choose the RO after this date, but these two effects will offset each other such that the assumed overall deployment under the RO may be similar but just slightly more spread out in time than occurs in the modelling

[11] Resource costs are defined as the full technology generation costs and system costs associated with supplying electricity to meet demand.

and revenues in a discounted cashflow model and setting ROC bands at the lowest rate which turns the Net Present value (NPV) of cashflow positive (see Table 1 for a summary of the cost and revenues used in the cashflow analysis). Put another way, if investment in a particular technology with a particular set of costs is to occur, the ROC banding would need to be set at such a level that it “tops up” the revenue streams enough for the investment to break even. Please note that all further references to ‘ROC bands required’, have this definition.

Table 1

Cash flows	
Costs	***Revenues***
Capex	Electricity sales revenue
Opex	ROC revenue
Fuel cost	LEC revenue
Avoided gas boiler cost (CHP plants)	

1.26 The revenue assumptions used in our calculations, and in the Pöyry modelling of investment decisions, were as follows:

- Levy exemption certificates: assumed to have a value of £4.72 in 2010/11, and for this value to remain constant in real terms;

- Wholesale electricity prices: an output of the Pöyry modelling. Investors are assumed to have five years of foresight of wholesale price changes, then assume the price stays constant in real terms for the rest of the project life;

- ROC value to a supplier: assumed to average at the buyout price plus 10%, which is the expected value when the headroom calculation sets the level of the Obligation, i.e. £36.99 x 1.1 = £40.69/MWh.= in 2010/11 prices;

- Power Purchase Agreement (PPA) discounts: assumed that under PPAs, a generator receives 90% of the wholesale value, 89% of the ROC value and 93% of the LEC value, except for offshore wind where it assumed that new plants will be so large they may have difficulty obtaining a PPA, and hence will sell directly to the wholesale market and receive 100% of the market value of the electricity.[13]

1.27 The Pöyry modelling has used a set of hurdle rates, which DECC considers are low for central assumptions, but within the ranges of hurdle rates for different projects. Each technology chapter below presents deployment, generation and RO support costs under current and proposed bands from the Pöyry modelling, using the lower set of hurdle rates. DECC has analysed in-house the impact to deployment, generation and RO support costs of assuming the higher central hurdle rates (set out in Annex B). In many cases, there is no difference to deployment, given the supply curves are stepped i.e. divided into five blocks rather than being a smooth curve. Where there is a difference to deployment, generation and RO support costs, the results using DECC’s central hurdle rates are presented in each relevant technology

[13] Assumptions from Pöyry

chapter as the lower end of a range and Pöyry's results using the lower hurdle rates form the upper end of which uses the lower set of hurdle rates.

1.28 The wholesale electricity prices in the Pöyry modelling are influenced by the level of carbon costs and fossil fuel price assumptions. The Pöyry modelling used the latest published set of DECC fossil fuel price assumptions at the time it was carried out. New fossil fuel price assumptions have just been published. In addition, a new set of carbon price (EUA) assumptions has also been published.[14] However, as a carbon price floor is being introduced, the change in EUA assumptions will have no effect on the modelling.

1.29 DECC has analysed in-house the difference that changing the fossil fuel price assumptions could make to renewables deployment, generation and RO support costs. The gas prices up to 2020 are generally higher than in the previous set of assumptions, and given that CCGT is the marginal plant in this period, this pushes up wholesale prices and therefore reduces ROC requirements for investment to proceed. Again, owing to the stepped supply curves,[15] the higher wholesale prices do not affect the renewables deployment, generation and RO support costs for all technologies. With the exception of co-firing and sewage gas, using the new fossil fuel prices and DECC's central (higher) set of hurdle rates together leads to the same deployment, generation and RO support costs as using together the old fossil fuel prices and the (lower) hurdle rates used in the Pöyry modelling. In the technology chapters below, the impact of using the new fossil fuel price assumptions together with DECC's central hurdle rate is set out where it is different from the Pöyry modelling results, which used the alternative assumptions of lower hurdle rates and previous fossil fuel prices.

1.30 Further details of key assumptions are set out in Annex B.

1.31 The resulting ranges of ROC bands are detailed below in the discussion of each technology's proposed banding.

1.32 Generation costs vary across projects (as reflected in the ranges we are using) and are also uncertain for any individual project, especially further into the future. There is a range of **uncertainties** around the revenue assumptions and around the central levelised costs used, relating to, for example, capital costs, hurdle rates, availability profiles, biomass fuel prices and/or waste gate fees.

1.33 This uncertainty around costs, implies uncertainty around the impact of different ROC banding levels and therefore on the required ROC bands. This is why, as part of the supply curve work, we have used **cost ranges** for each technology using low, medium and high capital cost numbers provided by Arup. The wide capex variation proxies for the variation in other parameters.

[14] Published on 14th October 2011, and available here: http://www.decc.gov.uk/en/content/cms/about/ec_social_res/analytic_projs/en_emis_projs/en_emis_projs.aspx

[15] The use of stepped supply curves is a modelling assumption that simplifies reality. For some technologies the supply curves may be stepped, but quite differently; other technologies may have a fairly continuous, smooth supply curve.

1.34 In the modelling of impacts by Pöyry consultants, full implementation of the Electricity Market Reform has been assumed, i.e.

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

1.35 After the introduction of the new FiT CfD scheme (the first contracts for difference are expected in 2013 or 2014), new renewables developers will have the choice between support under the RO and support under the FiT CfD, until the closure of the RO to new generation, including additional capacity, from 1 April 2017. The simplifying assumption has been that new renewables generation in 2013/14, 2014/15 and 2015/16 will all be supported under the RO (except where they are eligible for small-scale FITs). In the last of the four years of the banding review period, 2016/17, it is assumed that projects choose the new FiT CfD support scheme instead (due to the risk of construction overrun leading to missing the RO end-date). In reality, some new renewables stations may choose the FiT CfD in earlier years, and some may choose the RO in 2016/17, if they judge the risk of missing the RO end-date to be not significant.

Peer Review

1.36 The RO Banding Review Process Document published in March 2010 proposed a peer review stage before the consultation on the banding review proposals. In order to accelerate the banding review process, we have decided not to obtain a peer review in advance of this consultation. We published the Arup report on 10 June 2011, and have taken on board a number of comments in developing the proposals in this document. We have published an updated version of the report alongside this consultation. In addition, we are inviting consultees to indicate whether they agree with Arup's assessment of costs and deployment potential for each of the technology groups covered by this consultation.

[16] For full details, see the Electricity Market Reform White Paper, available at: http://www.decc.gov.uk/en/content/cms/legislation/white_papers/emr_wp_2011/emr_wp_2011.aspx

2. Technology banding proposals - summary

2.1 Our aims for the current banding review are to:

- Ensure that the RO will support renewables growth to help meet our 2020 renewables target;
- Increase the efficiency of the RO to ensure value for money;
- Support technologies with the potential for mass deployment;
- Ensure coordination with other DECC financial incentives schemes; and
- Contribute to the effective delivery of wider energy and climate change goals to 2050, including Greenhouse Gas (GHG) emissions reductions, decarbonising of the UK grid and energy security.

2.2 The banding review covers the provisions in the Renewables Obligation Order[17] which set the levels of support for renewable electricity. Before making any changes to those banding provisions, the Secretary of State is legally required to have regard to a number of matters. These are set out in primary legislation - Section 32D(4) of the Electricity Act 1989 (as amended by the Energy Act 2008) and are outlined below:

a) *the costs (including capital costs) associated with generating electricity from each of the renewable sources or with transmitting or distributing electricity so generated (and including costs associated with the production or supply of heat: section 32D(5));*

b) *the income of operators of generating stations in respect of electricity generated from each of those sources or associated with the generation of such electricity (including that connected with the acquisition of the renewable source, the supply of heat and the disposal of any generation by-product: section 32D(6));*

c) *the effect of paragraph 19 of Schedule 6 to the Finance Act 2000 (supplies of electricity from renewable sources exempted from climate change levy) in relation to electricity generated from each of those sources;*

d) *the desirability of securing the long term growth, and economic viability, of the industries associated with the generation of electricity from renewable sources;*

e) *the likely effect of the proposed banding provision on the number of renewables obligation certificates issued by the Authority, and the impact this will have on the market for such certificates and on consumers;*

f) *the potential contribution of electricity generated from each renewable source to the attainment of any target which relates to the generation of electricity or the*

[17] SI 2009/785 as amended by SI 2010/1107 and SI 2011/984.

production of energy and is imposed by, or results from or arises out of, a Community obligation.

2.3 In putting forward the proposals in this consultation on banding levels, we have considered all of these factors for each technology. To summarise:

- factors (a), (b) and (c) are considered through in-house DECC analysis of our supply curves and 'required ROC bands' (see chapter 1), which look at the range of costs and revenues for renewable projects in different technologies, and consideration of Pöyry's modelling results for deployment at different bands;
- factor (d) is considered qualitatively on a technology by technology basis;
- factor (e) is considered through the Pöyry modelling of different banding scenarios, which estimates the total numbers of ROCs produced[18] and the costs to consumers; and
- factor (f) is considered through the supply curves used in the modelling, showing where the potential is, by renewable technology, for hitting the UK's 2020 renewables target. Under the Renewable Energy Directive 2009/28/EC the UK is required to meet a target of 15% of all the energy consumed in 2020 to have come from renewable energy sources.

2.4 We have paid particular attention to the value for money, overall cost to consumer of the RO and the Levy Control Framework. The RO is subject to the Levy Control Framework[19] which sets an overall cap on the amount that can be spent over the current Comprehensive Spending Review (CSR) period – 2011-2015. The proposals outlined in this document are aimed at meeting our targets cost effectively.

2.5 The UK Renewable Energy Roadmap sets out our approach to unlocking UK renewable energy potential and focuses on the technologies that have either the greatest potential to help the UK meet the 2020 renewables target in a cost effective and sustainable way, or offer great potential for the decades that follow.

2.6 We have taken into account that some technologies, in particular wave and tidal, may require additional support in order for them to reach commercial viability. Where we consider it is clear that these technologies have both a high deployment potential, a clear plan for reducing costs once the pilot generating stations have been deployed, we are proposing to provide additional support in order that they can contribute to the 2050 decarbonisation target.

2.7 We have considered the availability of sustainably-sourced fuels where relevant, and the demand for alternative uses in both energy and non-energy sectors. The Government is developing a UK Bio-energy Strategy which will aim to set out our strategic framework for the use of bio-energy, based on our assessment of

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[18] The market for ROCs is not expected to be particularly affected by the new ROC bandings, as in the future the demand (the Obligation level) is expected to be set by the headroom calculation, i.e. the prediction of ROCs generated in the relevant year plus 10% headroom.

[19] Further details of the Levy Control Framework can be found at http://www.decc.gov.uk/en/content/cms/meeting_energy/renewable_ener/renewable_ener.aspx

sustainable feedstock supply, demand across the bio-economy, and the economic and CO2 impacts of the alternative uses. The strategy is expected to be published around the turn of the year.

Specific banding proposals

2.8 We are consulting on the following banding levels for the period 1 April 2013 to 31 March 2017 ("the banding review period"). This new level of RO support would apply to any new generating station accrediting on or after 1 April 2013. It would also apply to any additional capacity commissioned at existing accredited stations on or after this date. The proposals are for England & Wales, the UK territorial sea and the renewable energy zone (except for the territorial sea adjacent to Scotland and that part of the renewable energy zone in relation to which Scottish Ministers have functions):

Table 2

Renewable electricity technologies	Current support, ROCs/MWh[20]	Proposed ROC support/MWh[21]	Other proposed changes
Advanced gasification	2	2 in 2013/14 and 2014/15; 1.9 in 2015/16 and 1.8 in 2016/17 Call for evidence	Proposed change to definition and merger with advanced pyrolysis to create a combined advanced ACT band as described in chapter 12
Advanced pyrolysis	2	2 in 2013/14 and 2014/15; 1.9 in 2015/16 and 1.8 in 2016/17 Call for evidence	Proposed change to definition and merger with advanced gasification to create a combined advanced ACT band as described in chapter 12
Anaerobic digestion	2	2 in 2013/14 and 2014/15; 1.9 in 2015/16 and 1.8 in 2016/17	

[20] Different levels of support may apply to certain types of generating station accredited before 1 April 2009. The default rate of 1 ROC/MWh applies to eligible generation that does not fall within any other banding provision.
[21] Years refer to obligation periods under the RO. For example, 2013/14 refers to the period 1 April 2013 to 31 March 2014.

Biomass conversion	No current band but eligible to claim 1.5ROCs under current banding arrangements	1 Call for evidence	Proposal for a new band.
Co-firing of biomass	0.5	0.5	Changes proposed to add fossil derived bioliquids.
Co-firing of biomass (enhanced)	No current band but 0.5 ROCs under current banding arrangements	1 Call for evidence	Proposal for a new band.
Co-firing of biomass with CHP	1	1	Changes proposed to add fossil derived bioliquids, to exclude enhanced co-firing and to close this band to new accreditations from 1 April 2015.
Co-firing of energy crops	1	1	Changes proposed to the definition of energy crops and to exclude enhanced co-firing.
Co-firing of energy crops with CHP	1.5	1.5 Call for evidence	Changes proposed to the definition of energy crops, to exclude enhanced co-firing and to close this band to new accreditations from 1 April 2015.
Dedicated biomass	1.5	1.5 until 31 March 2016; 1.4 from 1 April 2016	Changes proposed to exclude biomass conversions and to add fossil-derived bioliquids (see chapter 9).
Dedicated energy crops	2	2 in 2013/14 and 2014/15; 1.9 in 2015/16 and 1.8 in 2016/17	Changes proposed to the definition of energy crops and to exclude biomass conversion.

Dedicated biomass with CHP	2	2 in 2013/14 and 2014/15	Changes proposed to add fossil derived bioliquids, to exclude biomass conversion and to close this band to new accreditations from 1 April 2015.
Dedicated energy crops with CHP	2	2 in 2013/14 and 2014/15 Call for evidence	Changes proposed to the definition of energy crops, to exclude biomass conversion and to close this band to new accreditations from 1 April 2015.
Energy from waste with CHP	1	0.5 Call for evidence	
Geothermal	2	2 in 2013/14 and 2014/15; 1.9 in 2015/16 and 1.8 in 2016/17	
Geopressure	1	1	
Hydro-electric	1	0.5	
Landfill gas	0.25	0 Call for evidence	
Microgeneration	2	2 in 2013/14 and 2014/15; 1.9 in 2015/16 and 1.8 in 2016/17	
Onshore wind	1	0.9	
Offshore wind	2 in 2013/14; 1.5 from 2014/15 onwards	2 in 2013/14 and 2014/15; 1.9 in 2015/16 and 1.8 in 2016/17	
Sewage gas	0.5	0.5 Call for evidence	

Solar photovoltaic	2	2 in 2013/14 and 2014/15; 1.9 in 2015/16 and 1.8 in 2016/17	
Standard gasification	1	0.5 Call for evidence	Proposed change to definition and merger with standard pyrolysis to create a combined advanced ACT band as described in chapter 12
Standard pyrolysis	1	0.5 Call for evidence	Proposed change to definition and merger with standard gasification to create a combined advanced ACT band as described in chapter 12
Tidal impoundment (range) – tidal barrage (<1GW)	2	2 in 2013/14 and 2014/15; 1.9 in 2015/16 and 1.8 in 2016/17	
Tidal impoundment (range) – tidal lagoon (<1GW)	2	2 in 2013/14 and 2014/15; 1.9 in 2015/16 and 1.8 in 2016/17	
Tidal stream	2	5 up to a 30MW project cap. 2 above the cap.	
Wave	2	5 up to a 30MW project cap. 2 above the cap.	

2.9 For details of our proposals on grandfathering and grace periods, see chapters 18 and 19 respectively.

3. Onshore Wind

3.1 The UK has among the best wind resource in Europe. This is a free energy source where the costs reside only in the manufacture, construction and maintenance of the infrastructure. Even taking into account the intermittency of wind energy, onshore wind is one of the lowest-cost renewables technologies. Real cost reductions are expected over the next decade, ensuring that it remains one of the cheapest going forward.

3.2 At present over 4 GW of onshore wind capacity is installed in the UK, generating around 9TWh/y of electricity generation annually.[22] The current pipeline of deployment shows that over 11GW of capacity is currently under construction (1.9GW), awaiting construction (3.2GW) or in planning (6.6GW). Some 40% of the UK's wind capacity is found in Scotland, but Wales and Northern and Eastern England also have significant resource.

Costs and Deployment Potential

3.3 Arup's analysis concludes that onshore wind within the UK still has significant deployment potential. Utilising the best onshore wind sites, together with the repowering of existing sites with newer, more efficient turbines, could provide an increase from present levels to deliver up to 13GW[23] of capacity by 2020, depending on the financial support available and degree of success in overcoming non-financial barriers. Longer term expansion to 2030 will be limited by the availability of suitable sites.

3.4 Arup indicate that installations of less than 5MW installed capacity have the potential to deliver a more modest contribution of up to 550MW by 2020, depending on the financial support available and degree of success in overcoming non-financial barriers. Installations in the range of 50 kW to 5 MW in Great Britain are able to choose between the RO and FITs. This capacity could therefore potentially be incentivised by either support mechanism.[24]

3.5 Non-financial barriers represent the most significant constraints to deployment, and the associated costs can affect the viability of schemes. The actions being taken to address these are set out in the UK Renewable Energy Roadmap.

3.6 Arup found that capital costs vary depending on scale of technology with central costs of £1.5m per MW (range of £1.2-1.8m) for installations above 5 MW. Installations below 5MW were found to have only slightly more expensive capital

[22] At the average load factor from 1997 to 2010 of 26.6%.

[23] UK Renewable Energy Roadmap, DECC, July 2011, URN 11D/698. http://www.decc.gov.uk/en/content/cms/meeting_energy/renewable_ener/re_roadmap/re_roadmap.aspx

[24] Excluding the up to 42MW of <5MW onshore wind potential identified by Arup in Northern Ireland, which would not be eligible for small-scale FITs.

costs of £1.6m per MW (£1.2-1.9m).[25] As a relatively mature technology, Arup found that capital costs were not expected to fall very quickly, but by around 8% to 2020 and 12% to 2030. DECC's calculated levelised costs come down by around 9% over the period 2010 to 2030 for >5MW projects, and around 8% for <5MW projects.

RO support

3.7 As one of the most cost-effective and developed of all the renewable energy technologies, we recognise the continuing significance of onshore wind for achieving our renewable energy target. Support for wind through ROCs is based on generation, not capacity, in order to encourage efficient deployment. It is important that ROC rates keep pace with cost reductions, to ensure value for money and that only efficient and well-located capacity comes forward.

Consideration of the statutory factors

3.8 Costs and incomes (statutory factors (a), (b) and (c))

- Onshore wind currently receives 1 ROC per MWh. DECC's levelised costs, derived from the Arup figures, show a gradual drop in levelised costs of around 9% between now and 2030. Our costs and incomes analysis shows that the cost effectiveness of the technology continues to improve, and is moving towards a situation where subsidies may no longer be required in the longer term. This suggests that the ROC level could be reduced slightly without significantly adversely affecting deployment rates.

- For large onshore wind projects (>5MW) commissioning in 2014/15 the variation in cost levels across the UK points to a range of ROC levels. According to our assumed average load factors for each country based on historic data, a range of 0.6-1.6 ROCs is required for England and Wales, 0.3-1.2 ROCs for Scotland and 0-0.8 ROCs for Northern Ireland. We believe that setting support at 0.9 ROCs would bring on the most cost-effective part of the large onshore supply curve and incentivise the most efficient developments.[26]

- Small onshore wind (<5MW) has a ROC range of 0.6-1.8 ROCs/MWh required for projects commissioning in 2014/15. New small-scale wind installations in Great Britain are eligible for the FITs mechanism. It is not thought cost-effective to set the RO onshore wind band to bring on all the small-scale potential, as it would lead to over-compensation for large-scale projects. Higher support for small-scale wind under the RO is currently available in Northern Ireland. The Northern Ireland Executive will be publishing its proposals for RO bands in Northern Ireland.

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[25] Throughout this document, capital costs quoted exclude pre-development costs.
[26] This varies across the UK according to our assumed average load factors for each country based on historic regional load factor data, available at the bottom of this webpage: https://restats.decc.gov.uk/cms/historic-regional-statistics/#load_factors.

3.9 *The desirability of securing the long term growth, and economic viability, of the industries associated with this technology (statutory factor (d))*

- As indicated above, onshore wind is a mature technology with significant potential for further deployment and contribution towards renewable energy objectives. However, as a mature technology there is limited capacity to grow the UK supply chain. Though we are keen to maximise the economic growth potential of onshore wind, there does not appear to be a strong justification for giving extra RO support to onshore wind on the grounds of supporting the development of industries associated with the technology, over and above the 0.9 ROC support level proposed

3.10 *Consumer costs (statutory factor (e))*

- Lowering the band will reduce costs to consumers. RO support costs from new build under the RO during the banding review period 2013/14 to 2016/17 reach £250-280m per year at the current 1 ROC band from 2016/17 onwards, and £170-220m per year from 2016/17 onwards at the proposed 0.9 ROCs band.[27].

3.11 *Potential contribution to targets arising out of a Community Obligation (statutory factor (f))*

- The UK Renewable Energy Roadmap identified onshore wind as one of the renewable electricity generation technologies having the greatest potential to help us meet the UK's 2020 renewables target. According to our modelling, support at 0.9 ROCs would bring forward approximately 350-430MW less new build[28] across the banding review period than if we left the band at 1 ROC. The new build at 0.9 ROCs would contribute around 5.0-6.1 TWh of generation towards the 2020 target compared with 6.1-7 TWh from new build at 1 ROC.[29] For context, in 2020 it is thought that large-scale electricity should contribute around 108TWh/y of renewable energy towards the UK's 2020 renewables target.

- We therefore **propose to set the band for onshore wind at 0.9 ROCs/MWh** for new accreditations, and additional capacity added in the banding review period.

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[27] These cost estimates take into account different ROC bandings for generation from <5MW installations in Northern Ireland.

[28] The projected deployment under the RO during the banding review period of 2013-17 is 2.3-2.6GW under current bands, and 1.9-2.3GW under proposed bands. The upper ends of the ranges come from the Pöyry modelling, and the lower ends from DECC analysis of the impact of using the higher hurdle rates detailed in annex B. This is also true of the ranges for generation from new build and RO support costs. DECC analysis also indicates that using new fossil fuel prices and DECC central hurdle rates, deployment, generation and RO support costs would be at the top of these ranges.

[29] These deployment estimates take into account different ROC bandings for generation from <5MW installations in Northern Ireland. The ranges for capacity, generation and RO support costs come from assessing deployment at central and low hurdle rates assumptions.

Consultation Questions	
1.	**Do you agree with the Arup assessment of costs and deployment potential for onshore wind? Please explain your response with evidence.**
2.	**Do you agree with the proposed level of support of 0.9 ROCs/MWh for onshore wind? Please explain your response with evidence.**

4. Offshore Wind

4.1 Offshore wind generation has a critical role to play in delivering the UK's renewable energy targets, decarbonisation goals and security of supply needs. The UK has the largest potential wind energy resource in Europe and wind power is currently one of the more developed and scalable technologies available. While offshore wind is more technically challenging and more expensive than onshore wind, it has a larger overall resource potential, partly due to a stronger and more consistent wind resource further out to sea, leading to higher power outputs per turbine and more generation per hour.

4.2 Additionally, offshore wind farms in the future will be much bigger in overall capacity than existing ones and will utilise bigger turbines, thereby benefitting from economies of scale.

Cost and deployment potential

4.3 The last decade has seen offshore wind in the UK become an established technology, and the UK is now the global leader for offshore wind with an installed capacity of over 1.5GW. A further six offshore projects are under construction with a combined installed capacity of around 2GW, and the Crown Estate has awarded development rights for up to 32GW of new offshore wind generation under Round 3 of its leasing programme and around 4.5GW in Scottish Territorial Waters. The Ernst and Young Renewable Energy Attractiveness Indices also consistently rank the UK as No. 1 for offshore wind[30].

4.4 Arup's analysis indicates that offshore wind has significant potential for deployment to 2020 and beyond to 2030. They suggest that an installed capacity of up to 23.5GW is achievable by 2020, with potential for up to 52GW to be in place by 2030. This will depend on the financial support available, degree of success in overcoming non-financial barriers, as well as how quickly costs are driven down. The UK Renewable Energy Roadmap sets out the actions that Government will take with others to address challenges to deployment.

4.5 Arup's estimates reflect a financially-unconstrained picture, although we recognise that technology costs will also have a significant bearing on deployment rates. Arup's scenarios are broadly similar to recent deployment estimates published by RenewableUK[31] and the Crown Estate[32], although they envisage a slower build out rate reaching similar deployment levels by 2030 rather than by 2020.

4.6 Arup found that capital costs vary depending on scale of technology with costs of £2.3m-£3.2m for Round 2 and Scottish Territorial Waters installations above

[30] http://email-emeia.ey-vx.com/exchange-sites/732/5502/landing-pages/may2011-cai-issue-29-final.pdf
[31] http://www.bwea.com/pdf/offshore/offshore-wind_building-an-industry.pdf
[32] http://www.thecrownestate.co.uk/supply_chain_gap_analysis_2010.pdf

100MW. These cost variations are mainly due to supply chain constraints which have affected larger projects to a greater extent. Cost data supplied to Arup indicate capital costs for round 2 projects may fall considerably by 2020 (around 23-36%), depending on deployment levels, learning rates and supply chain developments; operating costs fall at the same rates as capital costs. Round 3 capital costs are estimated at above the round 2 figures, but may fall considerably from 2014 to 2030, perhaps by around 30-46%; operating costs falling at the same rate.[33] DECC's calculated levelised costs for Round 2 projects come down by around 46% over the period 2010 to 2030; and levelised costs for Round 3 projects come down by the same margin over the period 2015 to 2030.

RO Support

4.7 When banding was introduced on 1 April 2009, the Government originally set the RO support for new offshore wind at 1.5ROC/MWh. However, we recognised early on that the offshore wind generation costs to which the Secretary of State had regard in making that banding decision were significantly different from those seen in the market place. In summer 2009 we consulted on a new band for offshore wind, and implemented 2 ROCs/MWh for turbines first forming part of a generating station after 1 April 2010. In order to provide investors with a long enough lead time to build their wind farms, we committed to maintaining this band up to 31 March 2014, rather than 2013, with the ROC level reverting to 1.5 ROCs for turbines first forming part of a generating station after that date.

Consideration of the statutory factors

4.8 *<u>Costs and incomes (statutory factors (a), (b) and (c))</u>*

- The cost evidence now suggests that the ROC level required for investment varies along our assumed supply curves (see chapter 1), giving a range of 2.0-3.0 ROCs for projects commissioning in 2014/15 for Round 2 offshore wind.

- As deployment increases, costs are expected to fall. An operational start in 2015/16 requires a ROC range of 1.8-2.7, Whereas an operational start in 2016/17 results in a range of 1.6-2.5 ROCs. [34]

- According to the banding review analysis, offshore wind Round 3 projects are unlikely to be deployed under the RO. The earliest Round 3 projects are thought likely to have similar characteristics (in terms of distance from shore and water depth) to Round 2 projects, and hence similar costs.

- As set out in the UK Renewable Energy Roadmap, and with membership formally announced on 12 October 2011, we have set up a task force with industry with

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[33] These capital and operating cost profiles over time used for the Pöyry modelling and DECC in-house analysis assume steel prices remain constant. See Appendix A in the Arup report. Note the Pöyry modelling links offshore wind costs endogenously to cumulative offshore wind deployment.

[34] Note that these are based on falling costs that are themselves dependent on continuing UK deployment, as we are the global market leader and therefore able to drive down cost with higher levels of deployment.

the aim of driving down the costs of offshore wind significantly by 2020. If costs are driven down to £100/MWh or less, deployment of offshore wind could reach 18GW by 2020 at the same RO cost as that of 12GW at central cost assumptions from Arup. It should also be stressed that the UK is the current leader in offshore wind deployment and with its large potential is likely to be at the forefront of driving costs down in the next decade.

- The Government's Energy White Paper, published on 12 July 2011, sets out a new mechanism for supporting low carbon generation. Contracts for difference (CfDs) under the new mechanism will be the default mechanism for offshore wind generators seeking to commission post-31 March 2017. CfDs will be available as a choice alongside ROCs before then, but are expected to be set at a lower level of support than the RO due to the more certain revenue they provide. This should encourage the early movers to ramp up deployment prior to 2017, and also encourage industry as a whole to drive costs down over the longer term.

4.9 *<u>The desirability of securing the long term growth, and economic viability, of the industries associated with this technology (statutory factor (d))</u>*

- Supporting offshore wind deployment should help to encourage the development of the supply chain. For example, it may help to attract offshore wind turbine manufacturers to the UK. They may invest significant Foreign Direct Investment (FDI) to build manufacturing and R&D operations. These would bring spill-over benefits to the areas where they are located, and also additional jobs. To realise these benefits would require the offshore wind industry to continue to deploy at a significant rate through the banding review period and, according to the cost evidence, it would be difficult to reduce the banding any further and still achieve that deployment.

4.10 *<u>Consumer costs (statutory factor (e))</u>*

- RO support costs from new build under the RO during the banding review period 2013/14 to 2016/17 reach around £100m per year under the current ROC regime (2 ROCs/MWh until 31 March 2014, declining to 1.5 ROCs/MWh from 2014/15, when according to the analysis no further deployment would be expected). Under the proposed bands, RO support costs from new build under the RO reach around £230-290m per year from 2016/17 onwards. This extra cost is considered necessary to maintain deployment of offshore wind, as offshore wind will be required to meet the 2020 renewables target.

4.11 *<u>Potential contribution to targets arising out of a Community Obligation (statutory factor (f))</u>*

- The UK Renewable Energy Roadmap identified offshore wind as one of the renewable electricity generation technologies having the greatest potential to help us meet the UK's 2020 renewables target. We believe that offshore wind is the most expensive technology that we must deploy at scale in order to have a credible path to 30% of our electricity coming from large-scale renewable generation. Therefore, in this consultation document offshore wind is described as <u>the marginal technology</u> for meeting the UK's 2020 renewables target.

- The Pöyry modelling shows that 2.8-3.6TWh/y[35] of generation from new build towards the 2020 renewables target would come on over the banding review period under the bands proposed below compared with 1.7TWh/y under the current ROC regime for offshore wind. Some of this new build is already in construction. For context, in 2020 it is thought that large-scale electricity should contribute around 108TWh/y of renewable energy towards the UK's 2020 renewables target.

4.12 Our modelling indicates that the bands proposed below are sufficient to incentivise the cheapest part of the offshore wind supply curve, which is the part necessary to meet our 2020 targets.

4.13 We therefore **propose to set the band for offshore wind at 2 ROCs/MWh** for new accreditations (and additional capacity added) **in 2014/15**. **As we aim to drive down costs of offshore wind, and encourage early movers, we propose to bring support levels down to 1.9 ROCs for generating stations accrediting (and additional capacity added) during 2015/16, and to 1.8 ROCs for generating stations accrediting (and additional capacity added) during 2016/17**. This should incentivise cost reductions in offshore wind and support the most cost effective developments.

4.14 We will **maintain our policy of allowing phasing for offshore wind generating stations**. This means that the relevant band applicable at the time of accreditation of the generating station shall apply to all subsequent phases of turbines forming part of the capacity of the generating station as accredited. This would apply even if offshore wind has been banded up or down since the date of accreditation, in line with our grandfathering policy. Each phase will be eligible for a maximum of 20 years support, subject to registration of the phase before 1 April 2017 and the 2037 end date of the RO.

Consultation Questions	
3.	**Do you agree with the Arup assessment of costs and deployment potential for offshore wind? Please explain your response with evidence.**
4.	**Do you agree with the proposed level of support of 2 ROCs/MWh for offshore wind, stepping down to 1.9 ROCs in 2015/16 and 1.8 ROCs in 2016/17? Please explain your response with evidence.**

[35] Generation from new build capacity during the banding review period, 2013-17, of 0.9-1.1GW under proposed bands and 0.5GW under current bands (dropping to 1.5 ROCs/MWh). The projected deployment under the RO during the banding review period of 2013-17 is 2.3-2.6GW under current bands, and 1.9-2.3GW under proposed bands. The upper ends of the ranges come from the Pöyry modelling, and the lower ends from DECC analysis of the impact of using the higher hurdle rates detailed in annex B. This is also true of the ranges for generation from new build and RO support costs. DECC analysis also indicates that using new fossil fuel prices and DECC central hurdle rates, deployment, generation and RO support costs would be at the top of these ranges.

5. Hydro-electricity

5.1 Hydro-electricity generation is a well-established technology in the UK. Currently about 1.3% of UK electricity is generated from hydroelectric schemes, most of which are large-scale schemes in the Scottish Highlands. Hydroelectric energy uses proven and efficient technology with the most modern plants having energy conversion efficiencies of 90 percent and above.

Cost and deployment potential

5.2 Arup's analysis focused on the potential for further deployment of both medium/large-scale (>5MW) and small-scale (<5MW) hydro-electric generation. They concluded that the majority of suitable sites for medium and large-scale projects have already been developed and that the remaining exploitable resource is very small, some 30-40MW remaining from a maximum feasible resource of 1.5GW. In contrast, Arup suggests that a large increase in small hydro-electricity deployment (of <5MW size) is possible, up to around 500MW by 2020 and 1GW by 2030.

5.3 Arup found that current capital costs vary from very high (£2.6-9.5m/MW per MW installed) in small-scale plants, i.e. <5MW, to relatively low (£1.4-2.9m per MW) in large scale plants, i.e. >5MW. This is mainly due to economies of scale in large plant, although the up-front costs of grid connection are a significant proportion of capital costs for small-scale plant. Levelised costs for both scales of plant are relatively flat from 2010 to 2030 using Arup's central cost projection scenario. Installations in Great Britain in the range of 50 kW to 5 MW are able to choose between the RO and FITs. Therefore, this capacity could potentially be incentivised by either support mechanism (excluding up to 60MW of potential in Northern Ireland which is ineligible for GB small-scale FITs).

RO Support

5.4 At present, hydro-electric power generation (but not pumped storage) receives 1 ROC per MWh.

Consideration of the statutory factors

5.5 *Costs and incomes (statutory factors (a), (b) and (c))*

- Our analysis suggests a ROC range of 0-0.5 ROCs, which indicates that all remaining medium/large scale potential could be built at 0.5 ROCs during the banding review period. The cost evidence for medium/large-scale (>5MW) developments commissioning in 2014/15 suggests an upper end of 0.5 ROCs. We therefore believe that setting support at the top end of this range, i.e. 0.5 ROCs, from 2013 represents the most cost effective way of incentivising the remaining medium/large-scale hydro-electricity potential on the supply curve. This cut in the band from 1ROC/MWh would not appear to have a significant effect on large scale hydro deployment.

- Cost evidence for small-scale (<5MW) hydro power suggest a ROC range of 0.2-5.3 is required. As small-scale hydro is eligible for the small-scale Feed-In Tariff (FIT), we do not believe that it is necessary to create a separate band for small scale hydro under the RO. Higher support for small-scale hydro is available in Northern Ireland under the RO. The Northern Ireland Executive will be publishing its proposals for RO bands in Northern Ireland.

5.6 *The desirability of securing the long term growth, and economic viability, of the industries associated with this technology (statutory factor (d))*

- The deployment of a small additional amount of large-scale hydro is not expected to lead to significant industrial development.

5.7 *Consumer costs (statutory factor (e))*

- Support costs from new build under the RO during the banding review period 2013/14 to 2016/17 are around £4.3m per year from 2016/17 onwards under the current 1 ROC band and around £2.8m per year from 2016/17 onwards at the proposed 0.5 ROC banding.[36]

5.8 *Potential contribution to targets arising out of a Community Obligation (statutory factor (f))*

- Hydro-electricity has a role to play in meeting the UK's 2020 renewables target. However, it is not among the technologies focused upon in the UK Renewable Energy Roadmap because other technologies have significantly greater remaining deployment potential. Around 32MW, i.e. all the available large-scale potential (and 4MW of <5MW hydro generation in Northern Ireland) under the Arup high scenario is built under both the current bands, i.e. 15MW before the banding review period and 21MW during. Under the proposed bands, all, or nearly all of this capacity is expected to come forward, i.e. 21MW during the banding review period.. The new build capacity during the banding review period), is estimated to deliver an additional 0.08TWh per year towards the 2020 renewables target.[37] For context, in 2020 it is thought that large-scale electricity should contribute around 108TWh/y of renewable energy towards the UK's 2020 renewables target.

5.9 We therefore **propose to set the band for hydro-electricity at 0.5 ROCs** for new accreditations (and additional capacity added) in the banding review period (1 April 2013 to 31 March 2017).

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[36] These cost estimates take into account different ROC bandings for generation from <5MW installations in Northern Ireland.

[37] These deployment estimates take into account different ROC bandings for generation from <5MW installations in Northern Ireland. Moving to the DECC central hurdle rates and new fossil fuel price assumptions would not change the level of deployment according to DECC's in-house analysis.

Consultation Questions	
5.	**Do you agree with the Arup assessment of costs and deployment potential for hydro-electricity? Please explain your response with evidence.**
6.	**Do you agree with the proposed level of support of 0.5 ROCs/MWh for hydro-electricity? Please explain your response with evidence.**

6. Marine Technologies

Wave and Tidal Stream

6.1 Marine energy can be generated from wave power, tidal stream or from tidal range. Tidal Range technologies (see paragraph 6.21 and following below) are considered to be 'mature' whilst wave and tidal stream technologies are at an early stage of development, but all are considered to offer the potential for bulk electricity generation. Around 4MW of single wave and tidal stream prototypes are currently being tested in the UK and a variety of sources suggest there is a wide range of possible wave and tidal stream deployment scenarios beyond 2020[38].The levels of deployment forecast in these referenced studies are dependent on a number of factors. These include the success of the marine technology development in reducing cost, the economics of the alternatives and the assumptions made on the sector's ability to overcome potential financial, technical and other barriers to deployment.

6.2 The UK Renewable Energy Roadmap estimates that, in "central range" modelling, small pre-commercial wave and tidal stream array demonstrations will be carried out between 2013 and 2015. Commercial-scale deployment is then expected to increase through the second half of the decade, reaching in the order of 200-300MW by 2020. DECC 2050 Pathways analysis suggests that deployment could range from a negligible level (in a worst case scenario) up to, at the higher end of the range, around 27GW by 2050[39]. Overall, the potential opportunities presented by this marine resource has led to the UK becoming a focus globally for the development and deployment of wave and tidal stream technologies.

6.3 The wave and tidal stream sector is currently reaching a critical stage of development. The challenge for the sector is to move from a research and development focus towards, initially, demonstration of small arrays (in the range of 5-10MW) and subsequently commercial-scale deployment in the period to 2020. As part of this process, the sector will need to prove that its technology will operate on a commercial basis in arrays and demonstrate that it can reduce costs of generation sufficiently to make the technology cost-effective in the longer term (with respect to other forms of renewable generation). So, given the developing nature of wave and tidal stream technologies, we anticipate their contribution to our 2020 renewables target will be relatively limited in comparison to the deployment of other renewable energy technologies.

6.4 The Government recognises the potential of marine energy and is committed to harnessing the benefits which a successful marine renewables sector could bring to

[38] DECC 2050 Pathways, 2010: 0-27GW (Scenarios 1-3, Scenario 4 not included); PIRC/Offshore Valuation Report, 2010: 4-35GW; DECC/Scottish Government, Cost of and financial support for wave, tidal stream and tidal range generation in the UK (Ernst & Young/Black & Veatch), 2010: 8.9-43.1GW; Unpublished DECC analysis, 2011: 0-27GW.
[39] 2050 Pathways Analysis, DECC, July 2010, URN10D/764

the UK. This commitment is acknowledged by marine energy being an explicit part of the Coalition Agreement which states: “We will introduce measures to encourage marine energy”.

6.5 This RO banding review is specifically set for the deployment from 2013 to 2017 and on the basis of the sector’s current progress we are expecting some important deployments to happen during this time in order to prove the sector’s viability. However, beyond 2017, it is the intention that marine technologies will continue to be supported via the proposed FiT with CfD support mechanism which we are introducing under Electricity Market Reform, which should provide greater clarity and long-term vision for investors.

6.6 To date, UK Government support for wave and tidal stream technologies has mainly been in the form of grants, with over £100m of funding to date from UK Government and Devolved Administrations. This has reflected the early stage of development of wave and tidal stream technologies and the potential for their future deployment. However, DECC’s £22m Marine Renewables Proving Fund has taken six of the leading device developers to a point where they are ready to test full-scale prototypes in the marine environment. Full-scale prototypes need to be deployed in small arrays before moving to commercial-scale, however, this route to commercialisation is very expensive and risky to those developing devices. It is only recently, with the development of promising near-megawatt scale devices, that major industrial players have begun to invest in the sector. Whilst larger investors are taking more interest, financial modelling carried out by DECC has shown that the first demonstration arrays (ranging in size from 5 to 10MW) will require both grant and market instrument support to generate the internal rates of return which will be necessary to justify investment from funding partners such as utilities and large industrial organisations[40].

6.7 To continue to attract investment in these technologies, our commitment to the wave and tidal industry was reaffirmed in June this year when we announced £20m of grant funding to support the deployment of pre-commercial array demonstrations in the UK (subject to satisfactory value for money assessment). Further grant funding for innovation in wave and tidal is planned by other delivery bodies such as the Energy Technologies Institute, the Technology Strategy Board and by Devolved Administrations, such as the Scottish Executive.

Wave and tidal stream costs and deployment potential

6.8 Due to the nascent stage of this emerging sector, there is a variation between results obtained through modelling of deployment using different methodologies. Therefore, the modelling and calculations which underpin the RO cost and deployment data are based on a number of assumptions and parameters including resource, learning rates and the timing of technology availability.

[40] Ernst & Young and Black & Veatch, September 2010 Cost of and financial support for wave, tidal stream and tidal range generation in the UK – a report for DECC and the Scottish Government

6.9 For wave energy, the Arup report suggests that we could see up to around 280MW of installed cumulative capacity by 2020 under a high build scenario, which increases rapidly to 2.5GW by 2030.

6.10 For tidal stream, the Arup report suggests that we could see up to around 400MW of installed capacity by 2020 under a high build scenario, ramping up to 2.2GW by 2030. These are maximum build levels, and achieving them would require high levels of financial support.

6.11 As well as financial support, deployment for both wave and tidal stream will depend critically on their technological development, financial support available, degree of success in overcoming non-financial barriers, and how quickly costs are driven down. Capital costs for demonstration-stage wave devices are estimated to be in the range of £3.9m and £5.6m/MW, whilst the capital costs for demonstration-stage tidal stream (shallow) devices range between £3.0m and £4.6m/MW[41]. However, costs are expected to reduce dramatically as the first deployments of arrays come forward, with learning rates of 10% to 15%. These cost estimates above refer to early production devices which will be deployed in the period to 2020 (as such they will not necessarily include a full apportionment of initial prototype development cost).

6.12 The banding review analysis has used Arup (2011) deployment potential assumptions for all technologies. In the case of marine technologies, Arup based these on Ernst & Young (2010). Arup assumed that up to 7MW of tidal steam and 6MW of wave could be deployed in 2013/14; 28MW of tidal stream and 12 MW of wave in 2014/15; and 44 MW of tidal stream and 26MW of wave in 2014/15.[42] This makes a total of up to 126MW over the banding review period. This represents the high case, where significant progress is made in overcoming non-financial barriers to deployment such as technology readiness, supply chain planning and grid, and does not take into account financial constraints. The Pöyry modelling which assumes that capital grants are available to wave and tidal stream demonstration projects in addition to ROC funding as long as state aid limits are not breached, uses the Arup build rates constraints. With the proposed banding of 5 ROCs/MWh for both technologies, in the Pöyry modelling there is 52MW of deployment over the banding review period.

6.13 In-house DECC analysis of marine projects currently in the pipeline suggests that up to 160MW of wave and tidal generation could be deployed by 2017, before considering non-financial barriers to deployment that could reduce deployment potential. Deployment of around 50-150MW during the banding period should enable developers to demonstrate viability of the technology at commercial scale, and pave the way for cost reduction which will allow them to compete with other low carbon technologies in the future.

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[41] The generation costs for the banding review analysis come from the Ernst & Young (2010) report. That report produced low, medium and high costs at low, medium and high resource types for wave, tidal stream shallow and tidal stream deep, i.e. nine configurations for each technology. The report presents low, medium and high capex and opex for the medium resource type, but the levelised costs in the report are based on a weighted average of resource types according to where deployment is assumed to occur. It is the costs of this weighted average of resource types that are quoted here and which were used in the Banding Review analysis.

[42] Arup deployment data provided in calendar year form; adjustment to financial years by DECC/Pöyry.

RO support wave and tidal stream

Consideration of the statutory factors

6.14 *Costs and incomes (statutory factors (a), (b) and (c))*

- The modelling that underpins the cost calculations is based on cost projections from an early stage of the technology's development and therefore are inherently uncertain. The ranges in cost below only reflect the uncertainty in capex, but uncertainty also exists in opex and load factors.

- The cost evidence suggests there is a need for ROC levels above 2 ROCs/MWh for these nascent technologies. Without grants, wave demonstration projects at central costs currently require 8.4 ROCs (7.1 – 9.7) and tidal stream demonstration projects require 5.5 ROCs (4.6 – 6.6). However, even in combination initially with grants, for example set at 25% (which is considered to be a likely level for near-commercial demonstration projects under the R&D State Aid guidelines), DECC analysis suggests that wave demonstration projects at central costs would need 6.6 ROCs/MWh (5.6-7.5); and for tidal stream demonstration projects at central costs, it suggests they would need 4.2 ROCs/MWh (3.6-5.1). It should also be noted that not all marine projects will be successful in gaining grant funding, and this will be determined by individual applications and budget availability.

- Any support above 2 ROCs, marks a significant change for the RO in England & Wales, and moves us away from supporting only the most marginal technology needed to meet our 2020 renewables target. As explained above in the offshore wind section of this consultation document, offshore wind is considered to be the most expensive technology required on a large scale to meet our 2020 renewables target. Therefore, in the context of meeting the 2020 renewables target, it would not be value for money to provide a higher level of support to any other technology for the purposes of meeting that target. There may however be other reasons for setting a higher level of support, as described below.

6.15 *The desirability of securing the long term growth, and economic viability, of the industries associated with this technology (statutory factor (d))*.

- Marine energy is identified in the UK Renewable Energy Roadmap as one of the technologies which have "either the greatest potential to help the UK meet the 2020 renewables target in a cost effective and sustainable way, or offer great potential for the decades that follow". As one of the few renewable energy technologies which offer the potential for new bulk electricity generation in the period beyond 2020, the Government considers it worthwhile to maintain investment in marine energy as a 'hedge' against underperformance of other forms of generation out to 2050.

- The UK has a global lead in wave and tidal stream technology development. As technology price makers the levels of deployment in the UK will be directly related to our ability to drive down the cost of generation. Wave and tidal stream technologies provide the UK with a unique opportunity to develop an indigenous industry which has the potential to secure significant inward investment, drive an export market and create economic growth. According to the Blue Map scenarios from the IEA *Energy Technology Perspectives 2010*, the global wave market could be particularly large, into the multi-GWs of new capacity per year in the 2030s and 2040s. Recent figures published by RenewableUK[43] suggest that by 2035 the marine energy industry in the UK could employ 19,500 people, bring an annual value of £6.1bn (Gross Value Added (GVA) approximately £800m) and support a UK share of the UK domestic market of 71% and a global export market share of 14%. The PIRC Offshore Valuation Report[44] estimated that domestic market size in 2050 could be 36GW.

6.16 <u>Consumer costs (statutory factor (e))</u>

- RO support costs from new build of wave devices under the RO during the banding review period 2013/14 to 2016/17 are estimated to reach around £9m per year from 2016/17 onwards under current bands; and would reach around £10m per year under the bands proposed below.

- RO support costs from new build of tidal stream under the RO during the banding review period 2013/14 to 2016/17 are estimated to reach around £13m per year from 2016/17 onwards under current bands, and would reach around £26m per year under the bands proposed below.

- Greater consumer costs will be incurred if greater volumes of deployment occur whilst costs are still relatively high, although our analysis suggests relatively modest levels of deployment during the banding period. If generation costs do come down dramatically, wave and tidal stream technologies may be a cost-effective part of the future decarbonised power sector mix.

- It should also be noted that there are potential beneficial balancing cost implications to consumers from a significant contribution from marine energy within a high renewables generation mix. This is particularly true for tidal stream because tidal is predictable, and with phasing of generation around the coast it can contribute towards baseload generation. Wave although intermittent is predictable over much longer timescales than wind.

- Ultimately the costs for the RO are borne by the consumer, and we must ensure that the RO is set at a level that provides value for money. Given that marine technologies are still yet to deploy at commercial scale in the UK, the value for money case for supporting them is based not just on their contribution to the 2020 target, but also in helping drive down their deployment costs so that they can make a viable contribution to our wider 2050 decarbonisation targets.

[43] Channelling the Energy: A Way forward for the UK Wave & tidal Industry Towards 2020. Renewable UK, October 2020
[44] The Offshore Valuation Report. Public Interest Research Centre, 2010

- We would like to see the wave and tidal stream industry rapidly moving from their current single device prototype tests through the small scale deployment of demonstration arrays to full commercialisation, and to enable that we recognise that some additional support may be needed to achieve this.

6.17 Potential contribution to targets arising out of a Community Obligation (statutory factor (f))

- For context, in 2020 it is thought that large-scale electricity should contribute around 108TWh/y of renewable energy towards the UK's 2020 renewables target.

- The current bands for wave and tidal stream in England & Wales (2 ROCs/MWh for wave and tidal stream) are not expected to lead to any deployment, but some deployment is expected in Scotland under the higher current bands there (5 ROCs/MWh for wave and 3 ROCs/MWh for tidal stream). The modelling assumes that grants are available for early marine projects and set not to exceed State Aid limits. As a result, at these current bands the modelling shows 17MW of new wave build coming on over the banding review period, generating 0.05TWh per year of electricity towards the 2020 renewables target. For tidal stream, the modelling shows 27MW of new build generating 0.10TWh per year of electricity towards the 2020 renewables target. Under the proposed bands of 5 ROCs/MWh for each project of up to a limit of 30MW, there is a little more wave deployment outside of Scotland, bringing the total wave deployment to 19MW, and more tidal stream across the UK bringing the total tidal stream deployment to 33MW over the banding review period. This new capacity would generate around 0.05TWh/y (wave) and 0.13TWh/y (tidal stream) generation towards the 2020 renewables target.

- In the UK Renewable Energy Roadmap we provided a central range of deployment potential for marine renewables which suggests that between 200-300MW could be deployed by 2020. The Roadmap also estimated that a range of 60-108 MW might be deployed in the banding period to 2017. More recent analysis of marine projects currently in the pipeline indicates that up to 160MW of wave and tidal generation could be deployed by 2017. This level of deployment during the banding period should enable developers to demonstrate viability of the technology at commercial scale, and allow them to reduce costs and subsidy needs, as other technologies have.

6.18 In order to prove the technology at such a scale, we recognise the need to provide an enhanced level of support for the initial demonstration arrays. **Our banding proposal is therefore to provide 5ROCs/MWh for both wave and tidal stream for each project of up to a limit of 30MW**. **This enhanced level of support will only be available for capacity installed and operational prior to 1 April 2017**. We anticipate that support for what we consider the highest likely level of deployment at 160MW of marine projects at 5 ROCs would cost approximately £1.5 billion (real, discounted) over the life of the projects supported.

6.19 Once the technology is proven and reaches commercial deployment levels, we expect costs to decrease, and we will be able to reduce the level of support for new build, as we are proposing to do with onshore and offshore wind. **For this reason we propose that any additional capacity on a project accredited in the period in excess of 30MW should be supported at 2 ROCs**.

6.20 In order to ensure value for money to the consumer as well as enabling demonstration arrays to proceed as we move towards commercial-scale deployment, we will also keep deployment levels under review. The normal conditions for reviewing any band or level of support (including unexpected changes in costs or deployment rates) would continue to apply.

6.21 We believe this approach will help us to achieve the acceleration that the sector requires in order to deploy the pre-commercial arrays that are necessary for its continued growth. At the same time, the 30MW project cap provides a protection to the consumer which limits the additional costs of supporting these technologies.

Consultation Questions	
7.	**Do you agree with the analysis on wave and tidal stream by Arup (2011) and their primary source Ernst & Young (2010)? Please explain your response with evidence.**
8.	**Do you agree with the proposed level of support of 5 ROCs/MWh for each project up to a limit of 30MW for wave and tidal stream (and 2 ROCs/MWh above that limit)? Please explain your response with evidence.**
9.	**Do you agree that 30MW is an appropriate level for the project cap? Please explain your response with evidence.**
10.	**Do you agree that the proposed level of support will help to drive deployment for the pre-commercial and early commercial deployment phases? Please explain your response with evidence.**

Tidal Range

6.22 Tidal range technologies are considered to be mature and some large scale tidal range barrages have been constructed, notably the facility at La Rance in Brittany, which has been operating since the mid-1960s. Although the generation technologies which are used within such a barrage are relatively conventional (e.g. bulb turbines) the large investment costs related to the civil engineering works required in building a barrage have hampered investment in projects. There are no tidal range schemes in the UK at present but several projects are under consideration including projects in the Severn, Mersey, Wyre, Duddon and Solway. However, these are still at a planning stage and are not expected to be in operation by 2017.

Tidal Range costs and deployment potential

6.23 The UK has one of the best tidal range resources in the world. Various studies have estimated the UK's theoretical tidal range resource at between 25 and 30GW – enough to supply around 12-15% of current electricity demand. The majority of this is in the Severn estuary (8-12GW), with the estuaries and bays of the North West (Solway, Mersey, Dee etc.) and north Wales representing a similar amount, and the east coast (Humber, Wash, Thames) contributing a further 5-6GW. Work we have done for the 2050 Pathways project, which is based on actual proposals that are being considered rather than theoretical resource, give four possible deployment levels: Level 1 – 0GW; Level 2 – 1.2-1.7GW; Level 3 – 13GW; and Level 4 – 20GW.

6.24 Tidal range faces barriers to deployment largely related to the construction costs and environmental effects. A number of tidal range projects are currently being worked up by developers for deployment in the UK. Because of the significant proportion of up-front capital costs of tidal range developments and the long lead times of such projects no deployment is currently expected by 2020, but up to 1000MW (excluding the Severn) is possible by 2030. Deployment will depend on the financial support available and the degree of success in overcoming non-financial barriers.

6.25 There are currently two bands for tidal range in the RO legislation. These are "tidal impoundment – tidal barrage" and "tidal impoundment – tidal lagoon". In this chapter, the term "tidal range" is used to refer to both of these technologies.

6.26 Arup's view was that Ernst & Young (2010) should provide the best estimates of UK tidal range costs, not including Severn Tidal Power. The analysis for that report produced low, medium and high cost estimates for 'low resource' and 'medium resource' tidal range sites, and a weighted average of the two resource types gives the following costs: £2.8m/MW (£2.0-3.5m) capex (including pre-development); and £37,000 per MW per year (£28,000-47,000) opex. Using this data, levelised costs for tidal range were calculated of around £275/MWh (£206-340/MWh) and these are projected to remain flat in real terms into the future.

RO support for tidal range

6.27 As noted above, we do not anticipate that any commercial-scale tidal range deployment will come on stream before 2020, and costs are therefore highly uncertain.

Consideration of the statutory factors

6.28 Costs and incomes (statutory factors (a), (b) and (c))

- Cost evidence from Ernst & Young (2010), suggests the need for ROC levels at 4-9 ROCs/MWh to get deployment, with little prospect of significant reductions in cost.

6.29 The desirability of securing the long term growth, and economic viability, of the industries associated with this technology (statutory factor (d))

- It is not thought likely that deployment of a mature tidal range technology in the UK would have a significant impact on the long term growth and economic viability of these industries, although the construction of a large Severn Tidal Power project would have a more material effect than the smaller schemes considered.

6.30 *Consumer costs (statutory factor (e))*

- Support costs from new build under the RO during the banding review period 2013/14 to 2016/17 are projected to be zero, as no deployment is projected. However, as noted below, there may be some limited deployment at minimal absolute cost of prototype novel tidal range technologies.

6.31 *Potential contribution to targets arising out of a Community Obligation (statutory factor (f))*

- Ernst & Young (2010) identified 1GW of reasonably-developed potential tidal range projects in the UK (excluding the Severn Estuary). However, none of these projects were expected to be able to begin operation by 2020 and so would not be expected to contribute to the UK's 2020 renewables target.

6.32 However, it is possible that smaller, prototype tests of novel tidal range technologies could be deployed in that timescale, particularly where demonstrating novel tidal range technologies with less environmental impact. Any such deployment would be at small scale (in comparison to a commercial tidal range facility), perhaps at the 10-50MW level. In view of this possibility, we **propose to retain the current tidal range banding levels of 2 ROCs/MWh for generating stations of less than 1 gigawatt** in line with the level of support proposed to ensure deployment of the marginal technology for meeting the UK's 2020 renewables target (offshore wind). The band **would step down to 1.9 ROCs for new accreditations, and additional capacity added, in 2015/16 and to 1.8 ROCs for new accreditations, and additional capacity added, in 2016/17**, in line with the falls in the banding levels proposed for offshore wind.

Consultation Questions	
11.	**Do you agree with the analysis on tidal range by Arup (2011) and their primary source Ernst & Young (2010)? Please explain your response with evidence.**
12.	**Do you agree with the proposed level of support of 2 ROCs/MWh for tidal range, stepping down to 1.9 ROCs in 2015/16 and 1.8 ROCs in 2016/17? Please explain your response with evidence.**

7. Geothermal and Geopressure

7.1 The UK deep geothermal power sector remains at an embryonic stage, though globally it is expanding rapidly. There is one existing UK geothermal plant, a heat-only station in Southampton. The technical potential for power generation from geothermal in the UK is projected, by the 2050 Pathways project, to be several GW by that date, depending on level of effort. This could amount to 10% of baseload in the extreme case.

Cost and Deployment Potential

7.2 Arup's assessment estimated that geothermal power could deploy up to 480MW by 2020 and 4GW of installed capacity by 2030, assuming the high maximum build rates for each year, However, they indicated that this would depend on successful demonstrations of geothermal electricity generation in the UK, with two or three of the currently planned schemes needing to be in operation by 2015 and a strong market for heat being in place. The medium and low scenarios of maximum build rates are considerable lower. As with the other technologies, Arup's low, medium and high scenarios represent maximum levels of deployment at different levels of success in overcoming non-financial barriers. Deployment will also depend on the degree of financial support.

7.3 The costs of deep geothermal energy are dominated by drilling costs, with a high level of risk exacerbating costs of finance. Uncertainty over quantifying the risk of first borehole failure, coupled with high capital costs, has made it difficult for UK deep geothermal projects to find investors. Arup's analysis shows that capital costs (real) are very high per MW installed, around £2.7-7.7m per MW power-only and £3.0-8.4m per MW CHP, but that these reduce substantially (by around 27-35%) over the period to 2030 as the industry becomes more established in the UK.[45] DECC's levelised costs indicate that costs in the high scenario would reduce by almost as much as 60% between 2010 and 2030. Arup suggest that operating costs would remain flat over the same period.

7.4 Arup also examined the deployment potential of geopressure power generation as part of their analysis. They found little evidence of activity and investment in this technology in the UK, and received no information on generation costs, or future development potential.

RO Support

7.5 At present, geothermal power is eligible for 2 ROCs/MWh and geopressure is eligible for 1 ROC/MWh.

[45] The capital and operating cost profiles over time assume steel prices remain constant. See Appendix A in the Arup report.

Consideration of the statutory factors

7.6 *Costs and incomes (statutory factors (a), (b) and (c))*

- In responding to the Arup cost data collection exercise, geothermal developers suggested that their post tax hurdle rates are 15% to 25%, which is well above what we would normally expect the RO to provide.

- We understand that a number of generators have argued that a high level of support would be needed for a limited period of time, reducing rapidly thereafter. This would seem to reflect the cost profile outlined above, with high capital costs now reducing substantially over time.

- The cost evidence for geothermal power generation suggests a ROC range of 1.9-7.3 ROCs required for power-only projects commissioning in 2014/15, and 0-5.8 for CHP projects. The assumed value of heat generation (avoided cost of generation or revenue from selling steam) is higher than Arup's extra capital costs of fitting CHP. The required ROC ranges for both power-only and CHP are high due to the large variability of possible capital costs. Although the evidence gathered by Arup suggests that geothermal electricity may have significant deployment potential at lower costs in the future, but this is highly uncertain.

7.7 *The desirability of securing the long term growth, and economic viability, of the industries associated with this technology (statutory factor (d))*

- There would be some investment and job creation associated with the deployment of geothermal in the UK, but as other countries have led the development of the technology thus far, we consider it unlikely that pursuing geothermal technology in the short to medium term would have any significant impact on the industries associated with this technology.

7.8 *Consumer costs (statutory factor (e))*

- RO support costs (which fall ultimately to consumers) from 14.6-15.3MW's of modelled geothermal new build[46] under the RO during the banding review period 2013/14 to 2016/17 are projected to reach £6.1-6.6m per year from 2016/17 onwards at current bands, and £5.9-6.4m per year under the proposed bands.

7.9 *Potential contribution to targets arising out of a Community Obligation (statutory factor (f))*

[46] The range of modelled new capacity under the RO during the banding review period, and generation and support costs relating to that capacity, show a range according to whether the central or low assumed hurdle rates are used. The upper ends of the ranges come from the Pöyry modelling, and the lower ends from DECC analysis of the impact of using the higher hurdle rates detailed in annex B. This is also true of the ranges for generation from new build and RO support costs. DECC analysis also indicates that using new fossil fuel prices and DECC central hurdle rates, deployment, generation and RO support costs would be at the top of these ranges.

- Power generation from new build geothermal during the banding review period contributes around 0.177-0.122TWh per year to the 2020 renewables target at both current and proposed ROC bands. For context, in 2020 it is thought that large-scale electricity should contribute around 108TWh/y of renewable energy towards the UK's 2020 renewables target.

- As set out in the UK Renewable Energy Roadmap, the Government's priority is to tackle the barriers to deployment for the renewable technologies that can make the largest contributions to meeting our future renewable energy targets, though the remaining technologies will also make a contribution to meeting the 2020 target. In setting ROC levels that offer energy consumers value for money, we must take account of the relatively modest size of the contribution geothermal can make by 2020, but also its longer term potential to contribute to the decarbonisation of our energy system. In the case of geothermal energy we also note the relatively fast reduction in costs expected by 2020.

7.10 By setting RO support for the more expensive technologies in line with the RO support for the marginal technology for meeting our 2020 renewables target (offshore wind) we aim to ensure that we are not paying more than is necessary to meet that target. We therefore **propose to set geothermal support at the same level as offshore wind** which may nevertheless help to incentivise some deployment during the banding review period 2013-17. As a result, **geothermal would receive 2 ROCs until 31 March 2015 stepping down to 1.9 ROCs for generating stations accrediting (and additional capacity added) between April 2015 and March 2016 and 1.8 ROCs for generating stations accrediting (and additional capacity added) in 2016/17**.

7.11 There is currently no evidence to suggest that there will be any electricity deployment from geopressure during the banding review period. We have no basis on which to change the level of support currently available to geopressure under the RO, i.e. **1 ROC, and propose to retain it at this level**.

Consultation Questions	
13.	**Do you agree with the Arup assessment of costs and deployment potential for geothermal and geopressure? Please explain your response with evidence.**
14.	**Do you agree with the proposed level of support of 2 ROCs/MWh for geothermal, stepping down to 1.9 ROCs in 2015/16 and 1.8 ROCs in 2016/17? Please explain your response with evidence.**
15.	**Do you agree with the proposed level of support of 1 ROC/MWh for geopressure? Please explain your response with evidence.**

8. Solar PV

8.1 Solar PV is a renewable technology that can be deployed at or near the point of demand and can therefore avoid the costs of the transmission network. We currently support solar PV at 2 ROCs/MWh within the RO, although we recognise that it has not been sufficient to date to bring on significant amounts of solar PV at large scale. Installations in the range of 50kW to 5MW are able to choose between the RO and FITs (with installations below 50kW eligible only for FITs). Since its establishment in April 2010, the FITs scheme has been the main policy for support of solar PV overall.

8.2 Given the current high costs of solar PV per unit of energy generated relative to other renewable electricity technologies, we have not so far concentrated our efforts on removing non-financial barriers to deployment. However, deployment is straightforward in comparison to many renewable energy technologies which means that cost is the most significant barrier.

Cost and Deployment potential

8.3 The Arup data suggests that we could see deployment of between 4.9 and 5.7 GW of solar PV capacity by 2020 in a financially unconstrained scenario. This relatively small range reflects the lower impact of non-financial barriers to deployment of this technology.

8.4 However, the Arup data suggest that solar PV is substantially more expensive than offshore wind at the moment, with capital costs for installations below 50kW ranging from £2.7 million to £5.1 million per MW installed and capital costs for installations above 50kW in the range £1.9 million to £3.7 million.

8.5 We are aware that solar PV costs have been declining, and certain industry representatives have indicated that there are still significant cost reductions that could be achieved over the Banding Review period, together with a very high deployment potential through to 2030, with figures of up to 1GW deployed per annum being suggested. This is reflected in DECC's calculation of levelised costs, which is based on Arup's costs data, which shows costs coming down by some 33% by 2020 and 47% by 2030.

8.6 These cost reductions in the Arup report come from a high starting point, and based on this evidence solar PV is not a cost-effective technology for reaching the 2020 renewables target, particularly given our expectations that the target can already be met through deployment of lower-cost technologies. However, if solar PV costs do come down to a competitive level with other renewables, we would encourage their deployment as part of the energy mix.

8.7 DECC are further investigating the costs of less than 5MW solar PV as part of the Comprehensive Review of Feed in Tariffs. Further evidence gathered through that process will be used alongside the Arup costs evidence and evidence provided in consultation responses to inform the final RO banding decisions for solar PV.

RO Support

Consideration of the statutory factors

8.8 *Costs and incomes (statutory factors (a), (b) and (c))*

- The cost evidence for the banding review suggests a range of 3.0-6.8 ROCs required for projects commissioning in 2014/15, with support at the higher end of this range being needed to support higher deployment rates. The Arup costs and hence the required ROC range is the same for large-scale (>5MW) and small-scale (<5MW).

8.9 *The desirability of securing the long term growth, and economic viability, of the industries associated with this technology (statutory factor (d))*

- It is likely there would be distribution and installation jobs associated with the deployment of solar PV in the UK, particularly for smaller installations. However, any other impact on the industries associated with solar PV is unlikely to be significant, because most of the world's manufacturing is based overseas and solar PV costs are driven primarily by global deployment rather than UK deployment, and hence early UK deployment at large-scale is unlikely to be necessary for its costs to fall (i.e. the UK is a price taker).

8.10 *Consumer costs (statutory factor (e))*

- According to the modelling, RO support costs from new build under the RO during the banding review period 2013/14 to 2016/17 are £1.2m from 2016/17 onwards under current bands. With 5 ROCs/MWh for >5MW solar PV, the RO cost of new build over the banding review period would be around £5.7m per year from 2016/17 onwards.[47]

8.11 *Potential contribution to targets arising out of a Community Obligation (statutory factor (f))*

- For context, in 2020 it is thought that large-scale electricity should contribute around 108TWh/y of renewable energy towards the UK's 2020 renewables target. At current bands (including those for small-scale generation in Northern Ireland) new build of 6MW in Northern Ireland is expected to generate less than 0.01TWh/y towards the 2020 renewables target is incentivised. No deployment is projected above 5 MW at the current 2 ROCs/MWh banding or proposed bands of 2 declining to 1.8 ROCs/MWh, whilst it is assumed deployment in Great Britain will be supported generally by small-scale FITs.

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[47] The Pöyry modelling assumed that new-build solar PV <5MW would be supported by FITs rather than the RO, although new-build stations in Great Britain from 50kW-5MW have the choice between FIT and RO support, so some may choose support under the RO, depending on their preferences and the relative levels of support.
These cost estimates take into account different ROC bandings for generation from <5MW installations in Northern Ireland.

- At 5 ROCs the modelling suggests that slightly more, around 0.03TWh/y of solar PV electricity from around 30MW of new build, would be generated towards the 2020 renewables target.

8.12 Given current technology costs, setting a band at anything above the level of RO support for the marginal technology for meeting our 2020 renewables target (i.e. offshore wind) would not be value for money, unless there were other compelling arguments to do so.

8.13 We therefore propose to set RO support for solar PV in line with the level of support for offshore wind. As a result, **solar PV would receive 2ROCs/MWh stepping down to 1.9ROCs for new accreditations (and additional capacity added) in 2015/16 and 1.8ROCs for new accreditations (and additional capacity added) in 2016/17**. However, we recognise that limited evidence of costs and deployment potential of this technology was available to Arup, and that they based their findings largely on German deployment rates, where the technology is already very well established. We also think it is possible that the evidence on the costs of solar PV may be changing more quickly than for other technologies. **We would therefore welcome further evidence (including UK specific evidence) on deployment and costs to inform our final decision**.

Consultation Questions	
16.	**Do you agree with the Arup assessment of costs and deployment potential for solar PV? We would particularly welcome UK-specific evidence on costs and deployment potential.**
17.	**Do you agree with the proposed level of support of 2 ROCs/MWh for solar PV, stepping down to 1.9 ROCs in 2015/16 and 1.8 ROCs in 2016/17? Please explain your response with evidence.**

9. Biomass Electricity

Introduction

9.1 This chapter proposes the establishment of two new bands, biomass conversion and enhanced co-firing, and proposes ROC levels for these and existing standard co-firing and dedicated biomass bands. The UK Renewable Energy Roadmap identifies biomass electricity as one of the technologies that has the greatest potential to help us meet our 2020 renewables target. Together with the actions set out there, our proposals for financial support via the RO and the new Contracts for Difference mechanism will help deliver the potential for 32-50TWh/y of biomass electricity by 2020. Alongside our work on the RO, the Government is developing a UK Bio-energy Strategy. This is expected to be published around the turn of the year.

9.2 Sustainably-sourced biomass electricity can play a strategically important role in the future UK renewable energy mix. Biomass electricity is valuable as it is both predictable and controllable, and so can be used for base load or peak load generation. We recognise that the value of biomass lies in its flexibility of use and that it is also an essential fuel for heat and transport as well as a multitude of uses outside energy.

9.3 Biomass electricity covers a range of well known, scalable technologies that have a role in helping us deliver on our 2020 targets. Supply sources include forestry by-products, generally chipped or pelleted; agricultural residues such as straw, husks and kernels; perennial energy crops; and biodegradable wastes and animal manures. The various biomass electricity sectors are covered individually in the following sections.

9.4 The proposed RO bands aim to focus biomass electricity support over the next period on the cheaper and more transitional technologies of conversion and co-firing. Creating new biomass electricity bands for these will enable us to provide appropriate support for the use of existing infrastructure. Although existing plants may use biomass feedstocks less efficiently than new power stations, this policy offers reduced costs and reduces the risk of locking in long-term feedstock demand.

9.5 As supply chains for biomass are well developed in North and South America and Europe, we expect that the overwhelming majority of fuels for the expansion of biomass electricity will be imported. Discussions with industry indicate that this is already happening.

9.6 Alongside this consultation, the Government is developing a UK Bio-energy Strategy which will aim to set out our strategic framework for the use of bio-energy. The strategy will consider three main issues:

- The availability of sustainable feedstocks to 2020 and beyond;
- The potential impacts (economic and carbon) of using biomass in the energy sector against alternative uses; and
- The possibilities and implications of different uses of biomass feedstocks in the energy sector (electricity, heat and transport) to 2020 and beyond taking into

account wider government objectives, such as cost effectiveness, carbon abatement potential, renewables targets and security of supply.

9.7 In addressing these issues the strategy will use evidence that is largely in the public domain, including the AEA 2010 report on UK and Global Bioenergy Resource[48]. This report also underpins the Government's ambition for biomass electricity presented in this consultation. It provides an analysis of the factors influencing the availability of sustainably-sourced feedstocks to 2030 for energy, taking into consideration the demand of non-energy sectors. The bioenergy strategy is expected to be published around the turn of the year.

Sustainability criteria

9.8 The RO applies sustainability criteria to all biomass (apart from solid waste, gaseous waste, landfill gas, sewage gas and microgenerators using solid and gaseous biomass). Generators are required to provide annual sustainability reports on the biomass feedstocks they use to Ofgem. From April 2011 bioliquid generators will need to meet the sustainability criteria in order to receive ROCs. Similarly, from April 2013, for generators of 1MW capacity or above, it is our intention that only solid biomass and biogas meeting the criteria will be eligible for support.

9.9 The purpose of the UK approach is to set credible and effective, minimum sustainability criteria, which it is expected that generators will wish to exceed through the ongoing development of best practice and cost-effective incremental improvements.

9.10 It has been suggested by some generators that existing generating capacity should be exempt from any future changes to the sustainability criteria for solid and gaseous biomass. This 'grandfathering' of the sustainability criteria would enable generators to sign long-term feedstock contracts, confident that these supplies would meet the sustainability requirements applying to the generating station over the full contract term. This would help the development of a robust supply-chain, in the UK and globally, as well supporting investment in new biomass power generation.

9.11 However, we are currently developing our approach to sustainable forest management with the Forestry Commission, supported by input from industry and NGOs. We also intend to consider how any proposals to address indirect land use change (ILUC), currently being considered by the European Commission for biofuels and bioliquids, could apply to biomass and biogas. Similarly, the European Commission is considering the issue of sustainability criteria for solid and gaseous biomass further, and will report at the end of 2011. It is likely that the Commission would expect any resulting proposals or recommendations on solid biomass and biogas to be applied equally by all EU member states to biomass generators.

9.12 Moreover, if the UK were to introduce amended criteria in the future, reflecting both advances in good practice and to be aligned to our carbon reduction goals out to 2050, we would want these to apply to all generating stations to maintain a simple and level playing field for those selling and buying biomass feedstocks. Generators, and other stakeholders will continue to play an important role in ensuring that amendments to the RO sustainability criteria, which would require a statutory consultation, are proportionate and timely.

9.13 For these reasons we do not propose to exempt existing generating stations from future changes to the UK's sustainability criteria for solid and gaseous biomass.

Consultation Questions	
18.	**Do you agree that we should not exempt existing generators from future changes to the UK's sustainability criteria for solid and gaseous biomass? Please explain your response with evidence.**

Biomass purity threshold

9.14 Biomass is currently defined under the RO legislation as needing to be at least 90% by energy content derived from plant or animal matter.[49] This was reduced from a previous level of 98% in 2006, in response to concerns that 98% was not practical for some types of high biomass content material and wastes which could contain small levels of fossil based contaminants which cannot be easily removed.

9.15 We have received some representation from industry that the 90% rate is still too high and is preventing significant quantities of high content biomass materials, especially waste wood, from being used in energy generation. On the other hand, evidence from some generators suggests that the 90% rate is working satisfactorily and is often being exceeded.

9.16 We are not minded at this stage to change the 90% biomass purity threshold further but would like to learn more about these conflicting views and therefore invite comments and evidence on whether the 90% biomass purity threshold is still appropriate.

[48] UK and Global Bioenergy Resource – Final Report ", AEA, 2010 http://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

[49] The precise definition of "biomass" is set out in article 4 of the ROO 2009.

Consultation Questions	
19.	**Do you consider that the 90% biomass purity threshold is still appropriate? Please explain your response with evidence.**

Biomass Conversion and Enhanced Co-firing

9.17 We are aware of plans by operators of some coal plants to convert from coal to biomass fuels if it is economic to do so. Such conversion, which can be whole or partial, is potentially a cheaper and faster way to bring on renewable electricity deployment than new-build dedicated biomass. It provides a useful transitional technology to contribute to our 2020 renewables target which avoids locking in biomass feedstocks over the longer term while at the same time helping to build the global biomass supply chain which still represents a barrier to investment in large-scale biomass electricity.

9.18 In the Government Response to the Consultation on the Renewables Obligation Order 2011, we said that we would look at the appropriate level of support for co-firing stations converting to biomass. We believe that there is merit in creating two new bands:

- "Biomass Conversion", for former fossil fuel generating stations (including co-firers) which convert, or have already converted, to generate all their electricity from biomass; and

- "Enhanced Co-Firing", for co-firing generators using biomass to generate at least 15% of their gross output.

Biomass Conversion - Costs and Deployment Potential

9.19 The Arup report suggests that there is significant coal fired generation which could convert to deliver up to 2.6GW of dedicated solid biomass deployment (generating around 18.5TWh/y) in 2020 on the high scenario before financial constraints are applied. Cost data obtained by Arup indicate that it should be possible to convert coal generation at lower cost than new build – with capital costs around £0.6m/MW, compare to £2.3-3.9m/MW for new build - and to do so on a faster timescale, making such conversions a relatively quick and cost-effective way to boost renewable electricity generation. This is borne out in our discussions with industry. By installing boiler and emission control modifications, these plant should be able to contribute to our 2020 renewables target in particular and make good use of existing infrastructure. Levelised costs are around £116/MWh based on the Arup cost data, and they remain virtually flat in real terms into the future.

RO Support

Consideration of the statutory factors

9.20 *Costs and incomes (statutory factors (a), (b) and (c))*

- Modelling by Pöyry consultants suggests that 1 ROC per MWh is sufficient for all biomass conversions that have the potential to help meet our targets, to convert. The modelling assumed that generators would compare their expected NPV of cashflows under continuing with coal generation to converting to biomass, and choose the highest NPV.

9.21 *The desirability of securing the long term growth, and economic viability, of the industries associated with this technology (statutory factor (d))*

- Conversions of generating stations to biomass should help build the global biomass supply chain. While the overall use of biomass in the Pöyry model is constrained so as to not to exceed the available supply of sustainable biomass, net of projected demands from the heat, transport and other biomass using sectors, the increased demand may impact biomass prices which in turn may affect other sectors that use similar feedstocks.

9.22 *Consumer costs (statutory factor (e))*

- Both new build and converted generating stations currently receive 1.5 ROCs/MWh if they generate all their electricity from regular biomass. Total RO support costs, falling ultimately to consumers, from biomass conversions built from 2011/12 to 2016/17 reach £980m per year from 2016/17 onwards at 1.5 ROCs/MWh and £650m per year from 2016/17 onwards at the proposed band of 1 ROC/MWh.

9.23 *Potential contribution to targets arising out of a Community Obligation (statutory factor (f))*

- For context, in 2020 it is thought that large-scale electricity should contribute around 108TWh/y of renewable energy towards the UK's 2020 renewables target.

- Modelling by Pöyry for the banding review suggests that 1 ROC is sufficient to incentivise the most cost-effective part of the conversion supply curve, and that at this rate a substantial amount of biomass conversion will be incentivised. At 1.5 ROCs/MWh in the Pöyry model, we get around 12TWh of annual generation towards the 2020 renewables target from stations converting in the banding review period, 2013-17. The same amount of generation from conversions is achieved at 1 ROC/MWh.

9.24 We propose that from 1 April 2013 a new band is created for biomass conversions. The new band will apply to former fossil fuel generating stations. We propose to treat as a former fossil fuel generating station any generating station which, following its entry into commercial operation, has generated more than 15% of its electricity from fossil fuel over any 6 month period (ignoring any fossil fuel used for permitted ancillary purposes or waste which is a renewable source).

9.25 Our intention is not to capture dedicated biomass stations that used fossil fuel for commissioning, or to capture dedicated biomass stations that temporarily slip into co-firing due to technical problems that cause them to go over the 10% fossil fuel limit for permitted ancillary purposes.

9.26 Support under the biomass conversion band will be provided for electricity generated by the former fossil fuel generating station from biomass (solid, liquid or gaseous, other than sewage gas, landfill gas or fuel produced by means of AD, gasification or pyrolysis) as long as during that month the station is generating electricity only from biomass. For the purpose of determining eligibility for the biomass conversion band, no account will be taken of fossil fuel or waste used for permitted ancillary purposes. As in the case of other biomass generating stations, from April 2013, biomass conversions of 1MW capacity and above will be required to meet the sustainability criteria for solid and gaseous biomass in order to receive ROCs.

9.27 We propose that the biomass conversion band should apply to conversions taking place before 1 April 2013, as well as to those taking place after that date.

9.28 Some generating stations may have already started or completed the process of converting their entire generation to biomass. If conversion is completed before 1 April 2013, generators will be able to receive support under the existing dedicated biomass band of 1.5 ROCs per MWh, for all generation up to, and including, generation on 31 March 2013. From 1 April 2013, these generators will be transferred to the new 'biomass conversion' band, receiving 1 ROC/MWh. We have decided not to grandfather support at 1.5 ROCs/MWh for biomass conversions taking place before 1 April 2013. Grandfathering at 1.5 ROCs would lead to consumers overpaying for the generation of renewable electricity from biomass conversions.

9.29 In 2009 we extended our grandfathering policy to dedicated biomass (excluding bioliquids) following representations that without grandfathering biomass deployment would not come forward as investors lacked revenue certainty. Grandfathering can encourage investment by providing increased certainty. However, we noted that we needed to consider how grandfathering would operate for stations switching between different processes in relation to different periods, as stations are not currently accredited for a particular technology. In the consultation on the Renewables Obligation (Amendment) Order 2011, we asked questions about the level of support for biomass conversions and in the Government Response we said our preferred option would be a lower banding level as this would more accurately reflect the costs of the conversion and ensure we do not overcompensate these projects.

9.30 Therefore, we believe that these proposals will still allow generators to move quickly to start converting their generating stations, ahead of the new bands being created, whilst also ensuring that consumers are not overpaying for this type of renewable generation in the longer term.

9.31 However, in recognition of the significant upfront capital costs of converting to biomass, we propose to adopt a policy of grandfathering the support for generators under this new band at the rate set from 1st April 2013. As with all grandfathered fuelled technologies, the fuel price risk therefore remains with the generator, and they are expected to put in place strategies to deal with the variability of fuel costs over time.

9.32 If, however, a converted station reverts to being a co-firer, their support will also revert to the levels proposed for the standard co-firing or enhanced co-firing bands, providing they meet the eligibility criteria for those bands.

Call for Evidence: Auto-generators converting to biomass

Currently support under the RO does not distinguish between the generation of electricity for own use or the generation of electricity for onward supply to external customers. Therefore, our proposals for the biomass conversion band would also apply to former fossil fuel generating stations generating electricity for their own use, which convert to generate all of their electricity from biomass.

However, it is possible that the investment case for the conversion of auto-generators is significantly different to those for other conversions, for example, due to the generation price required. At present, we do not have sufficient information on the incomes and costs associated with this type of conversion to propose different treatment at this time. **We therefore invite evidence** on the differential in generation costs, the costs of making biomass conversion economically viable for industrial auto-generators, and deployment potential for auto-generating coal to biomass conversion to help inform our decision on how this type of station should be supported under the RO from 1st April 2013. **(See Question 25 below)**.

Consultation Questions	
20.	**Do you agree with the Arup assessment of costs and deployment potential for biomass conversion? Please explain your response with evidence.**
21.	**Do you agree that 1 ROC/MWh is an appropriate level of support for biomass conversions? Please explain your response with evidence.**
22.	**Do you agree with our proposal for what should constitute a former fossil fuel generating station? Please explain your response with evidence.**
23.	**Do you agree that all former fossil fuel generating stations which convert their entire generation to biomass before April 2013 should be transferred to the biomass conversion band? Please explain your response with evidence.**
24.	**Do you agree that support under the biomass conversion band should be grandfathered at the rate set from 1st April 2013? Please explain your response with evidence.**

25.	**We would welcome evidence on the differential in generation costs, the costs of making biomass conversion economically viable for industrial auto-generators, and deployment potential for auto-generating coal to biomass conversion.**

Enhanced Co-Firing - Costs and Deployment Potential

9.33 Co-firing refers to the practice of generating electricity partly from renewable sources and partly from fossil fuel. Whilst we would very much like to see the full conversion of existing coal plants to biomass, we are aware that, for multi-unit generators, it may not be cost effective to convert the entire site in one go. Given their contribution to our security of supply, it may also not be desirable for very large coal generators to take all their units offline at the same time while undergoing conversion.

9.34 Our assumption is therefore that some generators will seek to convert on a unit by unit basis. Under current banding arrangements, such generators would only be eligible for the standard co-firing bands. This is unlikely to allow the financing of the upfront capital expenditure required in the move to full conversion. This creates a potential financial barrier to conversion, which we are seeking to remove by creating an enhanced co-firing band.

9.35 The exact timings of full conversion will vary by generator, and it is therefore difficult to estimate how much enhanced co-firing will take place each year. However, by 2020 we anticipate that the majority of enhanced co-firers will have fully converted their stations.

9.36 In determining whether a plant is operating as a standard co-firer or enhanced co-firer, we are proposing to set a threshold of 15% gross output per month since, based on discussions with industry, co-firing above this level requires both capital investment and changes to the operation of the plant.

9.37 Capital costs are around £0.5m/MW based on evidence from Arup, compared to £2.3-3.9m/MW for new build. Levelised costs are around £110/MWh based on the Arup cost data, and they remain virtually flat in real terms into the future.

RO support

Consideration of the statutory factors

9.38 *Costs and incomes (statutory factors (a), (b) and (c))*

- The evidence base on costs for enhanced co-firing is very limited. In the Pöyry modelling, 1 ROC for enhanced co-firing is not more profitable than continuing to burn coal, at central DECC coal price projections[50]. However, this depends on how future coal and biomass prices develop. It is likely there will be times when the coal price is high enough, relative to the biomass price, to make co-firing profitable.

- This is the experience we have seen with standard co-firing, where from month to month the changes in relative prices of coal and biomass have led to co-firing coming on and off stream. Thus, based on stakeholder evidence we propose that generating stations should generate at least 15%of their electricity from biomass in order to qualify for the enhanced co-firing band.

9.39 *The desirability of securing the long term growth, and economic viability, of the industries associated with this technology (statutory factor (d))*

- Increases in the proportion of biomass co-firing should help build the global biomass supply chain. While the overall use of biomass in the Pöyry model is constrained so as not to exceed the available supply of sustainable biomass, net of projected demands from the heat, transport and other biomass using sectors, the increased demand may impact biomass prices which in turn may affect other sectors that use similar feedstocks.

9.40 *Consumer costs (statutory factor (e))*

- RO support costs, falling ultimately to consumers, from enhanced co-firing under the RO during the banding review period 2013/14 to 2016/17 are zero at the current ROC band for co-firing of 0.5 ROCs/MWh and £180m per year at the proposed 1 ROC/MWh. However, these results should be treated with caution, given the high degree of uncertainty surrounding capex required, as well as future relative coal and biomass prices.

9.41 *Potential contribution to targets arising out of a Community Obligation (statutory factor (f))*

- For context, in 2020 it is thought that large-scale electricity should contribute around 108TWh/y of renewable energy towards the UK's 2020 renewables target.

- At the current banding of 0.5 ROCs/MWh in the Pöyry modelling for the banding review, we get 0TWh annual generation from stations moving to enhanced co-firing in the banding review period. The generation achieved at 1 ROC/MWh is 4.3TWh towards the 2020 renewables target, from partial conversion of around 580MW of biomass capacity within coal power stations that continue to burn coal alongside. However, these results should be treated with caution, given the uncertainty surrounding capex required, as well as future relative coal and biomass prices.

[50] Available at: http://www.decc.gov.uk/assets/decc/Statistics/Projections/file51365.pdf

9.42 We want to make a clear distinction between standard co-firing and enhanced co-firing. We see enhanced co-firing as a stepping stone towards full conversion, which entails significant capital costs. Therefore, we propose that, from 1 April 2013, **a new band is created for 'enhanced co-firing' at 1 ROC/MWh**.

9.43 We propose that in order to be eligible for the enhanced co-firing band, generators should demonstrate that they are burning a significant proportion of biomass. Biomass can be co-fired at levels of 1-5% with coal with very little by way of capital expenditure. To co-fire at levels of 15% and above, requires more substantive changes to be made to feedstock handling, fuel injection, de-ashing and boiler maintenance and hence increased capital and operating expenditure. We therefore believe that a minimum of 15%, averaged each month, is an appropriate proportion. This is a level of co-firing which will require increased capital expenditure, and which is clearly a first step towards full conversion of the generator.

9.44 The minimum 15% threshold can be achieved either through conversion of whole units to biomass, or by co-firing in each boiler (or a mixture of the two). Generators do not have to meet the minimum threshold on a daily basis, but must do so on a monthly basis. If they fail to meet the minimum percentage in any month, they will be ineligible for the enhanced co-firing band for that month, with support reverting to the 'standard co-firing' band instead.

9.45 This allows the generator to continue to operate flexibly, whilst ensuring that the enhanced support level is only available to those meeting the minimum 15% threshold over a sustained period of time.

9.46 Support under the enhanced co-firing band will be provided for electricity generated from biomass (other than sewage gas, landfill gas or fuel produced by means of AD, gasification or pyrolysis). The generating station must be generating electricity partly from fossil fuel and partly from renewable sources and the electricity generated from that biomass must be at least 15% by energy content of the gross output of the generating station over the month. As in the case of other biomass generating stations, from April 2013, enhanced co-firing generators of 1MW capacity and above will be required to meet the sustainability criteria for solid and gaseous biomass in order to receive ROCs.

9.47 Given the need for upfront capital investment, we propose to adopt a policy of grandfathering support for generators under the enhanced co-firing band. If however, a generating station reverts to being a standard co-firer, their support will also revert to that proposed for the standard co-firing band.

9.48 Similarly, if a generating station moves to a full conversion during the banding review period, they will become eligible for the biomass conversion band, as long as they meet the minimum eligibility requirements of that band. We are considering whether accredited generating stations should be permitted to move between bands after 1 April 2017.

9.49 To further support the anticipated increase in co-firing in the RO, we are proposing to remove the current 12.5% co-firing cap. This is discussed in detail in Chapter 17.

Consultation Questions	
26.	**Do you agree with the Arup assessment of costs for enhanced co-firing? Please explain your response with evidence.**
27.	**Do you agree that 1 ROC/MWh is an appropriate level of support for enhanced co-firing? Please explain your response with evidence.**
28.	**Do you agree that generating stations should generate at least 15% of their electricity from biomass in order to qualify for the enhanced co-firing band? Please explain your response with evidence.**
29.	**Do you agree that generators should meet this minimum 15% threshold on a monthly averaged basis? Please explain your response with evidence.**
30.	**Do you agree that support under the enhanced co-firing band should be grandfathered? Please explain your response with evidence.**

Biomass Co-firing (standard)

9.50 Co-firing is effective in abating carbon emissions from coal plant and is a cost-effective source of large-scale renewable electricity.

Costs and Deployment Potential

9.51 In the lead up to 2020, we expect significant deployment from enhanced co-firing and full biomass conversion together with a concomitant decline in standard co-firing (i.e. co-firing at levels below 15%). The Arup report anticipates the cumulative installed capacity of standard co-firing to decrease from 2.2GW in 2011 to around 1.2GW in 2020 on the central and low scenarios, and to zero on all scenarios by 2025.

9.52 This is due to several factors, including closure of existing fossil fuelled generation due to the Large Combustion Plant Directive, and inability to continue co-firing if constrained by the measures needed to comply with forthcoming tighter Industrial Emissions Directive environmental performance requirements.

9.53 Arup's analysis shows 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. DECC levelised costs, which are based on Arup's findings, suggest that standard co-firing at around £98/MWh is some 18% cheaper than enhanced co-firing and 22% less expensive than full conversion (when compared to the central biomass conversion cost estimates), and that costs remain relatively flat from 2010 out to 2030, declining slightly towards the end of the period.

RO Support

9.54 Standard co-firing of biomass is currently eligible to receive 0.5 ROCs under the RO.

Consideration of the statutory factors

9.55 *Costs and incomes (statutory factors (a), (b) and (c))*

- The cost evidence suggests a ROC range of 0.6-1.2 required for generation in 2014/15 at central coal prices. With new DECC coal prices the range drops to 0.4-1.0 ROCs, and the Pöyry modelling suggests some standard co-firing of biomass would take place with the previous DECC high coal prices and a ROC banding at the bottom end of this range. These ROC ranges do not take account of the volatility of relative coal and biomass prices, but use average annual values. In fact the relative prices may be fairly volatile. This is the experience we have historically with co-firing, where from month to month the changes in relative prices of coal and biomass have led to biomass co-firing generation coming on and off.

9.56 *The desirability of securing the long term growth, and economic viability, of the industries associated with this technology (statutory factor (d))*

- Standard co-firing of biomass already occurs at significant levels, but there is the potential for more generation, depending on its economics. Increases in biomass co-firing should help build the global biomass supply chain. But use by the power sector may reduce the quantity of biomass available at given prices for use in the heat sector, and in other industries. This represents a significant amount of biomass resource, but it should be noted the overall use of biomass in the Pöyry model is constrained not to exceed the available supply of sustainable biomass, net of projected demands from the heat and transport sectors, and all other industries using wood, whether globally or in the UK. Increased use of biomass in the energy sector could however affect the prices at which other sectors can access similar feedstocks.

9.57 *Consumer costs (statutory factor (e))*

- RO support costs to consumers from standard co-firing generation under the RO during the banding review period 2013/14 to 2016/17 is zero at 0.5 ROCs, as the modelling projects there is to be zero generation at central coal prices. However, these results should be treated with significant caution, given the uncertainty surrounding both the capex required, but also future relative coal and biomass prices.

9.58 *Potential contribution to targets arising out of a Community Obligation (statutory factor (f))*

- For context, in 2020 it is thought that large-scale electricity should contribute around 108TWh/y of renewable energy towards the UK's 2020 renewables target which arises out of a Community Obligation.

- The Pöyry modelling for the banding review shows no standard co-firing of biomass coming on at 0.5 ROCs/MWh at central coal prices. However, these results should be treated with caution, given the uncertainty surrounding both the capex required, but also future relative coal and biomass prices. In particular, it is noted that deployment is expected under a high coal price scenario.

9.59 Given the expected improvement of the economics of co-firing relative to coal due to an increasing carbon price and our desire to incentivise enhanced co-firing and conversions we **propose to maintain the band for standard co-firing of biomass at the current 0.5 ROCs.** The band will apply to the co-firing of regular biomass at levels below 15% by gross energy content, averaged over the course of a month. Regular biomass is defined in the ROO 2009 as meaning biomass other than sewage gas, landfill gas, energy crops or fuel produced by means of AD, gasification or pyrolysis.

9.60 Whilst we are proposing to adopt a policy of grandfathering support under the enhanced co-firing and biomass conversion bands, **we intend to maintain our policy of not grandfathering standard co-firing of biomass**. This reflects the fact that standard co-firing of biomass requires limited additional capital investment and the primary costs are fuel costs, which vary over time.

Consultation Questions	
31.	**Do you agree with the Arup assessment of costs and generating potential for standard co-firing of biomass? Please explain your response with evidence.**
32.	**Do you agree with the proposed level of support of 0.5 ROCs/MWh for standard co-firing of biomass? Please explain your response with evidence.**
33.	**Do you agree that standard co-firing of biomass should continue not to be grandfathered? Please explain your response with evidence.**

Dedicated Biomass

9.61 The proposed bands on conversion and co-firing reflect our desire to focus the deployment of biomass electricity in the near future on the cheaper and transitional technologies. The role of new dedicated biomass in that mix will depend on a series of factors, including its cost effectiveness relative to other renewable technologies and the wider energy system, as well as the availability of feedstock for both energy and non-energy users. It follows that at this point the Government takes a cautious approach to the support for dedicated biomass electricity. The proposals set out in this section aim to bring forward only the most cost effective potential of this technology. In doing so we aim to manage the risks associated with long-term locking of feedstock demand in this sector compared to potentially more cost effective ways of meeting wider longer term government objectives through alternative uses.

9.62 The bio-energy strategy that is currently underway will consider this relative role of dedicated biomass at different scales in delivery of renewable energy and carbon reductions alongside other electricity technologies and biomass using sectors as well as the lock-in implications of the potential deployment.

Costs and deployment potential

9.63 The Arup report highlighted that the costs of dedicated biomass vary depending on the size of the installation. This is primarily down to two key factors: the nature of the fuel supply chain and the ability to achieve economies of scale.

9.64 Information collected by ARUP, together with DECC's own assessment of planning applications indicate that larger plant (50-300MW) are intending to source primarily feedstock imported in bulk. Many are therefore intending to locate on or close to the coast or a port. Such plant will be in a position to take advantage of the international feedstock supply chains that will develop over the next few years. Smaller plants (below 50MW) are intending to use a wider range of locally sourced feedstock. Where this includes waste material, the plant will need to be Waste Incineration Directive compliant. Based on the Arup report we have assumed a 10:90 domestic to imported ratio for large (>50MW) plant and 90:10 for small (<50MW) plant.

9.65 The Arup report showed that capital costs for dedicated biomass plant of 50-300MW size could range from £2.3m per MW to £2.8m per MW and <50MW plant from £2.6m per MW to £3.9m per MW. The ranges reflects both the variations in configuration as well as economies of scale seen at this size range. Levelised costs for <50MW biomass in 2010 are £127-154/MWh and for >50MW are £152-165/MWh, where a higher assumed fuel price offsets lower assumed capital costs.

9.66 Arup estimate that, under a high potential deployment scenario, we could achieve up to 2.8GW of cumulative installed capacity by 2020 for above 50MW plant range. For sub 50MW we could expect to see up to 1.3GW of cumulative capacity in 2020. Note, however, these Arup scenarios are financially unconstrained; they are treated as *maximum* build rates in the Pöyry modelling.

RO support

Consideration of the statutory factors

9.67 *<u>Costs and incomes (statutory factors (a), (b) and (c))</u>*

- Arup's analysis of costs and deployment potential showed that dedicated biomass plants will require higher support levels than co-firing or conversions. The cost evidence suggests a range of 1.5-2.2 ROCs for small dedicated biomass plants and 2.3-2.6 ROCs for larger scale biomass developments, due to an increased proportion of imported fuel.

9.68 *The desirability of securing the long term growth, and economic viability, of the industries associated with this technology (statutory factor (d))*

- Small-scale biomass is more likely to use locally sourced biomass, which can also help develop jobs in growing and transporting biomass. However, use by the power sector may reduce the quantity of biomass available at given prices for use in the heat sector, and in other industries. The relatively moderate level of deployment and the scale of projects likely to come forward at 1.5 ROCs/MWh is less likely to cause problems in other industries.

9.69 *Consumer costs (statutory factor (e))*

- RO support costs to consumers from new build small scale dedicated biomass under the RO during the banding review period 2013/14 to 2016/17 come to an annual £32m at 1.5 ROCs/MWh. Based on Arup cost evidence, biomass fuel price assumptions from the AEA report, and Pöyry modelling for the banding review there would be no deployment of large scale dedicated biomass and no cost therefore to consumers.

9.70 *Potential contribution to targets arising out of a Community Obligation (statutory factor (f))*

- For context, in 2020 it is thought that large-scale electricity should contribute around 108TWh/y of renewable energy towards the UK's 2020 renewables target.

- At 1.5 ROCs/MWh in the Pöyry model, we get new build of small biomass <50MW under the RO over the banding review period which contributes an annual output of 0.5TWh[51] towards the 2020 renewables target. Large biomass does not get built, as it requires more ROCs to cover its assumed higher fuel costs (despite lower capital costs).

9.71 We **propose to retain the current RO support for dedicated biomass at 1.5 ROCs per MWh until 31 March 2016**. **From 1 April 2016 we will reduce support to 1.4 ROCs per MWh for new accreditations (and additional capacity added) after 31 March 2016.** Our intention in setting this band is to bring forward only cost effective dedicated potential, which also avoids risks around feedstock and technology lock-in. We believe that the reduction in the support level from April 2016 could bring forward quickly this most cost effective potential. The modelling suggests that 1.5 ROCs would bring forward only small scale dedicated biomass plants below 50MW. Such deployment would be compatible with our desire to focus on the cheaper and more transitional biomass technologies first (i.e. co-firing and conversion) and to avoid feedstock and technology lock-in. We are aware that there are uncertainties in dedicated biomass costs and are asking for submissions of evidence as to whether the Arup assessment of costs and deployment potential accurately reflect those of projects that could come forward.

[51] Moving to the DECC central hurdle rates and new fossil fuel price assumptions would not change the level of deployment according to DECC's in-house analysis.

9.72 In this chapter we have also proposed that as from 1 April 2013, all biomass conversions will be excluded from the dedicated biomass band. This includes former fossil fuel generating stations which convert to dedicated biomass before 1 April 2013, as well as conversions taking place after that date.

Consultation Questions	
34.	**Do you agree with the Arup assessment of costs and deployment potential for dedicated biomass? Please explain your response with evidence.**
35.	**Do you agree with the biomass fuel price assumptions for domestic and imported fuel from AEA, and the use of a 10:90 domestic to imported ratio for average fuel costs for large (>50MW) dedicated biomass and 90:10 for small (<50MW) dedicated biomass based on the Arup report? Please explain your response with evidence.**
36.	**Do you agree with the proposed level of support of 1.5 ROCs/MWh for dedicated biomass until 31 March 2016, reducing to 1.4 ROCs/MWh from 1 April 2016 ? Please explain your response with evidence.**
37.	**Do you agree that the support level proposed for dedicated biomass manages the risk of locking supplies of feedstock in to this sector? Please explain your response with evidence.**

Bioliquids

9.73 Many bioliquids are highly flexible fuels which can be used in a range of technologies, and can be readily co-fired or blended with fossil fuels at small or large scale. Some bioliquids can be used readily as transport fuels whilst others are only suitable for electricity and heat generation. At present, the use of bioliquids to generate electricity is supported through the dedicated biomass and co-firing bands described in the previous section if the eligibility criteria for those bands are met. In order to be eligible for support the bioliquids must meet the sustainability criteria imposed by the Renewable Energy Directive.

9.74 We expect technologies that use bioliquids to play a limited role in the generation of electricity to 2020. We think it is right that liquid fuels are prioritised in other sectors, such as transport, which also have challenging contributions to make to our 2020 renewables target but fewer alternatives to delivering renewable energy compared to electricity. In addition, feedstock estimates from AEA and E4Tech[52] suggest that the

[52] UK and Global Bioenergy Resource – Final Report ", AEA, 2010 http://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; and Assessing cost-effectiveness scenarios for biofuel deployment options across the UK transport sector to 2020 and 2050", forthcoming.

availability of key bioliquid feedstocks that will meet the sustainability criteria will be limited.

9.75 However, some bioliquids may be best suited to deliver renewable electricity and CHP, particularly those fuels which cannot yet be easily converted into transport fuel.

9.76 The cost analysis undertaken for the banding review suggests that using bioliquids for electricity generation constitutes a relatively expensive set of renewable technologies and that support needs to be significantly increased if we are to see widespread deployment in the electricity sector.

9.77 Considering this, we believe that in general there are other more cost effective technologies to reduce carbon emissions and achieve widespread renewable electricity deployment. However, we recognise that certain bioliquids may be sustainable and cheaper than suggested by the evidence for the banding review, and may therefore play a role in delivering some renewables generation for the 2020 renewables target.

9.78 We intend to continue to support bioliquids when used under the dedicated biomass and standard co-firing bands. Bioliquids will also be eligible for support under the enhanced co-firing and biomass conversion bands from 1 April 2013. However, we do not propose to give bioliquids a different level of support from solid or gaseous biomass used under those bands. Furthermore, as analysis indicates that sustainable bioliquids resource is limited, we propose to set a cap on the use of bioliquids by suppliers to meet their renewables obligation so as to ensure that resource is available for use in other sectors such as transport.

Fossil-derived bioliquids, including FAME Biodiesel

9.79 As part of ensuring compliance with the Renewable Energy Directive, fossil derived bioliquids were eligible for RO support from April 2011. Fossil-derived bioliquids, including FAME (fatty acid methyl ester) biodiesel, are produced partly from biomass and partly from fossil fuel and are currently awarded the default band of 1ROC.

9.80 It was not clear from the cost data that there was a significant difference between biodiesel and other bioliquids, and therefore **we propose to set support at the same level as for other bioliquids.** Accordingly, we propose that fossil-derived bioliquids should be eligible for support under the standard co-firing, enhanced co-firing, biomass conversion and dedicated biomass bands.

Applying a cap

9.81 It is important that the RO does not incentivise a high level of bioliquid deployment that reduces the availability of bioliquids for use in other sectors, or on sustainability. To reduce the risk of creating these effects we are proposing to apply a cap on the number of bioliquid ROCs that an electricity supplier can use to meet their obligation.

9.82 The proposed level of the cap is broadly based on the amount of electricity that can be generated from estimates of available sustainable bioliquid without impacting on heat and transport. We have adopted a cautious approach, in setting the cap at a low level, to take into account uncertainties in the data. The number of ROCs issued for bioliquid electricity generation is currently low, therefore at current rates of deployment, the proposed cap should not affect those plants which are currently operating or close to coming on stream, while also allowing for limited additional growth in the sector.

9.83 The cap will apply to ROCs issued for the generation of electricity using bioliquids under the standard and enhanced co-firing, biomass conversion and dedicated biomass bands (with or without CHP or energy crops). The cap will not apply to ROCs issued for bioliquids used in energy from waste with CHP and ACT. ACTs usually use solid biomass feedstocks, which are not subject to our proposed cap. For some biomass wastes, it is not practical to determine the proportion of electricity generated from a liquid fuel.

9.84 We **propose that suppliers may meet up to 4% of their annual renewables obligation** within this banding review period using bioliquid ROCs. This should broadly equate to **an overall cap of 2TWh/y** in 2017.

9.85 2TWh/y is an estimate of the level of electricity that can be generated from bioliquids with minimal risk of diverting resource from other sectors, but high enough to avoid a detrimental impact on existing generators of electricity using bioliquids. This estimate has a significant level of uncertainly because it is dependent on our estimate of sustainable bioliquid availability, an assumption of deployment of bioliquids between now and 2017, and the likely growth in the RO to 2017.

Setting a cap

9.86 We propose that the cap should operate in a similar way to the co-firing cap. This method is simple for suppliers to understand and administratively simple to deliver. Under the cap, the maximum number of bioliquid ROCs that can be submitted by each electricity supplier in respect of an obligation period must not exceed 4% of their total Renewables Obligation.

9.87 The 4% cap is based on an estimated number of ROCs broadly equivalent to 2TWh in 2017, and sets it as a percentage of the overall obligation. Because the obligation is likely to increase to 2017, the absolute quantity of bioliquid ROCs that can meet the obligation would be lower in 2013 than 2TWh, and as the obligation increases, so would the absolute quantity of bioliquid allowed in the RO, until it was roughly equivalent to 2TWh in 2017. However, because of uncertainties in future total ROCs production in each year and in average bioliquid banding levels, we cannot guarantee that the cap will be exactly 2TWh/y.

Grandfathering bioliquids

9.88 In 2010, we decided not to adopt a policy to grandfather bioliquids but committed to review the matter as part of this banding review. Our reservations at the time centred on the possibility that using bioliquids for electricity generation was not the best way of helping us achieve our legally binding 2020 renewables target, which also requires large contributions from other sectors such as transport. In addition, we had limited information about the capital and operating costs of the emerging bioliquid market which has now been addressed in reports by NNFCC[53] and Arup.

9.89 We have proposed measures which we believe will not over-incentivise bioliquids and fossil derived bioliquids, and therefore will generate limited deployment. Because this approach takes into account competing uses, we believe that once these measures take effect on 1 April 2013, it will be appropriate to treat bioliquids in the same way as solid and gaseous biomass for the purposes of our grandfathering policy. This means that generating stations using bioliquids to generate electricity under the dedicated biomass, biomass conversion and enhanced co-firing bands, will be covered by our grandfathering policy from 1 April 2013, at the support levels for those bands proposed in this consultation document. Bioliquid use in Energy from Waste CHP and ACT is already covered by our grandfathering policy.

Bioliquid Sustainability Audit Report

9.90 The Renewable Energy Directive ("RED") imposes sustainability criteria on bioliquids, which have been transposed by the Renewables Obligation (Amendment) Order 2011. Generators using bioliquids must have an independent audit of the information they submit to Ofgem to demonstrate compliance with the sustainability criteria. In January 2011, the European Commission issued a decision (Commission Decision 2011/13/EU) setting out some specific information that generators must submit for each consignment of bioliquid they use. The information is:

a) whether the consignment has been certified or accepted as fulfilling the requirements of a voluntary scheme that has been recognised by the Commission, as containing accurate data on measures taken for soil, water and air protection, the restoration of degraded land, the avoidance of excessive water consumption or to take into account the issues referred to in the second subparagraph of Article 17(7) of the RED;

b) (b) if the consignment has been certified or accepted as fulfilling the requirements of a voluntary scheme, the name of the voluntary scheme;

c) (c) whether a restored degraded land bonus (referred to in Annex V, part C, points 7 and 8 of the RED) has been used for the purposes of the greenhouse gas emissions calculation; and

d) (d) whether a factor for emissions savings from soil carbon accumulation via improved agricultural management (referred to in Annex V, part C, point 1 of the RED) has been used for the purpose of the greenhouse gas emissions calculation.

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

9.91 The information under (c) and (d) is not required in the case of bioliquids derived from waste or residues.

9.92 **We intend to amend the RO Order to make clear that this information must be included in the bioliquid sustainability audit report**.

9.93 There are additional elements of the Renewable Energy Directive which the European Commission is developing and which will, in the future, require transposition. These include:

- A further Decision to establish the criteria and geographic ranges to determine which areas should be covered by the definitions of highly biodiverse grassland;
- An impact assessment, and if appropriate, proposals of policy measures designed to mitigate indirect land use change.

Consultation Questions	
38.	**Do you agree with the Arup assessment of generation costs and deployment potential of bioliquids, and the bioliquid fuel prices as set out in the Impact Assessment? Please explain your response with evidence.**
39.	**Do you agree that support for bioliquids should be the same as for solid and gaseous biomass under the dedicated biomass, biomass conversion, enhanced co-firing and standard co-firing bands? Please explain your response with evidence.**
40.	**Do you agree that 'fossil-derived bioliquids' should receive the same level of support as other bioliquids? Please explain your response with evidence.**
41.	**Do you agree that a cap should be put in place on the amount of electricity generated from bioliquid that suppliers can use to meet their renewables obligation? Please explain your response with evidence.**
42.	**Do you agree with the level of the cap being set at 4% of each supplier's renewables obligation, broadly equivalent to a maximum level of generation of 2TWh/y in 2017? Please explain your response with evidence.**
43.	**Do you agree that from 1 April 2013, bioliquids should be treated in the same way as solid and gaseous biomass for the purposes of our grandfathering policy? Please explain your response with evidence.**

10. Energy from Waste with CHP

Introduction

10.1 The generation of energy from the biogenic content of waste through combustion with CHP ("EfW with CHP") is a highly efficient renewable technology that offers significant carbon savings. As with dedicated biomass, it is dispatchable, i.e. generation is controllable and predictable.

10.2 Furthermore, energy from waste has the additional advantage of using biomass at the end of its useful life, reducing damaging landfill methane gas emissions. *The Government review of waste policy in England*[54], published by Defra on 14 June 2011, sets out Government's commitment to increasing the generation of electricity from waste, particularly through CHP, which can play an important part in ensuring that we extract the maximum value from residual waste. We are therefore keen to continue supporting and promoting the use of EfW with CHP.

10.3 For the purposes of the RO, EfW with CHP means electricity generated from the combustion of waste (other than a fuel produced by means of anaerobic digestion, gasification or pyrolysis) in a combined heat and power generating station which has been accredited under the CHP Quality Assurance Standard. Where the waste stream can be demonstrated to have no more than 10% fossil fuel contamination, it may be eligible for support under the dedicated biomass band.

Cost and Deployment Potential

10.4 The Arup report estimates that median capital costs for energy from waste are £4.6 million per MW (low to high range of £3.6-6.4/MW). The report also highlights that energy from waste deployment is currently underdeveloped in the UK compared to other EU member states such as Denmark, Belgium, the Netherlands, France, Austria and Germany.

10.5 According to Arup, the level of renewable electricity generation capacity from energy from waste CHP has the potential to reach around 60-70MW by 2020, and around 100-130MW by 2030. This level of deployment could potentially generate in the region of 0.3-0.4TWh/y of renewable electricity by 2020 rising to around 0.6-0.8TWh/y in 2030[55].

RO support

Consideration of the statutory factors

10.6 <u>Costs and incomes (statutory factors (a), (b) and (c))</u>

[54] http://www.defra.gov.uk/publications/files/pb13540-waste-policy-review110614.pdf

[55] These figures relate to renewable electricity capacity only, based on assumptions that waste fuel has a biogenic content of 62.5%, the assumed renewable content under the Renewable Energy Directive. Deemed RO support is based on an assumed biogenic content of 50%.

- New cost information suggests required ROCs of 0 (i.e. no support needed); this ROC range includes a gate fee of £77/t that EfW with CHP plants are assumed to receive. However the evidence on gate fees is not clear cut (i.e. gate fees could be lower – and some of the potential would require ROCs with lower gate fee assumptions). The cost evidence also suggests that with no ROC support, EfW with CHP would have a better NPV of cashflows than EfW power only. This is because the assumed higher capital costs of CHP, from Arup, are more than offset by the assumed heat value (avoided costs of alternative means of generating the heat, or revenue from selling steam). However, the cost evidence on the differential made by adding heat offtake is limited.

10.7 *The desirability of securing the long term growth, and economic viability, of the industries associated with this technology (statutory factor (d))*

]According to data from and eko gen report for the Department of Business[56], the energy from waste sector already employs around 11,000 people, and generates around £1bn per year of gross value added. This would be expected to grow in line with Energy from Waste deployment. According to the report, the energy recovery sector has the highest value added per employee in the waste management sector at around £100,000. EfW with CHP would only represent a proportion of both current and future energy from waste (energy from waste also includes AD and ACT) employment and value added, but the incentive provided by ROCs should incentivise CHP over power only where there is a heat demand. The industry is important as it has a significant role to play in waste management, helping to avoid landfill and its associated greenhouse gas emissions.

10.8 *Consumer costs (statutory factor (e))*

- RO support costs to consumers from generation by new build and additional capacity EfW with CHP under the RO during the banding review period 2013/14 to 2016/17 reach £17m per year from 2016/17 onwards at the current 1 ROC band, and £8.7m per year from 2016/17 onwards at the proposed 0.5 ROCs banding.

10.9 *Potential contribution to targets arising out of a Community Obligation (statutory factor (f))*

- For context, in 2020 it is thought that large-scale electricity should contribute around 108TWh/y of renewable energy towards the UK's 2020 renewables target. The Pöyry modelling analysis shows new build EfW with CHP over the banding review period at the current 1 ROC band contributes an annual output of 0.5TWh towards the 2020 renewables target, and the same under the proposed 0.5 ROCs.

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[56] eko gen (2011) *From Waste Management to Resource Recovery: A Developing Sector*, available at: http://www.berr.gov.uk/policies/business-sectors/low-carbon-business-opportunities/market-intelligence. Data should be treated with caution due to small sample sizes in survey used to produce the results.

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10.10 EfW without CHP is not supported under the RO because electricity only energy from waste plant are already well established and economically viable. Our analysis suggests that this continues to be the case.

10.11 Our analysis of raw cost evidence from Arup suggests that EfW with CHP is also economically viable without RO support. However, we are aware that EfW with CHP faces a number of barriers which add to the overall risk and indirect costs of the projects, which cannot always be easily measured and fully captured in levelised cost calculations. It can be very difficult for generators to secure long term heat customers, as plants tend to be located further away from heat demands than conventional CHP plants. The value of any heat sales is often discounted by lenders or investors when considering the financing of such projects. Further issues, such as the cost and practical feasibility of fuel sampling, and the need for investment in infrastructure to deliver heat to the customer, can also prevent the development of EfW with CHP. Costs are also heavily influenced by gate fees which industry report vary widely.

10.12 Such barriers have resulted in a relatively low level of deployment to date with only four plants accredited under the CHP Quality Assurance standard. CHP in itself is desirable for its increased efficiency and carbon savings, and therefore it is important to maintain a differential in the economics of EfW with and without CHP.

10.13 We are keen to exploit the potential of EfW with CHP further. In order to encourage investment and offset the risks and indirect costs outlined above, we propose setting RO support at 0.5 ROCs for new accreditations (and additional capacity added) in the banding review period.

10.14 The introduction of the Renewable Heat Incentive (RHI) presents an opportunity to differentiate support for electricity and heat allowing generators to combine ROCs for electricity and RHI tariff support for the heat output. However, in the case of energy from waste plant, this is complicated by the fact that they are only eligible for ROCs if they are CHP. This is not an uplift but a condition of support.

10.15 We have received feedback from stakeholders about the importance of maintaining support for the electricity outputs for the plant, particularly in the early years of projects, when generators are unable to operate at high heat capacities, whilst building up a heat customer base. We therefore propose that the RO should continue to be available to provide support for EfW with CHP from 1 April 2013 to March 2017. As at present, we propose that any EfW with CHP plant accredited under the RO would continue to be ineligible for support under the RHI. Existing and new EfW with CHP plant which choose not to accredit under the RO may be eligible to receive support for their heat outputs from the RHI (subject to compliance with that scheme's conditions).

10.16 We will seek further evidence from industry over the consultation period on the costs and barriers that EfW with CHP operators face when developing their plants. Currently, support is available under the RHI for EfW using municipal waste feedstock. We intend that the development of Phase II of the RHI will include further consideration of EfW with CHP.

Determining the renewable content of wastes

10.17 When wastes comprising of both fossil-derived and renewable materials are utilised for electricity generation, the percentages of renewable and fossil-derived material contained in the waste need to be known for the purposes of calculating the renewable energy output of the generating station[57]. The percentage of renewable material in the waste is termed the 'qualifying percentage'.

10.18 ***Municipal Solid Waste fuels:*** Generating stations using fuels which meet the definition of municipal waste (MSW) have the option to deem the qualifying percentage at 50 per cent. To take advantage of this option, the generator must satisfy Ofgem by reference to information published by certain bodies or initial sampling results, which demonstrate that the fossil derived energy content of the waste is unlikely to exceed 50 per cent of the total energy content. Where an operator believes the qualifying percentage of their MSW fuel is greater than 50 per cent it is open to them to propose fuel measurement and sampling (FMS) procedures that will demonstrate this.

10.19 The European Commission has recently asked Defra to broaden their interpretation of the definition of MSW to include a wider range of waste, in particular additional commercial and industrial waste which has a similar composition to MSW. Bringing more waste into the MSW definition from other waste streams will increase the overall amount of waste that is eligible for deeming.

10.20 This wider interpretation of MSW has been adopted for the RHI and we intend that the same approach should be taken in the RO. This can be implemented through changes in Ofgem's RO guidance which will be updated in due course. In the meantime further details on Ofgem's proposed approach for the RHI are set out in the draft guidance issued for consultation on 24 June.[58]

10.21 Other Fuels: Where a generating station uses a waste fuel which does not meet the definition of MSW, for example a Solid Recovered Fuel (SRF) or Refuse Derived Fuel (RDF), Ofgem requires the qualifying percentage of the fuel to be determined on a monthly basis through FMS procedures. Historically, generating stations have developed FMS procedures utilising the Selective Dissolution Method[59] as a means of determining the qualifying percentage of the fuel.

10.22 In order to ensure generating stations have a wider choice of options as regards determining the qualifying percentage of mixed waste fuels we are working with Defra, industry and Ofgem to develop alternative methodologies in this area. For

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[57] As per Articles 3, 24, 25 and 26 of the RO Order

[58] See paragraphs 4.57 to 4.62 of Ofgem's RHI guidance , volume 1 at; http://www.ofgem.gov.uk/e-serve/RHI/Documents1/RenewableHeatIncentiveGuidanceConsultationVolumeOne.pdf

[59] Although in some cases FMS procedures based on the use of the manual sorting method have also been utilised. Both of these methods are described in EN 15440: 2006 standard 'Solid recovered fuels - Methods for the determination of biomass content' (since superseded by EN 15440: 2011).

example DECC, Defra and the Technology Strategy Board have issued calls for proposals to develop systems and potentially equipment to determine the biomass content of SRF or mixed waste fuels; while Ofgem has recently agreed to consider FMS procedures utilising carbon-14 (C-14) techniques.

Call for Evidence: Determining the renewable content of wastes other than MSW

In the interim, we are keen to simplify arrangements for other types of mixed wastes if this can be justified. Therefore we invite views on whether the deeming approach could be utilised for wastes other than MSW, and what qualifying percentage these could be deemed at. Any proposals will need to be supported by clear evidence regarding how the declared maximum fossil derived energy content might be reliably demonstrated. **(See Question 46 below)**.

Consultation Questions	
44.	**Do you agree with the Arup analysis on costs and potential on EfW with CHP, including the estimates of gate fees used? Please explain your response with evidence.**
45.	**Do you agree that 0.5 ROCS is an appropriate support level for EfW with CHP? Please explain your response with evidence. We would particularly welcome evidence relating to levels of gate fees received by generators and additional capital costs relating to heat offtake.**
46.	**In addition to municipal solid waste, do you consider that there are any other types of wastes which could benefit from provisions deeming their biomass content or benefit from more flexible fuel measurement and sampling procedures? If so, please specify and provide evidence on how we might determine accurately the renewable content of these wastes.**

11. Anaerobic Digestion

Introduction

11.1 It is a key aim of the coalition Government to increase the deployment of energy from waste through Anaerobic Digestion (AD). We recognise that there are significant barriers that must first be overcome. Defra and DECC published on 14 June 2011 the joint industry/government AD Strategy and Action Plan[60]. This sets out an agreed programme of work to increase the uptake of AD. Measures that the government is already taking to resolve some of the non-financial barriers are outlined in the UK Renewable Energy Roadmap.

11.2 AD can play an important role as a means of dealing with organic waste and avoiding, by more efficient capture and treatment, the greenhouse gas emissions that are associated with its disposal to landfill. It can be used to generate electricity, heat or transport fuels (or combinations of each). The process involves the biological conversion of biodegradable organic material by micro-organisms in the absence of oxygen. This results in a reduction in the quantity of organic material and the production of biogas, consisting mainly of methane and carbon dioxide, which can be combusted to generate renewable electricity. It also produces a nutrient-rich digestate that can be used as a fertiliser.

11.3 It is not our policy to encourage crop–based AD, particularly where this is at the expense of food production. However, we recognise that, at farm scale, some crops such as maize, grass silage or whole-crop cereals may be required in combination with slurries to improve the efficiency of the digester. We also recognise that such crops can be grown as part of the normal agricultural rotation and that land is available which is not suitable for food production but which may be used to supply AD.

11.4 If evidence shows large-scale use of crops in AD and a resulting change in land used, we will consider measures to exclude from RO support the large scale use of crops in AD. We are exploring how such a mechanism could work in practice. This is in line with similar commitments given under the Feed-in Tariffs Scheme and the Renewable Heat Incentive.

Cost and Deployment Potential

11.5 The technology is currently under-developed due to relatively expensive capital costs, estimated to be between £1.7 million and £7.3 million per MW for power-only plants (including use of heat for efficient running of the generator) and £1.8-7.7 million per MW for CHP plants[61] (where heat offtake is for a separate activity), coupled with non-financial constraints related to planning, permitting, grid connection, skills and lack of awareness. These non-financial constraints are particularly acute for AD due to the stringent regulation of the feedstocks used to

[60] http://www.decc.gov.uk/en/content/cms/news/gb_anaerobic/gb_anaerobic.aspx
[61] AD CHP plant capex estimated using data from SKM Enviros (2011) – see footnotes 60 and 63

create the biogas, namely sewage, slurries and food waste. In the UK, deployment of AD technologies has lagged behind other EU member states such as Austria, Denmark, Germany and Sweden.

11.6 If these barriers can be resolved, Arup suggest there is maximum technical potential of around **710MW** of installed capacity by 2020. Deployment in 2010 for AD plants using food waste and farm manures was **28MW**, so a significant increase in deployment should be possible.

RO Support

11.7 AD currently receives 2 ROCs per MWh under the RO. There are currently in excess of 25 AD stations accredited under the RO. This seems to suggest that this sector is growing at the current banding level.

Consideration of the statutory factors

11.8 Costs and incomes (statutory factors (a), (b) and (c))

- The cost evidence suggests a required ROC range of 0.4-3.6 for a electricity-only project that starts generating in 2014/15 and a range of 0-3.3 ROCs for a CHP project starting in 2014/15. Our analysis assumes a £10 per MWh input gate fee. As a small scale technology, we expect the main support mechanism for AD to be the Feed-in-Tariff and that only larger scale generation and a little small-scale generation that chooses the RO, will come on through the RO.

11.9 The desirability of securing the long term growth, and economic viability, of the industries associated with this technology (statutory factor (d))

- According to data from and eko gen report for the Department of Business[62], the energy from waste sector already employs around 11,000 people, and generates around £1bn per year of gross value added. This would be expected to grow in line with energy from waste deployment. According to the report, the energy recovery sector has the highest value added per employee in the waste management sector at around £100,000. AD would only represent a proportion of both current and future energy from waste (energy from waste also includes incineration and ACT) employment and value added. The industry is important as it has a significant role to play in waste management, helping to avoid landfill and its associated greenhouse gas emissions.

11.10 Consumer costs (statutory factor (e))

- RO support costs to consumers from new build under the RO are £4m from 2016/17 onwards. This cost is associated with uptake under the Northern Ireland

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[62] eko gen (2011) *From Waste Management to Resource Recovery: A Developing Sector*, available at: http://www.berr.gov.uk/policies/business-sectors/low-carbon-business-opportunities/market-intelligence. Data should be treated with caution due to small sample sizes in survey used to produce the results.

Renewables Obligation, while costs are zero under the RO in Great Britain in the Pöyry modelling as all new capacity in the modelling is assumed to accredit under FITs.[63] If it were all to choose the RO instead, which presents arguably an upper bound for the RO cost of AD, it would reach around £98m per year from 2016/17 onwards at 2 ROCs/MWh and £96m per year from 2016/17 onwards at the declining marginal rate.

11.11 *Potential contribution to targets arising out of a Community Obligation (statutory factor (f))*

- For context, in 2020 it is thought that large-scale electricity should contribute around 108TWh/y of renewable energy towards the UK's 2020 renewables target.

- Arup evidence suggests that all the available AD potential is in stations with less than 5MW of capacity, which are therefore eligible for the FIT. Some stations may choose to come on under the RO, or be slightly above the 5MW FIT threshold. Assuming the FIT will be the preferred financial mechanism by investors in Great Britain, the only AD uptake under the RO takes place in Northern Ireland, which has higher rates for AD micro-generation. This gives new build over the banding review period of 4.2 MW that would be expected to contribute around 0.03TWh towards the 2020 renewables target.

11.12 We **propose to retain the current band for AD at 2 ROCs until the end of March 2015 and then to reduce it to 1.9 ROCs for new accreditations (and additional capacity added) in 2015/16 and 1.8 ROCs in 2016/17** in step with the level of support proposed for the marginal technology (offshore wind). We do not believe it would be value for money for the purpose of meeting our 2020 renewables target to provide RO support for large scale AD (or for AD with CHP) at a level which exceeds the level of RO support proposed for offshore wind (the marginal technology for meeting the 2020 renewables target).

Consultation Questions	
47.	**Do you agree with the Arup analysis on costs and potential on AD and AD with CHP, including the estimates of gate fees used? Please explain your response with evidence.**
48.	**Do you agree with the proposed level of 2 ROCs/MWh for Anaerobic Digestion, stepping down to 1.9 ROCs in 2015/16 and 1.8 ROCs in 2016/17? Please explain your response with evidence.**

[63] Installations from 50kW-5MW have a one-off choice between support under FITs and support under the RO.

12. Advanced Conversion Technologies (Gasification and Pyrolysis)

Introduction

12.1 Advanced conversion technologies (ACT) treat waste and biomass fuel to produce syngas and/or liquid fuels which can be used to generate electricity. ACTs have the potential, in the longer term, to produce a wide range of energy outputs – electricity, heat and liquid fuels as well as biomethane and renewable low carbon chemicals. These technologies fall into two main groups: gasification and pyrolysis.

12.2 ACT experience and deployment to date is small. Gasification and pyrolysis are well known concepts that have been used in combination with homogeneous feedstocks, such as coal, for many years. However, they are still considered to be emerging and unproven technologies for the treatment of waste biomass and mixed municipal waste where there are number of technical issues to resolve, for example, achieving intended throughput and air emission standards.

12.3 To our knowledge, there are very few gasification and pyrolysis plants operating at a fully commercial scale in Europe and world-wide, although a number of international companies are working on projects, some of which are large in scale. There appears to be significant interest in ACTs in the UK and there are a number of companies looking to invest in the area.

Costs and Deployment Potential

12.4 Due to the immaturity of the technologies, capital costs are high, at £2.4-7.8 million per MW for power-only plants installed in 2010, according to Arup's analysis, and investors place a high risk premium on ACTs. Even without considering financial feasibility, Arup do not anticipate rapid deployment of ACTs in the next decade. Arup estimated that cumulative installed capacity by 2020 would be up to 35MW and up to 50MW by 2030 under high maximum build rates. Arup also estimated potential generation costs for ACT CHP plants, but judged there was no deployment potential.

12.5 However, because of the nascent state of the sector, we recognise that there are uncertainties around these projections. Feedback from stakeholders suggests that that there is significant future potential for deployment to grow in the 2020s. To realise this we need to encourage innovation, development of the knowledge base and a greater ability to resolve technical difficulties. The review of waste policy in England[64], published on 14 June 2011, recognised the role that ACTs can play in meeting waste management objectives and maximising the energy generated from residual waste, and set out a number of actions aimed at facilitating deployment. These included support for innovation and demonstration, examining the scope for

[64] http://www.defra.gov.uk/publications/files/pb13540-waste-policy-review110614.pdf

the forthcoming Green Investment Bank to provide support for high risk innovative waste projects, and improving access to commercial and industrial waste.

12.6 It is expected that ACT technology will evolve in stages. The lowest risk solution, and the one the industry is currently pursuing in the main, focuses on direct combustion of syngas to produce electricity and heat, usually through Rankine steam processes. As technology improves, it is hoped that the plant can progress to using more efficient gas turbines, internal combustion engines and combined cycle processes and ultimately reach a stage where they can reliably deliver a wider range of low carbon energy outputs. The key technical difficulty involves cleaning and reacting the syngas to a standard that will allow it to be used in these more efficient processes.

RO Support

12.7 Gasification and pyrolysis technologies are both currently included in the RO and are defined as:

- **"Gasification"** means the substoichiometric oxidation or steam reformation of a substance to produce a gaseous mixture containing two or all of the following: methane, hydrogen and oxides of carbon;

- **"Pyrolysis**" means the thermal degradation of a substance in the absence of any oxidising agent (other than that which forms part of the substance itself) to produce char and one or both of gas and liquid

12.8 There are currently two bands – standard and advanced – for each technology, defined and differentiated by the calorific output of the syngas or liquid fuel produced and used to generate electricity. In this chapter, syngas refers to the gas produced from waste or biomass by means of gasification or pyrolysis. The current bands are defined as follows:

- **"standard gasification**" means electricity generated from a gaseous fuel which is produced from waste or biomass by means of gasification, and has a gross calorific value when measured at 25 degrees Celsius and 0.1 megapascals at the inlet to the generating station which is at least 2 megajoules per metre cubed but is less than 4 megajoules per metre cubed.

- **"standard pyrolysis**" means electricity generated from a gaseous fuel which is produced from waste or biomass by means of pyrolysis, and has a gross calorific value when measured at 25degrees Celsius and 0.1 megapascals at the inlet to the generating station which is at least 2 megajoules per metre cubed but is less than 4 megajoules per metre cubed.

- **"advanced gasification**" means electricity generated from a gaseous fuel which is produced from waste or biomass by means of gasification, and has a gross calorific value when measured at 25 degrees Celsius and 0.1 megapascals at the inlet to the generating station of at least 4 megajoules per metre cubed.

- **"advanced pyrolysis"** means electricity generated from a liquid or gaseous fuel which is produced from waste or biomass by means of pyrolysis and

  a) in the case of a gaseous fuel, has a gross calorific value when measured at 25 degrees Celsius and 0.1 megapascals at the inlet to the generating station of at least 4 megajoules per metre cubed, and

  b) (b) in the case of a liquid fuel, has a gross calorific value when measured at 25 degrees Celsius and 0.1 megapascals at the inlet to the generating station of at least 10 megajoules per kilogram.

12.9 The calorific values for the 'advanced pyrolysis' and 'advanced gasification' bands were introduced in 2009 and set at a level which was considered necessary to allow the syngas or liquid produced to be used independently rather than directly combusted, and to clearly separate the technology from incineration. The standard pyrolysis and standard gasification bands with lower calorific value requirements were included to encourage industry to bring forward projects in which it had already invested, in anticipation of ROC support, but which would not be able to meet the new criteria for advanced pyrolysis and advanced gasification. Individual plant can move between the standard and advanced bands on a monthly basis, depending on the calorific value of their energy outputs.

12.10 Although these banding arrangements were designed to encourage more innovative and efficient forms of energy generation, we have seen little evidence that this is working, particularly given the limited deployment projections. In addition, analysis by Arup indicated that a number of gasification plants in operation or in planning are still intending to use the more straightforward means of generating electricity based on Rankine steam processes and that in some cases it will be possible to achieve the current definition of advanced pyrolysis or advanced gasification without the use of more complex innovative technologies.

12.11 We are therefore proposing to replace the standard and advanced pyrolysis and gasification bands with two new ACT bands in line with our policy objectives to ensure that support is differentiated between generating electricity using external combustion engines (such as Rankine cycles) and those more innovative versions of the technologies, which can produce a syngas or liquid capable of generating electricity using more efficient internal combustion engines such as gas turbines, and which have the potential to produce a wider range of energy outputs and products.

12.12 We recognise that a key benefit of developing ACTs is the contribution that they can make to producing sustainable transport biofuels that are suitable for road transport and for aviation. In order to increase the capacity for delivering these biofuels in the medium term, we propose to expand eligibility under the two new ACT bands to include liquid fuels that are produced by further chemical or biological processing of the syngas produced from pyrolysis or gasification and used to generate electricity.

New standard ACT band

12.13 We consider that there is merit in continuing to support the more standard types of ACT (which do not use internal combustion engines), as these can provide an important first step in the technical development of the more innovative versions of the technologies.

12.14 We are proposing that the new standard ACT band would cover electricity generated from a gaseous or liquid fuel produced from waste or biomass by means of gasification or pyrolysis. This would include electricity generated using steam cycles (Rankine cycles). It would also cover electricity generated from a liquid fuel produced from syngas. There would be no need to comply with current minimum gross calorific value requirements for the gaseous or liquid fuel. This is in line with the approach taken in the RHI.

Consideration of the statutory factors

12.15 Costs and incomes (statutory factors (a), (b) and (c))

- Arup have provided cost information on ACT, which they believe to be representative of costs for the current definitions of advanced pyrolysis and advanced gasification. However, we have also had feedback that they may be more representative of costs for the current definitions of standard pyrolysis and standard gasification. Therefore, we need to be cautious when interpreting the available data.

- If the Arup cost data is representative of the current standard pyrolysis and standard gasification bands, then the required ROC range is 0 to 0.4 ROCs. The ROC range includes a gate fee of £75/t, or £29/MWh fuel input, that ACT plants are assumed to receive. However, the evidence on gate fees is not clear cut (i.e. gate fees could be lower, which could justify more ROC support). It is also thought that the new standard ACT band may include some new projects that would previously have qualified for the current definitions of advanced gasification and advanced pyrolysis, but do not qualify for the new advanced ACT band. This would suggest that the top end of the required ROCs range may be higher than 0.4 ROCs for the new standard ACT band.

12.16 The desirability of securing the long term growth, and economic viability, of the industries associated with this technology (statutory factor (d))

According to data from and eko gen report for the Department of Business[65], the energy from waste sector already employs around 11,000 people, and generates around £1bn per year of gross value added. This would be expected to grow in line with energy from waste deployment. According to the report, the energy recovery sector has the highest value added per employee in the waste management sector at around £100,000. ACT would only represent a small proportion of both current and future energy from waste (energy from waste also includes incineration and ACT) employment and value added, The industry is important as it has a significant

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[65] eko gen (2011) *From Waste Management to Resource Recovery: A Developing Sector*, available at: http://www.berr.gov.uk/policies/business-sectors/low-carbon-business-opportunities/market-intelligence. Data should be treated with caution due to small sample sizes on

role to play in waste management, helping to avoid landfill and its associated greenhouse gas emissions.

12.17 *Consumer costs (statutory factor (e))*

- The current standard gasification and standard pyrolysis bands are supported at 1 ROC. If all the potential coming through in the Pöyry modelling was from standard ACT, support costs from new build under the RO during the banding review period 2013/14 to 2016/17 reach £2.3m per year from 2016/17 onwards at 1 ROC and £1.1m per year from 2016/17 onwards at 0.5 ROCs. However, it is believed that a large proportion of the Arup potential from ACT is advanced ACT.

12.18 *Potential contribution to targets arising out of a Community Obligation (statutory factor (f))*

- New build of ACT (covering both standard and advanced) in the Pöyry modelling during the banding review period contributes an annual output of 0.06TWh towards the 2020 renewables target, both under proposed and current bands. For context, in 2020 it is thought that large-scale electricity should contribute around 108TWh/y of renewable energy towards the UK's 2020 renewables target.

12.19 We **propose that electricity generated under the new standard ACT band should be eligible to receive 0.5 ROCs/MWh**, which may be enough to bring on most to all of the potential in this relatively cost-effective renewable technology. **However, we are calling for additional evidence on the costs, gate fees and deployment potentials of generating plant falling within the new standard ACT band.** The new standard ACT band would apply to new accreditations (and additional capacity added) on or after 1 April 2013.

New advanced ACT band

12.20 We are proposing that the new advanced ACT band would cover electricity generated by an internal combustion engine from a gaseous or liquid fuel produced from waste or biomass by means of gasification or pyrolysis. It would also cover electricity generated by an internal combustion engine from a liquid fuel produced from syngas.

12.21 The main distinction between the advanced ACT band and the standard ACT band is that under the advanced ACT band, the electricity must be generated by an internal combustion engine (such as a gas turbine). In addition we propose that the advanced ACT band would also cover the additional electricity generated using the waste heat captured from the internal combustion engine. This should help to encourage further innovation by supporting more efficient ACTs which are extracting the maximum energy value from the waste/biomass feedstocks used, such as for example integrated gasification or combined cycle operations and which have genuine potential to produce the range of fuels and outputs outlined above.

12.22 To maximise flexibility of fuel use, it is our intention that the liquid fuels produced from pyrolysis or from upgrading syngas do not need to be used immediately, but can be stored and used on the same site or at a different site.

RO Support

Consideration of the statutory factors

12.23 *Costs and incomes (statutory factors (a), (b) and (c))*

- Arup have provided cost information on ACT, which they believe to be representative of costs for the current definition of advanced pyrolysis and advanced gasification. However, we have also had feedback that they may be more representative of the costs of standard pyrolysis and standard gasification. Therefore, we need to be cautious when interpreting the available data.

- The assumed gate fee for ACT is £29/MWh of fuel input.

- Costs for advanced ACT are expected to be much higher than for standard ACT.

12.24 *The desirability of securing the long term growth, and economic viability, of the industries associated with this technology (statutory factor (d))*

According to data from and eko gen report for the Department of Business[66], the energy from waste sector already employs around 11,000 people, and generates around £1bn per year of gross value added. This would be expected to grow in line with energy from waste deployment. According to the report, the energy recovery sector has the highest value added per employee in the waste management sector at around £100,000. ACT would only represent a small proportion of both current and future energy from waste (energy from waste also includes incineration and ACT) employment and value added. The industry is important as it has a significant role to play in waste management, helping to avoid landfill and its associated greenhouse gas emissions.

12.25 *Consumer costs (statutory factor (e))*

- The current advanced gasification and advanced pyrolysis bands are supported at 2 ROCs. If all the potential coming through in the Pöyry modelling was from advanced ACT, RO costs to consumers from new build under the RO during the banding review period 2013/14 to 2016/17 reach £4.5m per year from 2016/17 onwards at 2 ROCs, and £4.4m per year from 2016/17 onwards with support declining as proposed to 1.9 ROCs/MWh for accreditations in 2015/16. However, it is likely that some proportion of the potential from ACT is standard ACT.

[66] eko gen (2011) *From Waste Management to Resource Recovery: A Developing Sector*, available at: http://www.berr.gov.uk/policies/business-sectors/low-carbon-business-opportunities/market-intelligence. Data should be treated with caution due to small sample sizes in survey used to produce the results.

12.26 *<u>Potential contribution to targets arising out of a Community Obligation (statutory factor (f))</u>*

- New build of ACT (covering both standard and advanced) in the Pöyry modelling during the banding review period contributes an annual output of 0.06TWh towards the 2020 renewables target, both under proposed and current bands.

12.27 Costs for advanced ACT are expected to be much higher than for standard ACT. Therefore, given the important role that we consider these technologies can play in helping to meet a range of renewable energy and climate change objectives up to 2050, **<u>we propose to set support under the new advanced ACT band at 2 ROCs/MWh</u>** for new accreditations (and additional capacity added) between 1 April 2013 and 31 March 2015. The band **<u>would fall to 1.9 ROCs for new accreditations (and additional capacity added) in 2015/16 and to 1.8 ROCs in 2016/17</u>** in line with the levels of support proposed for the marginal technology (offshore wind). 2 ROCs is consistent with the current level of support under the advanced pyrolysis and advanced gasification bands, and these proposals are in line with the support levels proposed for most other relatively expensive forms of generation.

Call for Evidence: Information on costs and deployment potential of ACTs

Because of the small size of the ACT sector, there were limitations in the cost data set that Arup were able to collect for these more innovative versions of ACTs. There were also uncertainties around the information available on gate fees. We would like to understand more about these matters and invite the submission of further evidence on the generation costs, deployment potential and gate fees for the ACT technologies falling within the two new ACT bands. **(See Question 52 below)**.

Call for Evidence: Air quality of pyrolysis oil

There is limited evidence available on the likely air emissions that may result in using pyrolysis oil for electricity generation. We therefore invite information about the nature and scale of actual or potential air emissions produced in the generation of electricity from pyrolysis oil. **(See Question 53 below)**.

Consultation Questions	
49.	**Do you agree with the proposal to replace the standard and advanced pyrolysis and gasification bands with two new ACT bands? Please explain your response with evidence.**
50.	**Do you agree with the eligibility criteria for the new standard ACT and advanced ACT bands? Please explain your response with evidence.**

51.	**Do you agree with the proposed levels of support for the new standard ACT and advanced ACT bands? Please provide evidence on the relevant technology capital and operating costs (including levels of gate fees) to support your comments).**
52.	**We would welcome evidence on the generation costs, deployment potential and gates fees for the ACT technologies falling within the two new ACT bands proposed above.**
53.	**We would welcome information on the nature and scale of actual or potential air emissions produced in the generation of electricity from pyrolysis oil.**

13. Landfill Gas

Introduction

13.1 Landfill gas is a mature and cost effective renewable technology. It has dual benefits of being the single largest technology contributor in the RO as well as significantly reducing greenhouse gas emissions from the waste sector. Modern, operational sites, and those closed after 2001 which are subject to the controls in the Landfill Directive, are under a legal duty to capture and utilise, where possible, landfill gas and most have comprehensive infrastructure in place. Based on the ROCs issued to the sector, landfill gas electricity generation contributed to 4,834GWh in 2009/10.

Cost and Deployment Potential

13.2 In the short term, landfill gas is likely to continue to contribute significantly to renewable electricity generation. However, the Arup report suggests that sector has peaked or is close to peaking. This is due to several key factors. Firstly, appropriate landfill sites in the UK are becoming exhausted. Secondly, the introduction of the Landfill Directive and UK waste policy is diverting biodegradable content from entering landfill. In the future, the increasing prevalence of high yielding treatment technologies (such as AD) will help divert further biodegradable resource.

13.3 Therefore, in the medium to long-term, Arup suggest generation capacity will reduce by more than half over the next 10 to 15 years. By 2020, we expect capacity to have reduced from around 1GW now to just above 400MW on the central scenario, and to drop away to zero towards the end of the next decade.

13.4 DECC levelised costs, based on capital and operating costs data obtained by Arup, show modest costs which remain flat from 2010 out to 2030 at £45/MWh.

RO Support

Consideration of the statutory factors

13.5 Costs and incomes (statutory factors (a), (b) and (c))

- The evidence based on Arup costs and a zero gate fee suggests 0 ROCs are required (i.e. no support).

13.6 The desirability of securing the long term growth, and economic viability, of the industries associated with this technology (statutory factor (d))

- Arup evidence indicates that there is no or very limited new landfill gas deployment potential. If this is correct, then limitations in available data are less likely to impact on future cost estimates.

13.7 Consumer costs (statutory factor (e))

- RO costs to consumers from new build under the RO during the banding review period 2013/14 to 2016/17 are zero as there is no new build in the modelling. This is because there is not thought to be any significant further deployment potential.

13.8 Potential contribution to targets arising out of a Community Obligation (statutory factor (f))

- According to the Arup evidence, there is no further deployment potential for landfill gas arising from sites governed by the Landfill Directive.

13.9 Landfill gas is a highly cost effective technology and it **has a valuable role to play in the short term.** It currently receives 0.25 ROCs per MWh of support. The Arup report suggests that new landfill gas generation from post-2001 sites is now viable without RO support. **Therefore, we propose to end support for landfill gas from 1 April 2013 for generating stations that are not accredited (and additional capacity which is not added) before that date.**

13.10 Landfill sites that closed before 2001 are not subject to the regulatory controls of the Landfill Directive and so are not under a statutory obligation to capture and utilise the gas. These number some 23,000 sites. According to modelling by Defra, many of these are still emitting large quantities of methane. There potentially exists a substantial, though harder to extract, resource for renewable energy that is currently not being exploited[67]. The technologies which could exploit the poorer quality gas produced at these sites and which could extract further reserves from existing sites once these become less economic, are currently under trial. The extent to which these technologies could cost-effectively exploit these older reserves, is unknown. It was not, therefore, possible to determine whether and at what level support for these technologies could be provided under the RO.

Call for Evidence: Pre-2001 landfill sites
We invite evidence on new technologies that can increase the technical potential of landfill gas in the UK, particularly from older landfill sites. Information on the costs, potential and viability of new technologies would be particularly valuable. **(See Question 56 below)**.

[67] SKM Enviros (2011) *ANALYSIS OF CHARACTERISTICS AND GROWTH ASSUMPTIONS REGARDING AD BIOGAS COMBUSTION FOR HEAT, ELECTRICITY AND TRANSPORT AND BIOMETHANE PRODUCTION AND INJECTION TO THE GRID*, available at: http://www.decc.gov.uk/en/content/cms/meeting_energy/renewable_ener/incentive/incentive.aspx

Consultation Questions	
54.	**Do you agree with the Arup assessment of generation costs and deployment potential of landfill gas, and the gate fee assumption of zero? Please explain your response with evidence.**
55.	**Do you agree that RO support for new landfill gas generation should end from 1 April 2013? Please explain your response with evidence.**
56.	**We would welcome evidence on new technologies that can increase the technical potential of landfill gas in the UK, particularly from older landfill sites. Information on the costs, potential and viability of new technologies would be particularly valuable.**

14. Sewage Gas

Introduction

14.1 Sewage gas is a mature renewable technology that uses biogas produced by the anaerobic digestion (AD) of sewage sludge. The process is widely used in the water industry with some 66% of sewage sludge treated with AD.

Cost and Deployment Potential

14.2 The Arup report suggests that increased deployment is relatively limited, estimating that there is a maximum technical potential of 175 MW of installed generation capacity, compared to an estimated existing installed capacity of 94.5 MW. As a cost-effective form of renewable electricity the Government is keen to bring forward the remaining generation potential.

14.3 The main capital cost of sewage gas-based renewable technologies is the combustion engine needed to generate electricity. According to Arup's analysis, costs appear to have changed little since the last banding review, and range from £2.3 million to £5.9 million per MW of installed capacity in 2010. Central levelised costs for sewage gas, at £81/MWh in 2010, falling slowly thereafter, are significantly higher than for landfill gas but substantially lower than for AD.

RO Support

Consideration of the statutory factors

14.4 *Costs and incomes (statutory factors (a), (b) and (c))*

- Sewage gas currently receives 0.5 ROCs/MWh. The analysis based on Arup cost evidence suggests a required ROC range of 0 to 1.9 ROCs. We propose to retain the level of support at 0.5 ROCs as we believe this is necessary to bring on the most cost-effective portion of the potential available supply and to encourage reinvestment in older, less efficient AD plant or where biogas is not currently used to generate electricity but flared.

14.5 *The desirability of securing the long term growth, and economic viability, of the industries associated with this technology (statutory factor d)*

- According to data from an eko gen report for the Department of Business[68], the energy from waste sector currently employs around 11,000 people, and

[68] eko gen (2011) *From Waste Management to Resource Recovery: A Developing Sector*, available at: http://www.berr.gov.uk/policies/business-sectors/low-carbon-business-opportunities/market-intelligence.

Data should be treated with caution due to small sample sizes in survey used to produce the results.

generates around £1bn per year of gross value added. This would be expected to grow in line with energy from waste deployment. According to the report, the energy recovery sector has the highest value added per employee in the waste management sector at around £100,000. Sewage gas would only represent a small proportion of both current and future energy from waste (energy from waste also includes incineration and ACT) employment and value added. The industry is important as it has a significant role to play in waste management, helping to avoid greenhouse gas emissions associated with the treatment of sewage sludge.

14.6 *Consumer costs (statutory factor (e))*

- RO support costs to consumers from new build under the RO during the banding review period reach £0.9-1.2m per year from 2016/17 onwards at 0.5 ROCs.

14.7 *Potential contribution to targets arising out of a Community Obligation (statutory factor (f))*

- For context, in 2020 it is thought that large-scale electricity should contribute around 108TWh/y of renewable energy towards the UK's 2020 renewables target.
- Our modelling suggests that new build sewage gas under the RO during the banding review period would contribute an annual output of 0.04-0.06TWh towards the 2020 renewables target at 0.5 ROCs.[69]

14.8 We **propose to maintain support for this technology at 0.5 ROCs/MWh**.

14.9 We understand that industry are developing new technologies that can generate electricity more efficiently from sewage gas and hence increase the suggested technical potential. We are keen to hear about these technologies and are issuing a call for evidence on the costs and constraints involved, as well the commercial viability of the technologies. We are also interested in whether there is potential cogeneration.

Call for Evidence: Increasing generation potential from sewage gas

We invite information on new technologies that can increase the technical potential from sewage gas in the UK. We are also interested in whether there is potential cogeneration. Information on the costs, potential and viability of new technologies will be particularly valuable. **(See Question 59 below)**.

[69] The deployment range of 7 to 10 MW in the banding review period (and resulting generation and RO support cost ranges) comes from DECC in-house analysis of using DECC central hurdle rates on the low side, and the Pöyry modelling using higher hurdle rates on the high side. Using DECC new fossil fuel prices could also increase sewage gas deployment by a further 1.2MW, around 0.01TWh/y of generation at an annual RO support cost of around £0.1m.

Consultation Questions	
57.	**Do you agree with the Arup assessment of generation costs and deployment potential for sewage gas, and the zero gate fee used in the analysis? Please explain your response with evidence.**
58.	**Do you agree that 0.5 ROCs/MWh is an appropriate level of support for electricity generated from sewage gas? Please explain your response with evidence.**
59.	**We would welcome evidence on new technologies that can increase the technical potential from sewage gas in the UK. We are also interested in whether there is potential cogeneration. Information on the costs, potential and viability of new technologies would be particularly valuable.**

15. Renewable Combined Heat and Power (CHP)

Introduction

15.1 Currently the RO provides extra support, or "uplift", where CHP is used with the following technologies; co-firing of biomass, co-firing of energy crops, dedicated biomass and dedicated energy crops. Each of these bands gives 0.5 ROCs/MWh more support than the equivalent band without combined heat and power up to a ceiling of 2 ROCs/MWh. This uplift acknowledges the additional capital costs associated with CHP, but rewards the electrical output of the generator, rather than heat. Energy from waste with CHP is a special case and is covered in chapter 10. Those stations which would otherwise be eligible for the RHI, are ineligible for support under the RHI if they use solid biomass to generate heat and electricity and are, or have been at any time, in receipt of the RO CHP uplift.

15.2 The introduction of the RHI presents an opportunity to differentiate support for electricity and heat allowing generators to combine ROCs for electricity and RHI tariff support for the heat output in line with the approach already taken allowing generators to combine RHI and FITs support.

15.3 Our view is that such a split would be the clearest, and most effective, policy outcome. However, we realise that an immediate removal of the CHP uplift from 1 April 2013 could disrupt projects which have built business cases on the basis of current RO support.

Dedicated biomass with CHP

15.4 We recognise the need to encourage deployment of both the larger, more cost effective generators as well as the smaller, more localised, bioenergy plants. Larger biomass plants are limited by the need for either a port location or a significant transport infrastructure for their biomass fuel and may also find it harder to secure an off-taker for any renewable heat. We therefore would not expect many of them to be CHP plants.

15.5 Smaller generators are more likely to be able to locate where they can establish a local biomass supply chain and where there may be increased opportunities to be CHP. Such local supply chains are important in helping to tap the potential of underused biomass resources within the UK.

RO support

Consideration of the statutory factors

15.6 <u>Costs and incomes (statutory factors (a), (b) and (c))</u>

- Cost evidence suggests a ROC range of 4.2-5.3ROCs. This is based on the stakeholder information provided to Arup, which was for a particular large CHP set-up. Anecdotal evidence suggests there may be more biomass CHP potential at lower capacities, which might rely on cheaper, local fuel supplies. Given the limited evidence Arup were able to collect, we would welcome further evidence on biomass CHP costs.

15.7 *The desirability of securing the long term growth, and economic viability, of the industries associated with this technology (statutory factor (d))*

- Small-scale biomass is more likely to use locally sourced biomass, which should be sustainable and develop jobs in growing and transporting biomass. However, use by the power sector may reduce the quantity of biomass available at given prices for use in the heat sector and in other industries. The relatively moderate level of deployment expected at 2 ROCs/MWh is less likely to cause problems in other industries, but it should be noted that the Pöyry model is constrained not to exceed the available supply of sustainable biomass, net of projected demands from heat, transport and other biomass-using sectors, both globally and in the UK.

15.8 *Consumer costs (statutory factor (e))*

- RO support costs from new build of dedicated biomass with CHP under the RO during the banding review period 2013/14 to 2016/17 come to £4.6m per year from 2016/17 onwards under both current bands (2 ROCs/MWh) and the proposed declining rate (falling to 1.9 ROCs/MWh in 2014/15 and 1.8 in 2015/16). It relates to new build which is already in construction. Other new build is not financially viable at the assumed costs..

15.9 *Potential contribution to targets arising out of a Community Obligation (statutory factor (f))*

- For context, in 2020 it is thought that large-scale electricity should contribute around 108TWh of renewable energy towards the UK's 2020 renewables target. At the current banding of 2 ROCs/MWh in the Pöyry model, we get new build of dedicated biomass with CHP under the RO over the banding review period which contributes an annual output of 0.06TWh towards the 2020 renewables target.

15.10 We therefore propose:

- to keep the CHP uplift at 0.5 ROCs for dedicated biomass, dedicated energy crops, co-firing of biomass and co-firing of energy crops. The uplift would therefore remain the same for all of these technologies subject to the overall cap of 2 ROCs on support, as now. We invite further evidence to help us decide whether we should extend the CHP uplift to the proposed new biomass conversion and enhanced co-firing bands;

- to provide a transition period during which developers will have a one-off choice between the CHP uplift or RHI support (if they are eligible under the terms of the

RHI). The transition period will run from 1 April 2013 to 31 March 2015 and will be available only to new accreditations and new additional capacity added between those dates. This will give developers and investors time to understand the support available under the RHI, and the interaction with the RO, while preventing them from receiving a double subsidy of CHP uplift and RHI. Generating capacity which chooses to receive the CHP uplift will be ineligible for the RHI;

- to grandfather the CHP uplift[70] from 1 April 2013 for all stations accredited before that date and which have at any time claimed the CHP uplift, and from 1 April 2015 for new accreditations and new additional capacity choosing to receive the CHP uplift before that date. We believe this is appropriate because such plants will have established plans around the RO support rather than the RHI, for which they will not be eligible in any case. Grandfathering the CHP uplift should also increase certainty for investors, encouraging a greater deployment of CHP;

- that from 1 April 2015, new accreditations and new additional capacity will not be eligible for the CHP uplift, but may receive the relevant level of support for their electricity output from the RO and for their heat output from the RHI, subject to satisfying the respective eligibility requirements of those schemes;

- that any technologies or energy sources currently eligible to receive the CHP uplift which are not eligible for the RHI on 1 April 2015, will remain eligible to apply to receive the CHP uplift until 2017. The ceiling for the total level of RO support is proposed to fall from the current 2 ROCs, to 1.9 ROCs for new accreditations (and additional capacity added) in 2015/16 and 1.8 ROCs in 2016/17. Subject to affordability and feasibility, RHI support may be extended to include additional technologies and energy sources in Phase II of the scheme. Our proposals for Energy from Waste with CHP are discussed separately in chapter 10;

- that in order to qualify for the CHP uplift, projects will continue to require accreditation as under the Combined Heat and Power Quality Assurance Standard;

- We have decided not to offer a choice between the CHP uplift and the RHI support to existing generating stations already accredited in a RO CHP band, because they will have been in receipt of the CHP uplift and offering a choice would slightly increase administration costs for the RO and RHI. In our consultation on the Renewables Obligation (Amendment) Order 2011 we proposed that generating stations accrediting between 15 July 2009 and 31 March 2013 should be offered a choice. However, we are now proposing that the transition period for new generating stations should end on 31 March 2015, and start on 1 April 2013, in line with the start of the banding review period.

[70] Note that by 'grandfathering the CHP uplift', we mean grandfathering stations accredited under the 'with CHP' bands at the rates applicable to those bands, e.g. grandfathering at 2 ROCs/MWh for stations accredited under the biomass with CHP bands [when they operate in that mode].

15.11 In conclusion, in order to ensure value for money for consumers, the maximum available support will be set at the level needed to ensure the deployment of the marginal technology – i.e. the most expensive technology that we need to support in order to meet the 2020 target. We therefore **propose to retain support for this band at its current level of 2 ROCs for stations claiming the CHP uplift before 1 April 2015**. In accordance with our policy proposals set out above, we **propose to adopt a policy of grandfathering this support from 1 April 2013** and **to close the band to new accreditations and additional capacity added on or after 1 April 2015**.

Dedicated energy crops with CHP

RO support

Consideration of the statutory factors

15.12 Costs and incomes (statutory factors (a), (b) and (c))

- Cost evidence suggests a ROC range of 4.2-5.3 ROCs. This is based on the stakeholder information provided to Arup, which was for a particular large CHP set-up. Anecdotal evidence suggests there may be more biomass CHP potential at lower capacities, which might rely on cheaper, local fuel supplies. However, even if this is the case, it is still likely much of the potential would require more than 2 ROCs to be built.

15.13 *The desirability of securing the long term growth, and economic viability, of the industries associated with this technology (statutory factor (d))*

- There are jobs associated with the existing small energy crops industry, which could be safeguarded, and there may be scope for the industry to be significantly expanded. Grandfathering can provide the long term price signal which will support investment over a 10-15 year period and protect existing investment in energy crops. However, no significant impacts are expected at 2 ROCs/MWh as the deployment potential at this banding level is assumed to be small in the short term.

15.14 *Consumer costs (statutory factor (e))*

- RO support costs from new build under the RO during the banding review period 2013/14 to 2016/17 are zero as the modelling does not show any new build at 2 ROCs/MWh.

15.15 Potential contribution to targets arising out of a Community Obligation (statutory factor (f))

- No deployment is expected from energy crops with CHP at the proposed banding level.

- The use of energy crops is beneficial to diversify the feedstock base, create jobs in the energy crops industry and limit competition with other biomass using industries. However, it is not considered sufficient to justify a banding above the marginal cost of meeting the renewables target.

15.16 We therefore **propose to retain this band at its current level of 2 ROCs, for stations claiming the CHP uplift before 1 April 2015**. In accordance with our policy proposals set out above, **we propose to adopt a policy of grandfathering this support from 1 April 2013 and to close the band to new accreditations and additional capacity added on or after 1 April 2015**.

Standard co-firing of biomass with CHP

RO support

Consideration of the statutory factors

15.17 Costs and incomes (statutory factors (a), (b) and (c))

- Based on cost evidence gathered by Mott MacDonald, which Arup believe to be the best available source of evidence on co-firing CHP, combined with the latest assumptions on biomass fuel prices from AEA (2010), and electricity prices from the Pöyry modelling, according to in-house DECC analysis suggest a central level of 1 ROC required to break even and allow investment to proceed. Pöyry modelling confirmed that deployment would proceed at 1 ROC.

15.18 *The desirability of securing the long term growth, and economic viability, of the industries associated with this technology (statutory factor (d))*

- Increases in biomass co-firing should help build the global biomass supply chain. But use by the power sector may reduce the quantity of biomass available at given prices for use in the heat sector and in other industries. The relatively moderate level of deployment expected at 1 ROC/MWh is less likely to cause problems in other industries, but it should be noted that the overall use if biomass in the Pöyry model is constrained not to exceed the available supply of sustainable biomass, net of projected demands from the heat and transport sectors, and all other industries using wood, whether globally or in the UK.

15.19 *Consumer costs (statutory factor (e))*

- RO support costs of generation from standard co-firing of biomass with CHP under the RO during the banding review period 2013/14 to 2016/17 reach £5.8m per year (£12m total CoCHP annual RO support cost including un-grandfathered build before the banding review period).

15.20 Potential contribution to targets arising out of a Community Obligation (statutory factor (f))

- For context, in 2020 it is thought that large-scale electricity should contribute around 108TWh of renewable energy towards the UK's 2020 target. The Pöyry modelling shows new standard co-firing of biomass with CHP coming on at 1ROC/MWh over the banding review period contributes an annual output of 0.14TWh towards the 2020 renewables target.

15.21 We are therefore **proposing to keep the band at its current level of 1 ROC for stations claiming the CHP uplift before 1 April 2015**. In accordance with our policy proposals set out above, **we propose to adopt a policy of grandfathering the CHP uplift element of the support under this band form 1 April 2013 (the CHP uplift element is 0.5 ROCs)** and to **close the band to new accreditations and additional capacity added on or after 1 April 2015.**

Standard Co-firing of energy crops with CHP

RO support

Consideration of the statutory factors

15.22 Costs and incomes (statutory factors (a), (b) and (c))

- Assuming that energy crops could be used as fuel in the CoCHP set-up described by Mott Macdonald (2010), combined with the latest assumptions on biomass fuel prices, based on AEA (2010), and electricity prices from the Pöyry modelling, suggests a central level of 2.9 ROC required to break even and allow investment to proceed.

15.23 *The desirability of securing the long term growth, and economic viability, of the industries associated with this technology (statutory factor (d))*

- There are jobs associated with the existing small energy crops industry, which could be safeguarded, and there may be scope for the industry to be significantly expanded. However, no significant impacts are expected here as the deployment potential at 1.5 ROCs/MWh is assumed to be small.

15.24 *Consumer costs (statutory factor (e))*

- RO support costs from standard co-firing of energy crops with CHP under the RO during the banding review period 2013/14 to 2016/17 are zero in the Pöyry modelling, as it does not show any use of energy crops in co-firing with CHP stations at 1.5 ROCs/MWh.

15.25 Potential contribution to targets arising out of a Community Obligation (statutory factor (f))

- No deployment is expected in standard co-firing with CHP stations using energy crops at the proposed banding level.

15.26 Currently standard co-firing of energy crops with CHP receives 1.5 ROCs. The use of energy crops is beneficial to diversify the feedstock base, create jobs in the energy crops industry and limit competition with other biomass using industries. However, we do not have much evidence on the costs and deployment potential of standard co-firing of energy crops with CHP. Therefore, while we propose to continue support under this band at 1.5 ROCs, for stations claiming the CHP uplift before 1 April 2015, we are also issuing a call for further evidence on costs and deployment potential.

15.27 We **propose to adopt a policy of grandfathering the CHP uplift element of the support under this band from 1 April 2013** (the CHP uplift element is 0.5 ROCs) and **to close this band to new accreditations and additional capacity added on or after 1 April 2015**.

Biomass conversion and enhanced co-firing of biomass with CHP

15.28 Elsewhere in this consultation document we proposed creating new bands for biomass conversion and enhanced co-firing with support at 1 ROC each from 1 April 2013. Those proposals were informed by the findings of the Arup report. However, Arup did not collect specific data or examine the potential for these technologies to operate with CHP, and we consider it unlikely that such plant will come forward within the period covered by the banding review, i.e. by 31 March 2017, but more realistically, by 31 March 2015, which is the date on which we propose to end the CHP uplift other than for grandfathered projects. Nevertheless, we do wish to consider whether to extend the CHP uplift to these two new bands for the two years from 1 April 2013, subject to those bands being introduced, and **invite evidence on costs and deployment potential to inform our decision**.

15.29 For example, extending a CHP uplift of 0.5 ROCs to these two new bands would mean that biomass conversion with CHP and enhanced co-firing of biomass with CHP would each receive 1.5 ROCs.

15.30 Furthermore, if we were, for example, to extend both the CHP uplift and energy crop uplift to these two new bands, then if each of these uplifts were set at 0.5 ROCs, energy crop conversion with CHP and enhanced co-firing of energy crops with CHP would each receive 2 ROCs. However, these bands would close to new accreditations and additional capacity added on or after 1 April 2015.

ACT and CHP

15.31 Up until now, no ACT using combined heat and power have been accredited under the RO and the current RO legislation does not include an uplift for CHP. We understand from stakeholders that there are some ACT plants in the pipeline which intend to operate in CHP mode, although Arup were not able to provide any cost or deployment evidence. **We would therefore like to invite views on whether it would be appropriate to introduce a CHP uplift into the RO for ACT and call for evidence on costs and deployment potential**.

15.32 As with other CHP technologies, our policy objective is to eventually differentiate support for electricity and heat allowing generators to combine ROCs for electricity and RHI tariff support for the heat output . We are aware that when the first phase of the RHI is introduced, it will initially only cover biomass and municipal solid waste fuels and only ACT plant up to 200kW thermal capacity will be eligible (unless they are upgrading biogas to biomethane for injection into the grid in which case there is no size limit). We will be reviewing these arrangements later this year with a view to implementing any changes for phase 2 of the RHI.

AD CHP

15.33 In order to maintain efficient biogas production, waste heat from electricity generation in AD plant is usually recycled to the digestion unit. We do not consider such use to be 'CHP' in the standard sense as its purpose is simply to increase the efficiency of performance of the AD unit. However, heat offtake can be added to AD generation where the heat can be used for entirely separate purposes, either on-site, or exported as steam. At the moment such AD CHP is eligible to receive 2 ROCs under the RO, and in some cases may be eligible for the RHI. AD CHP also delivers renewable heat, which counts towards the 2020 renewables target. This means that the level of support per unit of generation counting towards the renewables target is less than the equivalent of 2 ROCs.

15.34 The Arup evidence suggests the deployment potential for AD with CHP is small. Arup were unable to provide cost data for this technology. DECC have estimated AD with CHP capital and operating costs based on a combination of Arup costs for power-only plant and SKM Enviros (2011)[71] costs for CHP plant. The ROCs required for AD with CHP have a very large range at 0-3 ROCs (without RHI support), but lower than for AD. This is due to the DECC heat revenue assumptions being greater than the assumed additional capex, as based on SKM Enviros (2011).

15.35 Given the potential in some cases for AD to receive RHI, and that AD already receives support under the RO at the same level as the marginal technology (offshore wind), we do not proposed to create a separate AD with CHP band.

Consultation Questions	
60.	**Do you agree with the Arup assessment of generation costs and deployment potentials for CHP technologies, and with the fuel prices used in the analysis? Please explain your response with evidence.**
61.	**Do you agree that 2 ROCs/MWh is an appropriate level of support for dedicated biomass with CHP? Please explain your response with evidence.**

[71] SKM Enviros (2011) *ANALYSIS OF CHARACTERISTICS AND GROWTH ASSUMPTIONS REGARDING AD BIOGAS COMBUSTION FOR HEAT, ELECTRICITY AND TRANSPORT AND BIOMETHANE PRODUCTION AND INJECTION TO THE GRID*, available at: http://www.decc.gov.uk/en/content/cms/meeting_energy/renewable_ener/incentive/incentive.aspx

62.	**Do you agree that 2 ROCs/MWh is an appropriate level of support for dedicated energy crops with CHP? Please explain your response with evidence.**
63.	**Do you agree that 1 ROC/MWh is an appropriate level of support for standard co-firing of biomass with CHP? Please explain your response with evidence.**
64.	**Do you agree in principle that 1.5 ROCs/MWh is an appropriate level of support for standard co-firing of energy crops with CHP? It would be helpful if you could provide evidence on costs and deployment potential to inform our decision.**
65.	**Do you agree with the arrangements for transition from the CHP uplift to RHI support as set out in this chapter (i.e. no RHI for projects accrediting under the RO; one-off choice between RHI and CHP uplift for projects accrediting between April 2013 and March 2015; no CHP uplift for projects accrediting after that date, unless the RHI is unavailable for that technology on 1 April 2015)? Please explain your response with evidence.**
66.	**Do you agree that we should adopt a policy of grandfathering the CHP uplift for eligible projects from 1 April 2013? Please explain your response with evidence.**
67.	**Do you agree in principle that we should consider extending the CHP uplift to the new biomass conversion and enhanced co-firing bands until 31 March 2015? It would be helpful if you could provide evidence on costs and deployment potential to inform our decision.**
68.	**Do you consider it would be appropriate to introduce a CHP uplift into the RO for ACTs? If so, please provide evidence on capital and operating costs of plant operating in CHP mode, together with likely deployment potential between now and 2020 and, if possible, 2030?**

16. Energy Crop Uplift

Introduction

16.1 Currently the RO provides additional support, or “uplift”, where energy crops are used under the co-firing of energy crops or dedicated energy crops bands. Each of these bands gives 0.5 ROCs/MWh more support than the equivalent biomass band up to a ceiling of 2 ROCs.

16.2 The aim of this uplift is to develop the supply chain for purpose-grown crops that can substitute for woodfuel. The higher level of support was put in place in part to reflect the additional costs and infrastructure required for the development of these crops, and in part to encourage development of the industry. Since its introduction, we have seen little evidence of the energy crop uplift resulting in a rapid increase in the supply chain. There are several factors behind this, including a reluctance on the part of both energy generators and farmers to enter into long-term contracts and the attractiveness of high cereal prices. Our decision last year to not grandfather the uplift has been cited as another.

16.3 Despite this there are several reasons why we would wish to continue to encourage the use of energy crops:

- 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 we can grow and expand production;
- our wish to minimise the impacts on other biomass (wood) using industries;
- to achieve the security of supply benefits of having a diversity of indigenous biomass sources and supply chains;
- perennials are substantially cheaper and quicker to establish than new woodland; do not cause permanent land use change; and give significantly higher yields with scope to increase this through new varieties;
- land is available without competition with food crops
- they create new opportunities for farmers; and
- it recognises investments already made by farmers, processors and generators.

Definition of energy crops in the RO

16.4 Any crop planted after 31 December 1989 which is grown primarily for the purpose of being used as fuel is currently eligible for the uplift. To date, the vast majority of crops used under the RO have been perennial crops such as Miscanthus and willow. However, there is a risk that food crops could be grown specifically for energy purposes and receive the uplift. Given the concerns over growing food for fuel, this would not be in the spirit of the original policy intent.

16.5 We believe there is merit in continuing to provide an energy crop uplift, but only for non-food crops. We therefore propose to narrow the definition of 'energy crop' to cover only:

- short rotation coppice of the species Alder (Alnus), Birch (Betula), Hazel (Corylus avellana), Ash (Fraxinus excelsior), Lime (Tilia cordata), Sweet chestnut (Castanea sativa), Sycamore (Acer pseudoplatanus), Willow (Salix) or Poplar (*Populus*) and,

- perennial grasses of the species Miscanthus, Panicum or Phalaris

16.6 The crops must also be (a) planted after 31 December 1989 and (b) grown primarily for the purpose of being used as fuel. This is a further tightening of the eligibility criteria for miscanthus giganteus, salix and populus.

Grandfathering the energy crop uplift

16.7 The energy crop uplift is not covered by our current grandfathering policy because the primary costs are fuel costs and as supply chains develop we wanted the flexibility to reduce or remove this uplift. However, given our desire to establish a policy framework within which long-term supply contracts can be established and the other benefits outlined above can be realised, we propose that, from 1 April 2013, we will adopt a policy to grandfather the energy crop uplift.[72] This will mean that only those crops which meet our new, tighter definition will be eligible, so removing a risk that food crops could have become locked into the mechanism. This should provide some of the certainty that both generators and farmers are seeking in order to engage in long-term supply contracts.

RO support – dedicated energy crops

Consideration of the statutory factors

16.8 Costs and incomes (statutory factors (a), (b) and (c))

- Cost evidence shows for small dedicated plants with energy crops a required range of 2.8-3.5ROCs (i.e. 1.3 ROCs more than for a small dedicated biomass plant – which uses cheaper domestic biomass); this difference results from the assumed energy crops/ biomass price (mainly domestic) differentials from AEA.

16.9 *The desirability of securing the long term growth, and economic viability, of the industries associated with this technology (statutory factor (d)*

[72] [72] Note that by 'grandfathering the energy crop uplift', we mean grandfathering stations accredited under the 'with energy crops' bands at the rates applicable to those bands, e.g. grandfathering at 2 ROCs/MWh for stations accredited under the dedicated energy crops [when they operate in that mode].

- There are jobs associated with the existing small energy crops industry, which could be safeguarded, and there may be scope for the industry to be significantly expanded. However, no significant impacts are expected here as the deployment potential at 2ROCs/MWh is assumed to be small.

16.10 *Consumer costs (statutory factor (e))*

- RO support costs from new build under the RO during the banding review period 2013/14 to 2016/17 are zero under the modelling as it does not show any use of energy crops in dedicated stations.

16.11 Potential contribution to targets arising out of a Community Obligation (statutory factor (f))

- At the current banding of 2 ROCs/MWh in the Pöyry modelling, we get no generation from dedicated energy crops stations in the banding review period.

- The use of energy crops is beneficial to diversify the feedstock base, create jobs in the energy crops industry and limit competition with other biomass-using industries. However, it is not considered sufficient to justify a banding above the marginal cost of meeting the renewables target.

16.12 We therefore **propose to set support for dedicated energy crops in line with the marginal technology (offshore wind) for meeting our 2020 target, i.e. at 2ROCs/MWh for 2013-2015, stepping down to 1.9ROCs for new accreditations (and additional capacity added) in 2015/16 and 1.8ROCs in 2016/17**. In accordance with our policy proposals above, **we propose to adopt a policy of grandfathering this support from 1 April 2013**.

Standard co-firing of energy crops

Consideration of the statutory factors

16.13 Costs and incomes (statutory factors (a), (b) and (c))

- Cost evidence shows standard co-firing of energy crops has a required range of 0-1.2 ROCs; this range assumes no capital costs (most if not all co-firing will be at sites already set up to co-fire) and uses the AEA-based range of fuel prices for energy crops.

16.14 *The desirability of securing the long term growth, and economic viability, of the industries associated with this technology (statutory factor (d)*

- There are jobs associated with the existing small energy crops industry, which could be safeguarded, and there may be scope for the industry to be significantly expanded.

16.15 *<u>Consumer costs (statutory factor (e))</u>*

- RO support costs for energy crop co-firing from 2013/14 to 2016/17 are around £20 million per year in the modelling with support at 1 ROC/MWh.

16.16 *<u>Potential contribution to targets arising out of a Community Obligation (statutory factor (f))</u>*

- According to the Pöyry modelling, around 0.5 TWh/y of co-firing with energy crops could be possible. This includes energy crops resource limits based on AEA (2010).

- The use of energy crops is beneficial to diversify the feedstock base, create jobs in the energy crops industry and limit competition with other biomass-using industries.

16.17 We therefore **<u>propose to retain support for co-firing with energy crops at 1 ROC/MWh, towards the high end of the ROCs required range as it is a relatively cost-effective technology</u>**. In accordance with our policy proposals above, **<u>we propose to adopt a policy of grandfathering the energy crop uplift element (i.e. 0.5ROCs) of this support from 1 April 2013</u>**.

Biomass conversion and enhanced co-firing

16.18 In principle, we would favour extending the energy crop uplift to the two new bands for biomass conversion and enhanced co-firing. The use of energy crops is beneficial to diversify the feedstock base, create jobs in the energy crops industry and limit competition with other biomass using industries. However, we do not have evidence on the costs and deployment potential of biomass conversion and enhanced co-firing with energy crops. We would therefore welcome any evidence of likely deployment and associated costs to inform our thinking.

16.19 For example, extending an energy crop uplift of 0.5 ROCs to these two new bands would mean that energy crop conversion and enhanced co-firing of energy crops would each receive 1.5 ROCs.

Consultation Questions	
69.	**Do you agree that we should narrow the definition of energy crops to limit its scope to only the short rotation coppice and perennial grass species as described above? Please explain your response with evidence.**
70.	**Do you agree that we should grandfather the energy crop uplift from 1 April 2013, but only for those crops meeting the new definition? Please explain your response with evidence.**

71.	**Do you agree with the proposed level of 2 ROCs/MWh for dedicated energy crops, stepping down to 1.9 ROCs in 2015/16 and 1.8 ROCs in 2016/17? Please explain your response with evidence.**
72.	**Do you agree with the proposed level of 1 ROC/MWh for standard co-firing of energy crops? Please provide evidence on costs and deployment potential.**
73.	**Do you consider that we should extend the energy crop uplift to the new biomass conversion and enhanced co-firing bands? It would be helpful if you could provide evidence on costs and deployment potential to inform our decision.**

17. Co-firing Cap

Introduction

17.1 Co-firing of biomass is currently capped in the RO at 12.5%. This means that suppliers may only meet up to 12.5% of their annual Obligation via co-fired ROCs. The cap was put in place as we wanted to encourage construction of more new build biomass plant over co-firing of biomass with coal. We were also concerned that, without a cap, the Obligation level could be highly volatile, creating risks for all other technologies.

17.2 With the emergence of coal generating stations converting partially or fully to biomass, it is necessary to revisit the co-firing cap.

17.3 Both partial and full conversion of coal generating stations to biomass are cost-effective technologies that could play a significant part in achieving our 2020 renewables target. Under current banding arrangements, coal generators could convert to biomass either by taking all their units offline and converting at the same time, or by converting the units one by one, incurring the capital cost but not receiving any additional support until all units were converted.

17.4 We are therefore proposing to introduce an 'enhanced co-firing' band, which provides bridging support for those generators wishing to convert unit by unit, or to continue burning fossil fuel, but mixing it with a high proportion of biomass (at least 15%).

17.5 The enhanced co-firing band, which will encourage a higher proportion of biomass in generation, means that we need to revisit the co-firing cap. We believe we have three choices regarding the co-firing cap:

1) increase the cap, to continue to have some restriction on the amount of co-fired ROCs;
2) retain the existing cap, but exclude 'enhanced co-fired ROCs' from the cap, or
3) remove the cap altogether.

Increasing the cap

17.6 Increasing the cap to an appropriate level is complex – we would need to do work to ensure that it was set at a level that did not adversely impact the business cases of the generators converting from coal. In practice, we believe we would need to set it at a level that was at the upper end of expectations, which could make it meaningless.

Excluding enhanced co-firing from the cap

17.7 Excluding 'enhanced co-firing' from the cap involves slightly more administrative complexity. Co-firing of biomass with CHP, co-firing of energy crops and co-firing of energy crops with CHP are already excluded from the cap. Over time it is likely that a diminishing amount of standard co-firing capacity would remain captured by the cap, and again this probably means that maintaining the cap at 12.5% for standard co-firing would have no real impact on standard co-firing generation.

Removing the cap

17.8 It would be simplest to remove the cap, reducing admin burden for generators, suppliers and Ofgem, as administrators of the scheme, and therefore costs to consumers. We have considered whether removing the cap would have an adverse impact on our ability to accurately set the Obligation each year, and therefore the volatility of ROC prices, and have concluded that it would not.

17.9 In setting the Obligation for 2012/13 we analysed historic data on co-firing generation and likely changes to the amount of co-firing capacity. This meant that we have assumed that around **2**% of ROCs will come from co-firing in 2012/13. This approach means that we no longer need a cap to help set the Obligation.

17.10 We therefore propose to remove the co-firing cap completely from 1 April 2013, and continue to estimate co-fired generation in setting the Obligation.

Consultation Questions	
74.	**Do you agree that the co-firing cap should be removed completely from 1 April 2013? Please explain your response with evidence.**
75.	**If you think that the cap should be increased (i.e. to allow more co-firing) or restricted to standard co-firing of biomass, please state what an appropriate level for the cap would be and why? Please support your response with evidence.**

18. Grandfathering policy

Introduction

18.1 Grandfathering is a policy intention to maintain a fixed level of support for the full lifetime of a generating station's eligibility for the RO, from the point of accreditation. The Government remains committed to the principle of grandfathering, as set out in the 2005 Review of the RO, and more recently in the 2010 Review of Grandfathering Policy of Support for Dedicated Biomass, Anaerobic Digestion and Energy from Waste.

18.2 This chapter serves to provide a summative overview of our grandfathering policy for the RO. Further details and explanation can be found in the respective technology chapters of this consultation document.

Existing grandfathering policy

18.3 By providing industry and investors with revenue certainty, grandfathering has unlocked project finance and encouraged renewables deployment.

18.4 The 2010 Review extended our grandfathering policy to cover Dedicated Biomass, Anaerobic Digestion, Advanced Conversion Technologies, and Energy from Waste. These arrangements have helped increase deployment. Following the 2010 Review, the only technologies not covered by our existing grandfathering policy are co-firing, bioliquids and the CHP and energy crop uplifts. We also needed to consider how grandfathering would operate for stations switching between different bands.

Proposed extensions to grandfathering policy

18.5 In this consultation document we have proposed the following extensions to our grandfathering policy, to apply from 1 April 2013.

Bioliquids

18.6 Bioliquids have not been grandfathered to date to ensure that our support for bioliquids did not adversely impact on sectors in which a liquid fuels should be prioritised. We consider that the levels of support for bioliquids proposed in this consultation are consistent with this approach, and so we propose as from 1 April 2013 to treat bioliquids (including fossil derived bioliquids) in the same way as solid and gaseous biomass for the purpose of our grandfathering policy. This means that, as from 1 April 2013, bioliquids would be covered by our grandfathering policy in the same circumstances as solid biomass.

Biomass conversions and enhanced co-firing

18.7 Following the creation of these two new bands on 1 April 2013, as from that date we propose to adopt a policy of grandfathering biomass conversions and enhanced co-firing. This is in recognition of the increased capital costs required for deployment of these technologies compared to standard co-firing. We propose to maintain our position of not including standard co-firing within our grandfathering policy.

Energy crops

18.8 The energy crop uplift has not been grandfathered to date. This reflects the fact that the primary costs are fuel costs and the energy crop uplift was introduced as an intermediary measure. However, given our desire to establish a policy framework within which long-term supply contracts can be established, we have proposed that, from 1 April 2013, we will adopt a policy of grandfathering the energy crop uplift. This will mean that only those crops which meet our proposed new, tighter definition will be covered by the policy, so removing a risk that food crops could have become locked into the mechanism.

CHP

18.9 The CHP uplift has not been grandfathered to date, to allow for decisions to be taken on the transition arrangements between the RO and RHI. Proposals for the transition are set out in this consultation document, and therefore, we can now propose that, from 1 April 2013, we will adopt a policy of grandfathering the CHP uplift.

Applying the grandfathering policy

18.10 Subject to the exceptions set out below, the accredited capacity of generating stations accredited before 1 April 2013, and additional capacity added before that date, will continue to receive their existing bands under the RO, and the new bands proposed in this consultation document will apply only to new accreditations and additional capacity added on or after 1 April 2013.

Biomass conversions

18.11 We propose that all generating stations, including those accredited before 1 April 2013, will be moved to the biomass conversion band proposed in this consultation document, if they meet the eligibility criteria for that band.

Enhanced co-firing

18.12 We propose that generating stations, including those accredited before 1 April 2013, will be eligible for support under the enhanced co-firing band proposed in this consultation document, if they meet the eligibility criteria for that band.

Standard co-firing

18.13 Standard co-firing is not covered by our grandfathering policy. However, we have not proposed any change to the level of support for standard co-firing.

Fossil derived bioliquids

18.14 We propose that as from 1 April 2013, all generating stations using fossil derived bioliquids will receive support for fossil derived bioliquids at the new bands for standard co-firing, enhanced co-firing, biomass conversion or dedicated biomass as proposed in this consultation document, provided they meet the eligibility criteria for those bands.

ACT

18.15 We are introducing two new bands for standard ACT and advanced ACT for new accreditations (and additional capacity added) on or after 1 April 2013. In line with our grandfathering policy, we propose that generating stations accredited (and additional capacity added) before 1 April 2013 will continue to receive support under the standard gasification and standard pyrolysis (1 ROC) or advanced gasification and advanced pyrolysis (2 ROCs) bands, provided they meet the existing eligibility requirements for those bands.

Energy crops

18.16 The new narrower definition of energy crops will apply as from1 April 2013, to all generating stations claiming the uplift, including those accredited before 1 April 2013.

CHP

18.17 The proposals in this consultation document for the CHP uplift will apply to all generating stations claiming the uplift, including those accredited before 1 April 2013.

Wave & tidal

18.18 Wave and tidal stream generating stations are already covered by our grandfathering policy. But in order not to cause delays to deployment, we propose that wave and tidal stream generating stations accrediting after 1 April 2012, or adding additional capacity after that date, should be able to benefit from the new bands proposed in this consultation document from 1 April 2013. In accordance with our grandfathering policy, the accredited capacity of wave and tidal stream generating stations accredited before 1 April 2012, and additional capacity added before that date, will not be moved up to the new bands proposed in this consultation document.

19. Grace Periods

Introduction

19.1 When we introduced banding in April 2009, we provided for grace periods for some technologies where support was decreased, so as to ensure that projects that had invested on the expectation of receiving 1 ROC could realise this level of support when they commissioned post-1 April 2009. For example, with landfill gas ROC support has decreased from 1 ROC to 0.25 ROC/MWh. In the 2009 Order, we allowed some projects that had obtained preliminary accreditation by 31 March 2009, to be grandfathered at 1 ROC/MWh, as long as they had commissioned and been granted full accreditation with effect from 31 March 2011 or earlier.

19.2 We have considered whether we should follow a similar approach in this banding review. This would mean reducing bands at a later date, to take into account the potential for projects to slip. However, this is a blunt approach, which has potential to capture projects that may not reach financial close until after the banding review is published, and which are therefore able to secure the lower construction costs we are seeing for some technologies, but access the higher support rate. It also means that we are unable to use the cost savings to increase support levels for other technologies, delaying their deployment, and resulting in additional cost to consumers.

19.3 We are therefore not minded to implement a generic grace period. We are, however, committed to the principle of providing as much certainty to investors as we possibly can, and to not making retrospective changes to support levels.

19.4 We are therefore minded to maintain the current ROC bands for projects which expect to deploy ahead of 1 April 2013, but, for certain reasons outside their control, are unable to do so. **We feel this flexibility should <u>only apply to new accreditations of those technologies where RO support will decrease from 1 April 2013</u>, and in two distinct circumstances**:

- delays to grid connection, and/or
- delays to radar upgrades to prevent wind farm interference with aviation.

19.5 The grace period would also be available to projects facing both causes of delay. We propose to limit the grace period to six months from 1 April 2013, providing a period of time in which to resolve the delays set out above. Where a project is unable to resolve these delays and accredit before 1 October 2013, the new banding levels would apply. We would welcome views on whether this time limit is reasonable.

19.6 We propose that where a generating station has taken advantage of this grace period, the 20 year time limit for RO support for the station would start from 1 April 2013. Despite this, the generating station clearly cannot be accredited under the RO until the generating station has been commissioned and all eligibility criteria have been met.

Grid Connection

19.7 New build generating stations will usually require a grid connection, and the connection date will be set out within a bilaterally agreed construction agreement with the relevant network operator. Whilst it is in the interests of the network operator to ensure that the connection is delivered on time, there can be delays where, for example, issues may arise with planning consent for the necessary grid works. This can result in the grid connection dates being moved by the network operator.

19.8 We are aware of industry concerns that any such delays for projects due to be connected in late 2012 and early 2013 could push their commissioning date, and therefore accreditation date, beyond 31 March 2013. This would mean that generation by the project would realise support at the new ROC bands proposed in this document, rather than the current level, which would have been assumed at financial close.

19.9 We therefore propose that, where such delays have occurred, p**rojects which have a signed connection agreement stating a** grid connection date that would have enabled the project to be commissioned on or before 31 March 2013 should be able to receive the ROC band applicable on 31 March 2013, and not the new bands proposed in this consultation document**.** In order to access this grace period, generators will need to present Ofgem with written evidence from the network operator that the delay in the grid connection was not due to any action or inaction by the generator or developer of the generating station, and the generator will need to confirm that this factor alone[73] has delayed project commissioning beyond 31 March 2013. In addition, a copy of the connection agreement would need to be provided.

Radar deployment

19.10 Wind generating stations must comply with Ministry of Defence (MoD) and civilian aviation requirements on radar. This can involve developers paying for upgrades to MoD and non-military radar systems.

19.11 Given the critical importance for robust radar systems, MoD and UK commercial aviation organisations handle the procurement process for radar upgrades and installations. Wind farm developers may start construction ahead of the upgrade being in place, but due to the need to mitigate radar interference caused by turbine blades, the generating station may not be able to commission and hence accredit under the RO until the radar is installed/upgraded. This essentially means that the wind farm could be fully constructed less the turbine blades.

[73] Or this factor together with radar deployment delay, where the requirements for a grace period on those grounds are also satisfied.

19.12 A developer could therefore find themselves in a position where they had completed construction of the wind farm ahead of 1 April 2013, but delays by the relevant civilian aviation organisation or the MoD (or their suppliers) in carrying out the radar installation/upgrade mean that the wind farm is unable to secure the current bands.

19.13 This is not our desired policy outcome, and so we propose that where such delays have occurred, onshore wind projects which have a signed agreement for the completion of radar installation/upgrades that would have enabled the project to be commissioned on or before 31 March 2013 should receive the ROC band applicable on 31 March 2013, and not the new bands proposed in this consultation document.

19.14 In order to access this grace period operators will need to present Ofgem with suitable evidence from the MoD or the relevant civil aviation organisation that the delay to the radar installation/upgrade was not due to any action or inaction by the developer and the operator will need to confirm that this factor alone[74] has prevented the project being commissioned on or before 31 March 2013. In addition, a copy of the radar installation/upgrade agreement will need to be provided.

19.15 We are not proposing that the grace period for delays in aviation radar deployment should be available to offshore wind farms because under our banding proposals new offshore wind accreditations up to 31 March 2015 will continue to be eligible for 2 ROCs.

Grace period criteria

19.16 To ensure that grace period policy is robust and that other factors do not result in a delay to the commissioning and hence accreditation of the generating station, we are seeking views as to the criteria that must be met by 31 March 2013 if the above grace periods are to be exercised. Depending on the grace period in question, such criteria could include:

- the erection of all, or a certain percentage of turbines or turbine towers;
- ensuring that all installation payments have been made on time;
- a connection to grid being in situ;
- energisation of that connection;
- the handover of the wind farm from the contractors;
- that the necessary commissioning tests and procedures have been completed to the greatest extent possible before 31 March 2013.

Consultation Questions	
76.	**Do you agree with our proposals for a time-limited and strictly defined grace period as described above, including scope, time limit and criteria? If you wish to suggest a different scope, time limit or criteria, please explain why. Please support your response with evidence.**

[74] Or this factor together with grid connection delay, where the requirements for a grace period on those grounds are also satisfied.

20. Microgeneration Technologies

20.1 In June this year, the Coalition Government published its Microgeneration Strategy[75]. This set out a number of actions to tackle the non-financial barriers that affect the microgeneration sector and to ensure that the range of incentives in place to encourage the deployment of small-scale renewable energy generation work to their full potential.

20.2 Since 1 April 2010, the following microgeneration technologies - anaerobic digestion, hydro, solar PV and wind of 50kW or less – have not been eligible for support under the RO in England, Wales and Scotland. This is because support is provided for these microgeneration technologies under the Feed-in Tariffs (FITs) scheme.

20.3 The first comprehensive review of the FITs scheme was announced in February 2011. This review is currently underway and is considering all aspects of the scheme including tariff levels, degression rates and methods and eligible technologies. We will be consulting soon on proposals as part of the comprehensive review. Further information on this review is available at www.decc.gov.uk/FITs.

20.4 In Northern Ireland, microgeneration is supported under the Northern Ireland Renewables Obligation.[76] The Northern Ireland Executive will publish their own consultation and introduce any changes through their own secondary legislation.

20.5 For those microgeneration technologies which are not eligible for support under the FITs scheme, support remains available under the RO (if they meet the eligibility criteria). The level of support for microgenerators under the RO is currently 2 ROCs/MWh.

20.6 The Microgeneration Strategy highlighted the important part that financial incentives, such as the RO, FIT and RHI, will play in driving growth in the microgeneration sector. However, the Strategy indicated that it is the Government's expectation that industry will achieve cost reductions in parallel to ensure that the support provided by incentive schemes is affordable and offers real value for money as we create a cost-effective low carbon energy mix.

20.7 We therefore propose to set support under the RO for microgeneration at 2 ROCs until 31 March 2015 and then reduce it to 1.9 ROCs for generating stations accrediting (and additional capacity added) between 1 April 2015 and 31 March 2016 and 1.8 ROCs for generating stations accrediting (and additional capacity added) in 2016/17. This is in line with the level of RO support proposed for the marginal technology for meeting our 2020 renewables target (offshore wind). We do not

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

[76] Cost estimates set out in this consultation document assume average Northern Ireland ROC bandings for microgeneration technologies (AD, AD CHP, hydro, wind and solar PV).

consider that providing a higher level of RO support would be value for money for the purpose of meeting that target.

Consultation Questions	
77.	**Do you agree with the proposed level of support of 2 ROCs/MWh for those microgeneration technologies eligible for support under the RO, stepping down to 1.9 ROCs in 2015/16 and 1.8 ROCs in 2016/17? Please explain your response with evidence.**

21. EMR Transition

Electricity Market Reform and the Renewables Obligation Transition

21.1 In its White Paper of 12 July 2011, the Government set out its proposals for Electricity Market Reform (EMR). The key components of this reform are:

- **A Carbon Price Floor** to reduce uncertainty, fairly price carbon and provide a stronger incentive to invest in low carbon generation

- **A Feed-in Tariff with Contracts for Difference** to provide stable financial incentives to invest in low carbon electricity generation

- **An Emissions Performance Standard** to provide a clear regulatory signal, that no new coal fired power stations are built without Carbon Capture and Storage technology

- **A capacity mechanism** to ensure future security of electricity supply

Support for Renewable Electricity

21.2 Under EMR, renewable electricity will be supported through the new Feed-in Tariff Contract for Difference scheme for low carbon. The FiT CfD will provide generators with a long term contract for difference set at a fixed level, where variable payments are made to ensure they receive an agreed tariff. The FiT CfD will have technology specific tariffs, and vary for different groups of generation such as intermittent and dispatchable.

Renewables Obligation Transition

21.3 The Government is committed to maintaining the banded RO, and recognises there is a significant existing community of renewables investors and developers. We have therefore put in place measures to minimise any investment hiatus while the new scheme is introduced.

21.4 The FiT CfD is expected to be introduced in 2013/14, with the first CfDs signed in 2014. During a transition phase, new renewable stations will be able to choose between accrediting under the RO and signing a CfD.

21.5 The Renewables Obligation will be closed to new generation from 31 March 2017, which is the end of the Banding Review Period covered by this consultation. After that date, new renewable generation will supported by the FiT CfD mechanism.

21.6 We intend to offer limited grace periods for RO Transition on a similar basis to those proposed for the Banding Review in this consultation.

21.7 The end date for the RO is 31 March 2037. Generation which is accredited under the RO will continue to receive its full lifetime of support in the ‘vintaged’ scheme. The White Paper set out our preferred option for all technologies to be grandfathered at the RO support level applicable on 31 March 2017.

21.8 Within the vintaged scheme we will continue to set the obligation annually using the current ‘headroom’ mechanism (potentially with a fixed target underpin). From 2027, we will fix the price of a ROC at its long-term value, and Government will buy the ROCs directly from generators. This will reduce volatility in the final years of the mechanism. The long term value of a ROC is the buyout price plus 10% headroom, and is roughly £41 per ROC in 2010 prices.

21.9 Full details of the transition from the RO to the FiT CfD scheme are set out in the Annex to the White Paper.

Consultation Questions	
78.	**In addition to the specific questions asked throughout this consultation document, do you have any other comments on any aspect of our proposals? In each case, please explain your response with evidence.**

Annex A - Levelised costs

Levelised costs are a convenient shorthand summary of all project cost information. They are a single figure used to represent the sum of all lifetime generation costs – capital, operating and fuel costs – in relation to the amount of lifetime electricity generation. The low and high figures are based on Arup/ Ernst & Young high and low capex, but use central assumptions for all other input data.

Table 3 - Levelised costs of renewable technologies published in Arup (2011)

£ / MWh		**2010 financial close**	**2015 financial close**	**2020 financial close**	**2025 financial close**	**2030 financial close**
Offshore wind	low	149	123	95	87	81
	medium	169	139	107	98	91
	high	191	158	121	111	104
Offshore wind R3	low		168	127	113	92
	medium		192	145	129	105
	high		225	170	151	122
Onshore >5MW	low	75	72	71	69	68
	medium	91	88	86	84	82
	high	108	105	103	101	99
Onshore <5MW	low	82	80	78	76	75
	medium	104	102	99	98	96
	high	127	125	122	120	118
Solar	low	202	165	136	120	111
	medium	282	228	187	164	150
	high	380	306	250	218	199
Geothermal	low	132	105	77	76	63
	medium	242	190	133	130	103
	high	341	268	184	180	139
Geothermal CHP	low	57	16	-27	-49	-74
	medium	183	113	37	13	-28
	high	293	200	94	69	14
Hydropower <5MW	low	67	68	68	68	68
	medium	104	105	105	105	106
	high	215	217	218	218	219
Hydropower >5MW	low	42	42	42	42	42
	medium	59	59	59	60	60
	high	74	75	75	75	76
Dedicated biomass <50MW	low	127	125	120	119	118
	medium	143	141	134	133	133
	high	154	152	144	143	142
Dedicated biomass >50MW	low	152	151	146	145	145
	medium	156	154	149	148	148
	high	165	163	156	156	155
Biomass CHP	low	210	202	185	174	163
	medium	226	218	200	189	178
	high	250	241	220	209	199

Bioliquids – biodiesel	low medium high	288 301 357	302 315 370	303 316 371	299 312 366	298 310 364
Bioliquids CHP-biodiesel	low medium high	252 267 332	262 278 341	261 277 339	255 270 332	253 268 329
Standard Cofiring	low medium high	94 98 100	94 97 100	93 97 99	93 97 99	93 97 99
Enhanced Cofiring	low medium high	109 110 110	109 110 111	108 109 110	107 109 110	107 108 110
Biomass conversion	low medium high	106 116 128	106 116 129	106 115 127	106 115 127	106 115 126
EfW	low medium high	-23 -19 33	-24 -20 30	-25 -21 29	-25 -22 28	-25 -22 28
EfW CHP	low medium high	-52 -30 11	-54 -33 8	-63 -42 -3	-73 -52 -12	-82 -61 -22
AD	low medium high	75 122 194	74 119 188	70 110 173	70 110 171	70 109 170
AD CHP	low medium high	60 115 199	57 109 190	52 100 174	51 98 171	50 96 168
ACT	low medium high	-35 34 80	-39 26 71	-47 11 50	-50 7 46	-52 4 43
ACT CHP	low medium high	-59 18 69	-66 8 58	-75 -10 35	-79 -15 29	-82 -19 24
Sewage gas	low medium high	57 81 122	56 79 118	55 77 115	54 76 114	54 76 113
Landfill gas	low medium high	39 45 50	39 45 50	39 45 50	38 45 50	38 45 49
Wave	low medium high			208 237 266	168 191 214	130 147 163
Tidal stream shallow	low medium high			196 227 262	174 201 232	149 171 196
Tidal stream deep	low medium high			162 190 221	163 191 221	121 140 161
Tidal range	low medium high			206 275 340	206 275 340	206 275 340

Notes:

1) The wave and tidal figures are based on the same commercial cost assumptions as E&Y(2010), and the same proportions of different types of resource quality. As with E&Y(2010), the estimates use the Black & Veatch learning rates for each cost subcomponent. The levelised costs have been calculated using new hurdle rate assumptions from the Oxera report for the CCC.

2) Bioliquids levelised costs assume biodiesel fuel costs. Assuming vegetable oil fuel costs (which are linked to food rather than diesel price movements) would result in different levelised cost estimates.

Annex B - Key assumptions

Capital and operating costs

For renewable technologies these come from Arup (2011) and for non-renewable technologies from PB (2011) projects for DECC. The Arup costs are set out below as per Appendix A of the Arup report.

The differences to the capital and operating costs presented in the Arup main report are that:

- Capital costs exclude 'other infrastructure' costs (such as water, roads, waste disposal and land costs)
- Future cost projections assume that steel prices remain constant in real terms.
- Future cost projections apply the central learning rates to the high, median low costs, rather than the low learning rates to the high costs and the high learning rates to the costs.

The costs as set out below use the same assumptions used as for the Pöyry's modelling and DECC's in-house analysis.

<50MW biomass		**Financial close**				
		2010	**2015**	**2020**	**2025**	**2030**
Capex	High	3871	3764	3687	3652	3617
£/kW	Median	3342	3250	3183	3153	3123
	Low	2607	2535	2483	2459	2436
Fixed opex	High	193,858	188,678	184,993	183,393	181,808
£/MW/y	Median	128,550	125,115	122,671	121,611	120,559
	Low	94,171	91,655	89,864	89,087	88,317
Variable opex	High	8	8	8	8	7
£/MWh	Median	5	5	5	5	5
	Low	4	4	4	4	4
Insurance	High	12,026	11,705	11,476	11,377	11,278
£/MW/y	Median	16,416	15,977	15,665	15,530	15,396
	Low	24,756	24,094	23,624	23,420	23,217
Connection and UoS charges	High	1,160	1,129	1,107	1,097	1,088
£/MW/y	Median	1,584	1,542	1,512	1,498	1,486

	Low	2,388	2,324	2,279	2,259	2,240

>50MW biomass		**Financial close**				
		2010	**2015**	**2020**	**2025**	**2030**
Capex	High	2801	2724	2668	2642	2617
£/kW	Median	2417	2350	2302	2280	2258
	Low	2258	2196	2151	2130	2110
Fixed opex	High	166,396	161,950	158,786	157,414	156,053
£/MW/y	Median	110,338	107,390	105,292	104,382	103,479
	Low	80,831	78,671	77,134	76,468	75,806
Variable opex	High	7	6	6	6	6
£/MWh	Median	4	4	4	4	4
	Low	3	3	3	3	3
Insurance	High	10,322	10,046	9,850	9,765	9,680
£/MW/y	Median	14,090	13,713	13,446	13,329	13,214
	Low	21,249	20,681	20,277	20,102	19,928
Connection and UoS charges	High	996	969	950	942	934
£/MW/y	Median	1,359	1,323	1,297	1,286	1,275
	Low	2,050	1,995	1,956	1,939	1,923

Onshore wind > 5MW		**Financial close**				
		2010	**2015**	**2020**	**2025**	**2030**
Capex	High	1820	1739	1681	1638	1595
£/kW	Median	1524	1456	1408	1371	1336
	Low	1184	1132	1094	1066	1038
Fixed opex	High	58,649	58,766	58,884	59,001	59,119
£/MW/y	Median	45,694	45,785	45,877	45,969	46,061
	Low	24,160	24,209	24,257	24,306	24,354
Variable opex	High	4	4	4	4	4
£/MWh	Median	3	3	3	3	3
	Low	2	2	1	1	1

Insurance	High	10,322	10,046	9,850	9,765	9,680
£/MW/y	Median	14,090	13,713	13,446	13,329	13,214
	Low	21,249	20,681	20,277	20,102	19,928
Connection and UoS charges	High	996	969	950	942	934
£/MW/y	Median	1,359	1,323	1,297	1,286	1,275
	Low	2,050	1,995	1,956	1,939	1,923

Onshore wind < 5MW				**Financial close**		
		2010	**2015**	**2020**	**2025**	**2030**
Capex	High	1858	1776	1716	1672	1629
£/kW	Median	1548	1479	1430	1393	1357
	Low	1174	1122	1085	1057	1029
Fixed opex	High	55,804	55,916	56,028	56,140	56,252
£/MW/y	Median	38,073	38,150	38,226	38,302	38,379
	Low	30,927	30,989	31,051	31,114	31,176
Variable opex	High	4	4	4	4	4
£/MWh	Median	3	3	3	3	3
	Low	2	2	2	2	2
Insurance	High	4,273	4,282	4,290	4,299	4,307
£/MW/y	Median	5,261	5,272	5,282	5,293	5,303
	Low	7,711	7,726	7,742	7,757	7,773
Connection and UoS charges	High	6,709	6,722	6,736	6,749	6,763
£/MW/y	Median	8,259	8,276	8,292	8,309	8,325
	Low	12,105	12,129	12,154	12,178	12,202

Offshore wind R2				**Financial close**		
		2010	**2015**	**2020**	**2025**	**2030**
Capex	High	3183	2589	2242	2047	1900
£/kW	Median	2722	2214	1917	1750	1625
	Low	2300	1871	1620	1479	1373

Fixed opex	High	172,858	140,656	121,859	111,299	103,358
£/MW/y	Median	156,004	126,942	109,977	100,447	93,280
	Low	110,154	89,633	77,655	70,925	65,865
Variable opex	High	4	3	3	3	2
£/MWh	Median	2	2	1	1	1
	Low	2	2	1	1	1
Insurance	High	10,578	8,607	7,457	6,811	6,325
£/MW/y	Median	14,981	12,190	10,561	9,646	8,958
	Low	16,600	13,508	11,702	10,688	9,926
Connection and UoS charges	High	42,040	34,208	29,637	27,068	25,137
£/MW/y	Median	59,539	48,447	41,973	38,336	35,601
	Low	65,971	53,681	46,507	42,477	39,446

Offshore wind R3				**Financial close**		
		2014	**2015**	**2020**	**2025**	**2030**
Capex	High	3431	3279	2685	2373	2166
£/kW	Median	2825	2699	2211	1954	1784
	Low	2400	2293	1878	1660	1515
Fixed opex	High	220,705	210,918	172,810	152,794	139,553
£/MW/y	Median	168,641	161,163	132,044	116,750	106,633
	Low	110,076	105,195	86,189	76,205	69,602
Variable opex	High	-	0	0	0	0
£/MWh	Median	-	0	0	0	0
	Low	-	0	0	0	0
Insurance	High	21,944	20,971	17,182	15,192	13,875
£/MW/y	Median	33,681	32,188	26,372	23,317	21,297
	Low	44,079	42,124	34,513	30,516	27,871
Connection and UoS charges	High	40,615	38,814	31,801	28,118	25,681
£/MW/y	Median	62,195	59,437	48,698	43,058	39,326
	Low	81,396	77,787	63,732	56,350	51,467

Solar PV		Financial close				
		2010	2015	2020	2025	2030
Capex	High	3736	2961	2367	2029	1829
£/kW	Median	2710	2148	1717	1472	1326
	Low	1873	1485	1187	1017	917
Fixed opex	High	27,274	27,316	27,358	27,400	27,442
£/MW/y	Median	21,054	21,086	21,119	21,151	21,184
	Low	15,758	15,782	15,807	15,831	15,855
Variable opex	High	-	0	0	0	0
£/MWh	Median	-	0	0	0	0
	Low	-	0	0	0	0
Insurance	High	2,922	2,926	2,931	2,936	2,940
£/MW/y	Median	3,904	3,910	3,916	3,922	3,928
	Low	5,058	5,066	5,074	5,081	5,089
Connection and UoS charges	High	-	-	-	-	-
£/MW/y	Median	-	-	-	-	-
	Low	-	-	-	-	-

AD		Financial close				
		2010	2015	2020	2025	2030
Capex	High	7326	7009	6786	6690	6595
£/kW	Median	4013	3839	3717	3664	3612
	Low	1742	1667	1614	1591	1568
Fixed opex	High	689,651	691,722	693,800	695,884	697,974
£/MW/y	Median	351,405	352,461	353,520	354,581	355,646
	Low	69,347	69,555	69,764	69,974	70,184
Variable opex	High	40	40	40	40	40
£/MWh	Median	20	20	20	20	21
	Low	4	4	4	4	4
Insurance	High	11,092	11,125	11,159	11,192	11,226

£/MW/y	Median	56,207	56,376	56,545	56,715	56,885
	Low	110,309	110,641	110,973	111,306	111,640
Connection and UoS charges	High	1,650	1,654	1,659	1,664	1,669
£/MW/y	Median	8,359	8,384	8,409	8,434	8,460
	Low	16,404	16,454	16,503	16,553	16,602

Geothermal		**Financial close**				
		2010	**2015**	**2020**	**2025**	**2030**
Capex	High	7680	5723	5606	5450	5304
£/kW	Median	5363	3996	3915	3806	3704
	Low	2681	1998	1957	1903	1852
Fixed opex	High	141,649	142,075	142,501	142,929	143,359
£/MW/y	Median	105,579	105,897	106,215	106,534	106,854
	Low	79,001	79,238	79,476	79,715	79,955
Variable opex	High	14	14	14	14	14
£/MWh	Median	11	11	11	11	11
	Low	8	8	8	8	8
Insurance	High	51,688	51,843	51,999	52,155	52,312
£/MW/y	Median	69,077	69,285	69,493	69,702	69,911
	Low	92,677	92,955	93,234	93,514	93,795
Connection and UoS charges	High	1,463	1,468	1,472	1,476	1,481
£/MW/y	Median	1,956	1,961	1,967	1,973	1,979
	Low	2,624	2,631	2,639	2,647	2,655

Standard co-firing		**Financial close**				
		2010	**2015**	**2020**	**2025**	**2030**
Capex	High	167	160	156	154	152
£/kW	Median	121	116	113	112	110
	Low	40	39	37	37	37

Fixed opex	High	23,469	23,539	23,610	23,681	23,752
£/MW/y	Median	19,557	19,616	19,675	19,734	19,793
	Low	15,646	15,693	15,740	15,787	15,835
Variable opex	High	1	1	1	1	1
£/MWh	Median	1	1	1	1	1
	Low	1	1	1	1	1
Insurance	High	711	713	715	718	720
£/MW/y	Median	889	892	894	897	900
	Low	1,067	1,070	1,073	1,076	1,080
Connection and UoS charges	High	7,112	7,133	7,155	7,176	7,198
£/MW/y	Median	8,890	8,916	8,943	8,970	8,997
	Low	10,668	10,700	10,732	10,764	10,796

Biomass conversion		**Financial close**				
		2010	**2015**	**2020**	**2025**	**2030**
Capex	High	869	837	814	804	794
£/kW	Median	458	441	429	424	419
	Low	122	117	114	113	111
Fixed opex	High	37,982	38,096	38,211	38,325	38,441
£/MW/y	Median	36,862	36,973	37,084	37,196	37,307
	Low	34,882	34,986	35,091	35,197	35,303
Variable opex	High	2	2	2	2	2
£/MWh	Median	2	2	2	2	2
	Low	2	2	2	2	2
Insurance	High	1,420	1,424	1,429	1,433	1,437
£/MW/y	Median	1,501	1,505	1,510	1,514	1,519
	Low	1,546	1,551	1,556	1,560	1,565
Connection and UoS charges	High	12,624	12,662	12,700	12,738	12,776
£/MW/y	Median					

		13,341	13,381	13,421	13,461	13,502
	Low	13,746	13,787	13,828	13,870	13,912

Landfill gas		**Financial close**				
		2010	**2015**	**2020**	**2025**	**2030**
Capex	High	1332	1313	1299	1295	1290
£/kW	Median	1206	1189	1177	1172	1168
	Low	1000	986	976	972	968
Fixed opex	High	107,704	107,973	108,244	108,514	108,786
£/MW/y	Median	63,698	63,858	64,018	64,178	64,339
	Low	35,563	35,652	35,741	35,830	35,920
Variable opex	High	15	15	15	15	15
£/MWh	Median	9	9	9	9	9
	Low	5	5	5	5	5
Insurance	High	707	709	711	713	714
£/MW/y	Median	1,267	1,270	1,273	1,276	1,279
	Low	2,142	2,147	2,153	2,158	2,163
Connection and UoS charges	High	2,748	2,755	2,762	2,769	2,776
£/MW/y	Median	4,923	4,935	4,947	4,960	4,972
	Low	8,323	8,344	8,365	8,386	8,407

Sewage gas		**Financial close**				
		2010	**2015**	**2020**	**2025**	**2030**
Capex	High	5914	5694	5541	5476	5412
£/kW	Median	3618	3484	3389	3350	3310
	Low	2287	2202	2143	2118	2093
Fixed opex	High	133,896	134,298	134,701	135,106	135,512
£/MW/y	Median	105,414	105,730	106,048	106,366	106,686
	Low	73,940	74,162	74,385	74,609	74,833
Variable opex	High	-	0	0	0	0
£/MWh	Median	-	0	0	0	0
	Low	-	0	0	0	0

Insurance	High	-	0	0	0	0
£/MW/y	Median	-	0	0	0	0
	Low	-	0	0	0	0
Connection and UoS charges	High	1,650	1,654	1,659	1,664	1,669
£/MW/y	Median	8,359	8,384	8,409	8,434	8,460
	Low	16,404	16,454	16,503	16,553	16,602

Hydropower >5MW		**Financial close**				
		2010	**2015**	**2020**	**2025**	**2030**
Capex	High	2858	2867	2877	2887	2896
£/kW	Median	2307	2315	2322	2330	2338
	Low	1448	1453	1458	1462	1467
Fixed opex	High	39,257	39,404	39,552	39,701	39,850
£/MW/y	Median	31,887	32,006	32,127	32,247	32,368
	Low	14,342	14,396	14,450	14,505	14,559
Variable opex	High	7	7	7	7	7
£/MWh	Median	6	6	6	6	6
	Low	2	2	2	3	3
Insurance	High	398	400	401	403	404
£/MW/y	Median	886	889	892	896	899
	Low	1,090	1,095	1,099	1,103	1,107
Connection and UoS charges	High	3,187	3,199	3,211	3,223	3,235
£/MW/y	Median	7,086	7,113	7,139	7,166	7,193
	Low	8,724	8,756	8,789	8,822	8,855

Hydropower <5MW		**Financial close**				
		2010	**2015**	**2020**	**2025**	**2030**
Capex	High	9480	9511	9543	9575	9606
£/kW	Median	4429	4444	4459	4473	4488
	Low	2604	2613	2622	2630	2639
Fixed opex	High	64,559	64,802	65,045	65,289	65,534

£/MW/y	Median	39,115	39,262	39,410	39,558	39,706
	Low	12,735	12,783	12,831	12,879	12,928
Variable opex	High	11	11	11	11	11
£/MWh	Median	7	7	7	7	7
	Low	2	2	2	2	2
Insurance	High	354	355	356	358	359
£/MW/y	Median	1,087	1,091	1,095	1,099	1,103
	Low	1,793	1,800	1,807	1,814	1,820
Connection and UoS charges	High	2,830	2,841	2,851	2,862	2,873
£/MW/y	Median	8,692	8,725	8,758	8,791	8,824
	Low	14,346	14,400	14,454	14,509	14,563

EfW CHP				**Financial close**		
		2010	**2015**	**2020**	**2025**	**2030**
Capex	High	6446	6316	6225	6189	6154
£/kW	Median	4574	4482	4417	4392	4367
	Low	3561	3489	3439	3419	3400
Fixed opex	High	366,591	367,509	368,428	369,350	370,275
£/MW/y	Median	327,512	328,332	329,153	329,977	330,803
	Low	250,198	250,824	251,452	252,081	252,712
Variable opex	High	24	24	24	24	24
£/MWh	Median	21	21	21	21	22
	Low	16	16	16	16	16
Insurance	High	23,886	23,946	24,006	24,066	24,126
£/MW/y	Median	31,364	31,442	31,521	31,600	31,679
	Low	35,017	35,105	35,192	35,281	35,369
Connection and UoS charges	High	9,069	9,092	9,115	9,138	9,161
£/MW/y	Median	10,893	10,920	10,947	10,974	11,002
	Low	13,093	13,125	13,158	13,191	13,224

EfW		Financial close				
		2010	**2015**	**2020**	**2025**	**2030**
Capex	High	6133	6009	5923	5889	5855
£/kW	Median	3534	3463	3413	3393	3374
	Low	3388	3320	3272	3253	3235
Fixed opex	High	375,392	376,331	377,273	378,217	379,164
£/MW/y	Median	334,834	335,672	336,512	337,354	338,198
	Low	256,294	256,936	257,579	258,223	258,869
Variable opex	High	17	17	17	17	17
£/MWh	Median	15	15	15	15	15
	Low	11	11	11	11	11
Insurance	High	24,490	24,551	24,612	24,674	24,736
£/MW/y	Median	32,089	32,169	32,250	32,331	32,411
	Low	35,889	35,979	36,069	36,159	36,249
Connection and UoS charges	High	9,069	9,092	9,115	9,138	9,161
£/MW/y	Median	10,893	10,920	10,947	10,974	11,002
	Low	13,093	13,125	13,158	13,191	13,224

Bioliquids		Financial close				
		2010	**2015**	**2020**	**2025**	**2030**
Capex	High	1892	1836	1797	1780	1764
£/kW	Median	794	771	755	747	740
	Low	475	461	451	447	443
Fixed opex	High	297,057	293,752	291,541	290,927	290,314
£/MW/y	Median	134,961	133,459	132,455	132,176	131,897
	Low	54,365	53,760	53,355	53,243	53,131
Variable opex	High	12	12	12	12	12
£/MWh	Median	5	5	5	5	5
	Low	2	2	2	2	2
Insurance	High	1,924	1,903	1,889	1,885	1,881
£/MW/y	Median	4,777	4,724	4,688	4,678	4,669

	Low	10,514	10,397	10,319	10,297	10,276
Connection and UoS charges	High	4,727	4,674	4,639	4,629	4,620
£/MW/y	Median	11,734	11,604	11,516	11,492	11,468
	Low	25,828	25,541	25,348	25,295	25,242

ACT		**Financial close**				
		2010	**2015**	**2020**	**2025**	**2030**
Capex	High	7757	7421	7186	7084	6983
£/kW	Median	5697	5450	5277	5202	5128
	Low	2417	2313	2239	2208	2176
Fixed opex	High	372,809	355,613	339,211	323,565	308,640
£/MW/y	Median	301,824	287,902	274,623	261,956	249,873
	Low	225,374	214,978	205,063	195,604	186,582
Variable opex	High	18	17	16	16	15
£/MWh	Median	15	14	13	13	12
	Low	11	10	10	9	9
Insurance	High	16,170	15,424	14,713	14,034	13,387
£/MW/y	Median	21,655	20,656	19,704	18,795	17,928
	Low	26,748	25,515	24,338	23,215	22,144
Connection and UoS charges	High	9,257	8,830	8,423	8,034	7,663
£/MW/y	Median	12,397	11,825	11,280	10,759	10,263
	Low	15,312	14,606	13,932	13,290	12,677

ACT CHP		**Financial close**				
		2010	**2015**	**2020**	**2025**	**2030**
Capex	High	8138	7786	7539	7431	7326
£/kW	Median	5976	5718	5536	5457	5380
	Low	2536	2426	2349	2316	2283
Fixed opex	High	372,809	355,613	339,211	323,565	308,640
£/MW/y	Median	301,824	287,902	274,623	261,956	249,873

	Low	225,374	214,978	205,063	195,604	186,582
Variable opex	High	18	17	16	16	15
£/MWh	Median	15	14	13	13	12
	Low	11	10	10	9	9
Insurance	High	16,170	15,424	14,713	14,034	13,387
£/MW/y	Median	21,655	20,656	19,704	18,795	17,928
	Low	26,748	25,515	24,338	23,215	22,144
Connection and UoS charges	High	9,257	8,830	8,423	8,034	7,663
£/MW/y	Median	12,397	11,825	11,280	10,759	10,263
	Low	15,312	14,606	13,932	13,290	12,677

Bioliquids CHP				**Financial close**		
		2010	**2015**	**2020**	**2025**	**2030**
Capex	High	2244	2179	2132	2112	2092
£/kW	Median	942	915	895	887	878
	Low	563	547	535	530	525
Fixed opex	High	297,057	293,752	291,541	290,927	290,314
£/MW/y	Median	134,961	133,459	132,455	132,176	131,897
	Low	54,365	53,760	53,355	53,243	53,131
Variable opex	High	12	12	12	12	12
£/MWh	Median	5	5	5	5	5
	Low	2	2	2	2	2
Insurance	High	1,924	1,903	1,889	1,885	1,881
£/MW/y	Median	4,777	4,724	4,688	4,678	4,669
	Low	10,514	10,397	10,319	10,297	10,276
Connection and UoS charges	High	4,727	4,674	4,639	4,629	4,620
£/MW/y	Median	11,734	11,604	11,516	11,492	11,468
	Low	25,828	25,541	25,348	25,295	25,242

Geothermal CHP		Financial close				
		2010	**2015**	**2020**	**2025**	**2030**
Capex	High	8386	6249	6121	5951	5792
£/kW	Median	5932	4421	4330	4210	4097
	Low	3034	2261	2214	2153	2095
Fixed opex	High	146,674	147,114	147,556	147,999	148,444
£/MW/y	Median	109,324	109,653	109,982	110,312	110,644
	Low	81,803	82,049	82,295	82,543	82,791
Variable opex	High	14	14	14	14	14
£/MWh	Median	10	10	10	10	10
	Low	8	8	8	8	8
Insurance	High	55,705	55,872	56,040	56,208	56,377
£/MW/y	Median	74,446	74,669	74,894	75,119	75,344
	Low	99,879	100,179	100,480	100,782	101,085
Connection and UoS charges	High	1,398	1,402	1,407	1,411	1,415
£/MW/y	Median	1,869	1,874	1,880	1,885	1,891
	Low	2,507	2,514	2,522	2,530	2,537

Biomass CHP		Financial close				
		2010	**2015**	**2020**	**2025**	**2030**
Capex	High	4966	4829	4731	4685	4650
£/kW	Median	4078	3965	3884	3847	3818
	Low	3467	3372	3303	3271	3246
Fixed opex	High	189,622	184,555	180,950	179,386	177,835
£/MW/y	Median	133,388	129,824	127,288	126,188	125,097
	Low	97,433	94,829	92,977	92,173	91,376
Variable opex	High	12	12	12	11	11
£/MWh	Median	9	8	8	8	8
	Low	6	6	6	6	6
Insurance	High	15,208	14,802	14,513	14,387	14,263
£/MW/y	Median	20,821	20,265	19,869	19,697	19,527
	Low					

		29,581	28,790	28,228	27,984	27,742
Connection and UoS charges	High	996	969	950	942	934
£/MW/y	Median	1,359	1,323	1,297	1,286	1,275
	Low	2,050	1,995	1,956	1,939	1,923

BASED ON POWER ONLY + SKM (2011) CHP COSTS		**Financial close**				
		2010	**2015**	**2020**	**2025**	**2030**
Capex	High	7736	7580	7470	7428	7385
£/kW	Median	4237	4152	4092	4068	4045
	Low	1839	1802	1776	1766	1756
Fixed opex	High	69,347	69,555	69,764	69,974	70,184
£/MW/y	Median	351,405	352,461	353,520	354,581	355,646
	Low	689,651	691,722	693,800	695,884	697,974
Variable opex	High	40	40	40	40	40
£/MWh	Median	20	20	20	20	21
	Low	4	4	4	4	4
Insurance	High	11,092	11,125	11,159	11,192	11,226
£/MW/y	Median	56,207	56,376	56,545	56,715	56,885
	Low	110,309	110,641	110,973	111,306	111,640
Connection and UoS charges	High	1,650	1,654	1,659	1,664	1,669
£/MW/y	Median	8,359	8,384	8,409	8,434	8,460
	Low	16,404	16,454	16,503	16,553	16,602

Biomass fuel price and waste gate fee assumptions

Assumptions for biomass and waste fuel costs are from internal Government analysis based on AEA (2010), the WRAP gate fees report 2011, and summarised below:

Table 4 - Assumed Feedstock Prices for Solid Biomass and Waste Plant

£/MWh (fuel input)	Low	medium	high
small biomass <50MW	7	12	19
large biomass >50MW	22	25	30
small biomass energy crops <50MW	13	25	29
AD (assumed gate fee)	-38	-10	18
EfW/ ACT (gate fee)		-29	

Source: Internal analysis based on AEA (2011) and WRAP gate fee report (2010)

Table 5 - Assumed feedstock prices for bioliquid plant

	Current	**2020**			**2030**			
£/MWh input		**Low**	**Central**	**High**	**Low**	**Central**	**High**	**Very High**
Biodiesel	86	97	10	108	83	97	112	173

Source: AEA (2011)

Fossil fuel prices are the latest published estimates from UEP40, published by DECC in 2010.

Hurdle rate assumptions

Table 6 - Assumed hurdle rates at different financial close rates

	2010 - 2016	2017 – 2019	2020 - 2025	2026 - 2030
Onshore wind	9.6%	9.6%	9.6%	9.6%
Offshore wind	11.6%	11.6%	9.6%	9.6%
Offshore wind R3	13.2%	13.2%	11.6%	9.6%
Geothermal	22.7%	22.7%	16.3%	12.7%
PV	7.5%	7.5%	7.5%	7.5%
Biomass	12.7%	12.7%	11.6%	11.6%
Bioliquid	11.9%	11.9%	11.9%	11.9%
EfW	11.9%	11.9%	11.9%	11.9%
AD	11.9%	11.9%	11.9%	11.9%
ACT	13.2%	13.2%	11.9%	11.9%
Landfill gas	9.6%	9.6%	9.6%	9.6%
Sewage gas	9.6%	9.6%	9.6%	9.6%
Hydro	7.5%	7.5%	7.5%	7.50%
Wave	13.8%	13.8%	13.2%	11.6%
Tidal stream	14.5%	14.5%	13.2%	11.6%
Tidal barrage	11.9%	11.9%	11.9%	11.9%

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

Load factor assumptions

Load factors of dedicated biomass and co-firing technologies are determined in the Pöyry model. The load factors for new build of other technologies are based on Arup (2011), except Ernst & Young (2010) for marine technologies and are set out in the table below.

Table 7 – load factors for new build plant

Technology	Load factor (net of availability)
Advanced conversion technologies	83.6%
AD	83.7%
Biomass Conversion	90.0%
Biomass Dedicated CHP	76.9%
CoFiring Standard CHP	90.0%
Energy from waste	82.7%
Geothermal	93.5%
Hydro	45.8%
Landfill Gas	81.0%
Offshore Wind	37.7%
Onshore Wind	28.6%
PV	10.8%
Sewage Gas	68.0%
Tidal Stream Deep	35.2%
Tidal Stream Shallow	53% declining to 44% by 2016
Wave	35% declining to 30% by 2016

Efficiency assumptions

The following table shows the net Higher Heating Value efficiencies that have been used in calculating levelised cost estimates. These are based on the gross Lower Heating Value efficiencies collected by Arup.

Table 8 – efficiencies for new build plant

	HHV efficiency
5-50MW dedicated biomass	27.6%
>50MW dedicated biomass	33.0%
Bioliquids	37.5%
Bioliquids CHP	37.5%
Conventional co-firing	32.5%
Enhanced co-firing	30.9%
Conversion	30.1%
EfW CHP	19.2%
EfW	19.2%
ACT	20.6%
ACT CHP	20.6%
Biomass CHP	18.5%
AD	36.5%
AD CHP	36.5%

Heat revenues

1. 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.

2. 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)[77], DECC gas fuel price assumptions and DECC carbon price assumptions (where the installation would be large enough to be in the EU-ETS).

3. 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.

Table 9 - Heat revenues

Technology	**Levelised heat revenue, £/MWh(e)**
Energy from waste with CHP	£43
Geothermal with CHP	£102
Dedicated bioliquids with CHP	£41
ACT with CHP	£31
Dedicated biomass with CHP	£48

Fossil fuel price assumptions

The DECC fossil fuel prices used in the Pöyry modelling are those in Table 10 below.

The new DECC fossil fuel prices have been published here: http://www.decc.gov.uk/en/content/cms/about/ec_social_res/analytic_projs/ff_prices/ff_prices.aspx.

[77] AEA/Nera (2009) *UK Supply Curve for Renewable Heat*

Table 10: UEP40 fossil fuel wholesale and retail price assumptions, 2009 prices

		2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Low fossil fuel prices	**WHOLESALE PRICES**																					
	Gas price (p/therm)	33.5	33.6	33.7	33.8	33.9	34.0	34.1	34.2	34.3	34.4	34.5	34.6	34.7	34.8	34.9	35.0	35.0	35.1	35.2	35.3	35.4
	Oil price ($/bbl)	51.1	51.1	53.2	55.2	57.3	59.3	61.4	61.4	61.4	61.4	61.4	61.4	61.4	61.4	61.4	61.4	61.4	61.4	61.4	61.4	61.4
	Coal price (£/tonne)	51.1	47.3	43.5	39.6	35.8	32.0	32.0	32.0	32.0	32.0	32.0	32.0	32.0	32.0	32.0	32.0	32.0	32.0	32.0	32.0	32.0
	RETAIL PRICES*																					
	Gas																					
	Industrial (p/kWh)	1.7	1.7	1.8	1.8	1.8	1.9	2.0	2.0	2.2	2.3	2.5	2.5	2.5	2.5	2.5	2.5					
	Residential (p/kWh)	2.8	2.9	3.0	3.1	3.3	3.4	3.4	3.6	3.7	3.8	4.0	3.8	3.9	3.9	3.9	3.9					
Central fossil fuel prices	**WHOLESALE PRICES**																					
	Gas price (p/therm)	59.6	61.8	62.5	63.3	64.0	64.8	65.5	66.3	67.0	67.8	68.5	69.3	70.0	70.8	71.6	72.3	73.1	73.8	74.6	75.3	76.1
	Oil price ($/bbl)	71.6	72.6	73.6	74.6	75.7	76.7	77.7	78.7	79.8	80.8	81.8	82.8	83.9	84.9	85.9	86.9	87.9	89.0	90.0	91.0	92.0
	Coal price (£/tonne)	70.3	66.5	62.6	58.8	55.0	51.1	51.1	51.1	51.1	51.1	51.1	51.1	51.1	51.1	51.1	51.1	51.1	51.1	51.1	51.1	51.1
	RETAIL PRICES*																					
	Gas																					
	Industrial (p/kWh)	2.6	2.7	2.8	2.8	2.9	3.0	3.0	3.2	3.3	3.4	3.6	3.7	3.7	3.7	3.8	3.8					
	Residential (p/kWh)	3.7	3.9	4.0	4.2	4.4	4.5	4.6	4.7	4.8	4.9	5.1	5.0	5.1	5.1	5.2	5.2					
High high fossil fuel prices	**WHOLESALE PRICES**																					
	Gas price (p/therm)	85.8	91.7	97.6	103.6	109.5	115.4	121.3	121.3	121.3	121.3	121.3	121.3	121.3	121.3	121.3	121.3	121.3	121.3	121.3	121.3	121.3
	Oil price ($/bbl)	105.2	113.2	121.2	129.3	137.3	145.4	153.4	153.4	153.4	153.4	153.4	153.4	153.4	153.4	153.4	153.4	153.4	153.4	153.4	153.4	153.4
	Coal price (£/tonne)	83.1	83.1	83.1	83.1	83.1	83.1	83.1	83.1	83.1	83.1	83.1	83.1	83.1	83.1	83.1	83.1	83.1	83.1	83.1	83.1	83.1
	RETAIL PRICES*																					
	Gas																					
	Industrial (p/kWh)	3.6	3.8	4.0	4.2	4.5	4.7	5.0	5.1	5.2	5.3	5.4	5.4	5.5	5.5	5.5	5.5					
	Residential (p/kWh)	4.7	5.0	5.3	5.6	6.0	6.3	6.5	6.6	6.7	6.8	7.0	6.8	6.9	6.9	6.9	6.9					

* Retail price assumptions are estimated based on adding supply costs, costs to energy suppliers of delivering Government policy and taxes/duty

Renewable electricity revenue assumptions

The revenue assumptions used in our calculations, and in the Pöyry modelling of investment decisions, were as follows:

- Levy exemption certificates: assumed to have a value of £4.72 in 2010/11, and for this value to remain constant in real terms;
- Wholesale electricity prices: an output of the Pöyry modelling. Investors are assumed to have five years of foresight of wholesale price changes, then assume the price stays constant in real terms for the rest of the project life;
- ROC value to a supplier: assumed to average at the buyout price plus 10%, which is the expected value when the headroom calculation sets the level of the Obligation, i.e. £36.99 x 1.1 = £40.69/MWh.= in 2010/11 prices;

Power Purchase Agreement (PPA) discounts: assumed that under PPAs, a generator receives 90% of the wholesale value, 89% of the ROC value and 93% of the LEC value, except for offshore wind where it assumed that new plants will be so large they may have difficulty obtaining a PPA, and hence will sell directly to the wholesale market and receive 100% of the market value of the electricity.[78]

[78] Assumptions from Pöyry

Annex C - List of consultation questions

Chapter 3 - Onshore Wind

Consultation Questions	
1.	**Do you agree with the Arup assessment of costs and deployment potential for onshore wind? Please explain your response with evidence.**
2.	**Do you agree with the proposed level of support of 0.9 ROCs/MWh for onshore wind? Please explain your response with evidence.**

Chapter 4 - Offshore Wind

Consultation Questions	
3.	**Do you agree with the Arup assessment of costs and deployment potential for offshore wind? Please explain your response with evidence.**
4.	**Do you agree with the proposed level of support of 2 ROCs/MWh for offshore wind, stepping down to 1.9 ROCs in 2015/16 and 1.8 ROCs in 2016/17? Please explain your response with evidence.**

Chapter 5 - Hydro-electricity

Consultation Questions	
5.	**Do you agree with the Arup assessment of costs and deployment potential for hydro-electricity? Please explain your response with evidence.**
6.	**Do you agree with the proposed level of support of 0.5 ROCs/MWh for hydro-electricity? Please explain your response with evidence.**

Chapter 6 – Marine Technologies

Wave and tidal stream

Consultation Questions	
7.	**Do you agree with the analysis on wave and tidal stream by Arup (2011) and their primary source Ernst & Young (2010)? Please explain your response with evidence.**
8.	**Do you agree with the proposed level of support of 5 ROCs/MWh for each project up to a limit of 30MW for wave and tidal stream (and 2 ROCs/MWh above that limit)? Please explain your response with evidence.**
9.	**Do you agree that 30MW is an appropriate level for the project cap? Please explain your response with evidence.**
10.	**Do you agree that the proposed level of support will help to drive deployment for the pre-commercial and early commercial deployment phases? Please explain your response with evidence.**

Tidal Range

Consultation Questions	
11.	**Do you agree with the analysis on tidal range by Arup (2011) and their primary source Ernst & Young (2010)? Please explain your response with evidence.**
12.	**Do you agree with the proposed level of support of 2 ROCs/MWh for tidal range, stepping down to 1.9 ROCs in 2015/16 and 1.8 ROCs in 2016/17? Please explain your response with evidence.**

Chapter 7 - Geothermal and Geopressure

Consultation Questions	
13.	**Do you agree with the Arup assessment of costs and deployment potential for geothermal and geopressure? Please explain your response with evidence.**
14.	**Do you agree with the proposed level of support of 2 ROCs/MWh for geothermal, stepping down to 1.9 ROCs in 2015/16 and 1.8 ROCs in 2016/17? Please explain your response with evidence.**
15.	**Do you agree with the proposed level of support of 1 ROC/MWh for geopressure? Please explain your response with evidence.**

Chapter 8 - Solar PV

Consultation Questions	
16.	Do you agree with the Arup assessment of costs and deployment potential for solar PV? We would particularly welcome UK-specific evidence on costs and deployment potential.
17.	Do you agree with the proposed level of support of 2 ROCs/MWh for solar PV, stepping down to 1.9 ROCs in 2015/16 and 1.8 ROCs in 2016/17? Please explain your response with evidence.

Chapter 9 - Biomass Electricity

Sustainability

Consultation Questions	
18.	Do you agree that we should not exempt existing generators from future changes to the UK's sustainability criteria for solid and gaseous biomass? Please explain your response with evidence.

Biomass purity threshold

Consultation Questions	
19.	Do you consider that the 90% biomass purity threshold is still appropriate? Please explain your response with evidence.

Biomass conversion

Consultation Questions	
20.	Do you agree with the Arup assessment of costs and deployment potential for biomass conversion? Please explain your response with evidence.
21.	Do you agree that 1 ROC/MWh is an appropriate level of support for biomass conversions? Please explain your response with evidence.
22.	Do you agree with our proposal for what should constitute a former fossil fuel generating station? Please explain your response with evidence.

23.	**Do you agree that all former fossil fuel generating stations which convert their entire generation to biomass before April 2013 should be transferred to the biomass conversion band? Please explain your response with evidence.**
24.	**Do you agree that support under the biomass conversion band should be grandfathered at the rate set from 1st April 2013? Please explain your response with evidence.**
25.	**We would welcome evidence on the differential in generation costs, the costs of making biomass conversion economically viable for industrial auto-generators, and deployment potential for auto-generating coal to biomass conversion.**

Enhanced co-firing

Consultation Questions	
26.	**Do you agree with the Arup assessment of costs for enhanced co-firing? Please explain your response with evidence.**
27.	**Do you agree that 1 ROC/MWh is an appropriate level of support for enhanced co-firing? Please explain your response with evidence.**
28.	**Do you agree that generating stations should generate at least 15% of their electricity from biomass in order to qualify for the enhanced co-firing band? Please explain your response with evidence.**
29.	**Do you agree that generators should meet this minimum 15% threshold on a monthly averaged basis? Please explain your response with evidence.**
30.	**Do you agree that support under the enhanced co-firing band should be grandfathered? Please explain your response with evidence.**

Biomass co-firing (standard)

Consultation Questions	
31.	**Do you agree with the Arup assessment of costs and generating potential for standard co-firing of biomass? Please explain your response with evidence.**
32.	**Do you agree with the proposed level of support of 0.5 ROCs/MWh for standard co-firing of biomass? Please explain your response with evidence.**

33.	**Do you agree that standard co-firing of biomass should continue not to be grandfathered? Please explain your response with evidence.**

Dedicated biomass

Consultation Questions	
34.	**Do you agree with the Arup assessment of costs and deployment potential for dedicated biomass? Please explain your response with evidence.**
35.	**Do you agree with the biomass fuel price assumptions for domestic and imported fuel from AEA, and the use of a 10:90 domestic to imported ratio for average fuel costs for large (>50MW) dedicated biomass and 90:10 for small (<50MW) dedicated biomass based on the Arup report? Please explain your response with evidence.**
36.	**Do you agree with the proposed level of support of 1.5 ROCs/MWh for dedicated biomass until 31 March 2016, reducing to 1.4 ROCs/MWh from 1 April 2016 ? Please explain your response with evidence.**
37.	**Do you agree that the support level proposed for dedicated biomass manages the risk of locking supplies of feedstock in to this sector? Please explain your response with evidence.**

Bioliquids

Consultation Questions	
38.	**Do you agree with the Arup assessment of generation costs and deployment potential of bioliquids, and the bioliquid fuel prices as set out in the Impact Assessment? Please explain your response with evidence.**
39.	**Do you agree that support for bioliquids should be the same as for solid and gaseous biomass under the dedicated biomass, biomass conversion, enhanced co-firing and standard co-firing bands? Please explain your response with evidence.**
40.	**Do you agree that 'fossil-derived bioliquids' should receive the same level of support as other bioliquids? Please explain your response with evidence.**
41.	**Do you agree that a cap should be put in place on the amount of electricity generated from bioliquid that suppliers can use to meet their renewables obligation? Please explain your response with evidence.**

42.	**Do you agree with the level of the cap being set at 4% of each supplier's renewables obligation, broadly equivalent to a maximum level of generation of 2TWh/y in 2017? Please explain your response with evidence.**
43.	**Do you agree that from 1 April 2013, bioliquids should be treated in the same way as solid and gaseous biomass for the purposes of our grandfathering policy? Please explain your response with evidence.**

Chapter 10 - Energy from Waste with CHP

Consultation Questions	
44.	**Do you agree with the Arup analysis on costs and potential on EfW with CHP, including the estimates of gate fees used? Please explain your response with evidence.**
45.	**Do you agree that 0.5 ROCS is an appropriate support level for EfW with CHP? Please explain your response with evidence. We would particularly welcome evidence relating to levels of gate fees received by generators and additional capital costs relating to heat offtake.**
46.	**In addition to municipal solid waste, do you consider that there are any other types of wastes which could benefit from provisions deeming their biomass content or benefit from more flexible fuel measurement and sampling procedures? If so, please specify and provide evidence on how we might determine accurately the renewable content of these wastes.**

Chapter 11 - Anaerobic digestion

Consultation Questions	
47.	**Do you agree with the Arup analysis on costs and potential on AD and AD with CHP, including the estimates of gate fees used? Please explain your response with evidence.**
48.	**Do you agree with the proposed level of 2 ROCs/MWh for Anaerobic Digestion, stepping down to 1.9 ROCs in 2015/16 and 1.8 ROCs in 2016/17? Please explain your response with evidence.**

Chapter 12 - Advanced Conversion Technologies (Gasification and Pyrolysis)

Consultation Questions	
49.	**Do you agree with the proposal to replace the standard and advanced pyrolysis and gasification bands with two new ACT bands? Please explain your response with evidence.**
50.	**Do you agree with the eligibility criteria for the new standard ACT and advanced ACT bands? Please explain your response with evidence.**
51.	**Do you agree with the proposed levels of support for the new standard ACT and advanced ACT bands? Please provide evidence on the relevant technology capital and operating costs (including levels of gate fees) to support your comments).**
52.	**We would welcome evidence on the generation costs, deployment potential and gates fees for the ACT technologies falling within the two new ACT bands proposed above.**
53.	**We would welcome information on the nature and scale of actual or potential air emissions produced in the generation of electricity from pyrolysis oil.**

Chapter 13 - Landfill Gas

Consultation Questions	
54.	**Do you agree with the Arup assessment of generation costs and deployment potential of landfill gas, and the gate fee assumption of zero? Please explain your response with evidence.**
55.	**Do you agree that RO support for new landfill gas generation should end from 1 April 2013? Please explain your response with evidence.**
56.	**We would welcome evidence on new technologies that can increase the technical potential of landfill gas in the UK, particularly from older landfill sites. Information on the costs, potential and viability of new technologies would be particularly valuable.**

Chapter 14 - Sewage Gas

Consultation Questions	
57.	**Do you agree with the Arup assessment of generation costs and**

	deployment potential for sewage gas, and the zero gate fee used in the analysis? Please explain your response with evidence.
58.	**Do you agree that 0.5 ROCs/MWh is an appropriate level of support for electricity generated from sewage gas? Please explain your response with evidence.**
59.	**We would welcome evidence on new technologies that can increase the technical potential from sewage gas in the UK. We are also interested in whether there is potential cogeneration. Information on the costs, potential and viability of new technologies would be particularly valuable.**

Chapter 15 - Renewable Combined Heat and Power (CHP)

Consultation Questions	
60.	**Do you agree with the Arup assessment of generation costs and deployment potentials for CHP technologies, and with the fuel prices used in the analysis? Please explain your response with evidence.**
61.	**Do you agree that 2 ROCs/MWh is an appropriate level of support for dedicated biomass with CHP? Please explain your response with evidence.**
62.	**Do you agree that 2 ROCs/MWh is an appropriate level of support for dedicated energy crops with CHP? Please explain your response with evidence.**
63.	**Do you agree that 1 ROC/MWh is an appropriate level of support for standard co-firing of biomass with CHP? Please explain your response with evidence.**
64.	**Do you agree in principle that 1.5 ROCs/MWh is an appropriate level of support for standard co-firing of energy crops with CHP? It would be helpful if you could provide evidence on costs and deployment potential to inform our decision.**
65.	**Do you agree with the arrangements for transition from the CHP uplift to RHI support as set out in this chapter (i.e. no RHI for projects accrediting under the RO; one-off choice between RHI and CHP uplift for projects accrediting between April 2013 and March 2015; no CHP uplift for projects accrediting after that date, unless the RHI is unavailable for that technology on 1 April 2015)? Please explain your response with evidence.**
66.	**Do you agree that we should adopt a policy of grandfathering the CHP uplift for eligible projects from 1 April 2013? Please explain your response**

	with evidence.
67.	**Do you agree in principle that we should consider extending the CHP uplift to the new biomass conversion and enhanced co-firing bands until 31 March 2015? It would be helpful if you could provide evidence on costs and deployment potential to inform our decision.**
68.	**Do you consider it would be appropriate to introduce a CHP uplift into the RO for ACTs? If so, please provide evidence on capital and operating costs of plant operating in CHP mode, together with likely deployment potential between now and 2020 and, if possible, 2030?**

Chapter 16 - Energy Crop Uplift

Consultation Questions	
69.	**Do you agree that we should narrow the definition of energy crops to limit its scope to only the short rotation coppice and perennial grass species as described above? Please explain your response with evidence.**
70.	**Do you agree that we should grandfather the energy crop uplift from 1 April 2013, but only for those crops meeting the new definition? Please explain your response with evidence.**
71.	**Do you agree with the proposed level of 2 ROCs/MWh for dedicated energy crops, stepping down to 1.9 ROCs in 2015/16 and 1.8 ROCs in 2016/17? Please explain your response with evidence.**
72.	**Do you agree with the proposed level of 1 ROC/MWh for standard co-firing of energy crops? Please provide evidence on costs and deployment potential.**
73.	**Do you consider that we should extend the energy crop uplift to the new biomass conversion and enhanced co-firing bands? It would be helpful if you could provide evidence on costs and deployment potential to inform our decision.**

Chapter 17 - Co-firing Cap

Consultation Questions	
74.	**Do you agree that the co-firing cap should be removed completely from 1 April 2013? Please explain your response with evidence.**
75.	**If you think that the cap should be increased (i.e. to allow more co-firing)**

	or restricted to standard co-firing of biomass, please state what an appropriate level for the cap would be and why? Please support your response with evidence.

Chapter 19 - Grace Periods

Consultation Questions	
76.	**Do you agree with our proposals for a time-limited and strictly defined grace period as described above, including scope, time limit and criteria? If you wish to suggest a different scope, time limit or criteria, please explain why. Please support your response with evidence.**

Chapter 20 - Microgeneration Technologies

Consultation Questions	
77.	**Do you agree with the proposed level of support of 2 ROCs/MWh for those microgeneration technologies eligible for support under the RO, stepping down to 1.9 ROCs in 2015/16 and 1.8 ROCs in 2016/17? Please explain your response with evidence.**

Chapter 21 - EMR Transition

Consultation Questions	
78.	**In addition to the specific questions asked throughout this consultation document, do you have any other comments on any aspect of our proposals? In each case, please explain your response with evidence.**

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