PÖYRY

Potential impact of revised Renewables Obligation technology bands – updated modelling

Pöyry Management Consulting

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INTRODUCTION

This report presents an update to our modelling to account for DECC's latest input assumptions and RO banding decisions

- The Renewables Obligation (RO) is the main support mechanism currently in place in the UK for large scale renewable electricity generating technologies. It is a green certificate scheme which provides technology specific support through the number of Renewables Obligation Certificates (ROCs) issued per MWh (ROC bands).

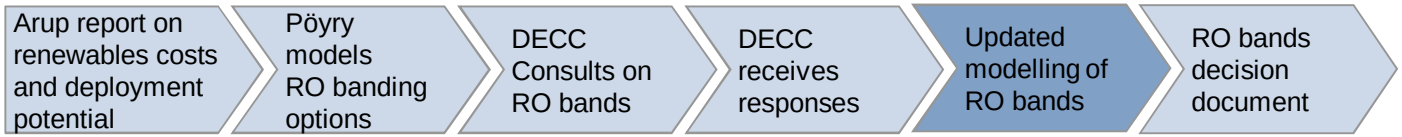
- In October 2011 DECC consulted on the ROC bands for generating stations commissioning, or new capacity added, from April 2013. To inform the consultation, Pöyry modelled the impacts of the bands on renewables deployment and the wholesale electricity market. The report presenting the results of Pöyry's modelling for the consultation can be found here.

- The consultation process provided DECC with additional information, and it had also updated its projections of fossil fuel prices. To take account of this new information, DECC commissioned Pöyry to undertake further analysis of potential ROC banding scenarios using its latest assumptions. An outline of the process for setting the bands is given in Figure 1 below.

- With the exception of the contracting assumptions[1] all the main assumptions were provided to Pöyry by DECC. For the contracting assumptions, these were suggested by Pöyry and agreed by DECC, with the exception of the offshore wind contracting assumption, which was provided by DECC.

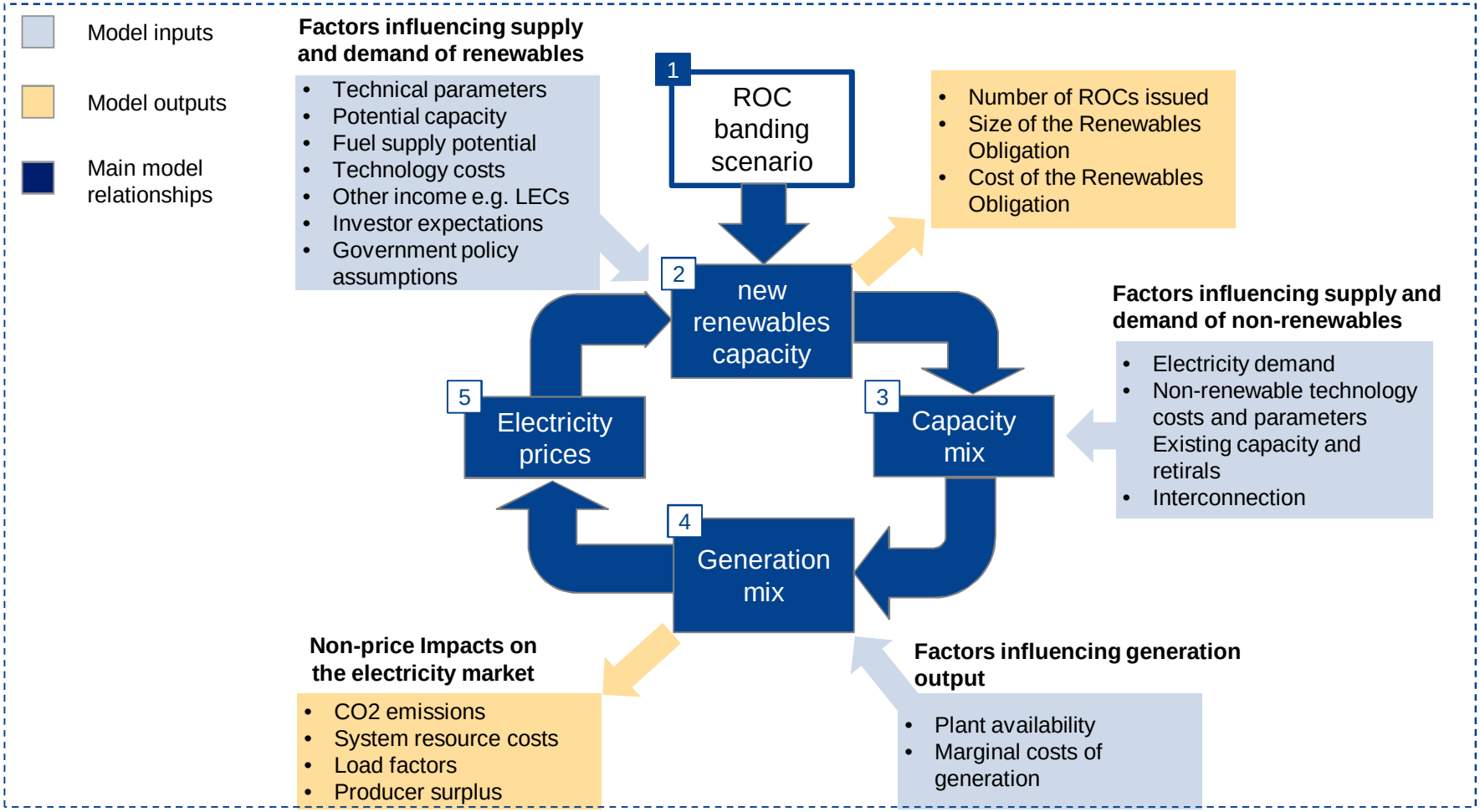
- There is considerable uncertainty over many of the input assumptions used e.g. how costs will change over time, and so actual investment decisions may differ from those presented. **In particular, a substantial differential between the scenarios modelled is the amount of generation from biomass conversion; this was provided by DECC for all scenarios presented, and was an input to our modelling, see Annex 2.**

Figure 1: Process for determining the RO bands



1 The contracting assumptions are the amount of value from a revenue stream a generator is assumed to retain under a long term contract.

OVERVIEW OF THE MODELLING APPROACH



The process begins with entering the technology specific ROC bands; these are then used to determine the amount of new renewables capacity commissioned, new thermal capacity commissioned, generation from available capacity and electricity prices. This process is circular as electricity prices themselves affect the economics of building new capacity (see Annex 3).

MAIN DIFFERENCES IN ASSUMPTIONS FROM THE CONSULTATION MODELLING

- The main differences between this analysis, and the analysis for the consultation are given below, some come from a general update of information others came as a result of DECC's October 2011 consultation.

- **General updates**
  - DECC's updated fossil fuel price projections, in summary the differences are:
    - lower coal prices projections across scenarios averaging £25/tonne less than DECC's previous projections; and
    - different gas price projections ranging from a reduction of 17p/therm, to an increase of 8p/therm from DECC's previous projections. Under the Central Fossil Fuel Price assumptions, gas prices are assumed to be lower to 2020 and higher beyond 2020 compared to DECC's previous assumptions.
  - Pöyry advised on the contracting assumptions for the consultation modelling, and advised a change to the previous assumptions to account for whether a generator is intermittent of not. These updated assumptions were: if a generator is intermittent, 87% of the value of the wholesale electricity price was assumed to be retained by the generator; if it is baseload, 93% of the value of the wholesale electricity price was assumed to be retained by the generator. This compared to the previous assumption of 90% of the value retained across all generators. DECC used its own contracting assumptions for offshore wind and asked us to assume that offshore wind captured 95% of the value rather than its previous assumption of 100%.

- **DECC's updates as a result of the consultation**
- Details of these are provided in pages 8 and 9 and Annex A of DECC's impact assessment accompanying its RO banding response document, a brief summary is:
  - Revisions to onshore wind >5MW load factors and technical potential, offshore wind operating costs;
  - Updates made to dedicated biomass CHP and ACT based on respective calls for evidence;
  - Updated biomass costs (lower for dedicated biomass but higher for co-firing) and waste gate fees assumptions (generally lower);
  - Updated deployment potentials, particularly for PV
  - Updated information on biomass conversions – the assumed potential was increased; and
  - An assumption that the LEC value reduces to 10% from April 2024, and then remains at that level, rather than continue at the full 100% value as a result of supply of LECs increasing, relative to demand for LECs.

SCENARIOS AND SENSITIVITIES MODELLED

We modelled three banding options and four fossil fuel price sensitivities

- In analysing the potential impact on renewables deployment and the wholesale electricity market, we modelled three options:
  - Option 1: Current Bands – these are the bands in place until March 2013;
  - Option 2: Consultation Bands – these are the bands proposed in DECC's October 2011 consultation; and
  - Option 3: Response bands[1] – these are the bands given in DECC's July 2012 consultation response document.

We also ran the following sensitivities:

- Current Bands with High Fossil Fuel Prices (HFFP);
- Current Bands with Low Fossil Fuel Prices (LFFP);
- Response Bands with High Fossil Fuel Prices; and
- Response Bands with Low Fossil Fuel Prices.

- We considered the impacts on the following:
  - new renewable generating capacity;
  - renewable generation;
  - ROCs issued;
  - wholesale electricity prices (where modelled);
  - cost of the RO;
  - cost to customers;
  - system costs; and
  - producer surplus.

1 At the time of modelling some technologies were subject to further consultation. For these technologies DECC provided indicative ROC bands to Pöyry for the purposes of modelling.

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EMR RELATED ASSUMPTIONS

It was assumed EMR proceeded as anticipated at the time of modelling

Feed-in Tarff with Contracts for Difference (FiT CfD):

- It was assumed that projects commissioning before April 2016 are supported under the RO and after this date are supported under the FiT CfD. In reality some projects commissioning prior to April 2016 may be supported by the FiT CfD rather than the RO, and some projects commissioning between April 2016 and April 2017 may be supported by the RO.
- Under the Current Bands option the analysis assumes that renewable generation in 2020 will be 108TWh – the electricity sector's share of the 2020 renewable energy target. This generation volume is achieved from RO, small-scale FiT and FiT CfD supported generation and assumes that future FiT CfD strike prices will be set at a level commensurate with this overall generation volume. Projected deployment under the FiT CfD was then kept the same for the purpose of modelling the renewable generation under the Response Bands and Consultation Bands option.

Capacity Payment Mechanism (CPM)

- The way in which we modelled the capacity mechanism simulated a targeted capacity mechanism, which was the best information on the likely structure of the capacity mechanism at the time of modelling. The latest proposals are for a market wide capacity mechanism. This could have a different impact on wholesale electricity prices than the type of capacity mechanism modelled.
- Under the assumption provided to us by DECC of five-year foresight of wholesale electricity prices in investment decisions, modelling a market-wide capacity mechanism instead of a targeted capacity mechanism would not have had a significant effect on investment decisions in the banding review period. However, if it was assumed that investors take a longer term view of future wholesale electricity prices than five years, then the impact of different electricity prices under a market wide capacity mechanism could result in different investment decisions being made than those presented in this report.

Carbon Price Floor (CPF)

- It was assumed that the CPF is implemented as intended reaching £30/tCO_2 in 2020 and £70/tCO_2 in 2030 (2009 prices).

Emissions Performance Standard (EPS)

- It was assumed that no new coal plants built unless fitted with CCS.

ASSUMED ROC BANDS

- Slide 12 shows the ROC bands assumed under the three different options modelled:
  - 1. Current Bands;
  - 2. Consultation Bands; and
  - 3. Response Bands.

- DECC's response stated that there would be further consultation in the following areas:
  - the band for PV from April 2013;
  - the band for **standard** co-firing from April 2013;
  - the energy crops uplift **for standard co-firing** from April 2013; and

- At the time of modelling, as the above technologies were subject to further consultation, DECC provided indicative ROC bands to Pöyry for the purposes of modelling.

ROC BANDS MODELLED

Response bands modelled may differ from announced decisions – see DECC's response to its consultation for the actual bands that will apply

Technology	1. Current Bands	2. Consultation Bands	3. Response Bands	Comments
Advanced Conversion Technology (Advanced)	2.0	2.0*	2.0*	*Falls to 1.9 in 2015/16
Advanced Conversion Technology (Standard)	2.0	0.5	2.0*	*Falls to 1.9 in 2015/16
Biomass conversion (all units)	1.5	1.0	1.0	
Biomass conversion (one unit)	0.5	1.0*	1.0	*Assumes >15% biomass
Co-firing of biomass (85 to < 100% in one unit)	0.5	1.0*	0.9**	*Assumes >15% biomass, **0.7ROCs/MWh in 2013/14
Co-firing of biomass (50 to < 85% in one unit)	0.5	1.0*	0.6	*Assumes >15% biomass
Co-firing of biomass (<50% in one unit)	0.5	0.5*	0.3**	*Assumes < 15% biomass , **rises to 0.5ROCs/MWh in 2015/16, 0.0 used as a proxy for 0.3ROCs/MWh
Biomass (New)/Bioliquids	1.5	1.5	1.5	
Energy from waste (CHP)	1.0	0.5	1.0	
Geothermal	2.0	2.0*	2.0*	*Falls to 1.9 in 2015/16
Hydro	1.0	0.5	0.7	
Landfill gas	0.25	0.0	0.2*/0.0**	* For open landfill sites, ** for closed landfill sites
Offshore wind	1.5*	2.0**	2.0**	*2 until April 2014, ** falls to 1.9 in 2015/16
Onshore wind	1.0	0.9	0.9	
Sewage gas	0.5	0.5	0.5	
Solar PV	2.0	2.0*	1.0**	* Falls to 1.9 in 2015/16, ** falls to 0.9 2014/15 and 0.5 in 2015/16 (for modelling purposes only)
Tidal stream/Wave (England & Wales)	2.0	5.0*	5.0*	* To a max. of 30MW, then 2ROCs/MWh
Tidal stream (Scotland)	3.0	5.0*	5.0*	* To a max. of 30MW, then 2ROCs/MWh
Wave (Scotland)	5.0	5.0*	5.0*	* To a max. of 30MW, then 2ROCs/MWh
CHP uplift	0.5	0.5*	0.5*	* Only available until in 2014/15
Energy crops uplift	0.5	0.5	0.5*	* Consulting on its removal for standard co-firing

No change from current band

Change to current band applicable to plants accredited after 31 March 2013

Change to current band applicable to all plants irrespective of accreditation date

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MAIN CONCLUSIONS

- Overall the Response Bands and Consultation Bands option are projected to lead to 11GWh more renewable electricity generation than the Current Bands option. Of this 11GWh, 10GWh is assumed to come from enabling the conversion of single units of a coal plant to be awarded up to 1ROC/MWh for converting to biomass (see Slide 34).

- Although the Response Bands option is projected to be more expensive than the Consultation Bands options overall, the cost per MWh of renewable generation is projected to be 11% cheaper due to the lower average ROC band awarded per MWh of generation.

- Most new deployment from April 2013 to April 2017 (the banding review period) is projected to come from onshore wind (2.6GW in the Response Bands option) and biomass conversion (2.0GW in the Response Bands option). Offshore wind was projected to make a comparatively lower contribution (0.6GW in the Response Bands option).

- The majority of ROCs are projected to be issued to onshore wind, offshore wind and biomass conversion. In the Response Bands option these technologies make up 27%, 29% and 20% of the projected ROCs issued respectively. Although a lower proportion of generation is projected to come from offshore wind than onshore wind or biomass conversion it still makes up a significant proportion of the overall projected number of ROCs issued due to the higher number of ROCs/MWh it is awarded.

- Electricity prices that investors base their decisions on will impact on the amount of new capacity that comes forward. Under the Response Bands option this lead to 5TWh (2TWh excluding Biomass Conversion differences) more projected generation under the High Fossil Fuel Price sensitivity and 24TWh (12TWh excluding Biomass Conversion differences) less generation under the Low Fossil Fuel Price sensitivity than when the option was modelled using Central Fossil Fuel Price assumptions.

COMPARISON OF OPTIONS

Higher renewable generation from the Response Bands relative to Current Bands is contingent on it encouraging more biomass conversion

The bands in DECC's response to its consultation are projected to result in around 2GW more renewable capacity and 11TWh more renewable generation than the Current Bands under the RO. Of this difference around 10TWh is expected to come from the anticipated increase in biomass conversion, as a result of introducing an enhanced co-firing band of 0.7ROC/MWh increasing to 0.9 ROCs/MWh from 14/15 and enabling the conversion of single units of coal plants to access 1ROC/MWh.

The remaining additional generation is projected to come from the increase in the offshore wind band from 1.5ROCs/MWh after April 2014 in the Current Bands option to 2ROCs/MWh in the Response Bands option.

The higher level of generation in the Response Bands option relative to the Current Bands option results in around 4million more ROCs being issued, and a £1.8 billion higher lifetime system cost of the RO.

The cost per MWh is projected to be lower in the Response Bands option than the Current Bands option. This is primarily the result of the ROC bands assumed for biomass in previously coal-fired plants (see Slides 34 and 35).

Key results – options

		Difference	
	Current Bands	Consultation Bands	Response Bands
Large-scale renewable capacity in 2016/17 (GW)*	19.8	+2.1	+1.8
Large-scale renewable generation in 2016/17 (TWh)*	68.3	+11.2	+11.2
ROCs issued in 2016/17 (Millions)*	78.6	+5.4	+4.2
Lifetime cost of the RO (real 2010 prices, £billion)	41.8	+2.3	+1.5
Lifetime system costs (real 2010 prices, £billion)**	635.2	+2.3	+1.8

*DECC defines large-scale renewable electricity as all renewable electricity excluding that supported by the small-scale FiT. It therefore includes existing capacity not supported by the RO or FiT. Capacity and generation reported excludes capacity modelled under the FiT CfD.

** this does not include all system costs. see definition of system costs in slide 26.

Source: DECC, calculated from Pöyry results.

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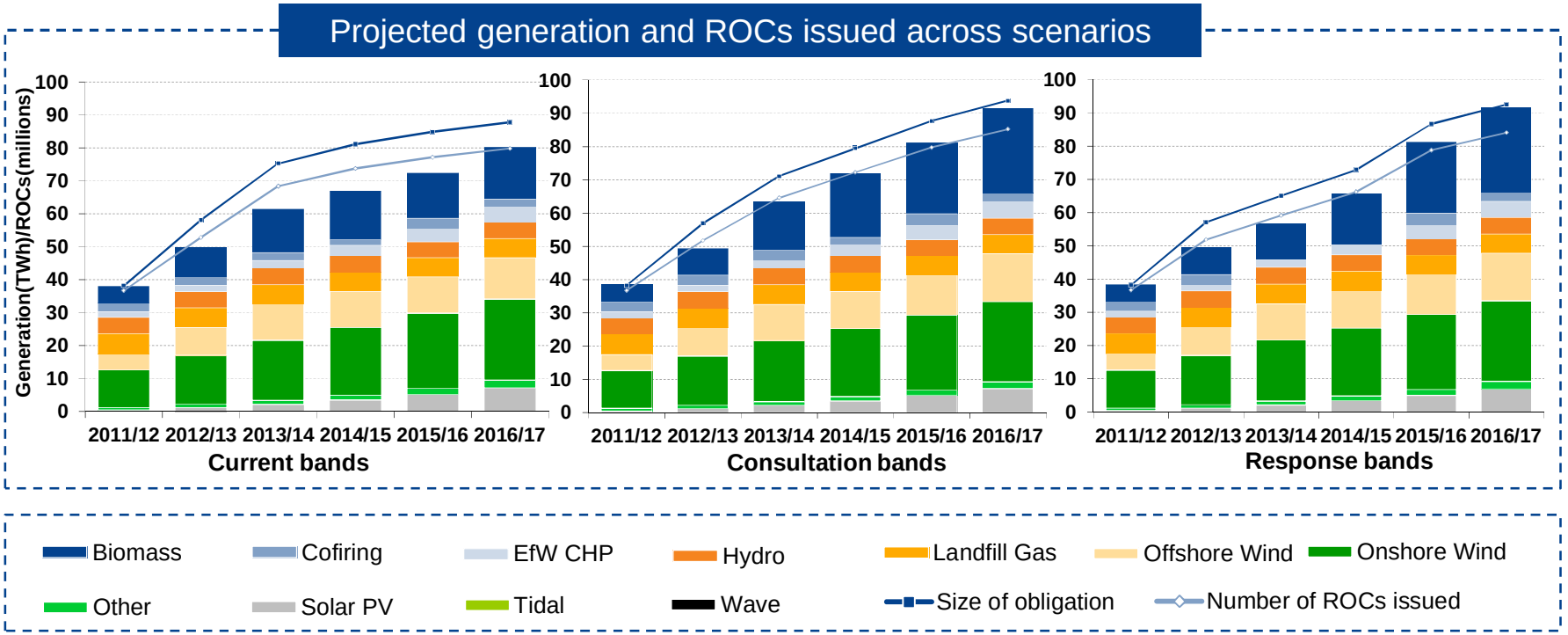
GENERATION ACROSS SCENARIOS

The majority of generation is projected to come from onshore wind, offshore wind and biomass

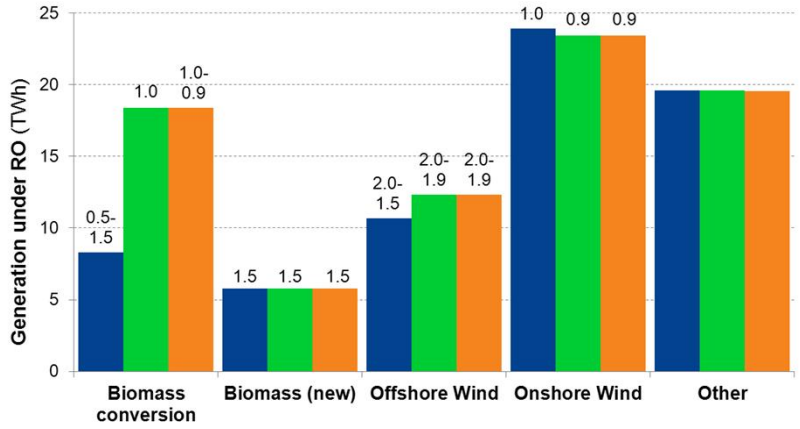


Of the three options, onshore wind is expected to contribute the largest amount of generation with between 29% and 35% of the generation projected to come from this technology depending on the option modelled. The other main contributors are Biomass (including Biomass Conversion) and Offshore Wind. Note that 1 ROC does not necessarily equal 1MWh of generation, as different technologies receive different levels of ROCs per MWh.

HOW THE BIGGEST CONTRIBUTORS TO THE TARGET COMPARE

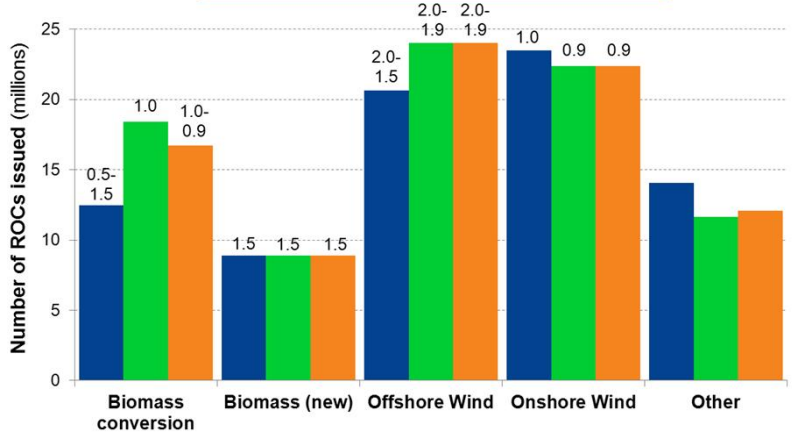
The differences in assumed ROC bands across scenarios resulted in some difference in projected generation, but a greater variance in ROCs issued

Generation 2016/17



Note: the numbers above the bars are the ROC band assumed

ROCs issued 2016/17



Note: the numbers above the bars are the ROC band assumed

■ Current Bands ■ Consultation Bands ■ Response Bands

In the Current Bands option, onshore wind is projected to contribute the most generation from a single technology and be issued with the largest proportion of ROCs. However, in the Consultation Bands and Response Bands options, whilst the most generation is still projected to come from onshore wind, the largest number is projected to be issued to offshore wind. This is because the ROC band for offshore wind is lower in the Current Bands option (1.5ROCs/MWh rather than 2ROCs/MWh) than the other two options and the band for onshore wind is higher (1ROC/MWh rather than 0.9ROCs/MWh).

For the conversion of coal plant to biomass the number of ROCs issued also varies by scenario. The same amount of generation is assumed under the Consultation Bands and Response Bands options but more ROCs are assumed to be issued under the Consultation Bands option. This is because there is no provision under the Consultation Bands option for a variable ROC band depending on the amount of biomass used. For the Consultation Bands option, relatively few ROCs are assumed to be issued reflecting the relatively low assumed generation in this scenario, for the Consultation Bands.

Small differences were also projected for other technologies where the ROC bands differed e.g. EfW CHP. New build in 2016/17 was assumed to commission under CfDs rather than the RO.

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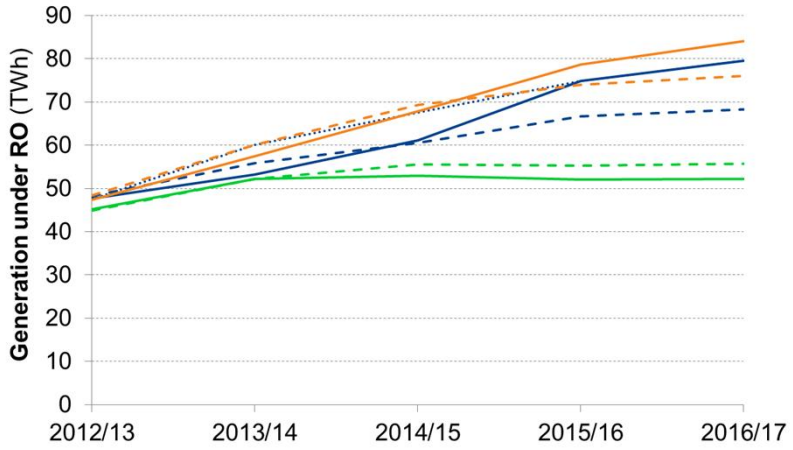
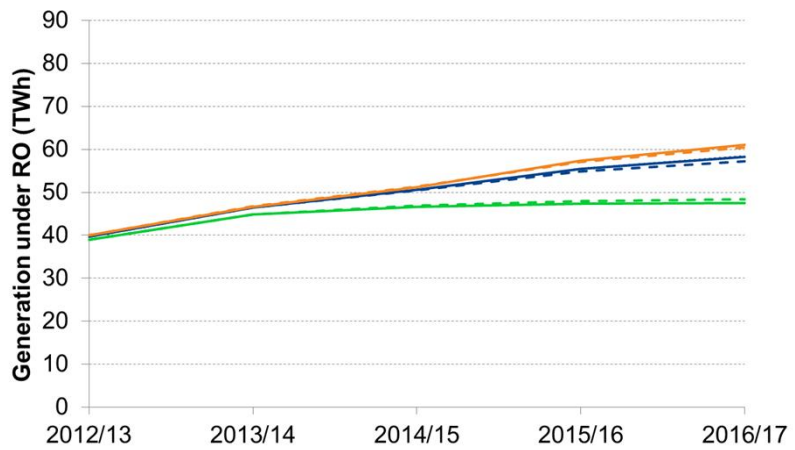
MODELLED RO GENERATION ACROSS FOSSIL FUEL PRICE SENSITIVITIES

Projected RO generation is influenced by investors expectations of electricity prices

All technologies



All excl. biomass conversion and co-firing



Current Bands CFFP
Consultation Bands CFFP
Response Bands CFFP
Current Bands HFFP
Response Bands HFFP
Current Bands LFFP
Response Bands LFFP

Over the period when the new bands apply, from April 2013 to April 2017, the Consultation Bands and Response Bands options are projected to reach a higher level of generation than the Current Bands option. This is primarily due to biomass conversions and to a lesser extent offshore wind. The chart on the right shows that removing biomass conversion assumptions results in very little difference in generation between the three options.

The area where a difference is clear between the scenarios run is the difference in generation when different fossil fuel prices are assumed. The variance between the fossil fuel price sensitivities reflects DECC's assumptions on future gas prices, which in turn feed into electricity prices. The gap between the low and central assumed gas prices is greater than the gap between the central and high gas prices (see Slide 38), this is the reason for closer projected renewable generation between the High and Central sensitivities than the Central and Low Fossil Fuel Price sensitivities.

ROCS ISSUED/SUPPORT ACROSS SCENARIOS

Biomass conversion and electricity price expectations also significantly impact on the projected amount of support

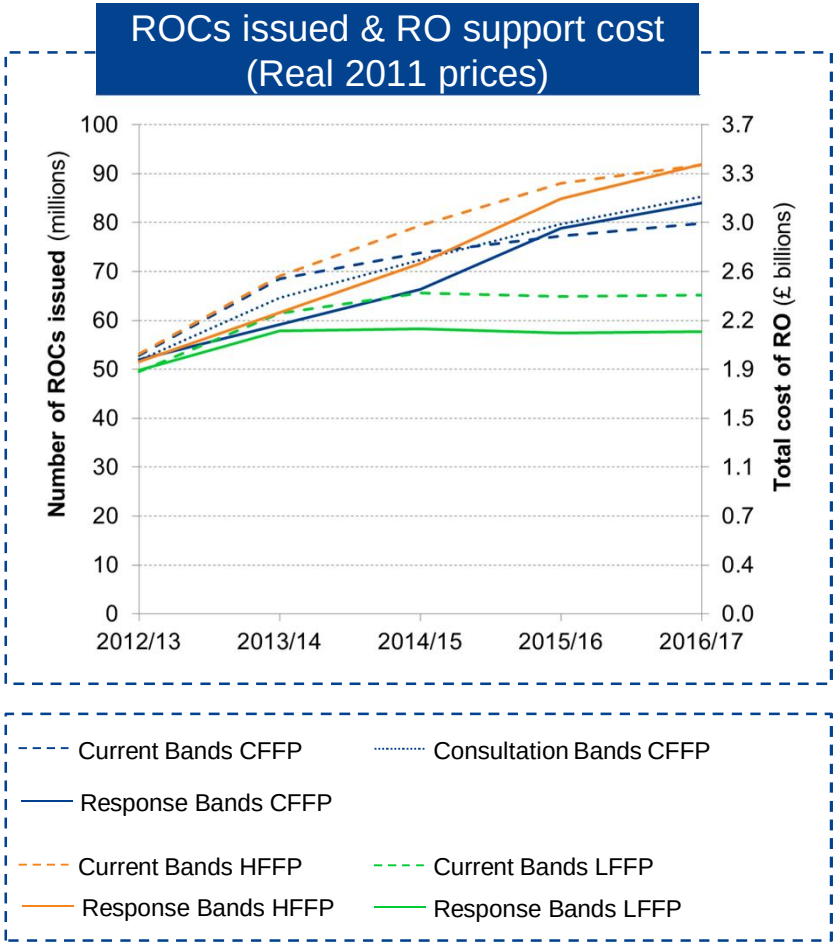
The amount of projected generation and assumed ROC band determines number of projected ROCs issued. This in turn is directly correlates to the projected amount of support under the RO[1].

Under Central Fossil Fuel Price scenarios, the number of ROCs issued and so cost of support is projected to be higher by 2016/17 under the Consultation Bands and Response Bands options than the Current Bands option reflecting the additional renewable generation anticipated under these options

Under the High Fossil Fuel Price sensitivities, very similar numbers of ROCs are projected to be issued under the Current and Response bands options. This is despite higher projected generation under the Response Band option, meaning the cost per MWh of generation is projected to be less under the Response band option.

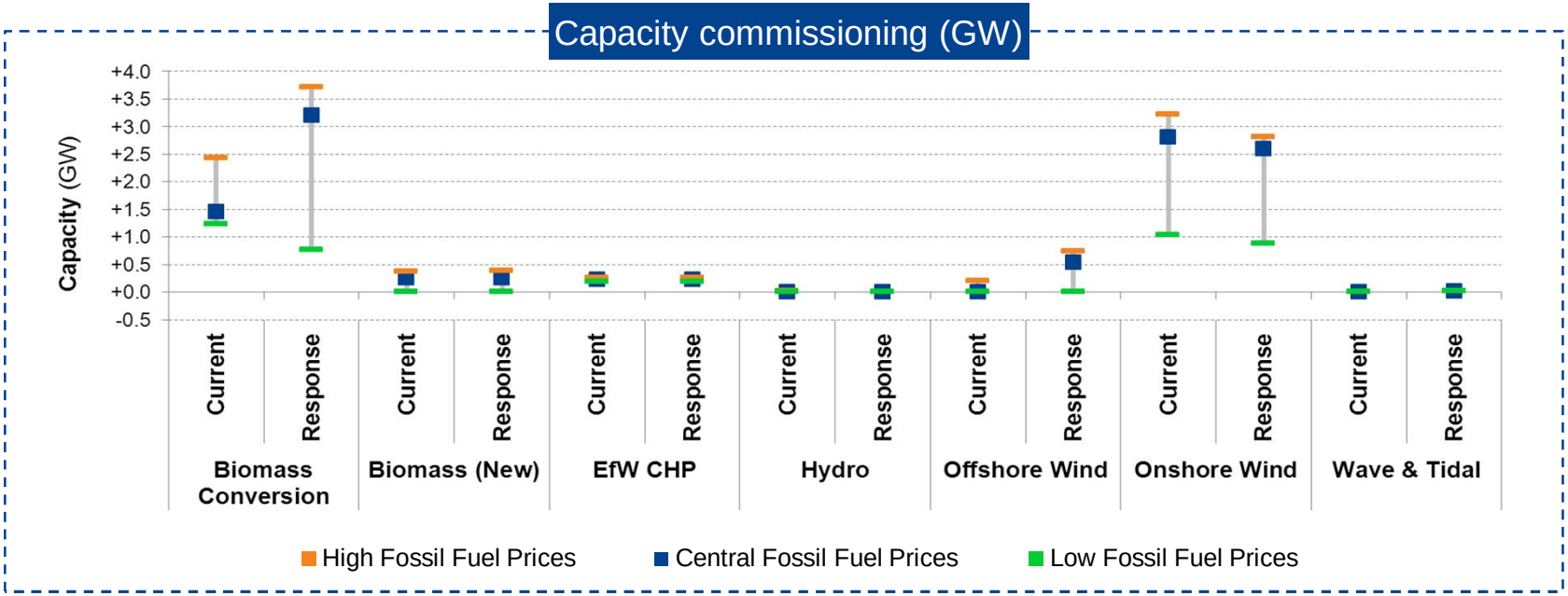
Under the Low Fossil Fuel Price sensitivities, the Current Bands option is projected to result in more ROCs issued than the Response Bands option. This is due to the additional generation projected for the Current Bands option over the Response bands option when electricity prices are low.

1 Assuming the Obligation is set using the headroom calculation which sets the Obligation at 10% above the projected number of ROCs issued rather than the fixed Obligation. The headroom calculation is projected to be used to set the Obligation for all years of our projections.



CAPACITY COMMISSIONING FROM APRIL 2013 - APRIL 2017

Onshore wind and biomass conversion are projected to be most sensitive to future expectations of electricity prices, offshore wind is less so



The charts above shows the additional capacity projected to be installed under the RO by technology when the bands under the Current Bands or Response bands options are in place from April 2013 with different fossil fuel price assumptions.

The range of capacity across wholesale electricity price scenarios varies most for onshore wind and biomass conversion. This is due to:

- the relatively high deployment potential assumed for these technologies; and
- that based on the costs and revenue assumptions they appear relatively economic (in the case of biomass conversion, as modelled by DECC).

In the Low Fossil Fuel Price sensitivities very little new capacity is projected by April 2017, with onshore wind making the only notable contribution under both the Response Bands and Current Bands options.

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COST DEFINITIONS

- **Renewable generation costs** = capex (annuitized over 15 years with an interest rate equal to the assumed project hurdle rate) + opex + fuel costs.

  Renewables capacity commissioned before 2011 is assumed to have the same costs as capacity commissioned in 2011.

- **System cost** = costs of renewable generation + costs of non-renewable generation + balancing cost + EUA purchase costs.

  Note: this does not include all system costs e.g. transmission, distribution costs and retail costs are not included.

- **Non-renewable generation costs** = capex (annuitized over 15 years with an interest rate equal to the assumed project hurdle rate) + opex + fuel costs.

- **Balancing cost** = assumed balancing cost per unit of intermittent generation x intermittent generation + balancing cost per unit of non-intermittent generation x non-intermittent generation.

  Note: this uses a rough estimate of the level of current balancing costs that are assumed to be attributed to intermittent and non-intermittent generation.

- **Cost of purchasing EUA's** = grid emissions of CO_2 x projected EUA price.

- **Consumer cost** = RO cost + wholesale price cost + balancing cost.

  Note 1: the consumer cost does not include assumed FiT CfD subsidy costs, as the design of the scheme and technology specific 'strike prices' are yet to be determined. This means that whilst wholesale prices might be lower to 2039/40 in scenarios where wind and nuclear generation is higher, reducing the cost to consumers, the increase in consumer costs as a result of the FiT CfD will not be taken into account.

  Note 2: the consumer cost does not represent all costs to consumers as other costs which may be assumed to remain constant (e.g. supplier transaction) are not included.

- **RO cost** = buyout price x obligation size.

- **Wholesale price cost** = wholesale price x demand for each period, summed over all periods.

- **Producer surplus for renewable generators** = sum of NPV of total revenues to each generator minus NPV of total generation costs.

GLOSSARY

- CFFP – Central Fossil Fuel Prices
- DECC – Department of Energy and Climate Change
- EMR – Electricity Market Reform
- FiT CfD – Feed-in Tariff with Contracts-for-Difference
- GW – Gigawatt
- GWh – Gigawatt hour
- HFFP – High Fossil Fuel Prices
- LEC – Levy Exemption Certificate
- LFFP – Low Fossil Fuel Prices
- MW – Megawatt
- MWh – Megawatt hour
- PPA – Power Purchase Agreement
- RO – Renewables Obligation
- ROC – Renewables Obligation Certificate
- TW – Terawatt
- TWh – Terawatt hour

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MAIN INPUT ASSUMPTIONS

- Here we have listed some of the main input assumptions to the modelling, including any input assumptions which have changed since the modelling for the Consultation Bands. As in the last set of modelling all the input assumptions came from DECC, with the exception of the assumption on contracting. The following slides contain the input assumptions for:
  - hurdle rates;
  - deployment potential;
  - fossil fuel and carbon prices; and
  - biomass conversion generation.

The modelling was undertaken in real, 2010 prices and so all costs are shown in this price base.

For more information on the sources of the input assumption and how the assumptions are used in the modelling, see our report on the modelling of the Consultation Bands[1].

The capex and opex costs used are those given in DECC's response to the consultation on the proposed RO bands[2].

COSTS – FUEL COSTS

DECC's assumed costs fed into DECC's calculation of the technology ROC band to award

Fuel price assumptions (real 2010 prices)

Technology	Fuel price (£/MWh$_{th}$)
Bioliquids	48 to 77
Biomass (<50MW)	12
Biomass (>50MW)	23
Biomass (CHP)	23
Biomass (conversion/high range co-firing/ mid range co-firing)	23 to 29
Biomass (Energy crops)	28
Cofiring (CHP)	7 to 18
Cofiring (Energy Crops)	22 to 33
Cofiring (Standard)	25 to 33

Source: DECC, AEA

Gate fee paid to generator assumptions (real 2010 prices)

Technology	Gate fee (£/MWh$_{th}$)
Advanced Conversion Technology	1 to 9
Anaerobic Digestion	-1 to 8
Energy from Waste	19 to 26

Source: DECC

COSTS - HURDLE RATES

DECC assumed discount rates were lower under the FiT CfD than the RO due to greater wholesale price certainty

Assumed discount rates by technology

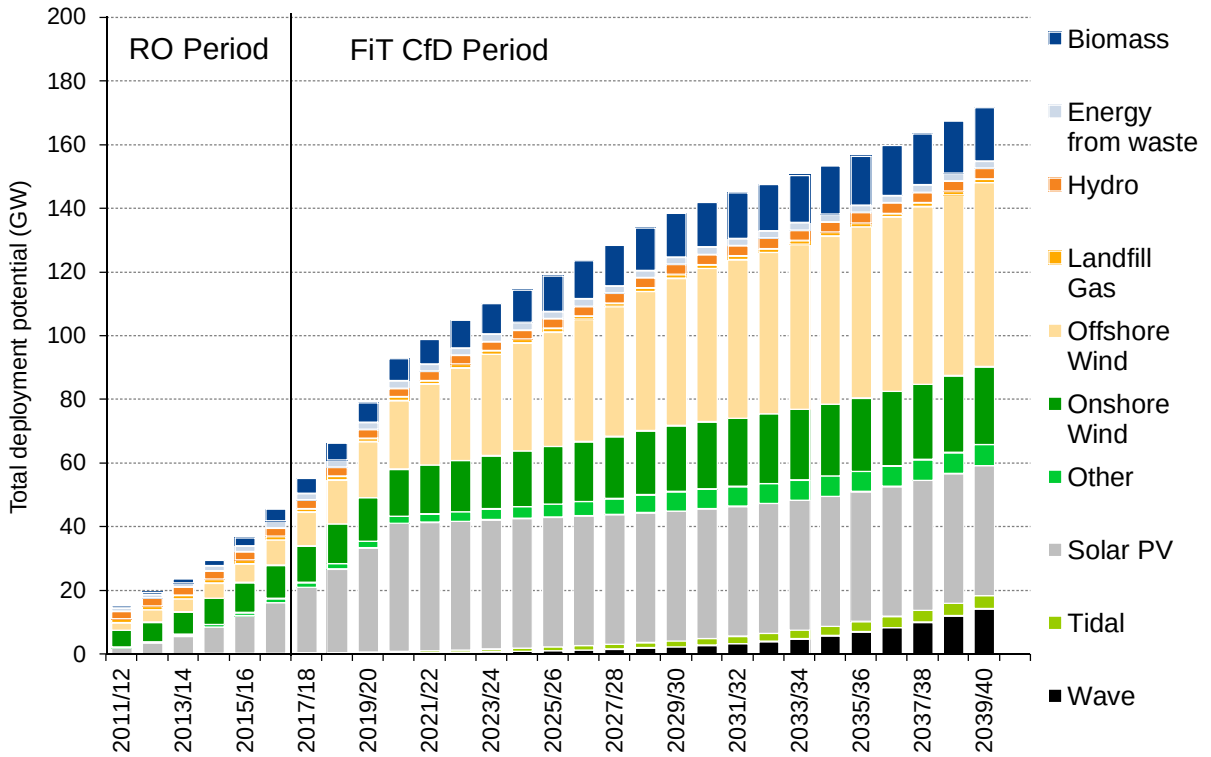
Technology	RO	FiT CfD
ACT (CHP)	14%	12% - 13%
ACT (Advanced Power only)	13%	11% - 12%
ACT (Standard Power only)	10%	9%
AD (CHP)	14%	12% - 13%
AD (Power only)	13%	11% - 13%
Bioliquid (CHP)	14%	12% - 13%
Bioliquid (Power only)	13%	11% - 12%
Biomass (CHP)	14%	12% - 13%
Biomass (Power only)	13%	11% - 12%
Cofiring (CHP)	12%	11%
Cofiring (Power only)	10%	10%
EfW (CHP)	13%	12%
EfW (Power only)	12%	11%
Geothermal (CHP)	24%	13% - 22%

Technology	RO	FiT CfD
Geothermal (Power only)	23%	12% - 21%
Hydro (>5MW)	8%	7%
Hydro (<=5MW)	7%	7%
Landfill gas	10%	9%
Offshore wind (Round 2)	12%	9% - 11%
Offshore wind (Round 3)	13%	9% - 12%
Onshore Wind (>5MW)	10%	9%
Onshore wind (<=5MW)	9%	9%
PV (>5MW)	8%	7%
PV (<=5MW)	7%	7%
Sewage gas	10%	9%
Tidal	8%	8% - 14%
Wave	8%	8% - 13%

Source: DECC

DEPLOYMENT POTENTIAL

Arup's high deployment potential was assumed, with some adjustments provided by DECC reflecting information provided during consultation



Note: Includes operational capacity, capacity currently under construction and potential new capacity. Biomass used in previously coal-fired power stations is not included

Source: DECC, ARUP

BIOMASS CONVERSION ASSUMPTIONS UNDER THE THREE OPTIONS MODELLED

DECC expects widening the eligibility for biomass conversion will enable more renewable generation at lower cost

Comparison of support assumed across the options

	Band (ROCs/MWh)	No. of band categories	DECC projected installed capacity in 2016/17 (MW)	Projected support in 2016/17 (£million, real 2010 prices)	Comments
Current bands	1.5	1	1,460	460	Only 100% biomass across the generator qualifies
Consultation bands	1.0	1	3,200	680	Anything over 15% across the generator qualifies
Response bands	0.6-1.0	3	3,200	620	Band dependent on amount of biomass burned in a single unit

The table above compares the DECC's capacity assumptions and ROC banding assumptions for the use of large quantities of biomass in a previously coal-fired generating station under each option.

The way in which biomass conversion was assumed to be supported under the different options varied:

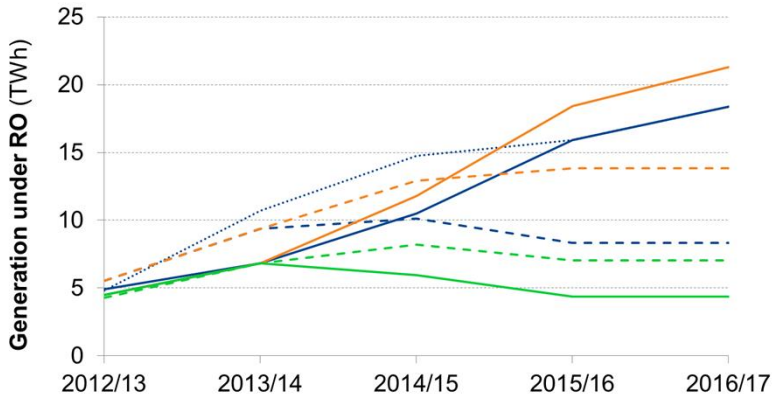
- Under the Current Bands option a generating station could only qualify as biomass conversion if the whole generating station used 100% biomass.
- Under the Consultation Bands option a wider definition was assumed, so if 15% of the fuel used at the generating station was biomass it would qualify for the Biomass Conversion band.
- The Response Bands option was based on qualification of individual generating units rather than the amount of biomass used in the generating station as a whole. Anything upwards of 50% biomass qualified for a higher ROC band, with the band increasing from 0.6ROCs/MWh to 1ROC/MWh depending on the percentage of biomass used in the unit.

The result of these different support regimes was that DECC's assumptions on capacity and ROCs issued differed by Option. Although the Current Bands option offered the highest support per MWh, its restrictive definition means DECC expects that fewer generators will convert to biomass under this option. The capacity assumed for the Consultation Bands and Response Bands options was the same, however, the number of ROCs assumed to be issued (and hence the level of support projected) was lower under the Response Bands option due to the ability to award a variable ROC band depending on the amount of biomass used.

BIOMASS CONVERSION ASSUMPTIONS ACROSS THE SENSITIVITIES

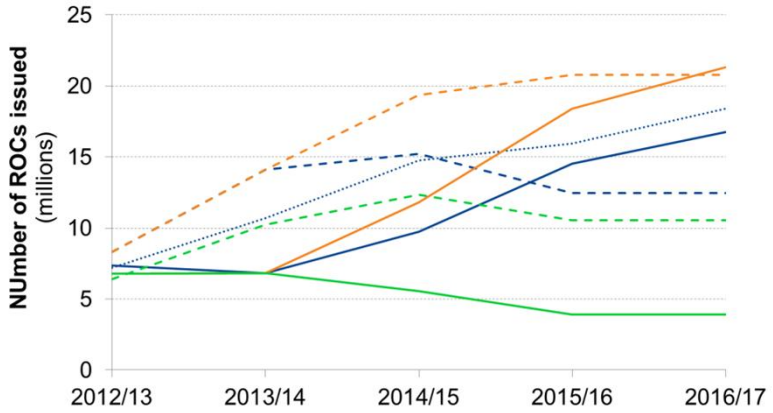
In the Central and High Fossil Fuel Price sensitivities more biomass conversion was assumed under the Response Bands than the Current Bands

Assumed generation from biomass conv.



Source: DECC

Assumed ROCs issued to biomass conv.



Source: DECC

Current Bands CFFP
Consultation Bands CFFP
Response Bands CFFP
Current Bands HFFP
Response Bands HFFP
Current Bands LFFP
Response Bands LFFP

Under the Central Fossil Fuel Price scenarios the amount of generation under the Response Bands option was assumed to reach the same level as the Consultation Bands option by 2015/16, and surpass the Current Bands option by 2014/5 due to the different definitions of biomass conversion (see Slide 34).
The generation assumptions under the High Fossil Fuel Price sensitivities follow a similar pattern, however, the number of ROCs issued (and so cost of support) assumed under the Response Bands was almost the same as under the Current Bands due to the 1.5ROC/MWh band for conversions of whole generating stations under the Current Bands option.
Unlike under the Central and High Fossil Fuel price sensitivities, under the Low Fossil Fuel Price sensitivities, more capacity was assumed to commission under the Current Bands option due to the higher ROC band of 1.5ROCs/MWh available to the conversion of whole generating stations (conversions under other options were less viable due to the low electricity price).

TECHNICAL PARAMETER ASSUMPTIONS – FUELLED GENERATORS

Key technical parameters assumed

Technologies	Efficiency (%)	Load factor (%)	Technical lifetime (years)
ACT (Advanced, Power only)	25.8	86.8	24
ACT (CHP)	19.0	77.4	24
ACT (Standard, Power only)	22.1	89.0	24
AD (CHP)	36.5	84.0	21
AD (Power only)	36.5	84.0	21
Bioliquid (CHP)	27.5	72.7	10
Bioliquid (Power only)	27.5	72.7	10
Biomass (>50MW, Power only)	36.3	61.0-90.0	25
Biomass (Energy crops)	31.0	66.0-90.0	23
Biomass (5-50MW, Power only)	31.0	90.0	25
Biomass (CHP)	20.0	83.3	25
Biomass (Conversion/High range co-firing)	34.0-36.0	42.0-65.0*	22
Co-firing (Power only)	36.5	n/a	9
EfW (CHP)	19.8	85.5	30
EfW (Power only)	24.0	83.0	31
Landfill gas	35.0	81.0	20
Sewage Gas	35.1	68.0	28

TECHNICAL PARAMETER ASSUMPTIONS – NON FUELLED GENERATORS

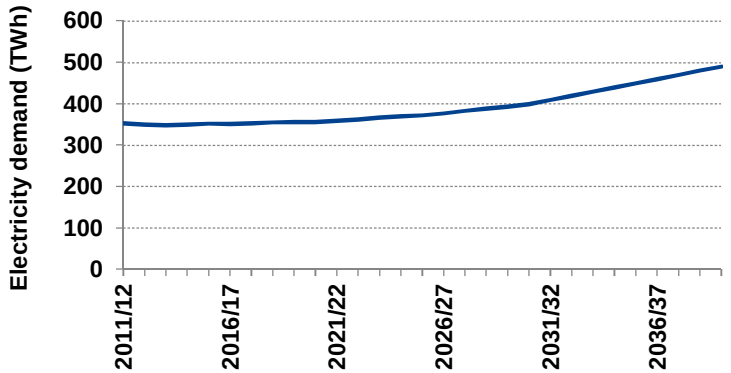
Key technical parameters assumed

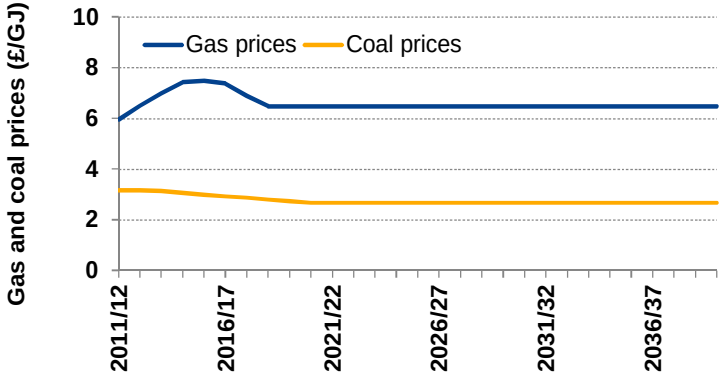
Technologies	Load factor (%)	Technical lifetime (years)
Geothermal (CHP)	91.2	25
Geothermal (Power only)	91.2	25
Hydro (<5MW)	35.0	25
Hydro (=>5MW)	35.0	41
Offshore wind (Round 2)	37.7	23
Offshore wind (Round 3)	39.5	22
Onshore wind (<=5MW)	25.0	24
Onshore wind (England, >5MW)	25.5	24
Onshore wind (Scotland, >5MW)	28.7	24
Solar PV (<50kW)	9.7	25
Solar PV (>50kW)	10.8	25
Tidal Stream (England, Wales & NI, Deep)	35.0-40.0	3-20
Tidal Stream (England, Wales & NI, Shallow)	35.0-40.0	5-20
Tidal Stream (Scotland, Deep)	35.0-40.0	3-20
Wave (England, Wales & NI)	25.0-33.0	5-20
Wave (Scotland)	25.0-33.0	5-20

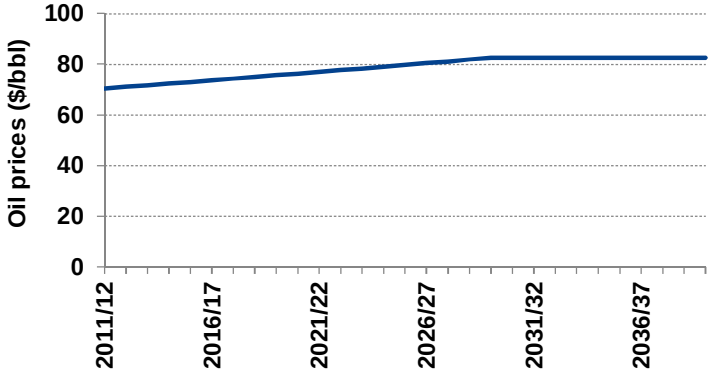
ELECTRICITY MARKET ASSUMPTIONS

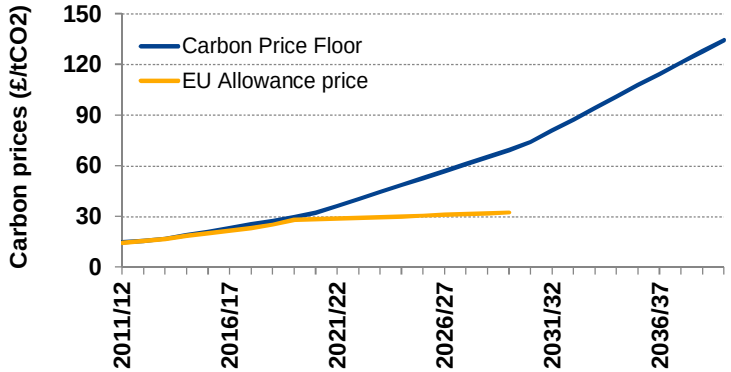
The main drivers of electricity prices are electricity demand and carbon, gas, oil and coal prices

Electricity demand and fuel price assumptions (real, 2010 prices)





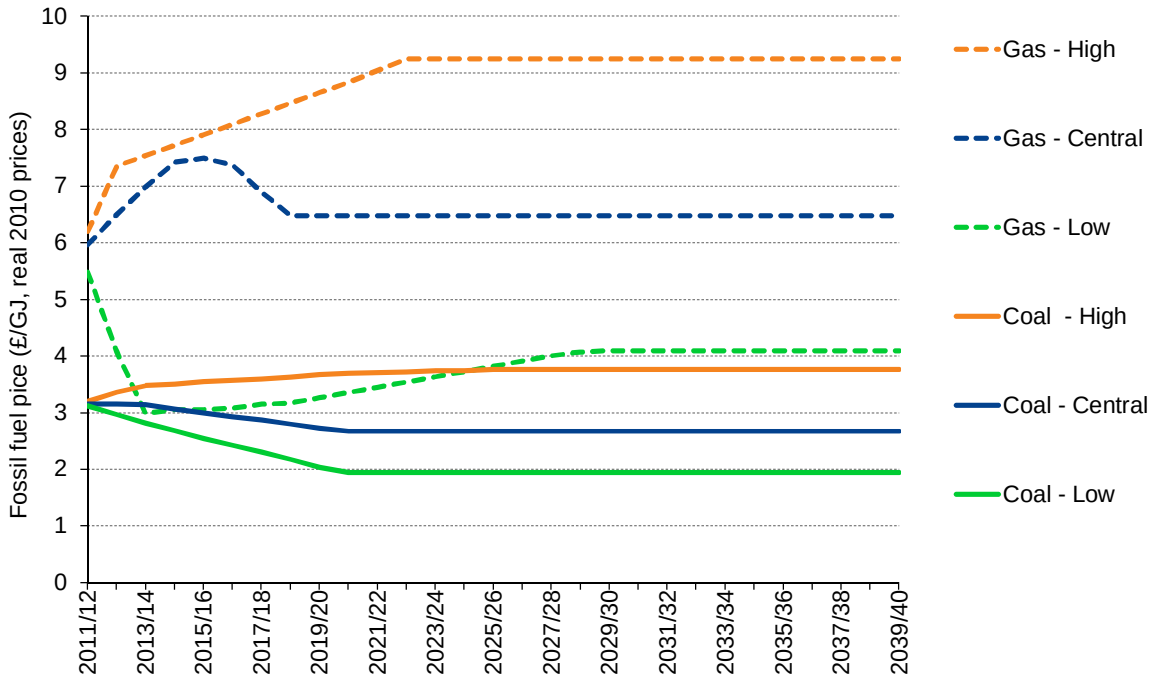




Source: DECC

GAS AND COAL PRICE ASSUMPTIONS FOR SENSITIVITIES

High, Central and Low fuel price assumptions (real, 2010 prices)



Source: DECC

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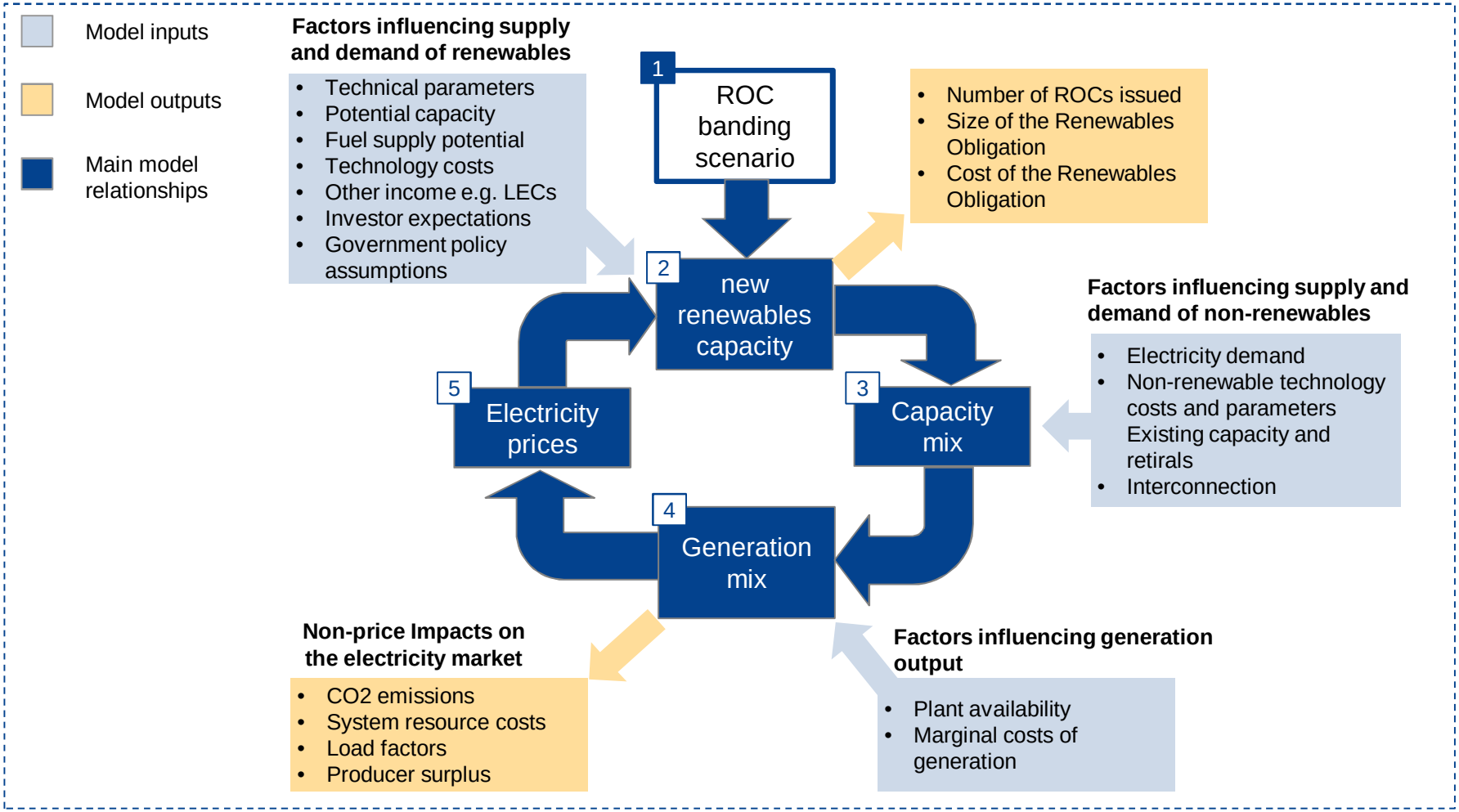
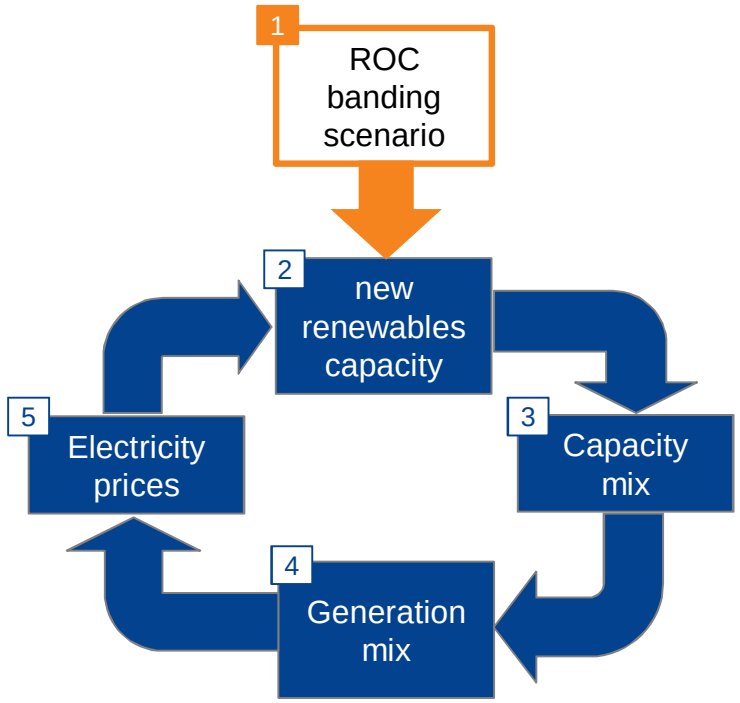
ANNEX 3 – MODELLING APPROACH



The process begins with entering the technology specific ROC bands; these are then used to determine the amount of new renewables capacity commissioned, new thermal capacity commissioned, generation from available capacity and electricity prices. This process is circular as electricity prices themselves affect the economics of building new capacity. Our modelling process includes this circularity.

STAGE 1, ROC BANDING SCENARIOS

Stage 1, ROC banding scenarios. This stage kicks off the modelling process with a set of pre-determined technology specific ROC bands. The bands entered into the model then feed into the amount of new renewables capacity that is projected to be to be developed.



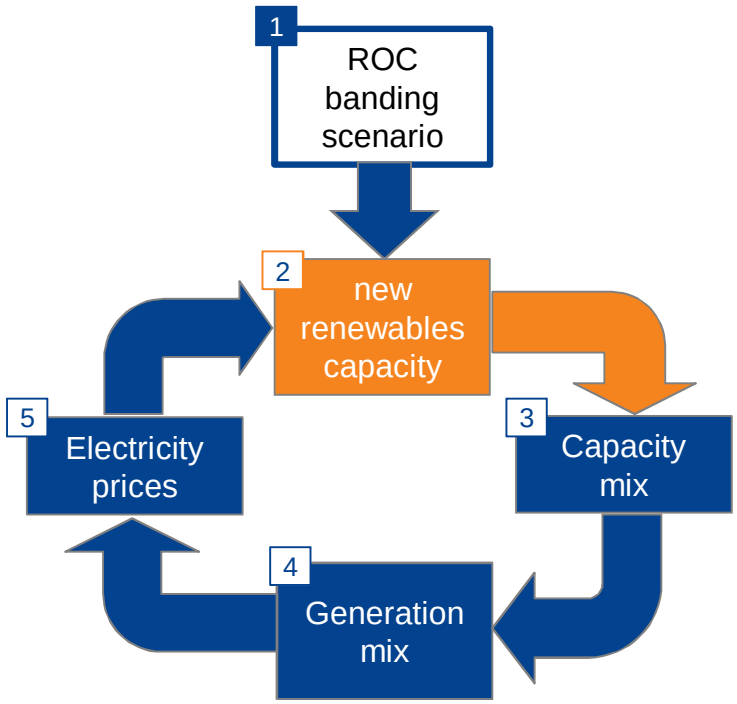
STAGE 2, NEW RENEWABLES CAPACITY

Stage 2, new renewables capacity. To determine what new renewables capacity is built, the model considers whether a project appears economic to investors, taking account of the ROC bands entered in Stage 1, and what can feasibly be built given practical constraints. The higher the ROC bands, the more attractive renewables will be to develop, and the more capacity will get built, subject to non-financial constraints.

For the economic test, assumed costs include capex, opex and fuel costs. Along with the ROC bands, the assumed income includes the sale of electricity, the sale of LECs and gate fees. Technical characteristics such as load factors and efficiencies are also necessary to understand the return per MWh of generation.

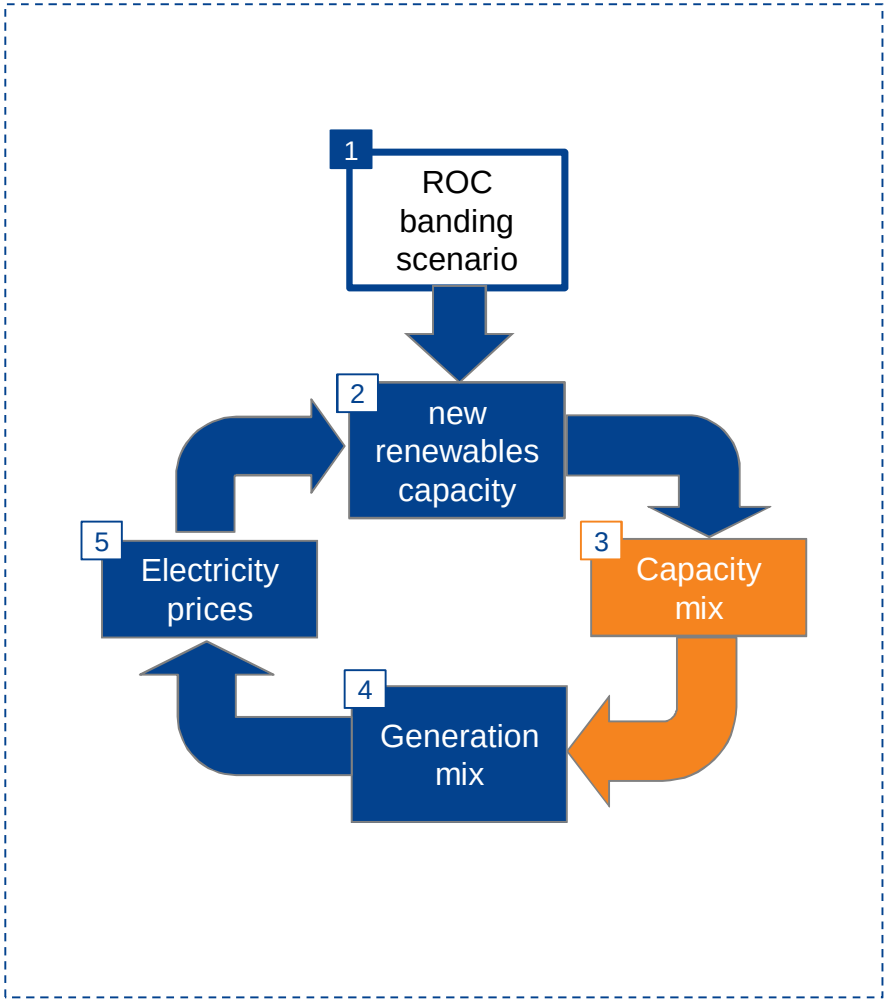
The potential for non-financial constraints, e.g. supply chain constraints, is taken into account by constraining the maximum capacity that could be built of each technology in each year. Renewable thermal capacity is also constrained by the available fuel supply.

Once the build-out of renewables capacity is determined, it is possible to determine the potential impact on the ROC market, including the number of ROCs issued and cost of the RO.



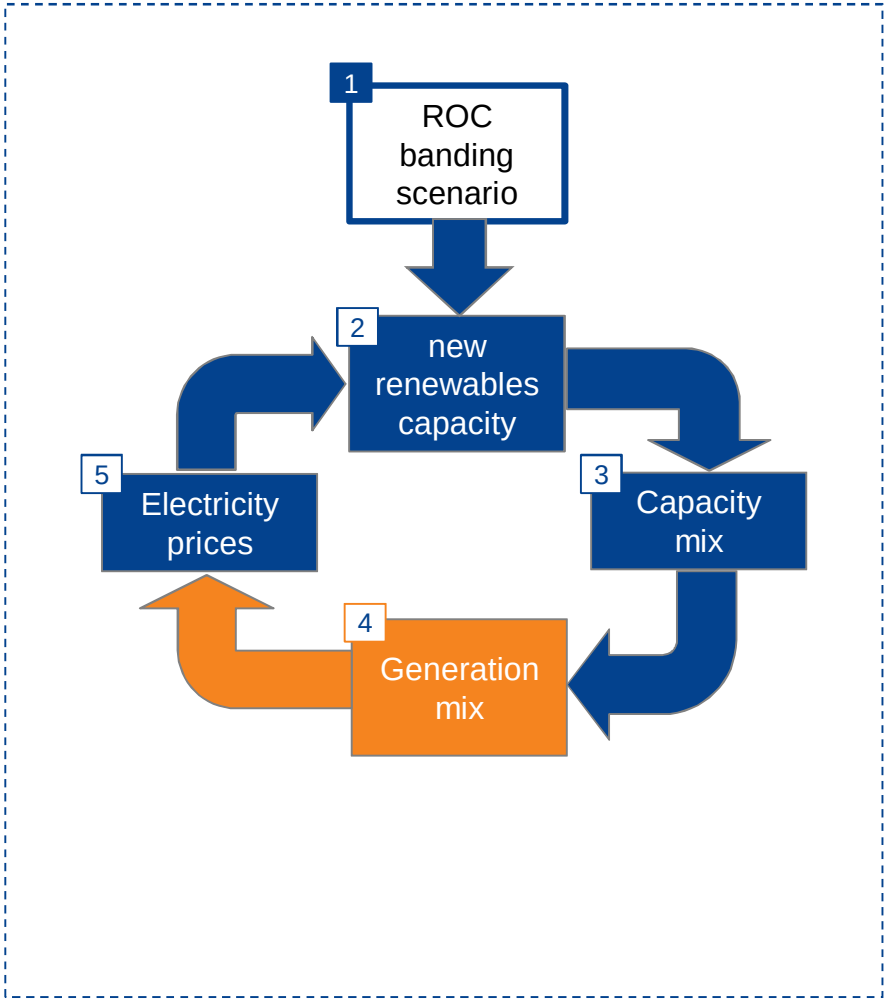
STAGE 3, CAPACITY MIX

Stage 3, capacity mix. The amount and type of renewables capacity that gets built impacts on the demand for new non-renewable capacity. This means the overall capacity mix will be affected e.g. large amounts of biomass may reduce the amount of new CCGT capacity built. To determine the extent of this effect, assumptions were made on the supply and demand for non-renewable capacity, including non-renewable technology costs and overall electricity demand.



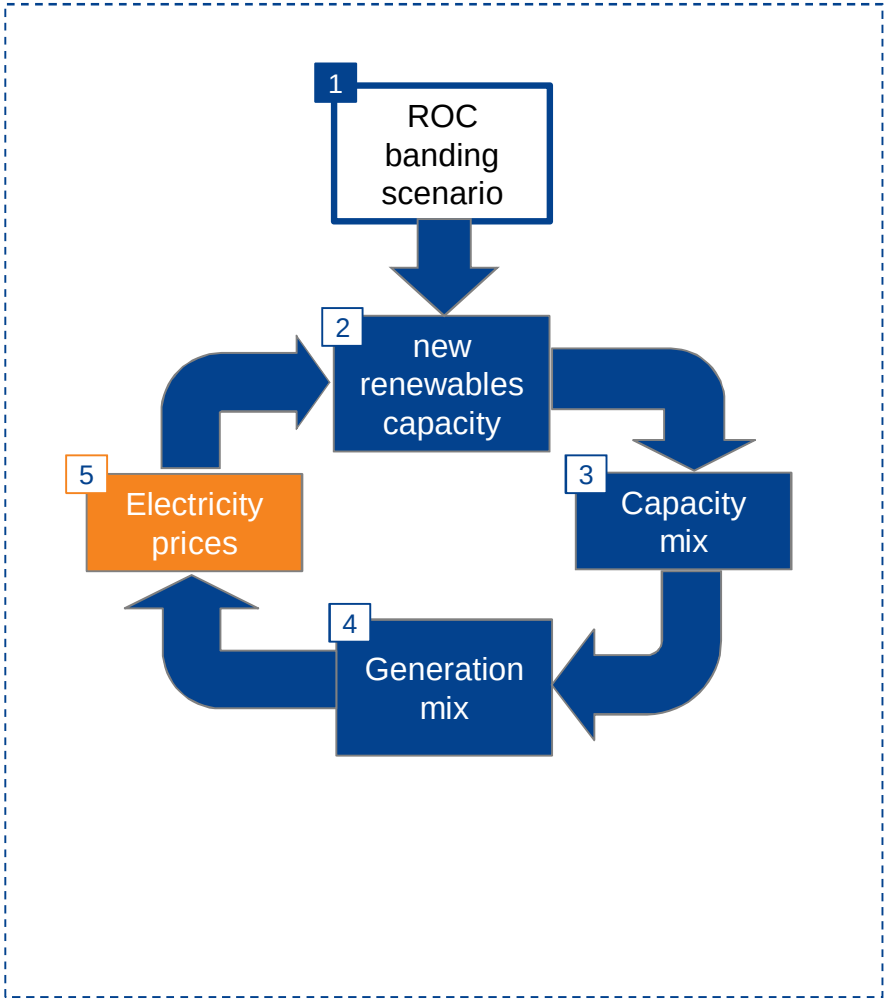
STAGE 4, GENERATION MIX

Stage 4, generation mix. The overall capacity mix will determine the amount of generation that is expected from each technology. This is dependent on both the availability of the technology and its marginal cost of generation. For example, higher levels of renewable generation, with low marginal cost, might reduce the level of non-renewable thermal generation, with a relatively high marginal cost.



STAGE 5 ELECTRICITY PRICES

Stage 5, electricity prices. As different technologies have different fixed and marginal costs the change in capacity and generation mix will impact on the overall costs of generation. This in turn will affect electricity prices – the higher the costs, the more revenue generators will require to recover costs. In addition, subsidising renewable generation will mean some of the cost to these generators will be covered outside of the wholesale electricity market. In general, this will mean the more renewable generation is supported through the RO, the more costs are covered outside the electricity market, and the lower projected wholesale prices are.

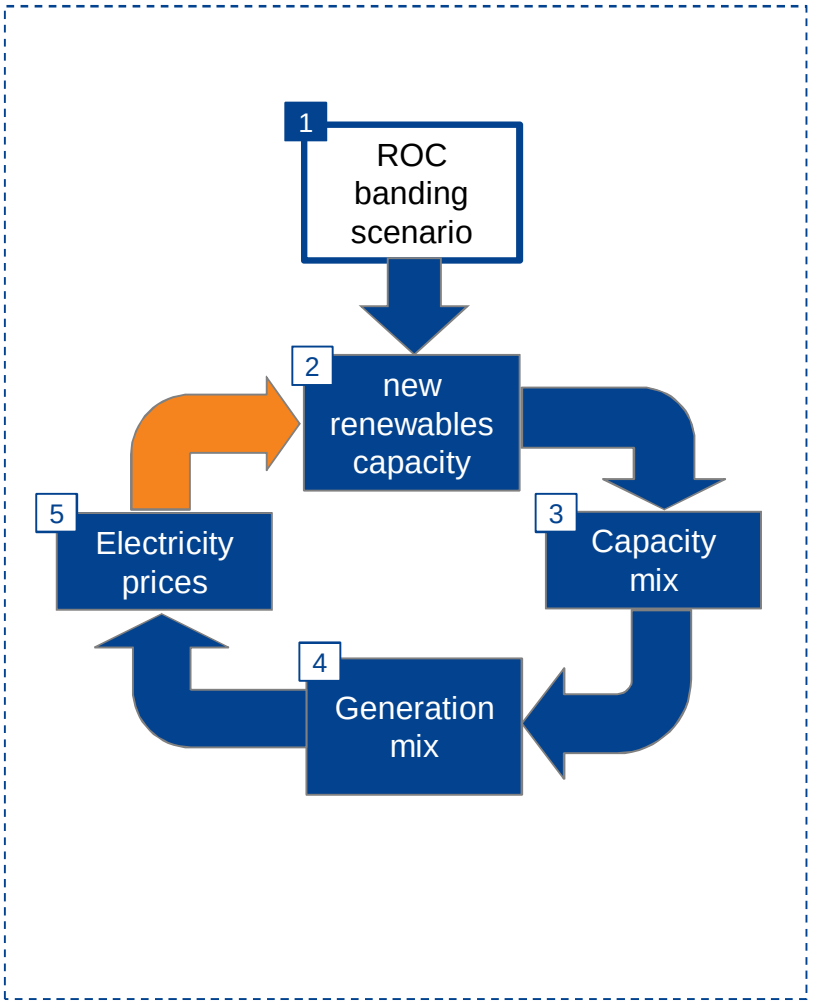


STAGE 5 BACK TO STAGE 2, IMPACT OF WHOLESALE PRICES ON NEW RENEWABLES CAPACITY

Stage 5 back to Stage 2. The interaction of the five stages described above is circular. Electricity prices resulting from Stage 5 impact on the level of income available to renewables developers in Stage 2.

In our modelling the interaction between the electricity market and investment in new renewables capacity is accounted for by iterating between our wholesale electricity market and ROC market models. With Stages 1 and 2 performed by our ROC market model and Stages 3 to 5 performed by our electricity market model.

In Stage 3, new renewables capacity determined by our ROC market model was entered into our electricity market model. Moving from Stage 5 to Stage 2 wholesale electricity prices and biomass load factors were passed through from the electricity market model to our ROC model. This included accounting for the generation-weighted average price projected for intermittent technologies e.g. wind, which enables the situation to be accounted for whereby intermittent generators capture lower than average wholesale prices, due to large amounts of installed intermittent capacity generating at similar times.



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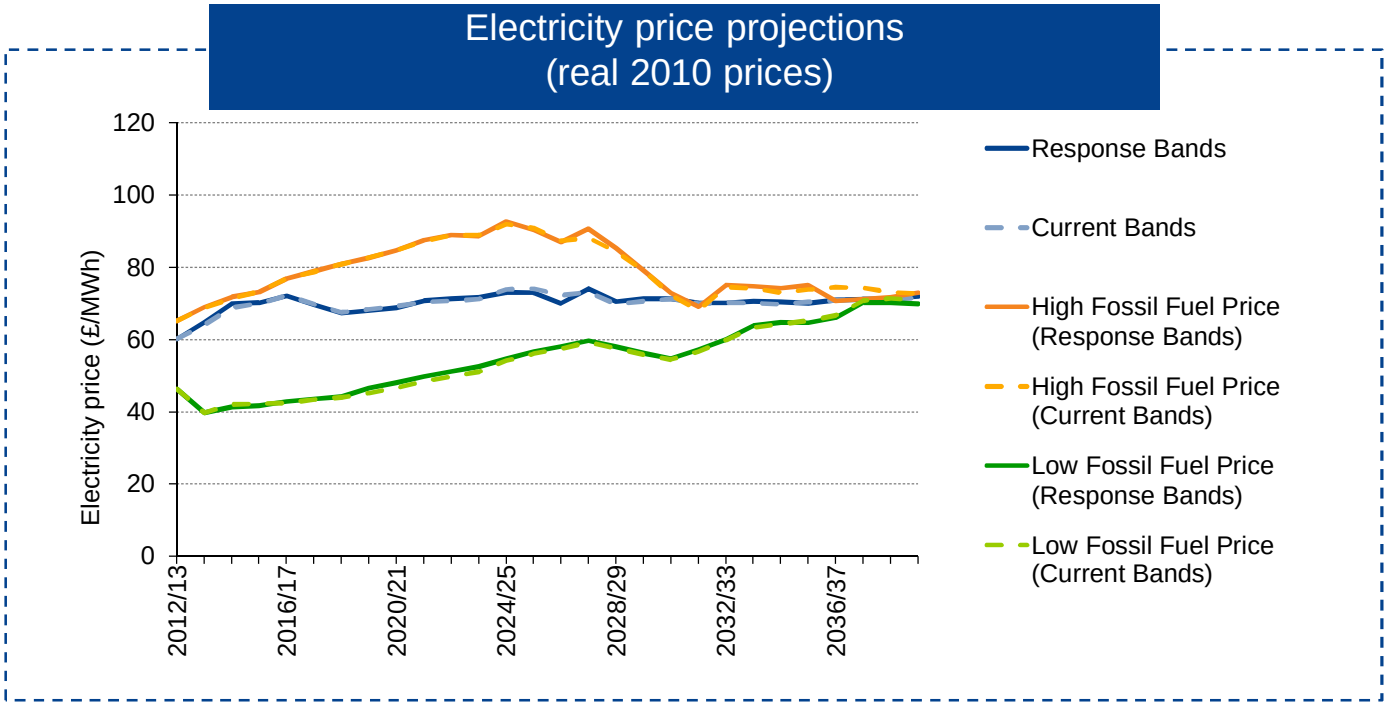
MODELLED ELECTRICITY PRICES

The electricity price projections are dependent on the cost of the marginal cost technologies at that time



Initially electricity prices are primarily driven by coal, gas and carbon prices, with the divergence between the scenarios reflecting the assumptions for these prices. However, from 2024/25 onwards the increase in renewables and nuclear in the high scenario means that these technologies more frequently become the marginal technologies, putting downwards pressure on prices.
As nuclear and renewables capacity continues to increase, prices are projected to continue to fall until they reach the cost of new nuclear which is around £70/MWh by 2037/38. The Central and Low Fossil Fuel Price sensitivities also converge to this level, although this does not occur until 2037/38 in the Low Fossil Fuel Price sensitivities, as the build out of nuclear is projected to be slower due to lower electricity prices.

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KEY RESULTS ACROSS OPTIONS AND SENSITIVITIES

Key results

	Current			Response - Difference			Consultation - Difference
	High	Central	Low	High	Central	Low	Central
Large-scale renewable capacity in 2016/17 (GW)*	21.6	19.8	16.9	+1.2	+1.8	-0.9	+2.1
Large-scale renewable generation in 2016/17 (TWh)*	76.0	68.3	55.7	+8.0	+11.2	-3.5	+11.2
ROCs issued in 2016/17 (millions)*	90.7	78.6	64.8	-0.1	+4.2	-8.0	+5.4
Lifetime cost of the RO (£billion)	47.7	41.8	34.7	-0.4	+1.5	-3.7	+2.3
Lifetime system costs (£billion)	654.4	635.2	592.9	+4.0	+1.8	-2.9	+2.3

* DECC defines large-scale renewable electricity as all renewable electricity excluding that supported by the small-scale FiT. It therefore includes existing capacity not supported by the RO or FiT. Capacity and generation reported excludes capacity modelled under the FiT CfD.
** this does not include all system costs. see definition of system costs in Slide 26.

Source: DECC, calculated from Pöyry results.

CAPACITY COMPARISON

	Capacity up to and including 2015/16 (MW)						
	Biomass Conversion	Biomass (New)	EfW CHP	Hydro	Offshore Wind	Onshore Wind	Wave & Tidal
Projected capacity by April 2013 (MW)	1,200	386	28	1,653	3,536	7,050	4
Current Bands - capacity change by 2016	+260	+252	+223	-85	+53	+2,801	+0
Consultation Bands - capacity change by 2016	+2,003	+252	+223	-85	+586	+2,585	+23
Response Bands - capacity change by 2016	+2,003	+252	+223	-85	+586	+2,585	+23
Current Bands HFFP - capacity change by 2016	+1,231	+372	+264	-66	+257	+3,253	+0
Current Bands LFFP - capacity change by 2016	+36	-34	+176	-85	+53	+805	+0
Response Bands HFFP - capacity change by 2016	+2,509	+388	+264	-78	+790	+2,849	+23
Response Bands LFFP - capacity change by 2016	-435	-34	+176	-91	+53	+649	+15

Source: DECC, calculated from Pöyry results.

COST COMPARISON ACROSS MODELLED OPTIONS

Projected costs (£billion, real 2010 prices)

		Difference	
	Current Bands	Consultation Bands	Response Bands
Lifetime system costs[1], of which:	**635.2**	**2.3**	**1.8**
Renewable generation costs	264.1	11.9	10.9
Non-renewable generation costs	310.1	-7.7	-7.3
Balancing costs	24.3	0.1	0.1
EUA costs	36.8	-2.1	-1.9
Lifetime consumer costs2[3], of which:	**344.2**	**2.2**	**1.3**
RO costs	41.8	2.3	1.5
Balancing costs	24.3	0.1	0.1
Wholesale price	278.1	-0.3	-0.3
Lifetime producer surplus for renewables generators	**19.6**	**-1.1**	**-1.2**

1. System costs do not include all system costs e.g. transmission, distribution costs and retail costs are not included.
2. The consumer cost and system costs do not represent all costs to consumers as other costs which may be assumed to remain constant (e.g. supplier transaction) are not included.
3. The consumer cost does not include assumed FiT CfD subsidy costs, as the design of the scheme and technology specific 'strike prices' are yet to be determined. This means that whilst wholesale prices might be lower to 2039/40 in scenarios where wind and nuclear generation is higher, reducing the cost to consumers, the increase in consumer costs as a result of the FiT CfD will not be taken into account.

Note: All figures rounded to one decimal place and costs discounted at the social discount rate of 3.5%.

Source: DECC, calculated from Pöyry results.

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