Title: Renewable Heat Incentive - Biomethane Tariff Review URN: 14D/446 IA No: DECC0182 Lead department or agency: Department of Energy and Climate Change Other departments or agencies: N/A	Impact Assessment (IA) Date: 19/11/2014 Stage: Final Source of intervention: Domestic Type of measure: Secondary legislation Contact for enquiries: correspondence@decc.gsi.gov.uk

Summary: Intervention and Options

RPC: N/A

Cost of Preferred (or more likely) Option				
Total Net Present Value	**Business Net Present Value**	**Net cost to business per year** (EANCB in 2009 prices)	**In scope of One-In, One-Out?**	**Measure qualifies as**
£0m	N/A	N/A	No	N/A

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

The UK Government's Renewable Heat Incentive (RHI) provides financial support for renewable heat installations to support the UK's renewable energy obligations (EU 2020 renewable target) and CO2e emissions reduction ambition. The non-domestic RHI supports "biomethane injection to grid" installations, which generate biomethane (either through anaerobic digestion or gasification) for injection into the UK gas grid, so displacing natural gas, a fossil fuel. The existing biomethane tariff is set at 7.5p/kWh for all sizes of plant and all output levels (volume of gas injected), whilst there is evidence that unit costs decline with increasing output. This presents an overcompensation risk to the RHI budget; a tariff that accounts for 'economies of scale' in costs could potentially support the same level of renewable heat deployment at less cost to the taxpayer or more renewable heat for the same RHI budget.

What are the policy objectives and the intended effects?

The policy objective and intended effects are to change the tariff in a way that:

i) Reduces the risk of overcompensation resulting from economies of scale in technology costs i.e. ensures that the RHI biomethane injection to grid tariff delivers value for money

ii) Maintains the incentive for further investment in biomethane injection to grid plants, including plants at larger scales that can deliver renewable heat at lower unit costs

Without a change, there is a risk overcompensation would lead to degression(s) of the tariff through the RHI's budget management mechanism. Degression would not align the tariff with changing unit costs at different scales, eventually resulting in a tariff that only supported the very largest plants.

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

This Impact Assessment considers the following options:

1. Do nothing – leave the current biomethane tariff structure in place (7.5 p/kWh for all output)

2. Implement a tiered tariff structure: (7.5 p/kWh for the first 40,000 MWh injected p.a., 4.4 p/kWh for the next 40,000 MWh injected p.a. and 3.4 p/kWh for any additional eligible biomethane injected p.a.)

A further option of banding the tariff (different tariffs based upon plant capacities) was considered at consultation stage. This was rejected post consultation primarily because determining the capacity of biomethane plants is difficult but also because of the potential for banding to incentivise inappropriate sizing of plants.

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

Does implementation go beyond minimum EU requirements?			N/A		
Are any of these organisations in scope? If Micros not exempted set out reason in Evidence Base.	**Micro** No	**< 20** No	**Small** No	**Medium** No	**Large** No
What is the CO_2 equivalent change in greenhouse gas emissions? (Million tonnes CO_2 equivalent) (Net savings total to 2015/16)			**Traded:** 0	**Non-traded:** 0	

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

Signed by the responsible Minister: Amber Rudd Date: 4.12.2014

Summary: Analysis & Evidence

Description: This impact sheet compares implementation of the new tiered biomethane tariff structure with a counterfactual of "do nothing" in which the current tariff is maintained (but is not degressed). The figures presented here are for Scenario 1 (see Section 5) in which implementing tiering involves a reduction in RHI expenditure but no impact on deployment relative to the counterfactual. Alternative impact scenarios involving changes to deployment under tiering and the possibility of degression under the counterfactual are discussed in Section 5 of this IA.

FULL ECONOMIC ASSESSMENT

Price Base Year: 2015/16	PV Base Year: 2015/16	Time Period Years: 20	Net Benefit (Present Value (PV)) (£m)		
			Low: N/A	High: N/A	Best Estimate: £0m

COSTS (£m)	Total Transition (Constant Price)	Years	Average Annual (excl. Transition) (Constant Price)	Total Cost (Present Value)
Low	N/A		N/A	**N/A**
High	N/A		N/A	**N/A**
Best Estimate	£0m		£0m	**£0m**

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

The key cost to society of any change to biomethane deployment is the additional resource cost associated with investment and operation of biomethane to grid plants (net of the resource cost associated with the natural gas that the biomethane displaces). Under Scenario 1 there is no change in deployment compared with the counterfactual so the change in cost is zero.

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

None – no change to deployment.

BENEFITS (£m)	Total Transition (Constant Price)	Years	Average Annual (excl. Transition) (Constant Price)	Total Benefit (Present Value)
Low	N/A		N/A	**N/A**
High	N/A		N/A	**N/A**
Best Estimate	£0m		£0m	**£0m**

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

The key benefit to society of any change to biomethane deployment is the carbon emissions saving associated with biomethane injection. This arises through the displacement of natural gas supply to the UK gas grid and the lower life-cycle emissions associated with biomethane to grid vs. fossil fuel natural gas supply. Carbon emissions savings are attributable to both the non-traded sectors (e.g. use of gas from the gas grid in domestic buildings) and the traded sector (mainly use of gas for power generation and industrial processes). Again, under Scenario 1 there is no change in deployment compared with the counterfactual so the change in benefits is zero.

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

None

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

The cost-benefit analysis presented in this IA (Section 5) makes the following assumptions:

1. Resource Costs
   - The resource costs of biomethane plants reflect a feedstock mix using food waste and energy crop. In practice, the resource costs of biomethane plants will vary according to their feedstock mix and plant configurations
   - Wholesale gas prices are a reasonable approximation of the unit resource costs associated with natural gas production – for the purposes of estimating the incremental resource cost associated with biomethane deployment over the natural gas it displaces
2. Carbon Benefits
   - Carbon benefits estimates assume plants (at least) meet the emissions reduction requirement set out in DECC biomass sustainability requirements

The analysis does not make any assessment of the potential impacts (costs or benefits) arising from diversion of biogas from biomethane to other renewable energy purposes (e.g. electricity generation) as a result of the tariff change.

The main sensitivities/risks associated with the cost-benefits estimates are:

- How biomethane deployment responds to the new tiered tariff under the policy option and whether the existing tariff would be degressed (reducing deployment) under the counterfactual (scale uncertainty – impacts both resource costs and carbon benefits)
- Biomethane feedstock and capital costs and (projected) natural gas price (resource cost uncertainty)

BUSINESS ASSESSMENT (Option 1)

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

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Executive Summary

1. The Renewable Heat Incentive (RHI) is a voluntary incentive scheme providing tariff based support for renewable heating systems in both the domestic and non-domestic sectors. One of the non-domestic scheme technologies is 'biomethane injection to grid' which involves the production of methane by either anaerobic digestion (AD) or gasification that can be injected into the gas grid as an alternative to natural gas. At present the UK has a nascent AD biomethane industry with gasification still at demonstration stage; biomethane injection to grid deployment over the rest of this decade is expected to come mainly from AD. DECC projections have indicated the technology could account for (at least) 15% of renewable heat deployment supported by the RHI scheme in 2015/16[1].

2. The current biomethane tariff pays 7.5 p/kWh for all units of (eligible) biomethane injected into the grid, irrespective of plant size or output. There is evidence that AD biomethane to grid is characterised by economies of scale in costs meaning that unit costs fall with output. This presents an overcompensation risk to the tariff for larger plants; the key objective of DECC's biomethane tariff review is to mitigate this risk through changing the tariff structure, whilst retaining an incentive for further plant deployment.

3. DECC consulted on two options for reforming the tariff in June this year; tiering, which would pay a reduced tariff for successive increments of gas injected by a plant and banding, which would pay a differentiated tariff dependent upon plant size, with larger plants receiving a lower tariff. The consultation presented illustrative tariff levels under each of these structures using DECC's cost and performance evidence for biomethane at the time.

4. Feedback from the consultation process indicated industry favours tiering for reforming the tariff but also that the tariff levels presented in the consultation would be too low to incentivise biomethane deployment. In particular, the waste feedstock gate fees assumed did not adequately reflect the current market for waste or account for feedstock security risk. DECC has revised its tariff model in accordance with this feedback and other cost and performance information provided in the consultation.

5. On the basis of analysis and the consultation responses, DECC has decided to proceed with a tiered tariff solution to address the issue of economies of scale. The main arguments for implementing tiering are that it is easier to administer than banding and it involves less risk of inefficient sizing of plants as a result of gaming. The revised tariff will pay 7.5 p/kWh for up to 40,000 MWh p.a. (eligible) biomethane injected, 4.4 p/kWh on the next 40,000 MWh p.a. (eligible) biomethane injected and 3.4 p/kWh for additional (eligible) units injected p.a.[2]

6. The overall budget for the RHI has been agreed until financial year 2015/16. DECC does not intend to alter the budget management degression triggers for biomethane when it introduces the new tariff and any tariff degressions will apply equally to all tiers. To promote tariff stability immediately following the revision there will be a limited period of protection from degression until the end of June 2015.

7. In terms of impact, if the new tariff addresses overcompensation without impacting deployment (relative to the counterfactual) then it will result in a reduction in RHI expenditure only. Based

[1] See for example Table 8 in RHI Tariff Review, Scheme Extensions and Budget Management – Impact Assessment (December 2013). https://www.gov.uk/government/consultations/renewable-heat-incentive-expanding-the-non-domestic-scheme.

[2] The tariff will be paid up to the maximum volume of biomethane the producer is entitled to inject under the Network Entry Agreement (NEA).

upon DECC's range of market intelligence scenarios for RHI heat deployment and spend in 2015/16 it would deliver annual savings of approximately **£5-10m** for new plants coming forward in 2015/16 (or approximately **£55-£145m** savings over the corresponding plants' lifetimes in 2015/16 prices, discounted). This represents a 15% reduction in spend and would improve the cost-effectiveness of the biomethane tariff from **£77/MWh** to **£65/MWh**. With no impact on deployment there is no change to resource costs or carbon emissions savings under this scenario.

8. It is possible that introducing the tiered tariff will impact biomethane deployment. A scenario in which deployment (of affected plants) is reduced by 25% results in correspondingly lower resource cost and carbon emissions savings relative to the counterfactual. Tariff cost-effectiveness is ("only") reduced to **£67/MWh** in this scenario, owing to the loss of some larger plants which require a lower p/kWh incentive.

9. Similarly, it is possible that, under the counterfactual, the existing tariff would be degressed anyway, itself impacting deployment. Under scenarios in which the counterfactual involves a similar sized tariff cut (approximately 15%), it can be seen that a degression would result in a similar improvement in the tariff cost-effectiveness but at the expense of reduced deployment of smaller plants i.e. lower (absolute) renewable heat deployment and carbon emissions savings. However, degression would not align the tariff with changing unit costs as plant scales increase meaning the overcompensation risk would not be addressed as effectively.

Section 1: Context

10. The Renewable Heat Incentive (RHI) is a voluntary incentive scheme providing tariff based support for renewable heating systems in both the domestic and non-domestic sectors. The scheme is based on powers taken in the Energy Act 2008. The non-domestic scheme, which provides support to all sectors excluding single domestic premises, was launched in November 2011, while the domestic scheme was launched in April 2014.

11. The non-domestic scheme supports a range of technologies including 'biomethane to grid'. This involves the generation of methane, either through anaerobic digestion (AD) or gasification (Bio-Synthetic Natural Gas or BioSNG). At present, AD biomethane is the more developed technology with several plants in operation in the UK and a pipeline of approximately 25 plants due to come on stream in the near future with others being considered for development. BioSNG is at an earlier ('proof of concept') stage of development as a technology and has not been the focus of this review.

12. AD involves the production of 'biogas' (methane, carbon dioxide, oxygen and trace gases) from anaerobic digestion of organic materials such as food waste, agricultural wastes (manures, slurries), sewage or energy crops. The biogas is 'upgraded' to separate the methane, producing 'biomethane' which (once propane is added) can be injected into the gas grid. There are alternative uses for biogas; it can be used to generate electricity (eligible for Feed in Tariffs and Renewables Obligation) or similarly upgraded to biomethane for use in transport (eligible for the Renewable Transport Fuels Obligation)

13. If AD is used to inject biomethane into the grid, it displaces "natural gas", a fossil fuel, providing potential carbon emissions savings. The growth of the feedstocks used in AD takes carbon dioxide out of the atmosphere, which is released either during the production process or during the combustion of the methane for heating (or power). This offers potential carbon savings versus the 'counterfactual' of using natural gas which releases carbon dioxide embedded in fossil fuels. Emissions savings can also arise from better management of agricultural wastes associated with fugitive methane emissions and from the use of digestate in place of manufactured fertilisers. Offsetting this are any additional emissions of methane during the production process. The Government intends to introduce biomass sustainability criteria, which will apply to all biomethane plants receiving the RHI to ensure that the technology delivers carbon emissions savings.

14. Table 1 shows the range of potential renewable heat deployment for biomethane to grid under different market intelligence (MI) scenarios as published in DECC's December 2013 Non-domestic Tariff Review[3]. It illustrates that for 2015/16 biomethane to grid could deliver approximately 15% of renewable heat (biomethane injected into the grid) under the range of scenarios considered with potentially ~1 TWh delivered under the central MI scenario.

[3] Table 8, RHI Tariff Review, Scheme Extensions and Budget Management – Impact Assessment (December 2013). https://www.gov.uk/government/consultations/renewable-heat-incentive-expanding-the-non-domestic-scheme.

Table 1 - Potential heat deployment and spend in 2015/16 across the three MI scenarios

	2015/16 scenarios					
	Renewable Heat GWh			Nominal Spend £m		
	Low MI	Central MI	High MI	Low MI	Central MI	High MI
Biomethane to Grid	691	1,053	1,465	53	81	113
Total RHI (non-domestic and domestic)	5,167	7,373	9,701	301	426	556

15. As with any government incentive scheme, DECC has a duty to ensure that the RHI delivers value for money to the taxpayer. It is also a condition of the EU State Aid clearance secured for the RHI scheme that whilst tariffs are permitted to compensate for the difference in the costs of production of renewable energy versus conventional heat production, they should not systematically over-compensate recipients. DECC has put in place a budget management mechanism to ensure that scheme spend is controlled to agreed budgets. There is also a recognition that over time tariffs might need to be changed through reviews as DECC's evidence base on technology costs develops. The conditions under which these early tariff reviews would take place were outlined within the Government Response to the 'Providing Certainty, Improving Performance' July 2012 consultation, published in February 2013.

Section 2: Problem

16. The current biomethane tariff was introduced in November 2011 with the launch of the non-domestic RHI scheme. At the time there were no commercial scale plants in the UK to base a tariff upon and it was uncertain what range of plant scales might come forward as the industry developed. However, DECC was able to set a tariff based upon cost and performance evidence from the AD biogas industry and international evidence.

17. The tariff was based upon a 1 MW (gross biogas) capacity 'reference plant' using 100% food waste feedstock in line with the Government's intention to promote economic uses of waste as an alternative to landfill. The tariff was set to compensate developers for the capital, operating and feedstock costs of biomethane to grid plants, net of the revenue earned from selling the biomethane to the grid[4] and to provide a 12% Internal Rate of Return (IRR), in line with terms of the RHI's EU State Aid clearance. It is set on a levelised cost basis i.e. per unit of energy produced (p/kWh) and is payable on all eligible[5] units of biomethane injected into the grid for 20 years from a project's commissioning. A comprehensive explanation of DECC's tariff setting methodology was given in the Technical Annex of the Consultation Document[6].

18. Currently, the tariff pays 7.5 p/kWh for all biomethane injected into grid irrespective of plant capacity or output[7]. However, it is clear from cost evidence for biomethane plants and anaerobic digestion plants more generally that some elements of capital costs do not increase proportionately with output giving rise to economies of scale i.e. unit costs fall to some extent as plant capacity and output increase. For example, a review of the commercial technologies available for biogas upgrading by the Swedish Gas Technology Centre in 2013[8] showed clear reductions in investment costs per unit of capacity as the upgrading unit's capacity increases – up to plants of approximately 10 MW capacity.

19. In addition, the biomethane market has begun to respond to the RHI with four plants currently accredited to the scheme and a pipeline of around 25 plants in development for completion in 2014 and early 2015. Almost all of these plants are at scales larger than the 1 MW reference plant upon which the original tariff was set, some at scales of 10 MW and above.

20. Taken together, this presents a risk that the current tariff will over-compensate plants beyond a certain scale unless it is changed to account for the fact that some costs are characterised by economies of scale. This motivated DECC's review of the tariff; to investigate this risk and understand if the tariff should be changed in order to improve its 'value for money' (VfM) to the taxpayer i.e. deliver the same renewable heat for less budget or more renewable heat for the same budget. As well as DECC's own evidence and analysis motivating the review, the industry's trade bodies have called for the Government to address this risk.

21. To summarise, the purpose of DECC's biomethane tariff review has been to review the tariff structure and level to ensure it is aligned with the unit costs of the scales of plant now coming forward in the market. The objectives of the review, as set out in the Consultation Document,

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[4] Alternatively, this can be viewed as compensating developers for the incremental cost of producing and supplying biomethane to the grid over and above the cost of the counterfactual – natural gas. This assumes the wholesale price of natural gas is a reasonable proxy for its production and supply costs.

[5] After allowing for deductions for the addition of propane and parasitic heat load provided from sources other than the biogas produced at the biomethane plant.

[6] See p.27 of RHI biomethane to grid tariff review. https://www.gov.uk/government/consultations/rhi-biomethane-injection-to-grid-tariff-review

[7] Up to the maximum output set out in plants' Network Entry Agreement

[8] Swedish Gas Technology Centre: Biogas Upgrading Technologies – Review of Commercial Technologies SGC Rapport 2013:270 http://www.sgc.se/en/?pg=1445651

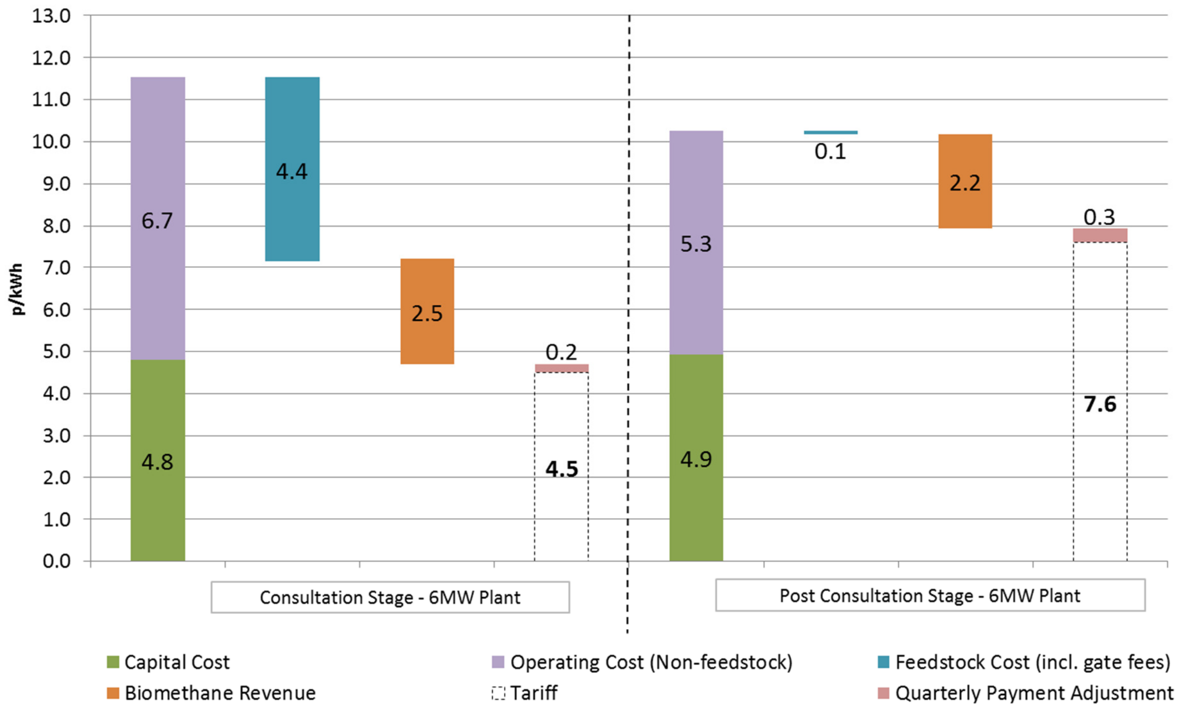
were to ensure continued growth in biomethane deployment, ensure value for money in the use of RHI budgets (address any overcompensation risk) and to recognise and maintain the role of large scale plant in the RHI.

Section 3: Cost and Performance Evidence Update

22. The purpose of this section is to set out the main updates to DECC's cost and performance evidence base for AD biomethane plants following the responses DECC received during the consultation. This is key to explaining the basis of the final tariff presented in the next section. The Technical Annex of the Consultation Document set out DECC's evidence base at the time and this section assumes familiarity with that Annex.

23. To summarise the main changes, Chart 1 shows how the main components of the tariff calculation have changed for a 6 MW (gross biogas) plant at consultation stage and post consultation. These are shown in levelised cost terms i.e. per unit of (eligible) biomethane injected.

Chart 1 – Comparison of net levelised cost components underpinning tariff for a 6 MW (gross biogas) plant at consultation stage and post consultation



Notes:

1. Consultation stage shows £25/t gate fee scenario; post consultation assumes a 70%/30% waste/energy crop feedstock blend assuming a £15/t gate fee and a £35/t crop price

2. A further adjustment is made to the Net Levelised Cost (capital cost + operating cost + feedstock cost – biomethane revenue) to derive the required tariff; a 4% discount is applied to reflect the fact the RHI payments are made quarterly rather than annually.

24. As Chart 1 shows, the key revision to the evidence base has been to feedstock costs in light of feedback around gate fees for waste feedstocks and feedstock security concerns. This has resulted in an increase in the (blended) feedstock cost assumed and an increase in the net levelised cost. Operating costs have also fallen as have capital costs (though capital costs have increased slightly in levelised terms) and there has been a reduction in biomethane revenue assumed. Finally, plant performance has been revised to assume lower availability (the percentage of annual hours for which the plant is operational) reducing annual output; this has the effect of increasing all the cost/revenue components shown on a levelised cost basis.

25. The main changes to the cost and performance evidence base are discussed below.

Feedstock Model and Costs

26. DECC's reference plant for setting the current biomethane tariff was an AD plant using 100% food waste feedstock to generate biogas. This model assumed that AD plant owners were being paid a "gate fee" to take the waste. For the tariff options presented at consultation stage, DECC used gate fee assumptions based upon the Waste and Resources Action Programme's (WRAP) 2013 survey of waste gate fees for AD plants, the only survey of its kind that DECC is aware of. Two scenarios were presented; one assuming gate fees of £41 per tonne (the median WRAP observation) and one assuming £25 per tonne (the lower end of WRAP's range).

27. The overwhelming feedback from consultation was that the gate fees underpinning the tariff options presented were too high compared with levels being observed in the market today. Furthermore assuming gate fees for the entirety of a project's lifetime does not adequately reflect 'feedstock security risk' i.e. the risk that plants will not be able to secure the necessary feedstock to maintain continuous biomethane output.

28. To respond to this feedback, DECC has revised its feedstock assumptions such that the model now has a blended feedstock cost close to zero, based upon a combination of "paid for" feedstock (energy crop) and feedstock that attracts a gate fee (unpackaged food waste). This and a downwards revision to the assumed gate fee are the key drivers behind the change to feedstock costs in Chart 1 above.

29. In particular, consultation feedback indicated:
    a. WRAP's gate fee survey results reflect historic long-term contracts for Local Authority waste which are no longer readily available at the same prices or for the same duration
    b. Local Authority contracts only represent a fraction of the waste market with most waste being provided from the "Commercial & Industrial" (C&I) sector and commercial waste management companies. New AD plants will be reliant upon these other sources
    c. Increasing competition for waste means gate fees are lower than the levels assumed at consultation and may be expected to fall further in future. Also these contracts are typically much shorter now (1-3 years) increasing feedstock security risk
    d. Given this environment, plant owners are mitigating feedstock security risk either by diversifying feedstocks (building plants to accommodate a range of feedstocks such as food waste, agricultural waste and energy crop) or are discounting the level of waste gate fees assumed.

30. As such, DECC has changed the feedstock assumptions underpinning its model as follows:
    a. The reference plant has been changed to one using a (long-term) feedstock mix of 70% (unpackaged) waste and 30% energy crops. The inclusion of energy crops is intended to capture feedstock security risk i.e. the fact that it may not always be possible for plants to secure waste supplies or to secure them at current gate fee levels. This approach to tariff-setting has been agreed with Ministers at the Department of Environment, Food and Rural Affairs

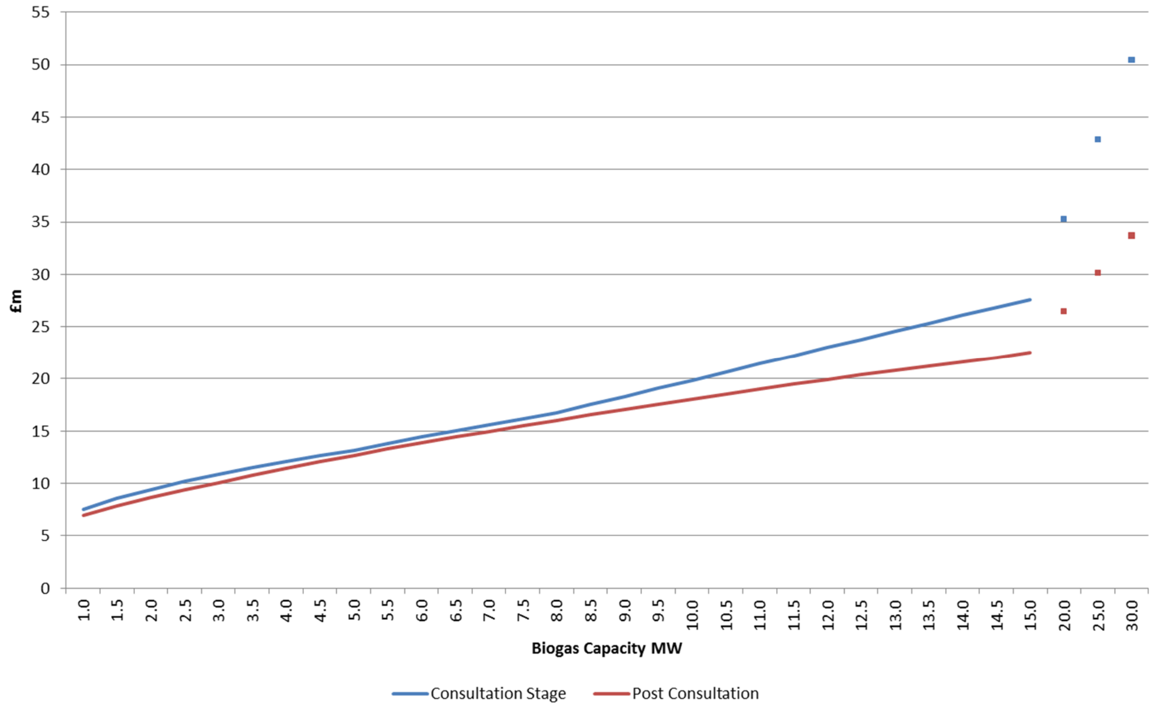
b. The “blended” feedstock cost associated with this mix is now close to £0 per tonne. This reflects a gate fee of £15 per tonne for unpackaged waste[9] and an energy crop feedstock price of £35 per tonne. These figures are based upon the averages of feedstock prices presented to DECC in consultation responses. A blended feedstock cost close to zero is similar to fully discounting gate fees in a 100% waste model
c. The model continues to account for landfill costs from disposing of packaging material and for the capital costs of equipment needed to treat the waste prior to the AD process. It also now reflects the capital costs associated with storage of energy crop feedstocks (see below)

Capital Costs

31. This section provides a summary of the key changes to the capital cost inputs to the model. The updates reflect additional capital costs that were not accounted for before but also updates to assumptions regarding economies of scale – how capital costs change with output. Additional charts are presented in Annex 1.

32. Chart 2 shows the change to total capital costs for plants at different scales following the update. The key points to observe are that capital costs have been reduced slightly for plants between 1-8 MW and to a greater extent for plants at greater capacities. The latter in particular reflects updates to the assumptions for waste pre-treatment and digester costs.

Chart 2 – Comparison of total capital costs by plant scale at consultation stage and post consultation



33. Waste pre-treatment capital costs were previously assumed to show economies of scale up to 5 MW capacity and to increase proportionately after that point, owing to lack of any data for higher capacity plants. Evidence presented indicated this proportionality assumption was not realistic

[9] More evidence was presented for unpackaged waste gate fees than for packaged waste. Consultation evidence indicated packaged waste gate fees are currently around ~£25 per tonne and unpackaged waste gate fees around £15 per tonne on average. For unpackaged waste, DECC has assumed 5% is rejected to landfill at £102 per tonne (based upon consultation responses) which means an additional cost to the plant of ~£5 per tonne of waste received.

and resulted in excessively high capital costs, particularly for larger plants. This has been revised to extend the economies of scale relationship over the capacity range.

34. Digester capital costs were previously assumed to show economies of scale up to 8 MW and proportionately increasing costs above that, again in absence of any evidence for larger plants. Evidence presented in the consultation indicated economies of scale would be expected to continue up until 12 MW capacity plants which has been reflected in the updated costs.

35. No specific cost estimates were presented for digester costs at greater scales. Some responses indicated that economies of scale for AD plants could be expected to continue even for much larger plants whilst others proposed that digesters must exhibit proportionate or “step costs” at some point. In this case, DECC has decided to extrapolate the economies of scale assumption for capacities above 12 MW. This is largely a judgment based upon the relationship observed up to 12 MW given the lack of evidence for plants above that capacity. It is worth noting though that assuming a proportionate increase in costs beyond 12 MW instead would add no more than 0.5 p/kWh to the average tariff required for a 30 MW scale plant (Chart 5) compared to assuming that economies of scale persist beyond 12 MW.

36. Other areas where capital costs were reduced on the basis of evidence presented are development costs (kept constant at £0.8m, £0.5m lower) and injection equipment costs (previously fixed at £0.9m but now increasing with scale from £0.4m-£0.9m over the capacity range).

37. Offsetting these cost reductions to an extent are capital costs that have been added to the model to reflect the mixed feedstock approach. These include: silage clamps (£0.5m-4.7m depending upon scale), digestate storage (£0.4m–£1.1m depending upon scale) and additional upgrading equipment to deal with H_2S and volatile organic carbons (VOCs) (both biogas contaminants) on advice that this is needed for plants using waste feedstocks (an additional £0.6m at all scales).

38. In addition, some existing costs have been increased. Civil engineering costs (“Civils”) were previously assumed flat over all scales at £0.9m (in the absence of data to suggest a relationship with scale) but are now assumed to increase with scale as would be expected: between £0.4m-4.5m over 1-30 MW. Similarly grid connection costs, fixed previously at £0.3m now increase with scale from £0.2m-£0.7m based upon connections to the low pressure distribution network.

39. Other capital costs were presented in consultation responses for consideration such as land and contingency costs. These have not been included though; land costs are excluded from the incentive to avoid creating land planning distortions in line with DECC policy on other energy incentives. The RHI is not intended to support cost overruns met through contingency funds either.

Operating Costs

40. As shown in Chart 1 there has been a reduction in overall operating costs overall. This is partly due to lower maintenance costs in line with lower overall capital costs (see above). It is also due to lower landfill costs which are the result of adjusting the proportion of waste feedstock rejected to landfill from 10% to 5%, based upon consultation responses. The cost per tonne of landfill disposal has remained broadly similar at £102 per tonne.

41. Other operating costs in the model remained unchanged or with only slight updates. Digestate disposal costs have increased slightly as a result of updated assumptions; the ratio of digestate to feedstock (by weight) has been reduced from 2:1 to 1:1 on the basis of consultation responses

whilst the cost per tonne of digestate disposal has been increased from £4.6 per tonne to £10 per tonne, similarly on the basis of consultation feedback.

42. Propane costs were reduced slightly on the basis of additional quotes for propane prices, labour costs were kept approximately the same (a slight reduction due to a shift in feedstock mix away from waste which is relatively more labour intensive) and there was support for the assumption that insurance costs are 1% of capital costs per year. Electricity costs also remained similar following the update to DECC's retail electricity price projections.

43. The main operating costs presented in consultation responses for addition in the model were land rent and business rates. These have not been included in the model with the same reasoning applying for land rent as for land costs above and in the case of business rates because the RHI aims to target a pre-tax rate of return.

Biomethane Revenue

44. The levelised cost contribution from biomethane revenue has fallen from 2.5 p/kWh to 2.2 p/kWh (Chart 1). This assumption is based upon the average of DECC's central wholesale gas price projection over 2014-2030. The consultation used the 2013 price projection – since then, DECC has published its 2014 projection[10] with the fall in the projected (average) price the result of increased prospects for global LNG supply in the medium term. This feeds directly through as an increase in the tariff at all output levels of 0.3 p/kWh.

Plant Performance

45. In terms of plant performance, the main updates made on the basis of the consultation evidence have been to reduce the assumed plant availability (load factor) and to increase the assumed methane capture percentage in the upgrading process. The net impact of these changes has been to increase the tariff at all scales by approximately 10% as the energy output (units of biomethane produced per year) assumed in the levelised cost calculation is reduced by approximately 10% at each plant capacity.

46. Plant availability (load factor) has been reduced from 95% to 86% on the basis of consultation feedback. Previously, the model assumed 100% availability for the anaerobic digesters and 95% for the biogas upgrader giving an overall plant availability of 95%. Feedback from consultation suggested that 100% availability for the digester is unrealistic and this should be lower; responses suggested 90%. Taking this assumption of 90% and keeping the upgrader availability at 95% (responses did not suggest this should be different) gives an overall plant availability of 86% which corresponds well with separate estimates provided by consultation responders for overall plant load factors.

47. The second change has been to base the tariff upon an upgrader methane capture assumption of 99.5% rather than 98%[11]. This reflects the fact that both membrane and amine upgrading technologies have been shown to achieve these levels of methane capture and we want to set the tariff on the basis of better practice in this area.

48. The overall impact of these changes upon the relationship between plant (gross biogas) capacity and annual (eligible) biomethane output is shown in Chart 3.

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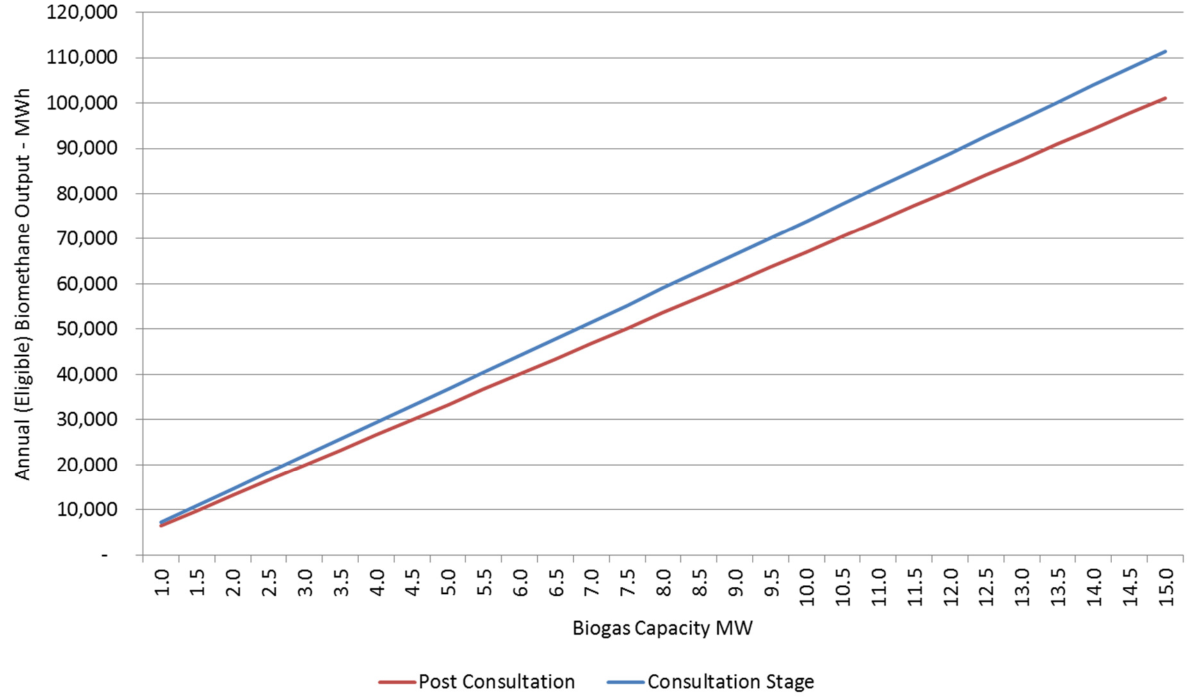
[10] https://www.gov.uk/government/publications/fossil-fuel-price-projections-2014

[11] Note, this assumption is for the purposes of tariff-setting only - we are not requiring that plants achieve this in the regulations.

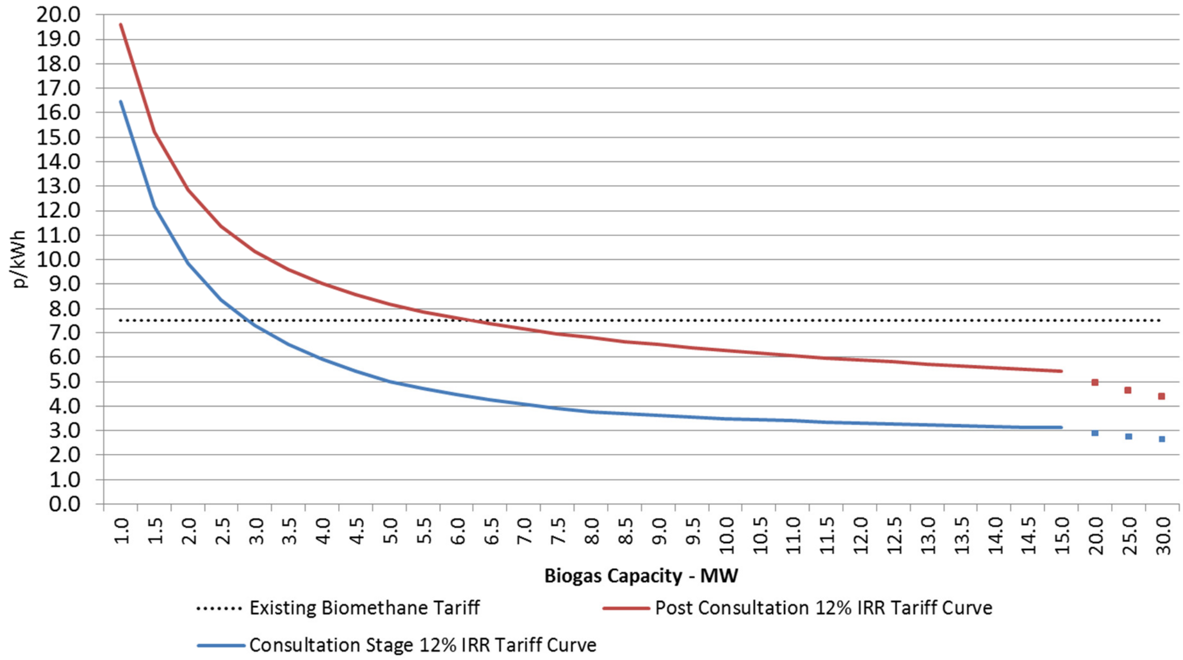
Chart 3 – Eligible biomethane output by plant capacity – consultation stage and post consultation



Impact of Changes on 12% IRR Tariff Curve

49. Chart 4 illustrates the effect of the updates to DECC's cost and evidence base post consultation. Overall, the changes have increased the tariff required to provide a 12% IRR by 2-3 p/kWh over the capacity range shown, due largely to the revision to the feedstock model and feedstock price assumptions. Further, the chart shows the overcompensation risk under the existing biomethane tariff; for AD plants larger than 6 MW, the current tariff could be reduced whilst maintaining a 12% IRR. For very large plants the (average) tariff could potentially be reduced by up to 3 p/kWh.

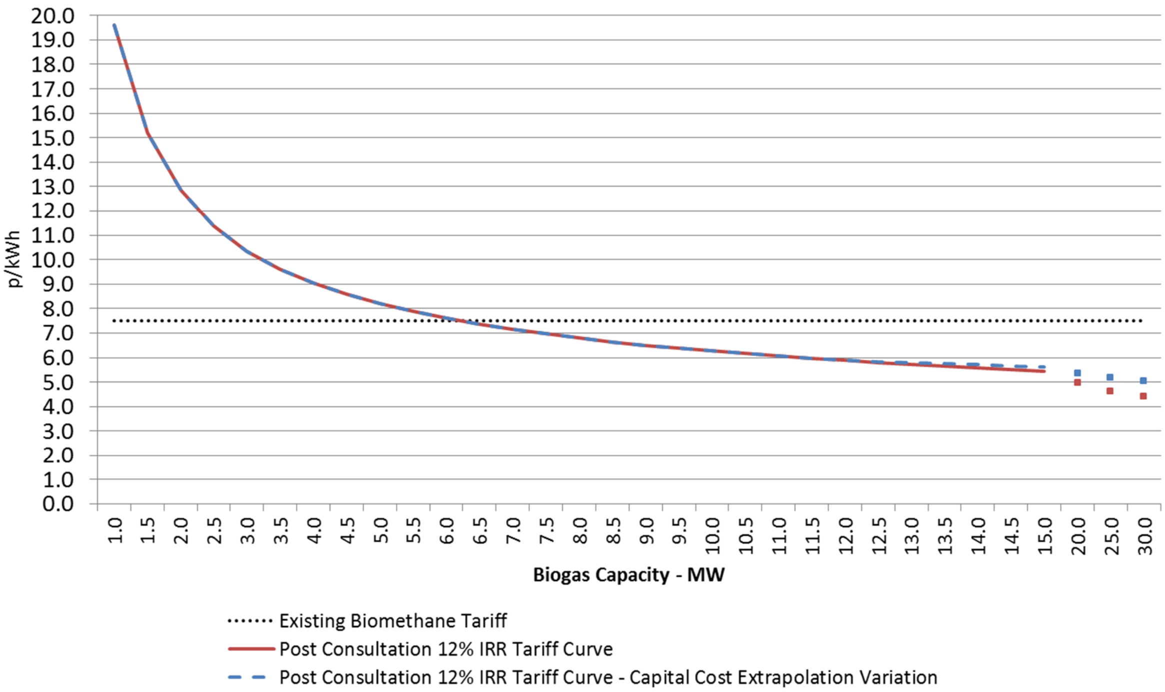
Chart 4 – Comparison of the 12% IRR Tariff curves at consultation stage[12] and post consultation



[12] Consultation stage curve shown is for the £25 per tonne gate fee scenario

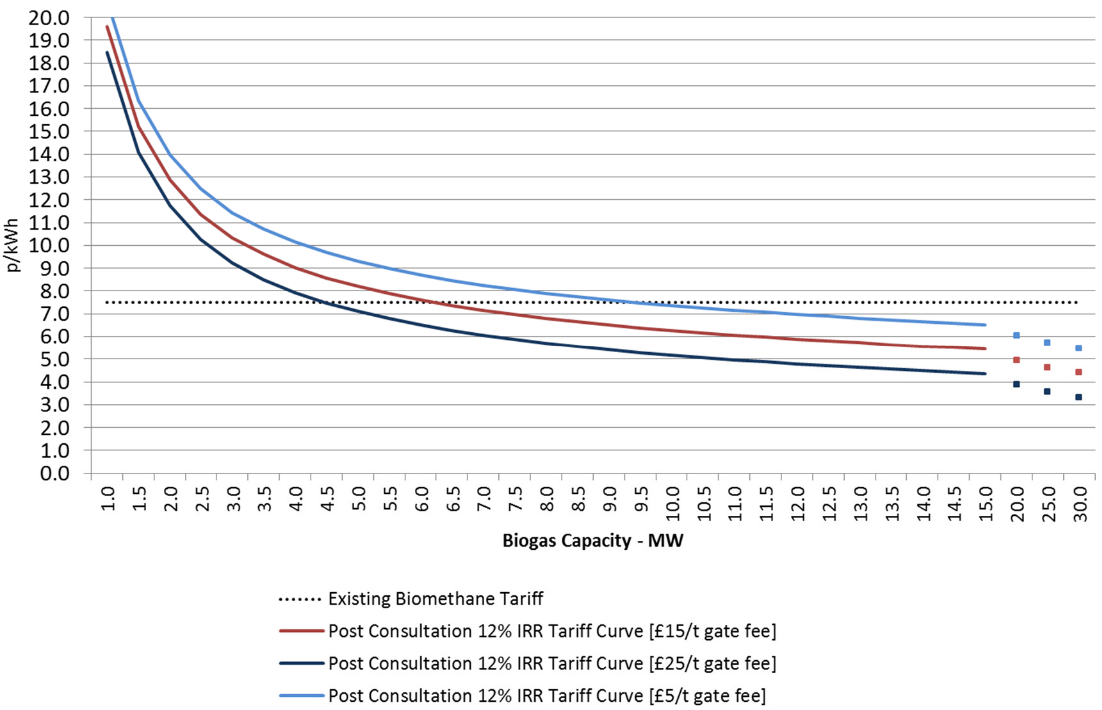
50. Charts 5 and 6 show the sensitivity of the required tariff to two assumptions. Chart 5 shows the impact if, beyond 12 MW, AD plant capital costs are assumed to increase proportionately rather than assuming that economies of scale persist. For plants up to around 15 MW this makes almost no difference to the tariff; for a plant of scale 30 MW, assuming economies of scale persist (the chosen approach) reduces the average tariff required by ~0.5 p/kWh.

Chart 5 – Post Consultation 12% IRR Curve – sensitivity to capital cost extrapolation



51. Chart 6 indicates that a +/- £10 per tonne range around our central gate fee assumption of £15 per tonne gives an associated range of approximately +/- 1.0 p/kWh around the final tariff curve. Under the central assumption of £15 per tonne, the current tariff of 7.5 p/kWh is justified out to a plant size of 6 MW; under a gate fee of £25 per tonne this changes to 4.5 MW and under a gate fee of £5 per tonne this changes to 9.5 MW.

Chart 6 – Post Consultation 12% IRR Curve – sensitivity to gate fee assumption



Section 4: Policy Options and Solution

52. The purpose of this section is to recap the policy objectives for the tariff review, present the options for changing the tariff and the chosen option and to present the accompanying budget management policy for the new tariff.

Policy objectives

53. The following policy objectives were set for the tariff review:

    1. Ensure continued growth in biomethane to grid deployment in order to support the Government's ambitions for renewable heat deployment and its commitments to carbon emissions abatement, including meeting the 2020 renewables target;
    2. Ensure value for money in the use of RHI budgets, which require a tariff structure that incentivises deployment but does not routinely overcompensate biomethane to grid installations; and
    3. Recognise and maintain the important role of large scale biomethane plants in the RHI.

54. These objectives recognise the risk of overcompensation presented by the existing tariff but also the potential value of large plants in delivering renewable heat at lower unit cost as a result of economies of scale.

Policy options and tariff solution

55. The following are the main options that have been considered in order to meet these objectives:

    a. Option 1: do nothing – leave the current tariff structure as it is

    b. Option 2: **Preferred Option** - implement a tiered tariff structure

    c. Option 3: implement a banded tariff structure – not taken forward

56. "Do nothing" is not considered a viable option though it is retained here as the counterfactual for comparison. Effectively it would defer the response to the overcompensation risk to the RHI budget management mechanism, which imposes "degressions" (tariff cuts) in the event that RHI support (for biomethane installations) exceeds pre-defined spending limits. However, degressions to the existing single tariff structure would not align the tariff with the economies of scale and successive degressions could eventually result in a tariff that only supported the very largest plants. Whilst very large plants are to be valued for the economies of scale they deliver (objective 3), their potential deployment is limited by feedstock requirements and an outcome that only supported the very largest plants would compromise delivery of objective 1.

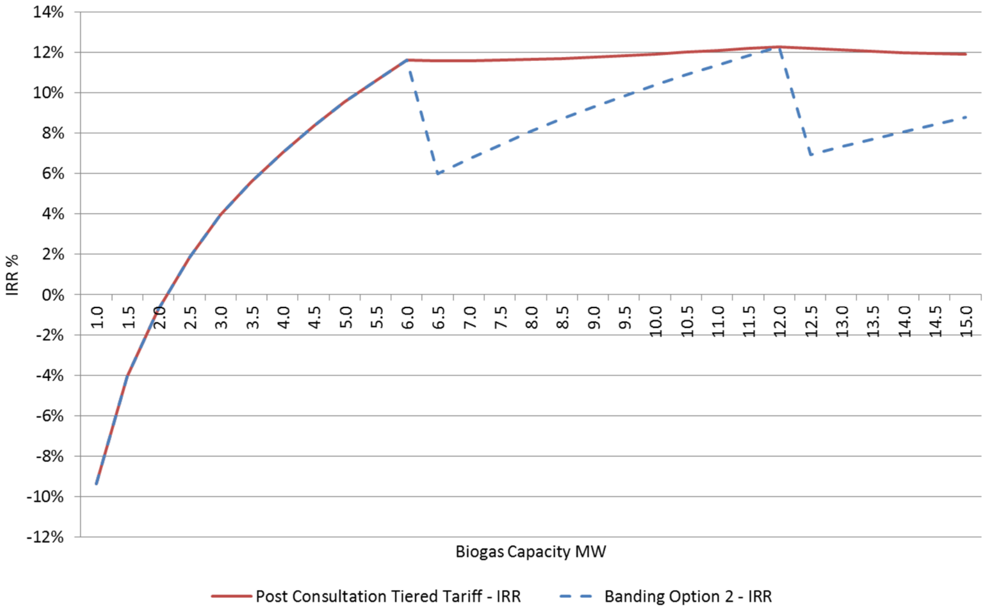
57. Option 3 (which has not been taken forward) was to use tariff banding which involves defining a plant's capacity and assigning it a tariff according to that capacity. In the Consultation Document, two variants of banding were considered:
    1. Banding Option 1 - assign individual tariffs to plants on the basis of the 12% IRR tariff curve (shown in Chart 4) according to their defined capacity
    2. Banding Option 2 - divide the capacity range into capacity bands (3, 4 or 5 bands say) and assign a tariff to each band based upon the 12% IRR tariff curve. Plants would be assigned a tariff band and tariff according to their defined capacity

58. Banding the tariff would help address the overcompensation risk by better aligning the tariff with economies of scale, whilst maintaining a sufficient incentive for plants across the capacity range. However, banding would likely be problematic to implement for two reasons: defining capacity and avoiding unintended incentives.

a. Consultation responses were clear that it is difficult to define biomethane plants' capacity with sufficient accuracy. Basing the capacity definition on the injection flow rate defined in the Network Entry Agreement would also be problematic since this represents a maximum possible flow rate into the grid rather than the average flow rate in practice. It would be possible in theory to make an adjustment for this though it would likely have to be done on a plant by plant basis increasing administrative complexity and cost. In any case, consultation responses indicated that AD plant capacity is more akin to an output range (given that AD is a biological process) such that it would be difficult to assure that a plant operating close to a band capacity threshold (say) was definitively in one band and not another.

b. The second reason is that banding could introduce unwanted incentives. By setting a single tariff within each capacity band (and lower tariffs for higher capacity bands), there would be an incentive for plant developers to re-size plants in order to maximise project returns. Given economies of scale, the highest returns would be realised at the upper capacity limit of each band (Chart 7). However, since feedstock availability and access to gas grid capacity place maximum limits on a given project's size, this could lead to developers deliberately under-sizing plants in order to maximise returns. Under-sizing plants would be inefficient in that it would not (fully) realise the benefits of economies of scale. Note that this risk applies to banding option 2 though not option 1 which effectively sets an 'infinite' number of capacity bands each offering a 12% IRR, removing the variation in rates of return.

Chart 7 – Internal Rate of Return for Tiering and Banding Options[13]



[13] Tiering and Banding Option 1 set to align with 12% Tariff Curve shown in Chart 4 (for plants above 6 MW). Banding Option 2 capacity bands and associated tariffs set to align to the same curve at 6 MW, 12 MW and 20 MW.

Preferred Option:

59. Tiering works by paying a higher tariff for the first designated amount of kilowatt hours of biomethane injected into the grid (the “tier 1” tariff), and lower tariffs for subsequent volumes of biomethane injected (the “tier 2” tariff, the “tier 3” tariff), over a period of 12 months. As with banding, tiering has the potential to address the overcompensation risk by better aligning the tariff with economies of scale whilst maintaining a sufficient incentive for plants across the capacity range.

60. Tiering avoids the two key drawbacks associated with banding. It is easier to implement and administer since the volume of gas injected is already measured for the purpose of calculating RHI payments. It also better avoids inefficient sizing of plants since rates of return are much less variable over the capacity range (Chart 7); under tiering, lower tariffs are only paid on marginal units of gas as output increases, which aligns the average tariff paid at each capacity level much more closely with the 12% IRR tariff curve.

61. For these reasons DECC has decided to implement a tiered tariff to address the objectives of the review. In particular, the practical difficulties of implementing banding mean that it is discounted as an option here. Table 2 shows the tiering solution that DECC intends to implement.

Table 2: Tiering solution to be implemented

Tier	Tariff - p/kWh (FY 2014/15)	Tier break (Output at which tariff changes) - MWh per annum of eligible biomethane injected	Approximate biogas plant capacity that produces an annual output equivalent to tier break - MW
Tier 1	7.5	40,000	6
Tier 2	4.4	80,000	12
Tier 3	3.4	> 80,000	> 12

Note: Tiering is set in terms of annual output rather than plant capacity. Chart 3 above shows the relationship assumed between plant capacity (gross biogas capacity) and annual biomethane output. This reflects our updated assumptions on plant availability and methane capture at upgrader stage.

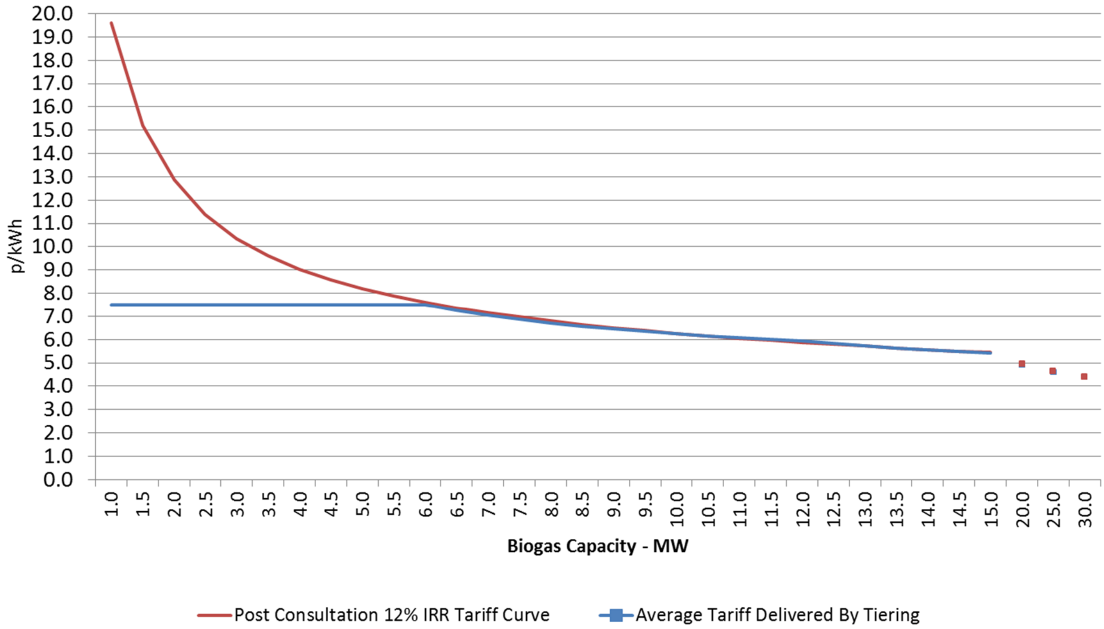
62. This tiering solution has been set to match 12% tariff curve as closely as possible. This has been achieved by setting three different tiers. The first tier has been set to maintain the existing biomethane tariff with the associated tier break set according to the output level (or equivalent plant capacity) at which the existing tariff intersects the 12% IRR curve (Chart 4). This is a plant of approximately 6 MW biogas capacity producing 40,000 MWh per year[14]. The first tier will pay 7.5 p/kWh for the first 40,000 MWh of eligible biomethane injected per annum.

63. The second and third tier breaks were set in order that the tiering structure provides the average tariffs required for plants of 12 MW and 30 MW capacity, according to the 12% IRR curve. These tier breaks ensure that the average tariff delivered by the tiering structure adheres closely to the

[14] Note, plant capacities and equivalent outputs reflect the updated plant performance (availability) assumptions post consultation (see Chart 3).

12% IRR curve (shown in Chart 8) for plants above 6 MW. The second tier will pay 4.4 p/kWh for the next 40,000 MWh of eligible biomethane injected per annum (i.e. for biomethane output between 40,000-80,000 MWh per annum). The third tier will pay 3.4 p/kWh for any eligible biomethane injected above an output of 80,000 MWh per annum[15].

Chart 8 – Average tariff delivered by tiering solution vs. 12% tariff curve



64. A further consideration is whether the tiering solution maintains a sufficient incentive for biomethane to grid deployment versus alternative uses of biogas. The main alternative option is to use the biogas from anaerobic digestion, typically in a combined heat and power (CHP) engine to generate electricity. Such plants can claim Feed in Tariffs (FiTs) support or the Renewable Obligation for units of electricity produced and, if eligible, the RHI for heat produced for an eligible purpose.

65. Feedback from the consultation indicated the proposed tier 1 tariff of 7.5 p/kWh is sufficient to maintain an incentive for using biogas for injection of biomethane into the grid. DECC has examined whether there is an incentive to divert incremental biogas to CHP when increasing output above the tier breaks i.e. whether the marginal tariffs under tiering (tiers 2 and 3) are sufficient to maintain the incentive for biomethane to grid production. Analysis of the marginal returns from using incremental biogas for biomethane versus using it for CHP and claiming FiTs/RO support indicates that tiers 2 and 3 provide similar returns under either option.

Budget management policy

66. The RHI's budget management mechanism is designed to control RHI spending to the scheme's agreed (annual managed expenditure) budget. The budget is currently set out to financial year 2015/16 with a requirement that total nominal spend across both the non-domestic and domestic RHI schemes is controlled to a maximum of £426m (Table 1).

67. In order to control non-domestic RHI spending to budget, a mechanism is in place to degress (reduce) tariffs if spending at the scheme level and/or at the individual technology level exceed certain pre-defined trigger levels. An assessment of whether these triggers have been exceeded

[15] The tariff will be paid up to the maximum volume of biomethane the producer is entitled to inject under the Network Entry Agreement (NEA).

takes place every quarter with any tariff degression taking effect one month after the outcome of the assessment has been made public. A full explanation of the budget management mechanism can be found on DECC's website[16].

68. The following points are made to provide clarity over how the budget management mechanism and the new tariff will interact:

    a. DECC does not intend to revise the biomethane expenditure thresholds used to determine if a degression of the biomethane tariff should take place. This is because the current triggers have been established in tandem with those for the other RHI technologies in order to control the RHI scheme spend to budget (currently agreed to 2015/16)

    b. All spend by biomethane installations, whether accredited to the scheme under the existing tariff or the new tiered tariff, will contribute to projected RHI spend for the purposes of making degression assessments

    c. Any degressions that apply to the tiered biomethane tariff from its introduction will apply equally to all three tiers i.e. the same percentage reduction will apply to each tier. Implementing a system to degress tiers individually would be difficult as it would require attributing RHI spend to the individual tiers and setting separate degression triggers for each

69. The sole change that DECC intends to implement to its budget management mechanism when introducing the new biomethane tariff is to provide a temporary protection from degression between the introduction of the tariff and the end of June 2015. The rationale is to avoid the new tariff being degressed soon after its introduction, which would be destabilising for investor certainty. Further, the tariff change we are making represents a discount to the existing tariff of approximately 15% (on average) anyway so there is a risk that applying a further degression would "over-penalise" the tariff. However, there is a balance to be struck between providing tariff stability and enforcing budget control; as such, the new tariff will be eligible for degression from 1 July 2015 inclusive.

70. For the avoidance of doubt, this means:

    a. The new biomethane tariff will not be degressed on 1 April 2015, even if the outcome of the degression assessment for 1 April 2015 indicates a degression to the tariff should be applied
    b. The new biomethane tariff can be degressed from 1 July 2015 (inclusive) onwards
    c. The outcome of the degression assessment for 1 April 2015 will still apply for the purposes of assessing the level of any degression to be applied on 1 July 2015

[16] https://www.gov.uk/government/statistical-data-sets/rhi-mechanism-for-budget-management-estimated-commitments

Section 5: Impact Assessment

71. This section considers the potential impacts of implementing the tiered tariff solution. It compares implementing tiering (Option 2) with 'do nothing' (Option 1). The impacts are uncertain as they depend upon how plant deployment will react to the new tiered tariff and also what would happen to the existing tariff under the counterfactual.

72. DECC's policy intention is that the new tiered tariff will significantly reduce the risk of overcompensation without significantly impacting deployment. The first scenario considered is one in which the new tariff does not impact deployment and this is compared to a counterfactual under which the existing tariff remains as is (without degression).

73. However, it is possible that some plants incentivised under the current tariff require (real, pre-tax) rates of return in excess of 12% and would not come forward under the tiered tariff. As such, the assessment considers scenarios in which deployment of plants facing a tariff reduction is reduced by 25%. The 25% is arbitrary given there has been no previous tariff reduction on which to base a likely deployment reduction.

74. A second uncertainty is what would happen under the counterfactual of "do nothing". Under this scenario, tariff overcompensation would potentially result in a degression of the tariff at some point owing to higher deployment of plants. As such, the assessment considers scenarios in which there is a degression of 15% to the current tariff under the counterfactual. This could (approximately) represent a 5% degression followed by a further 10% degression. This is a similar sized reduction (on average) as is being implemented through the tiering solution, though the impact on plants at different sizes is not the same, owing to the different tariff structures.

75. Four scenarios are considered to reflect these two uncertainties, shown in Table 3. The main impacts of changing the tariff (relative to the corresponding counterfactual) are considered in the following sections.

Table 3 – Scenarios Considered For Impact Assessment

		Option 1 – Do Nothing	
		No degression to current tariff	Degression of 15% to current tariff
Option 2 – Implement Tiering	No change to deployment	Scenario 1	Scenario 3
	25% reduction in deployment*	Scenario 2	Scenario 4

* for those plants receiving a lower average tariff under tiering vs. the current tariff (i.e. > 6 MW)

Scenario 1: No degression to existing tariff if do nothing, no change to deployment if introduce tiering

76. Scenario 1 assumes that implementing the tiered tariff has no impact upon deployment versus a counterfactual in which the current tariff is not degressed. The key impact is to reduce RHI expenditure i.e. this scenario just represents a transfer from biomethane producers to the taxpayer. Since there is no change to deployment, there is no impact upon the levels of renewable heat, resource costs or carbon emissions savings.

77. Table 4 illustrates the impact under DECC's low, central and high market intelligence scenarios for biomethane deployment. Note the impacts shown here are based only upon new plant coming forward in financial year 2015/16; plants deploying earlier than this will (largely) be unaffected by the tariff change. This is the same for Tables 5-7, which relate to the other scenarios.

78. Based upon the approximate capacity distribution of plants coming forward in the biomethane market, the tiered tariff solution represents an average discount of 15% against the current tariff. This improves the cost-effectiveness of the biomethane tariff (from the perspective of achieving the 2020 renewables target) from £77/MWh to £65/MWh. Applying this to the MI deployment scenarios indicates this would represent RHI expenditure savings of approximately £5m-£10m (on an annual basis) for plants accrediting to the scheme in 2015/16. Over the 20 year lifetime for which plants can claim the RHI, that translates into a £55m-£145m reduction in RHI spend (discounted to 2015/16 at the social discount rate of 3.5%).

Table 4 – Scenario 1: Annualised biomethane heat deployment, RHI spend, lifetime resource cost and lifetime carbon emissions savings for new plant deployment in 2015/16

	Option 1 – Do Nothing			Option 2 - Tiering			Difference		
	Low	Central	High	Low	Central	High	Low	Central	High
Annual Renewable Heat – GWh	330	613	858	330	613	858	0	0	0
Annual RHI Spend - £m	25	47	66	22	40	56	-4	-7	-10
Lifetime Resource Cost - £m	237	439	615	237	439	615	0	0	0
Lifetime Carbon Emissions Savings (Low) - £m	46	86	120	46	86	120	0	0	0
Lifetime Carbon Emissions Savings (High) - £m	70	130	182	70	130	182	0	0	0

Prices are £2015/16. Lifetime Resource Costs and Carbon Emissions savings are discounted over 20 year RHI lifetime to 2015/16 using social discount rate of 3.5%. Low, Central and High represent DECC's market intelligence scenarios for potential biomethane deployment in 2015/16 formed mid-2013. Difference figures may not tally exactly with absolute figures due to rounding.

79. Table 4 also shows the (discounted) lifetime resource cost and lifetime carbon emissions savings associated with plants deploying in 2015/16 under both options.

80. Resource costs represent the capital and operating costs of biomethane plants net of the cost of producing the gas from alternative natural gas sources (which is assumed to be captured by the wholesale gas price); since biomethane displaces natural gas in the gas grid, it is the incremental resource cost that is of interest.

81. For carbon emissions benefits, a range of carbon emissions savings has been calculated – a lower and an upper bound. The "low" savings are based upon biomethane plants producing emissions of 34.8g CO2e / MJ at the point of injection for all biomethane injected, consistent with the maximum emissions that will be permitted by DECC's biomass sustainability requirements[17]. This represents an emissions saving of 0.15 tCO2e / MWh at point of injection, when compared with the EU fossil heat average (adjusted to emissions at the point of injection)[18].

82. The "high" savings are based upon an assumption that the proportion of biogas produced from energy crop meets the criteria of 34.8g CO2e / MJ at the point of injection and the proportion produced by food waste produces zero emissions[19]. This latter assumption is clearly extreme but serves for the purpose of this upper bound of emissions savings. This represents an emissions saving of 0.23 tCO2e / MWh at point of injection compared with a counterfactual of the EU fossil heat average.

83. For both the low and high emissions savings, carbon savings have been valued using DECC's 2014 traded and non-traded carbon price projections with savings apportioned to these sectors according to their share of UK gas demand[20].

Scenario 2: No degression to existing tariff if do nothing, 25% reduction in deployment if introduce tiering

84. Scenario 2 assumes there is a reduction in biomethane deployment in 2015/16 as a result of introducing the tiered tariff and compares this against a counterfactual of no change to the existing tariff. The reduction in deployment (of 25%) is assumed to impact plants over 6 MW; below this capacity, the tariff remains the same as the current level whether or not tiering is introduced. Note this view does not consider the impact of resources potentially being diverted to other uses of biogas as a result of reduced biomethane deployment.

85. Table 5 illustrates the main impacts. Annual renewable heat deployment for new plants in 2015/16 is reduced by approximately 15% (all the result of reduced deployment) and annual RHI spend for those plants reduced by approximately £7m-18m. About half of this reduction in spend is due to the new tariff and half due to the reduction in deployment (by comparison to Table 4).

[17] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/370604/Non-domestic_RHI_-_Biomass_and_Biomethane_Sustainability_November_2014.pdf

[18] The lifecycle emissions for the EU fossil heat average are 87.0 gCO2e / MJ (see p.17 in http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2010:0011:FIN:EN:PDF). Assuming an 88% efficiency conversion for final heat use, this counterfactual is adjusted to emissions of 76.6 g CO2e / MJ at point of injection. The difference of 41.8 gCO2e / MJ (76.6 g CO2e / MJ – 34.8 g CO2e / MJ) converts to a saving of 0.15 t CO2e / MWh biomethane injected assuming 1 MJ = 0.00028 MWh. Biomethane injected is biogenic methane eligible for RHI payments.

[19] Given the assumed feedstock mix and biogas yields, 39% of the biogas in our reference plant is produced from energy crop and 61% from food waste.

[20] Based upon DUKES Table 4.2 (Supply and consumption of natural gas), the approximate shares of the traded and non-traded sectors in UK gas consumption in 2013 were 30% and 70% respectively.

Lifetime resource costs and lifetime carbon emissions savings are both reduced by approximately 15%, again the result of the reduced deployment.

86. Under this scenario the average tariff per unit of biomethane injected is reduced from £77/MWh (counterfactual) to £67/MWh (tiering). The lost deployment results in a slightly higher RHI cost for tiering under this scenario (than scenario 1) since larger plants require a lower incentive (per kWh).

Table 5 – Scenario 2: Annualised biomethane heat deployment, RHI spend, lifetime resource cost and lifetime carbon emissions savings for new plant deployment in 2015/16

	Option 1 – Do Nothing			Option 2 - Tiering			Difference		
	Low	Central	High	Low	Central	High	Low	Central	High
Annual Renewable Heat – GWh	330	613	858	277	514	719	-53	-99	-138
Annual RHI Spend - £m	25	47	66	18	34	48	-7	-13	-18
Lifetime Resource Cost - £m	237	439	615	204	378	530	-33	-61	-86
Lifetime Carbon Emissions Savings (Low) - £m	46	86	120	39	72	101	-7	-14	-19
Lifetime Carbon Emissions Savings (High) - £m	70	130	182	59	109	152	-11	-21	-29

Prices are £2015/16. Lifetime Resource Costs and Carbon Emissions savings are discounted over 20 year RHI lifetime to 2015/16 using social discount rate of 3.5%. Low, Central and High represent DECC's market intelligence scenarios of biomethane deployment. Difference figures may not tally exactly with absolute figures due to rounding.

Scenarios 3 and 4: 15% degression to existing tariff if do nothing, no reduction in deployment if introduce tiering (Scenario 3) or 25% reduction in deployment if introduce tiering (Scenario 4)

87. Scenarios 3 and 4 consider the same outcomes from introducing tiering, but against a different counterfactual in which the current tariff is degressed by 15%, an approximately similar level to that imposed by the introduction of tiering. The degression is similarly assumed to take effect prior to 2015/16 and it is assumed it results in a deployment reduction. Specifically, plants requiring RHI support greater than the degressed tariff (those lower than 8.5 MW in capacity according to the 12% IRR tariff curve) would no longer come forward.

88. Under Scenario 3 (Table 6), introducing tiering avoids the reduced deployment brought about by degression; consequently renewable heat deployment, RHI spend, resource cost and carbon emissions savings are all higher than under the counterfactual. The impact is similar under

Scenario 4 (Table 7) though to a lesser extent since there is also some deployment reduction associated with introducing tiering.

89. A 15% degression to the existing tariff achieves a similar RHI cost-effectiveness in as does tiering: approximately £66/MWh However, note that degression does not address the issue of tariff structure i.e. further degressions might occur since the overcompensation risk would be reduced but not fully addressed at higher capacities.

Table 6 – Scenario 3: Annualised biomethane heat deployment, RHI spend, lifetime resource cost and lifetime carbon emissions savings for new plant deployment in 2015/16

	Option 1 – Do Nothing			Option 2 - Tiering			Difference		
	Low	Central	High	Low	Central	High	Low	Central	High
Annual Renewable Heat – GWh	172	319	446	330	613	858	158	294	411
Annual RHI Spend - £m	11	21	29	22	40	56	10	19	27
Lifetime Resource Cost - £m	102	189	264	237	439	615	135	251	351
Lifetime Carbon Emissions Savings (Low) - £m	24	45	63	46	86	120	22	41	58
Lifetime Carbon Emissions Savings (High) - £m	36	68	95	70	130	182	34	62	87

Prices are £2015/16. Lifetime Resource Costs and Carbon Emissions savings are discounted over 20 year RHI lifetime to 2015/16 using social discount rate of 3.5%. Low, Central and High represent DECC's market intelligence scenarios of biomethane deployment. Difference figures may not tally exactly with absolute figures due to rounding.

Table 7 – Scenario 4: Annualised biomethane heat deployment, RHI spend, lifetime resource cost and lifetime carbon emissions savings for new plant deployment in 2015/16

	Option 1 – Do Nothing			Option 2 - Tiering			Difference		
	Low	Central	High	Low	Central	High	Low	Central	High
Annual Renewable Heat – GWh	172	319	446	277	514	719	105	195	273
Annual RHI Spend - £m	11	21	29	18	34	48	7	13	19
Lifetime Resource Cost - £m	102	189	264	204	378	530	102	190	266
Lifetime Carbon Emissions Savings (Low) - £m	24	45	63	39	72	101	15	27	38
Lifetime Carbon Emissions Savings (High) - £m	36	68	95	59	109	152	22	41	58

Prices are £2015/16. Lifetime Resource Costs and Carbon Emissions savings are discounted over 20 year RHI lifetime to 2015/16 using social discount rate of 3.5%. Low, Central and High represent DECC's market intelligence scenarios of biomethane deployment. Difference figures may not tally exactly with absolute figures due to rounding.

Annex 1 – Additional Cost and Performance Evidence

Prices adjusted to December 2013 in line with FY 2014/15 RHI tariffs

Capital Costs

Chart A – Development Costs

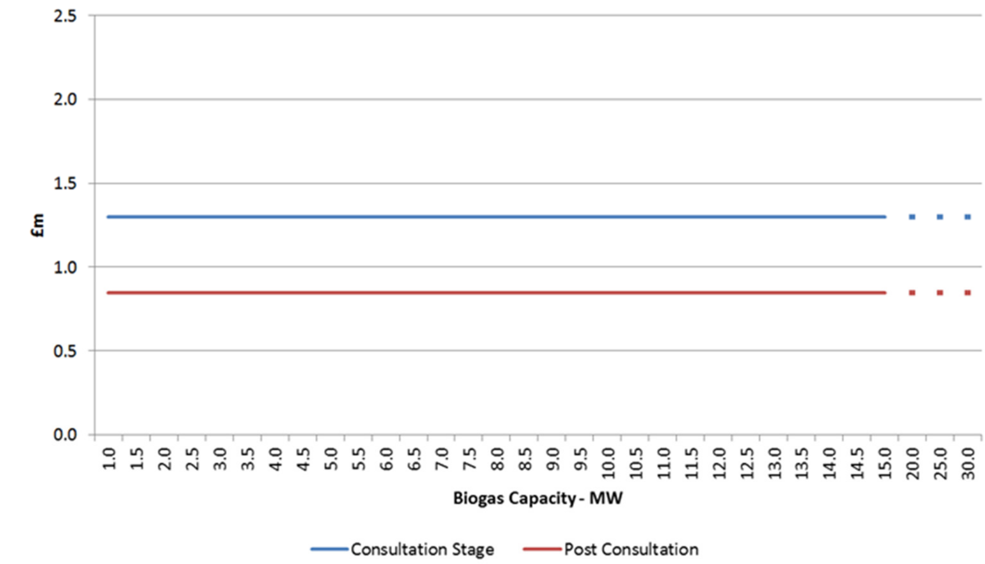


Chart B – Civil Engineering Costs

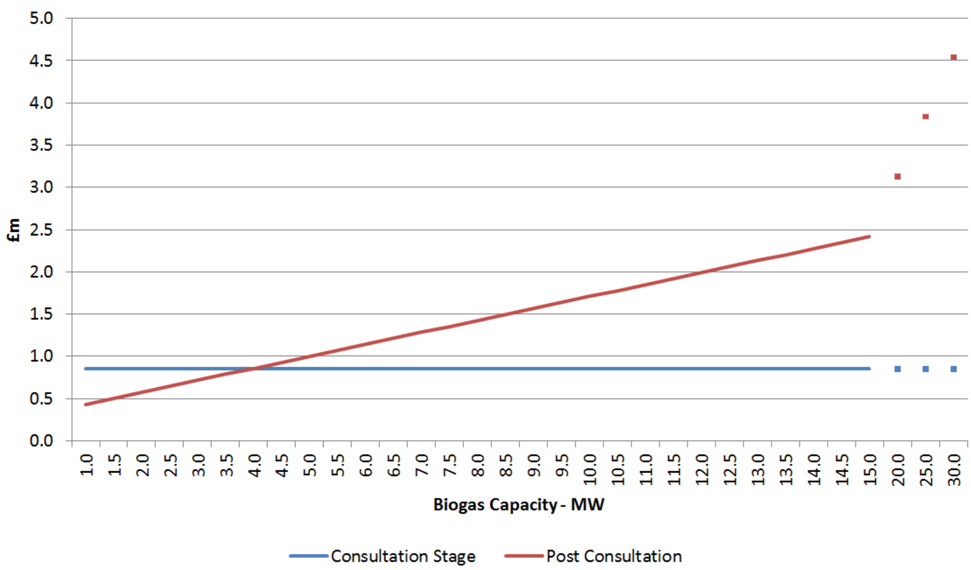


Chart C – Silage Clamps

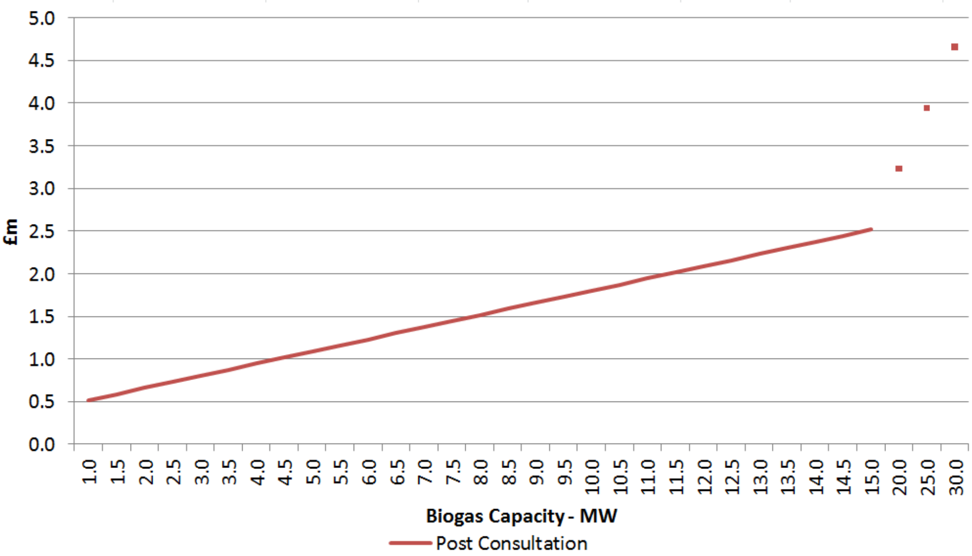


Chart D – Waste Pre-Treatment Capex

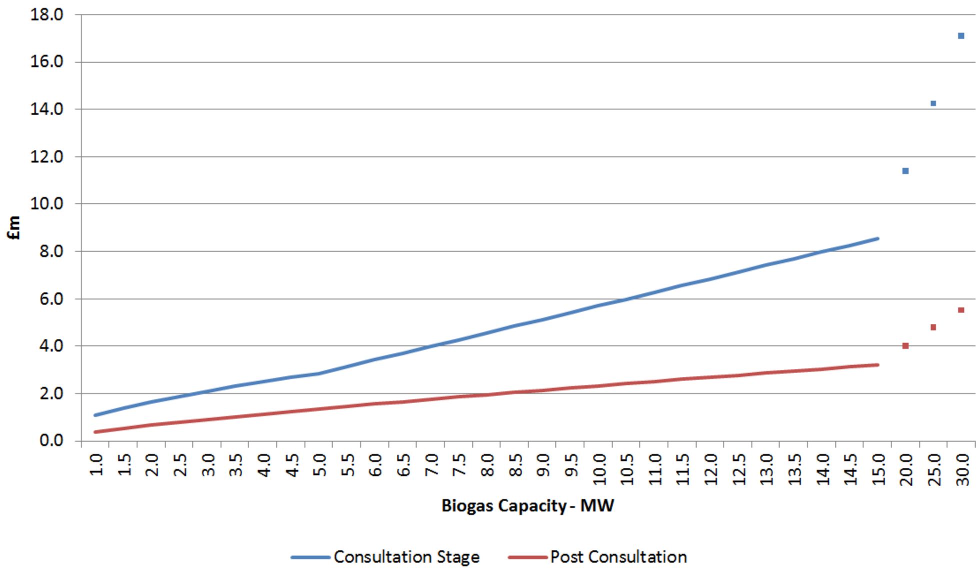


Chart E – Anaerobic Digester Capex

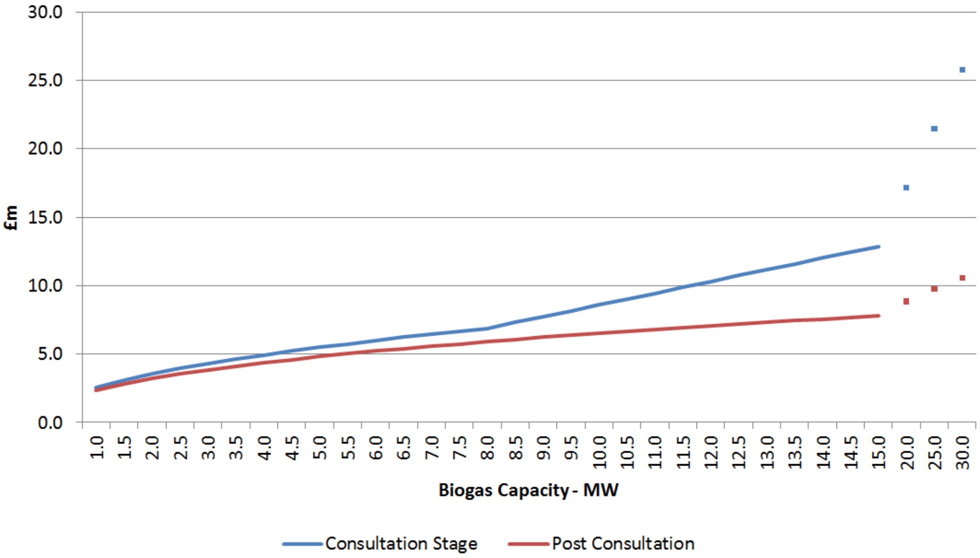


Chart F – Boiler Capex

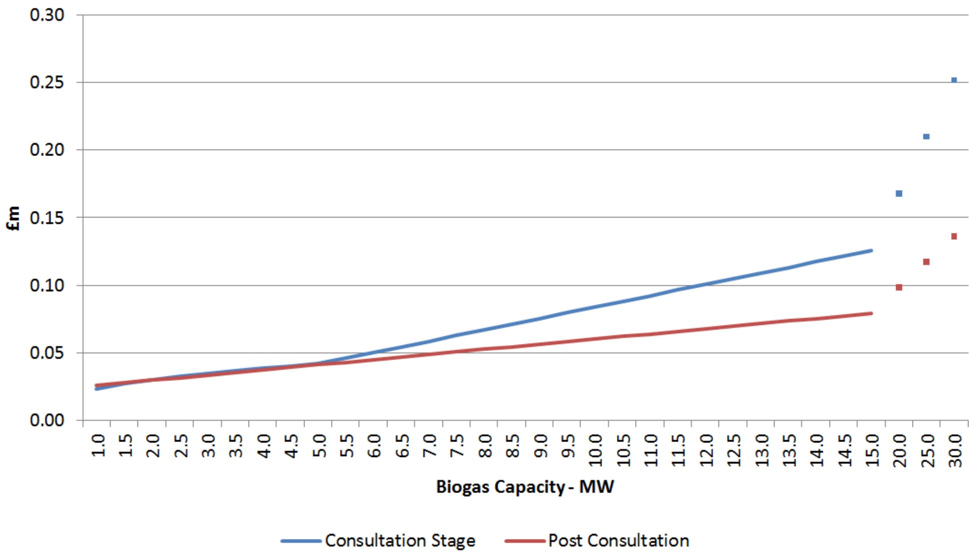


Chart G – Digestate Storage Capex

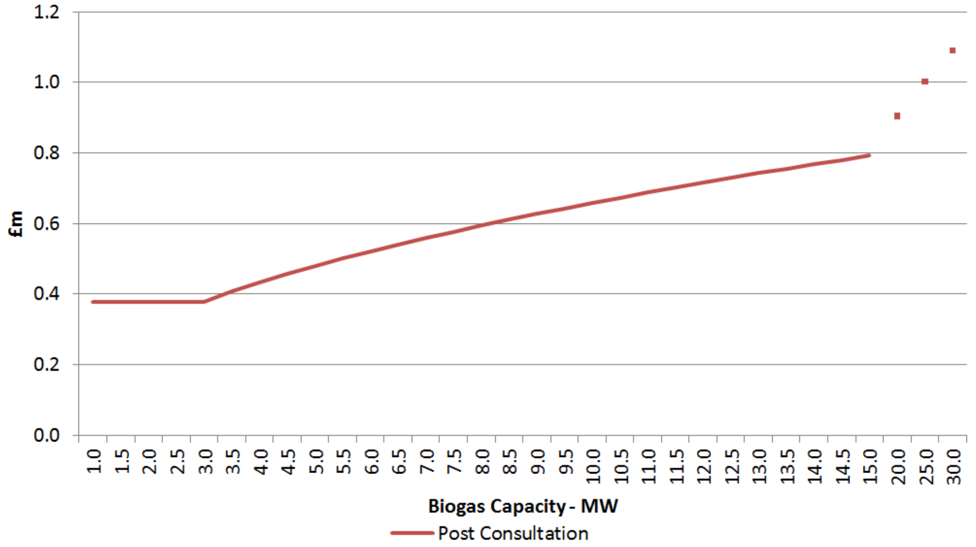


Chart H – Upgrader Capex

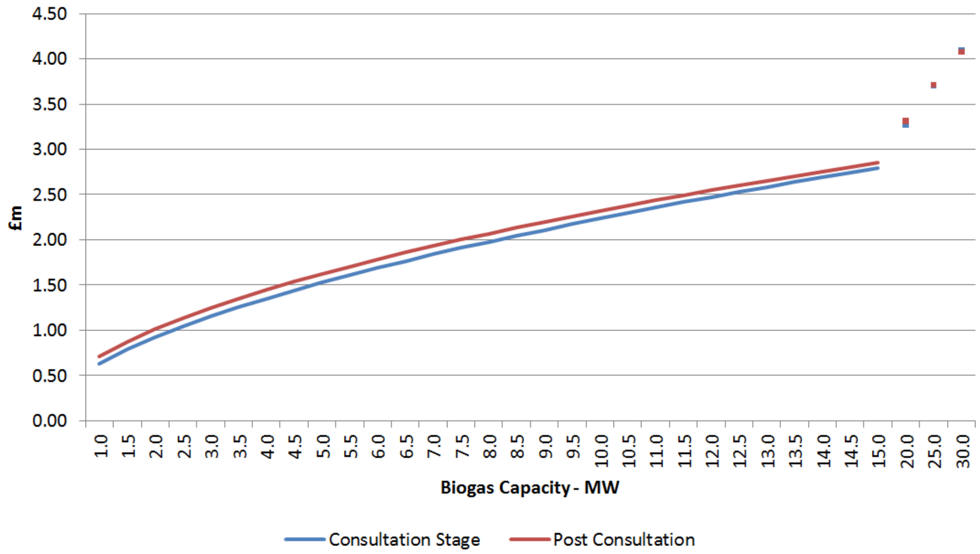


Chart I – H2S/VOC Capex

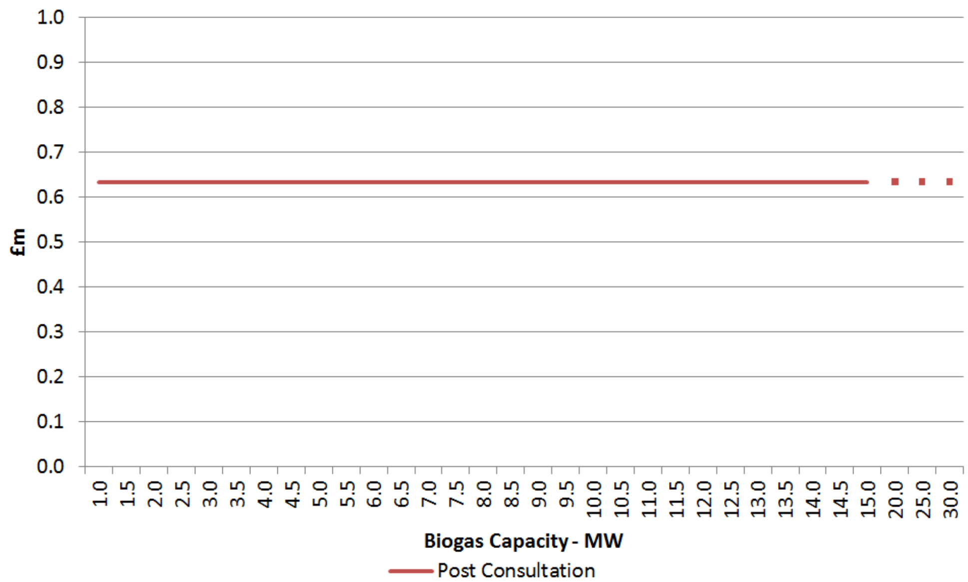


Chart J – Injection (Propane, Metering & Monitoring, Grid ROV/Telemetry) Capex

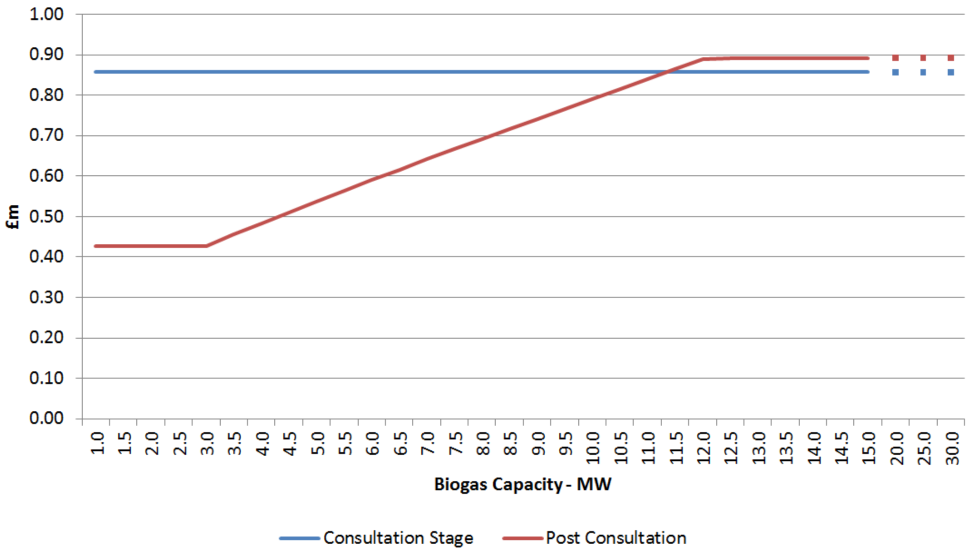


Chart K – Gas Grid Connection

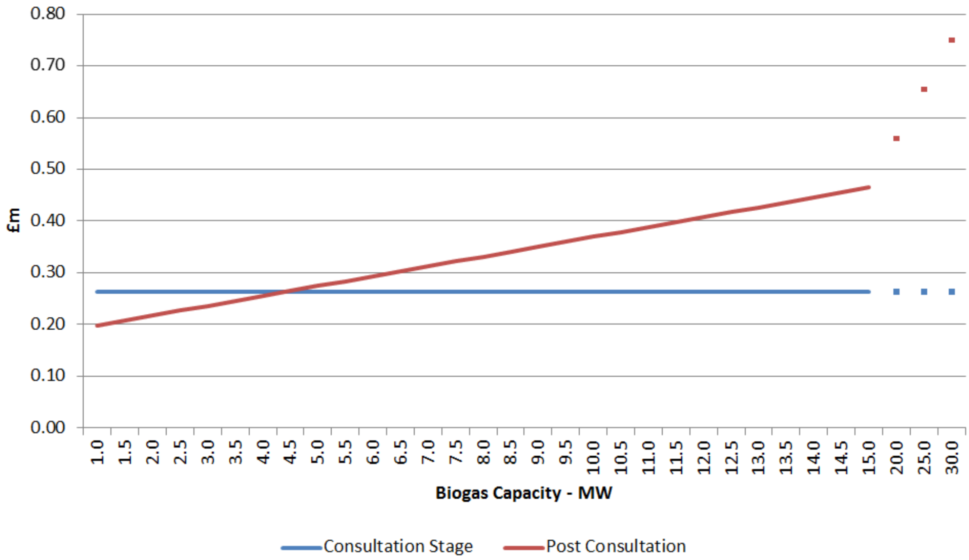


Table A – Capital Component Lifetimes

Capital Cost	Lifetime
Development Costs	Weighted average by Capex of other components at each capacity
Civil Works	Weighted average by Capex of other components at each capacity
Silage Clamps	20
Waste pre-treatment	10
Digester Waste	20
Boiler	10
Digestate Storage	20
Upgrader	15
H2S/VOC Cleanup	15
Injection	15
Gas grid connection	25

Table B – Operating Cost Assumptions - Maintenance

Capital Cost	Pre-Consultation Annual Maintenance - % Capex	Post-Consultation Annual Maintenance - % Capex
Silage Clamps	N/A	1.7
Waste pre-treatment	4.3	4.7
Digester Waste	1.7	1.7
Boiler	6.5	6.7
Digestate Storage	N/A	1.7
Upgrader	2.9	3.5
H2S/VOC Cleanup	N/A	3.5
Injection	4.7	7.5
Gas grid connection	1.1	1.1

Table C – Operating Cost Assumptions - Various

Assumption	Pre-Consultation	Post-Consultation
Average of DECC Retail Electricity Price Projection (2014-2030) - £/MWh	£136	£133
Gross Propane Price - £/MWh	£60	£54
Labour – Annual £/FTE	£31,300	£31,300
Insurance - % Capex	1%	1%
% Waste Rejected to Landfill	10%	5%
Landfill Tax - £/tonne	£80	£80
Landfill Gate Fee - £/tonne	£25	£22
Ratio digestate : feedstock (tonnage)	2:1	1:1
Digestate Disposal Cost - £/tonne	£4.6	£10

Table D – Feedstock Cost Assumptions

£/tonne	Pre-Consultation	Post-Consultation
Food Waste Gate Fees (Unpackaged Waste)	- £25-£41	- £15
Energy Crop	£35	£35

Table E – Feedstock Yield Assumptions

Biogas Yield – Nm3/t	Pre-Consultation	Post-Consultation
Food Waste	125	125
Energy Crop	186	186

Energy Content of Biogas Yield - MWh/t	Pre-Consultation	Post-Consultation
Food Waste	0.76	0.76
Energy Crop	1.04	1.04

Table F – Biomethane Revenue Assumptions

£/MWh	**Pre-Consultation (2013 Projection)**	**Post-Consultation (2014 Projection)**
Average of DECC Wholesale Gas Price Projection (2014-2030)	24.8	22.3

Table G – Plant Performance Assumptions

	Pre-Consultation	Post-Consultation
Digester Availability	100%	90%
Upgrader Availability	95%	95%
Upgrader Methane Capture	98%	99.5%