Title: Consultation Stage IA: The Renewable Heat Incentive: A reformed and refocused scheme	Impact Assessment (IA)
IA No: DECC0211	**Date:** 03/03/2016
Lead department or agency: Department of Energy and Climate Change	**Stage:** Development/Options
Other departments or agencies: N/A	**Source of intervention:** Domestic
	Type of measure: Secondary legislation
	Contact for enquiries: RHI@decc.gsi.gov.uk

Summary: Intervention and Options

RPC Opinion: Not Applicable

Cost of Preferred (or more likely) Option				
Total Net Present Value	**Business Net Present Value**	**Net cost to business per year** (EANCB on 2009 prices)	**In scope of One-In, Two-Out?**	**Measure qualifies as**
£831m	NA	NA	No	NA

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

The Renewable Heat Incentive (RHI) is an incentive to owners of renewable heat installations. It was introduced in the non-domestic sector in November 2011 and the domestic sector in April 2014. It is intended to help overcome the cost differential between renewable and conventional heating systems in order to incentivise deployment and contribute to meeting the UK's legally binding 2020 Renewable Energy Directive target.

What are the policy objectives and the intended effects?

The aim of the RHI is to incentivise the cost effective installation and generation of renewable heat in order to contribute renewable energy to help meet the UK's 2020 renewable energy target and develop the renewable heat market and supply chain so that it can support the mass roll out of low carbon heating technologies.
This consultation is designed to ensure that the RHI is affordable, offers value for money, contributes to the development of sustainable markets, promotes widespread access and incorporates robust scheme design

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

Option 0: Counterfactual / Close the RHI - The RHI did not previously have a budget settlement to allow for new installations to be accredited onto the scheme after March 31st 2016. Had the budget and accompanying changes not been agreed, this would likely have resulted in the scheme being closed to new applicants after this date.

Option 1: Implement changes to RHI to maintain affordability and refocus the scheme - Consisting of two packages, with the first occurring in 2016 helping to maintain the affordability and implement simplifications to enhance the functioning of the scheme. The second is implementing the re-focusing of the RHI, through tariff and eligibility reviews, introduction of assignment of rights and tariff guarantees, whilst also establishing the long term budget management and affordability mechanism.

Will the policy be reviewed? We will consider need for review

Does implementation go beyond minimum EU requirements?			N/A		
Are any of these organisations in scope? If Micros not exempted set out reason in Evidence Base.	**Micro** n/a	**< 20** n/a	**Small** n/a	**Medium** n/a	**Large** n/a
What is the CO_2 equivalent change in greenhouse gas emissions in Carbon Budget 4? (Million tonnes CO_2 equivalent)			**Traded:** - 1 to - 2		**Non-traded:** -26 to -38

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

Signed by the responsible Minister: ______________ Date: 03 March 2015

Summary: Analysis & Evidence   Policy Option 1

Description: Implementation of the proposals outlined in this consultation.

FULL ECONOMIC ASSESSMENT

Price Base Year 2015	PV Base Year 2015	Time Period Years 27	Net Benefit (Present Value (PV)) (£m)		
			Low: See IA	**High: See IA**	**Best Estimate: £831**

COSTS (£m)	**Total Transition** (Constant Price)	Years	**Average Annual** (excl. Transition) (Constant Price)	**Total Cost** (Present Value)
Low	-		-	**Table C12 Pg 68**
High	-		-	**Table C12 Pg 68**
Best Estimate	-		-	**£5,872m**

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

The reformed RHI will see costs arising only from the lifetime resource cost of supporting all eligible renewable technologies, with a value of £5,872m within the central scenario. This is mainly as a result of the additional costs of installing low carbon technologies. These estimates are subject to significant uncertainty, both in terms of the types of installations which may come forward and the additional costs they may face.

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

Rebound Effect: For some users, installing a low carbon heat technology could lead to an overall lowering of fuel bills. This could lead to an overall increase in energy consumption.

BENEFITS (£m)	**Total Transition** (Constant Price)	Years	**Average Annual** (excl. Transition) (Constant Price)	**Total Benefit** (Present Value)
Low	-		-	**Table C12 Pg 68**
High	-		-	**Table C12 Pg 68**
Best Estimate	-		-	**£6,703**

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

The main monetised benefit of the RHI is the significant reduction in carbon emissions which mainly occurs in the non-traded sector and is significantly influenced by savings as a result of biomass and biomethane. The other important benefit is the air quality impact whichis highly uncertain as RHI is a demand led scheme. Thus the air quality impact is highly dependent on the location of deployment, the actual insitu performance of systems and the fuel use being replaced.

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

Additional benefits include: innovation benefits and reduced technology costs due to learning from wider deployment and cost reductions in renewable heating system installation driven by the RHI leading to future decarbonisation being more cost effective. These benefits have not been monetised and are not included in the Present Value

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

There is a significant amount of uncertainty in many elements of the analysis, for reasons outlined within the impact assessment. These key sensitivities include changes in assumptions surrounding: the level of carbon abatement, Carbon Prices, Air quality costs, Resource costs and finally deployment

BUSINESS ASSESSMENT (Option 1)

Direct impact on business (Equivalent Annual) £m:			**In scope of OITO?**	**Measure qualifies as**
Costs: NA	**Benefits: NA**	**Net: NA**	No	NA

Executive Summary

1. This Impact Assessment is part of the consultation on changes to the Renewable Heat Incentive. It aims to appraise the impact of proposed changes to the scheme and illustrate the analysis which has supported key policy proposals.

2. The proposed changes include:

   a. Review of the support for Air Source Heat Pumps and Ground Source Heat Pumps and the incentives for high performing systems;
   b. Restructured support for non-domestic biomass;.
   c. Support for the best value for money biomethane and biogas feedstocks;
   d. Introduction of tariff guarantees to promote deployment of large installations and assignment of rights to enable greater access to the domestic scheme and;
   e. Introduction of a cap and use of the consumer price index for annual tariff increases to new installations.

3. To assess the impact of these changes we use market intelligence to qualitatively assess the possible impact of the individual policy decisions and then develop deployment estimates which set out potential trajectories for spend, carbon savings and renewable heat supported. These estimates have been produced by drawing on a range of sources including industry estimates of potential, scheme data collected to date, project pipeline data and direct engagement with industry.

4. We anticipate that by 2020/21, the RHI could deliver 23.7TWh of renewable heat with spending of £1.15bn on the total scheme for the year. This could deliver 27-40MtCO2e of carbon abatement by Carbon Budget 4 (depending on abatement from biomethane).

5. We anticipate that changes to the scheme will help promote the installation of large biomass systems through a combination of increased support and tariff guarantees, biomethane based on food waste and heat pumps for domestic households through a revised tariff and assignment of rights.

6. There is considerable uncertainty about these impacts which are explored in more detail in this impact assessment and we would welcome views from industry on the deployment these suggested changes could unlock.

7. There are also significant uncertainties in the Net Present Value (NPV) of the scheme as a whole. We anticipate a central estimated NPV of these changes of £831m, but with a significant range around this.

8. All the changes proposed are designed to best meet the overall scheme objectives in a manner which:

a. **Is affordable** Ensuring that the RHI is affordable by firmly controlling costs;

b. **Offers value for money** Maximising the benefits of the scheme including carbon abatement and renewable heat generation to achieve value for money for the taxpayer;

c. **Promotes deployment of those technologies which are likely to be strategically important in the longer-term** Providing support to technologies which are likely to be strategically important and making use of the right technologies for the right uses;.

d. **Contributes to development of sustainable markets:** Drive cost reductions and innovation in technologies to help build markets that are sustainable in the future;

e. **Promotes widespread access:** Support families that are less able to pay in accessing the scheme; and

f. **Incorporates robust scheme design:** Avoid the creation of, or respond to, existing perverse incentives and minimise overcompensation as far as possible.

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Section A: Background

1. The Renewable Heat Incentive (RHI) was introduced to support households, businesses, public bodies and charities in transitioning from conventional forms of heating to renewable sources of heat.

2. The RHI is central to the Government's plans for the long-term decarbonisation of heating in the UK. It's also an important contributor to meeting the UK's binding renewable energy target, as set out in the EU Renewable Energy Directive.

3. The Non-Domestic RHI scheme was launched in November 2011. This was followed by the Domestic RHI scheme in April 2014. So far the schemes have supported over 30,000 renewable heat installations in the UK – 18,493 through the domestic scheme, and 13,580 through the non-domestic scheme.

4. In November 2015, the Government renewed its commitment to the transition to a low carbon heat by confirming a continued budget for the Renewable Heat Incentive. We expect spending on the RHI to rise from £430m in 2015/16 to £1.15bn in 2020/21 in nominal terms.

Policy History

5. The scheme has undergone updates and extensions since the Non-Domestic scheme launch in 2011. These have included:

    a. Launch of the domestic scheme in 2014;

    b. Support for new technologies in the Non-Domestic scheme, consulted on in 2012, launched in 2014;

    c. A tariff review for non-domestic technologies consulted on in 2013, launched in 2014;

    d. A review of the biomethane tariff in 2014/15; and

    e. Introduction of biomass sustainability criteria in 2015.

6. The majority of deployment to date seen under RHI has been in the bioenergy market. For Non-Domestic RHI this has been small biomass (<199kW) and biomethane, and to a lesser extent medium biomass (200-999kW). Within the Domestic RHI biomass has also seen the largest spend by technology for new installations.

Table A.1 Installations, heat and spend by technology

Technology	Installations (no of accreditations since scheme launch)	Spend (£m, Committed spend end Dec-15)
Non-Domestic	13,580 (2,210MW of capacity)	£454.9m
Domestic (excl Legacy)	18,493	£49.27m

7. Further details can be found in the latest statistical release[1].

Spending Review Process

8. The budget for the RHI is determined through the spending review process. The spending review settlement for the RHI, in 2013, confirmed a budget of £430m for the financial year 2015/16. No budget for subsequent financial years was confirmed.

9. Annual budget caps for each year, from 2016/17 to 2020/21, were agreed as part of the Spending Review 2015.

[1] https://www.gov.uk/government/collections/renewable-heat-incentive-statistics

Rationale

Problem under consideration

10. RHI is the key policy mechanism that DECC has put in place for heat's contribution towards the EU Renewable Energy Directive Target (RED) and also develop the low carbon heating market for mass deployment in the 2020's and 2030's.

11. The objectives of the scheme and changes are outlined below in the policy objectives section.

Rationale for intervention

12. The current market for renewable heat is relatively small and these technologies are largely unable to compete on cost with conventional heating options such as gas, oil and electricity. In addition to cost differences, there are a number of non-financial barriers to the uptake of renewable heat.

13. The economic rationale for subsidising renewable heating in the domestic and non-domestic sectors is:

    a. The negative carbon externality associated with the conventional heating of buildings is not reflected in the cost of those systems. Renewable heat technologies enable buildings to be heated using significantly less fossil fuel thereby reducing greenhouse gas emissions;

    b. The UK operates under the EU Renewable Energy Directive (RED) which sets out a legally binding target for the UK of 15% to generate energy from renewable sources by 2020;

    c. Preparing the supply chain (installer and manufacturer) for the mass roll-out and deployment of low carbon heat potential;

    d. Reducing barriers to renewable heat and increasing innovation through increased deployment, as the spillover benefits to society of marginal increases in performance or marginal decreases in costs are not reflected in the price of renewable heating; and

    e. Renewable technologies add a further non-monetised benefit through diversifying the UK's energy supply, reducing the exposure of the UK to the volatility of oil and gas prices.

14. The RHI is designed to achieve these goals by incentivising cost effective installations, creating cost reductions for installation and operation, and improving performance of renewable heating systems.

15. However, any intervention in the market should ensure economic inefficiencies such as deadweight loss and the payment of economic rents, are minimised. Minimising inefficiencies and economic rents will mean an improvement in the value for money of the scheme and ensure market distortions are minimised.

16. The rationale for the potential changes to the RHI is specifically designed to ensure that the external benefits of lower carbon emissions, potential innovation and minimal distortions are maintained.

Policy objectives

17. The overarching aim of the RHI, both Domestic and Non-Domestic schemes, is to incentivise the cost effective installation and generation of renewable heat in order to:

    a. Contribute renewable energy in order to help meet the UK's 2020 renewable energy target for sourcing 15% of energy demand from renewable sources; and

    b. Develop the renewable heat market and supply chain so that it is in a position to support the mass roll out of low carbon heating technology required in the 2020s and onwards in order to meet the UK's carbon budgets.

18. This consultation sets out the Government's proposals for reform to both the Domestic and Non-Domestic RHI schemes to ensure the objectives of the schemes are met in a manner which:

    a. **Is affordable** Ensuring that the RHI is affordable by firmly controlling costs;

    b. **Offers value for money** Maximising the benefits of the scheme including carbon abatement and renewable heat generation to achieve value for money for the taxpayer;

    c. **Promotes deployment of those technologies which are likely to be strategically important in the longer-term** Providing support to technologies which are likely to be strategically and making use of the right technologies for the right uses;

    d. **Contributes to development of sustainable markets** Drive cost reductions and innovation in technologies to help build markets that are sustainable in future;

    e. **Promotes widespread access** Support families that are less able to pay in accessing the scheme; and

    f. **Incorporates robust scheme design** Avoid the creation of, or respond to, existing perverse incentives and minimise overcompensation as far as possible.

Evidence Base, Uncertainty, and analytical approach

Sources and Impacts of Uncertainty

19. The market for renewable heat technologies is still in a relatively nascent state in the UK which means that data, evidence, and understanding of the technologies remains uncertain. This also means market sizes and consumer awareness can change rapidly. The existing evidence also often has large ranges for the same types of applications and varies significantly from source to source. Additional sources of uncertainty are:

    a. ***Heterogeneity*** Both heat demand and renewable heat installations are extremely heterogeneous, this is particularly true in the non-domestic sector. For example, the cost of heat generation per unit of heat varies considerably for a single technology, dependent on factors such as location, heat load, size, and user behaviour;

    b. ***Feedback between policy design and uptake*** The costs, performance and deployment of technologies are all heavily influenced by factors such as technical design, installation and use which are influenced by individual and market wide reactions to the way policy is designed; and

    c. ***Biomass Emissions*** The lifecycle emissions from biomass are subject to a high degree of uncertainty and depend on sourcing and plant characteristics.

20. These significant uncertainties create risks in both the setting of new tariffs and the forecasting of the impacts of tariffs, by affecting two main areas:

    a. ***Tariffs –*** The consultation document that this IA accompanies proposes changes to tariffs for several technologies. There is significant uncertainty about the appropriate level of tariff to offer due to factors described above. For example, the data we have can be combined in a number of ways which leads to a wide range of potential tariffs.

    b. ***Forecasting deployment –*** The factors which lead households and firms to install renewable heating systems is not consistent or predictable. They rest on factors outside of the control of Government through this policy, such as fossil fuel prices. Coupled with the uncertainty about the cost and performance of technologies, this means that technical potential and likely deployment are very uncertain.

21. In both areas, market intelligence (MI) and stakeholder views have been used significantly to offer a more complete picture than our modelling and data offer. The following sections outline the approach taken to appraisal for this IA given the challenges set about above.

Evidence Base

Box A1 Cost and Performance Evidence collection
A detailed summary of the assumptions used in this Impact Assessment can be found in Annex 2.
We welcome comment on these and any further evidence to improve these assumptions

22. The evidence on the cost and performance of technologies that we use to inform tariff setting comes from a wide array of sources. These parameters will all feed in to the design of tariffs for different renewable heating technologies, as well as informing the impacts appraisal. There is a significant amount of uncertainty around many of these key assumptions:

    a. There is significant variation in the cost and performance of low carbon heating technologies, arising from a variety of sources, including variation in the building stock, the types of technology solutions and use;

    b. The fact that many of the technologies are emerging, or are growing from very small deployment levels. Tthis can cause significant variation, and changes, in costs and performance across the market and over time;

    c. The fact that technology specific aspects being reported can vary. These include for example market segmentation, types of systems considered, or target building type; and

    d. The relationship between different variables (for example where the performance of a system and the cost of a system may be linked), or where boundaries have been set (for example if the costs include just equipment, or installation costs as well).

23. For these reasons above, the evidence we gather needs to be examined and interpreted by experts within DECC. This allows us to develop an agreed set of assumptions for parameters such as the capital cost of technologies, their performance or efficiency, likely installation sizes, and the appropriate conventional counterfactual technology to consider.

24. A list of major sources of evidence is set out in Table A2 below. More detail on the values used for specific parameters for each technology can be found in the technology specific sections later in this document (as well as in the detailed annexes).

Table A.2 Major sources of evidence

Source	Description
Ofgem RHI scheme data	The administration of the scheme provides detailed information regarding the types of installations supported by the scheme. This is used to inform the design of the scheme as appropriate.
Market Intelligence	Through direct industry contact and through established channels such as the Industry Advisory Group, DECC gathers market intelligence to support the development of policy and interpretation of evidence to inform scheme design.
Sweett Cost and Performance Report (2013)	Evidence collated on the cost, performance and use of low carbon heating systems.
Renewable Heat Premium Payment (RHPP) metering evidence	In-situ performance evidence for heat pumps supported under the RHPP.
NERA/AEA Report (2009 onwards)	Wide review of cost and performance of low carbon heating technologies in the domestic and non-domestic sector.
Evidence collated from previous schemes	DECC has previously run several heat schemes. Where possible we have used evidence from these to inform our thinking about RHI evidence, such as RHPP. This includes cost and performance data.
Industry evidence received during consultations	During calls for evidence or consultation on changes, industry often provides evidence on a wide range of issues and questions. This includes data on costs, deployment and performance. DECC publishes summaries of the evidence received during consultation in Government Responses[2].
Additional engineering consultancy reports	DECC engineers commission reports to address specific evidence gaps. Where possible these are published on DECC's website. These include reports on performance.

[2] Links to RHI Consultations and Government Responses for both the Domestic and Non-Domestic scheme are at: https://www.gov.uk/government/publications/renewable-heat-incentive-policy-overview

Analytical Approach

25. The approach to analysing this proposed package of changes is focused on two elements:

    a. **Revising support & eligibility -** looking at the policy intent of proposed changes, using new tools and where possible updated evidence.

    b. **Appraising costs and benefits –** using the latest evidence and market intelligence to develop potential deployment projections. Using scenarios given the significant uncertainty because of the demand led nature of the RHI. This method is described in detail in Section C and the counterfactual is described below.

26. The implementation of the changes in this consultation will take place in two stages and these are changes in early 2016 and then those after consultation and State aid approval. However, for simplicity, the approach we have taken is to analyse the whole package as one.

Revising Tariffs

27. Tariffs are set to compensate businesses and households for the additional costs of installing renewable heat technologies compared to conventional heating technologies such as oil or gas (for non-domestic) fuelled systems.

28. The tariff calculation methodology takes into account several components of cost which may differ between the renewable and conventional heating technology, and include:

    a. ***Additional capital cost*** The compensation for net capital costs is required because renewable heating systems are typically significantly more expensive to install than conventional systems;

    b. ***Differences in operating and fuel costs*** changes in the required maintenance, as well as the type and amount of fuel used can impact the ongoing costs faced by consumers. These can either be savings or increases depending on the case; and

    c. ***Rate of return*** Installing renewable heating systems often face barriers which decision makers require a financial rate of return to overcome. For example, this can be additional work on the building, a risk premium associated with the technology. Additional returns are assumed to be required in the Non-Domestic scheme to compensate for the opportunity cost of funding the installation of the measure.

29. The tariffs available to different technologies may have changed over time either due to DECC adjusting tariffs after receipt of additional evidence during well-defined tariff reviews and consultation period, or due to degressions which lower tariffs automatically when deployment reaches certain levels.

30. The Non-Domestic and Domestic scheme tariffs differ in a number of key ways. Table A3 details their respective features:

Table A3: Tariff properties

Property	Domestic Scheme	Non-Domestic
Period payable	7 years	20 years
Rate of return on additional investment when setting tariff support for the reference installation	7.5%	12%
Payment basis	Deemed renewable heat output (metering required for bivalent systems and second homes)	Metered total heat output for eligible heat uses
Payment timing	Quarterly in arrears (following submission of meter readings for metered systems)	Quarterly in arrears when meter reading provided.
Degression	Tariffs can be reduced (degressed) if spending hits certain triggers; these are discussed further in the benefits management section.	
Other requirements (examples)	Microgeneration Certification Scheme (MCS) certification, Energy Performance Certificate and loft and cavity wall insulation where appropriate Sustainability requirements for biomass installations Metering standards.	Various (e.g. Coefficient of performance (COP) levels for heat pumps and design standards), Combined Heat and Power Quality Assurance (CHPQA) for Combined Heat and Power (CHP) systems) Sustainability requirements for biomass, biogas and biomethane installations Metering standards.

31. Scheme tariffs are not intended to offer a fixed rate of return to all installations for the duration of the scheme. Instead they act as a guide to the rate of return targeted when we set tariffs. There are many reasons why a householder or business may not achieve the above rate of return. For example, there is significant heterogeneity in the building stock and in the operation of renewable heating installations. In addition, the function of degression is to protect budgets, ensure that there is diversity of deployment and value for money, so that over time the actual rate of return may well change.

32. The changes in tariff setting methodology are set out in Box A2.

Box A2: Tariff setting based on distributions of cost and performance

In previous impact assessments tariff setting was based on incentivising 50% of the supply curve of renewable heat. The objective of this method was to avoid overcompensation while also setting the tariff that would work for a reasonable proportion of technical potential.

This method however required a high bar of evidence, both for cost and performance, but also the potential market size. This has a high degree of uncertainty, particularly for non-domestic buildings.

The new tariff setting methodology retains the same overall objective as the previous one, but does, however recognises the evidence limitations. It uses the cost and performance information we have available to create a range of tariffs for different types of installation and targets what we expect to be the median installation.

This approach allows us to be clearer about the impact tariffs might have. For example, for various installations, more closely match policy objectives and properly capture the benefits and impacts of issues such as capping payments.

In addition to the tariff level we have other tools for limiting overcompensation. These include degression for all technologies, proposed caps on payments in the Domestic scheme, tiering in the Non-Domestic scheme. Taken together these provide assurance on overcompensation risks [3]

Appraisal of Costs and Benefits

33. In order to understand the impact of the RHI we consider a number of costs and benefits. These include renewable heat generated, air quality impacts, carbon savings and resource costs.

34. To understand these costs we have developed an impacts calculator which estimates the costs and benefits associated with the forecasts of deployment. This accounts for factors such as tariff tiering, seasonality of heat demand and deployment profiling. More detail on the calculator's approach can be found in Annex 1.

35. In addition to the evidence base on technologies used for setting tariffs, we have also drawn upon appraisal values from various sources and the Green Book guidance on appraisal[4], including:

    a. **Emissions factors** these look at the greenhouse gases, oxides of nitrogen (NOx) and particulate matter emissions for various low carbon options and

[3] https://www.gov.uk/government/consultations/renewable-heat-incentive-proposals-for-a-domestic-scheme

[4] https://www.gov.uk/government/publications/the-green-book-appraisal-and-evaluation-in-central-governent

the technologies they are replacing. These are sourced from DECC and Defra emissions guidance and projected electricity carbon intensity factors[5];

b. **Costs of emissions** these look at monetising the costs to human health and the costs of carbon emission again using guidance from DECC and Defra and carbon prices; and

c. **Other standard analysis** is used, such as OBR projected inflation series.

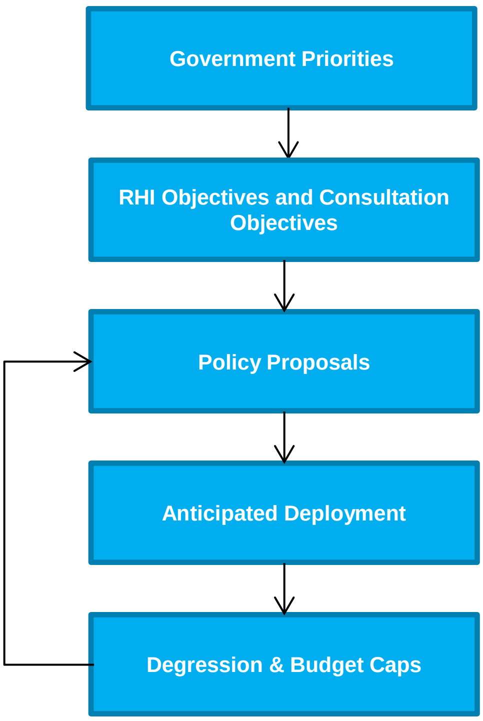
Deployment

36. Anticipating the level of deployment which will come forward as a result of the proposals contained within this consultation is difficult. There is significant uncertainty about how the market will respond to the proposals and there are major uncertainties around the stock, decision making processes and functioning of low carbon heating systems.

37. The deployment estimates used in this Impact Assessment are qualitatively derived, based on a combination of market intelligence and underlying analytical drivers.

38. The process of decision making for all the proposals within this consultation has been iterative. A simple outline is detailed below:

Figure A4: Process for assessing deployment



The proposals are developed on the basis of the objectives of RHI and the consultation.

We then use market intelligence to estimate what could come forward as a result of the changes.

We then develop degression and budget caps to ensure that spending is within budget and risk is appropriately managed.

We then review policy proposals to ensure that the objectives are sufficiently met given anticipated deployment and budget management proposals, updating as appropriate.

[5] https://www.gov.uk/government/publications/valuation-of-energy-use-and-greenhouse-gas-emissions-for-appraisal

39. Deployment estimates in this IA reflect a balance between what policy objectives are, the changes being made to policy, the capacity of markets to drive deployment under that policy and the budget available to each technology under degression policy. It is not possible to separate the impact of these factors.

Market Intelligence

40. The process of deriving anticipated deployment based on policy proposals has been done by combining the stakeholder views and pipelines of orders we have access to. These are developed from a number of sources:

    a. Industry reports;

    b. Trade Association data;

    c. pipeline data;

    d. scheme performance to date;

    e. stakeholder interviews;

    f. RHI Evaluation; and

    g. DECC judgement.

41. Using these we have developed alternative scenarios, central, low and high to illustrate the risk of higher or lower deployment. This is explored in more detail in Section C: Impacts. Also explored in more detail is the interaction of a high scenario with the budget management mechanism.

> **Box A3 Deployment evidence collection**
>
> A key part of the evidence on deployment potential will come through the consultation period as market experts and stakeholders are able to respond to the proposals outlined in this consultation.
>
> We would welcome further evidence from stakeholders of deployment potential for low carbon heating technologies.

Section B: Policy Options

Outline of policy options

42. This section presents a summary of the policy options being assessed in this impact assessment, additional information can also be found in the accompanying consultation document. More detail on what the policy proposals mean for each technology can be found in the technology-specific sections later in this document, as well as in the detailed annexes.

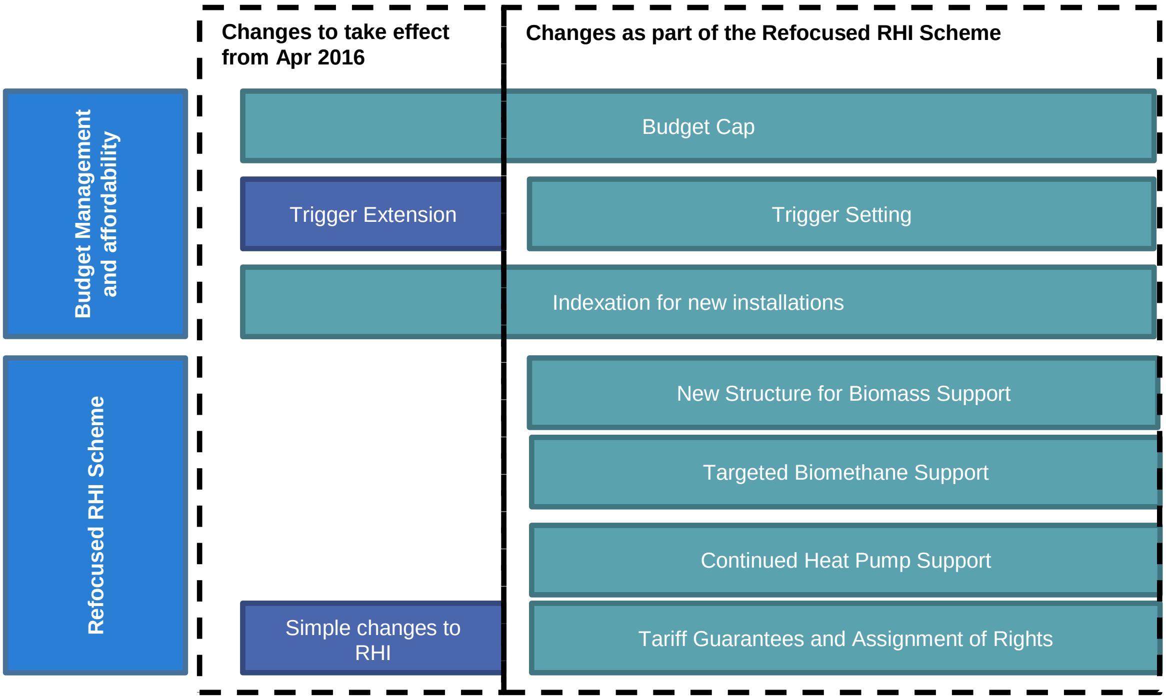
Option 0: Counterfactual / Close the RHI

43. The RHI did not previously have a budget settlement to allow for new installations to be accredited onto the scheme after March 31st 2016. Had the budget and accompanying changes not been agreed, this would likely have resulted in the scheme being closed to new applicants after this date. More detail on this counterfactual can be found below.

Option 1: Implement changes to RHI to maintain affordability and refocus the scheme

44. The policy option would have two broad components implemented in two packages. The first element would be immediate changes from April 2016 to maintain affordability of the scheme and implement simplifications to enhance the functioning of the scheme. The second would be implementing the re-focusing of the RHI, through tariff and eligibility reviews, introduction of assignment of rights and tariff guarantees, while also establishing the long term budget management and affordability mechanism.

Diagram B1: Scheme Changes



Step 1: Maintaining affordability and essential changes

45. In order to keep the scheme open in 2016/17, we need to implement essential changes in 2016. Regulations will be introduced to extend degression triggers and a budget cap policy will be introduced to provide protection against overspend.

46. This will seek to: enable a transition to the new refocused RHI from 2017 and provide continuity in advance of the scheme refocus.

47. Full details on all of these policy proposals can be found in the consultation document. The summary here is for reference only.

Table B2: Proposed Changes to the RHI in 2016

Change	Implementation Date	Brief description
Budget Cap	2016 to end of scheme	A single budget cap covering the whole scheme, if breached then scheme would close to new accreditations.
Extending triggers	2016 to 2017	In order to maintain the RHI over the next year while large changes are consulted on, we propose to extend triggers based on current ratios.
CPI Indexation for new accreditations	2016 to end of scheme	Instead of the Retail Price Index being used for scheme uprating, the Consumer Price Index will be used for all new accreditations
Simple changes to RHI function	2016 to end of scheme	Some other changes to the RHI design will be implemented in Apr 2016. These are set out in detail in the consultation document.

Step 2: Refocusing the RHI

48. Following the Spending Review 2015 we are proposing to refocus the RHI including new tariffs and tighter eligibility restrictions for a number of technologies, as well as additional budget management controls to constrain spend and deployment. Full details are in the consultation document and Table B3 below lists some of the proposed changes.

49. These changes may require consultation to obtain stakeholders' views and/or State aid approval in order for DECC to implement them.

Table B3: Proposed Changes to the RHI from 2017

Change	Brief description
New Structure of Biomass Support	Focusing biomass support to ensure that it provides the best value for money and is better aligned with the Government's longer-term decarbonisation strategy. This includes: a. A single non-domestic biomass tariff to better support large biomass systems which offer the best value for money and changes to tiering to better support systems with higher heat loads. b. Offering tariff guarantees to help large projects come forward
Targeted biomethane & biogas support	Focusing biomethane & biogas support on the feedstocks which are most consistent with delivering cost effective carbon abatement potential and optimal environmental outcomes. Delivering value-added benefits by avoiding methane emissions in the waste and agriculture sectors, as well as displacing fossil fuel heating. This significantly increases potential carbon benefits. Removing support of digestate drying. Introduce tariff guarantees for the large biogas and biomethane.
Continued Heat Pump Support	Revising domestic tariffs for heat pumps to better match these scheme ambitions for heat pump deployment, value for money and performance, including in the domestic sector delivering heat pumps in smaller households, which had previously been under-incentivised. In addition we are proposing changes to the eligibility for shared ground loops and are consulting on whether it best fits in the Domestic or Non-Domestic scheme. Tariff guarantees for large heat pumps in the non-domestic sector and removing requirement for heating-only air source heat pumps, for consistency across both schemes.
Tariff guarantees and assignment of rights	Delivering changes to the proposition for large investors in low carbon heating by: a. Introducing tariff guarantees, allowing large installations with long lead times certainty about tariff levels for financial planning purposes and investment decisions b. Introducing assignment of rights in the domestic sector to reduce financial barriers in the less able to pay market. This will also allow innovative finance products to be developed.
Solar Thermal	Remove support for Solar Thermal in both the Domestic and Non-Domestic scheme to ensure RHI delivers value for money and supports alternative technologies.

Counterfactual

50. The RHI did not previously have a budget settlement to allow for new installations to be accredited onto the scheme after March 31st 2016. The counterfactual against which impacts have been appraised in this document is no deployment of renewable heat technologies supported under the RHI.

51. In the absence of a budget settlement and reform of the scheme there would be two options:

    a. **No active intervention –** the RHI would stay open, with the triggers for degression unchanged and no additional budget protection.

    This option would not have proper budget management control and, although degression would quickly curtail further deployment, is not considered a viable counterfactual.

    b. **Closing the scheme –** the scheme would be closed to new applicants after March 2016 to ensure that proper control of budget could be maintained.

52. In practice proper budget management is necessary so, in absence of this, the scheme would be closed. For the consideration of the costs and benefits of these changes, it is therefore the appropriate counterfactual to consider.

53. If the scheme were to close, it is likely that some low level of deployment of low carbon heating technologies would continue as suggested through the RHI evaluation.[6,7]

54. However these are likely to be low as are the impacts in terms of renewable heat generated and carbon savings. It is not possible to accurately assess the low level of deployment which might occur without support, although the RHI evaluation findings offer a qualitative insight into the current level of additionality. As such we are presenting the impacts of the proposed changes against a counterfactual of no deployment of the renewable heat technologies supported under the RHI after March 2016.

55. Assessing the proposed refocused RHI against a scenario of no deployment will also provide greater clarity and ease of engagement as to the proposals for the scheme than comparing to a market intelligence led counterfactual which would have a high degree of subjectivity, and an appropriate benchmark against which to assess performance and benefits in future.

[6] RHI Domestic Evaluation: https://www.gov.uk/government/news/evaluation-of-renewable-heat-incentive-rhi

[7] RHI non-domestic evaluation: https://www.gov.uk/government/news/evaluation-of-renewable-heat-incentive-rhi

Budget Management and other cross-cutting policy decisions

56. The 2015 Spending Review established budget caps for the RHI in the period 2016 to 2021.

57. There are several elements to ensuring that we have appropriate control over spending.

    a. **Budget Management:** how the scheme responds to greater spend than anticipated on either individual technologies, or for the scheme as a whole. This is proposed through caps for spending and degression of tariffs for new applicants.

    b. **Eligibility and other policy enablers:** the eligibility criteria for the pool of projects which are able to take advantage of RHI. This controls costs by expanding or limiting those who are able to access the scheme.

    c. **Tariff rates and structure:** the tariff rates offered by the RHI establish the financial attractiveness of the RHI for potential participants.

58. These elements combined give some control over the level of spending. However as a demand led scheme the exact level of spending and deployment of different technologies does remain highly uncertain.

59. We anticipate that these elements will work together in the following way:

    a. **Tariffs and eligibility:** role is to create demand through offering a rate of return on additional investment, as compared to the counterfactual

    b. **Degression:** designed to reduce the level of incentive if pre-set spending levels are reached, the impact would be (if nothing else changes) to reduce the rate of return for new applications. This is partly to control potential overcompensation, but also would decrease the likelihood of activating the cap.

    c. **Caps:** designed to give additional certainty about the potential for overspending on RHI.

60. This section outlines the policy proposals for the two elements of budget management policy, caps and degression and outlines the qualitative impacts.

Budget caps

61. Budget management in the RHI to date has relied on degression, which was designed to strike a balance between controlling spend and providing certainty to industry and consumers. Degression has kept the RHI within its budget allocation for each financial year of operation up until this point.

62. Degression alone however, cannot guarantee that expenditure will not breach budgets. This is because while degression leads to reduced tariffs for new deployment, the RHI is a demand led scheme so deployment could continue to come forward even at significantly degressed tariff levels.

Policy Proposals

63. We will therefore also introduce a budget cap in order to create additional certainty that the budget will not be breached. It will take effect for the financial year 2016/17 in advance of changes to implement the refocussing of the scheme from 2017 onwards.

64. The cap will be a single overall budget cap covering expenditure from all technologies and both the Non-Domestic and Domestic schemes[8]. The cap will be based entirely on the budget settlement and will only be triggered based on an assessment of financial commitments made across the schemes on deployment to date and market intelligence. The budget caps agreed at Autumn Statement 2015 are set out in Table B4, below.

65. Determination of whether the cap is likely to be hit, and closure triggered, will not be set out in regulations, but instead determined through regular financial forecasting and monitoring of real time data of plants on the scheme, providing an up to date and accurate picture of spend commitments based on all plants on the scheme to date and we would use market intelligence to interpret that information.

66. If our assessment of overall forecast expenditure (based on all applications received to the scheme and market intelligence on immediate pipeline) is that the budget cap for any year is likely to be hit, the schemes would be closed to new deployment.

67. The budget cap will act as a final defence against overspend for the RHI budget and we anticipate that degression would act first in most cases, prior to the scheme cap being at risk of being hit.

Table B4: Level of RHI Budget Caps

Year	2016-17	2017-18	2018-19	2019-20	2020-21
Budget Caps	£ 640m	£ 780m	£ 900m	£ 1,010m	£ 1,150m

[8] From 2017/18 onwards, we propose extending the Secretary of State's discretion to include implementing scheme closure to only the Non-Domestic scheme, if the risk to the overall budget is considered to arise chiefly from this scheme, and the risk of exceeding the overall budget if the Domestic scheme is left open is not considered unacceptably high.

Impact

68. The budget cap will provide government with greater certainty over budget control, for both individual years as well as on committed expenditure for the scheme lifetime.

69. We anticipate the budge cap will operate to control spending in two key ways:

    a. **Hard limit –** the hard limit set out by the cap will enable DECC to have greater certainty with regard to the level of spending for the RHI and provide greater assurance that budget levels will not be breached.

    b. **Signalling to the market –** As the cap is approached there will likely be a downward pressure on applications to the RHI as there would be a risk of the scheme being suspended prior to completion of the commissioning of an installation. Alternatively the cap could prompt earlier applications to the RHI in order to join the scheme prior to hitting the cap level.

70. For the projects with the longest lead times, this signalling could prove a strong disincentive to invest in low carbon technologies. We therefore propose to also introduce tariff guarantees, which will address this issue and help large schemes with long lead times to have confidence in the RHI tariff payment they might be eligible to receive.

71. In order to give industry as much information as possible on which to make investment decisions, we will provide monthly updates of progress towards the budget cap to enable industry to make a risk-based judgement as to the likelihood of funds being available when technologies commission and they are in a position to apply to the RHI scheme.

Box A4 Caps within RHI scheme design

Within RHI there are 3 parts of policy design which are caps, they each have a specific function:

- **Budget Cap:** Designed to control spending and ensure that the scheme does not overspend. Applies to the whole scheme.
- **Value for Money Cap:** Limits tariffs to a set level to protect the value for money of support within RHI. Applies to setting tariffs.
- **Heat Demand Caps:** For the domestic scheme to control potential for over-compensation. Applies to payments to householders

Degression

72. Degression is the key mechanism used to control spend in the RHI. It reduces tariffs by a set amount if pre-determined levels of deployment are hit. In its current form degression has been successful in delivering its key aims, including:

    a. Improving value for money for the taxpayer; reducing tariffs where high growth has been experienced.

    b. Keeping RHI spend within our overall budget.

    c. Providing certainty to the market and investors compared to other budget control mechanisms by ensuring sufficient transparency in likely future tariffs, when compared with other options, such as unplanned tariff reviews.

73. The design of degression, where steeper reductions in tariffs can occur if deployment doesn't slow following initial reductions, can result in significant reductions in tariffs over a short space of time before the market has had chance to recalibrate.

Policy Proposals

74. We continue to have confidence in the mechanism to achieve its aims but we are reviewing whether there are changes which should be made. Further details can be found in the consultation document.

75. For the degression policy to function correctly, the triggers need to be introduced to be in line with the broader policy refocus and achievable ambitions for the technologies supported in the schemes for the next spending review period. This will be implemented in two steps.

    a. **2016/17 –** a set of interim triggers to allow continuity of the current scheme in 2016/17, while the refocused RHI is being consulted on.

    b. **2017 onwards –** triggers based on deployment which aligns with the proposals for a refocused RHI.

Table B5: Degression policy decisions

Do Nothing	
Without changes to the degression triggers the mechanism will degress all tariffs which are over the January 2016 trigger.	
Proposals for 2016/17	
Degression Triggers	Set interim triggers for Apr-16 to Mar-17 by extending the triggers on a consistent growth trajectory
Proposals for 2017/18 onwards	
Degression Triggers	Degression triggers set on a combination of market intelligence, scheme objectives and affordability/risk management.
Other Budget decisions	Non-Domestic Tariff triggers for small, medium, large biomass tariff, and biomass CHP to be merged into one trigger. Amend degression to appropriately take into account tariff guarantees No further budget allocation for new Solar Thermal accreditations.

76. Degression continues to be the primary budget management mechanism designed to keep expenditure within budget with the cap remaining a back-stop to provide assurance there is a mechanism in place to prevent further commitments if there is a risk the budget could be breached. Degression will allow the scheme to remain open if deployment is high and reduces the risk of the cap being deployed. Through reducing the tariffs of those technologies deploying above expectations, it lessens the impact on the budget of any further deployment

77. The degression triggers for the period Apr-16 to Mar-17 will be set by extending the current triggers over the next financial year (see consultation document for indicative values).

78. The rationale for this is that it would not be appropriate to make strategic decisions about support for some areas of the low-carbon heat market prior to the conclusions of the consultation on the refocused RHI. This is because of the link between budget management and the significant policy changes being consulted on.

79. Degression triggers and budget allocations for the refocused RHI need to balance:

   a. **Affordability and risk management:** triggers and budget management must be set in order to appropriately manage the risks of over- and under-spend.

   b. **Scheme Objectives:** how a budget allocation can best meet the overall scheme objectives and aims of the proposed scheme reforms.

   c. **Market Intelligence:** the triggers must be set in such a way as to minimise the chance of large under- or overspending in particular technology groups.

Therefore market intelligence and consultation feedback on the deployment potential under the proposals in this consultation are an important factor to determining budget allocations and triggers.

80. The triggers are not in themselves intended to be a policy tool to achieve the scheme objectives (with the exception of providing budget protection and diversity of deployment). Rather they will reflect Government's view of the scheme spend after policy and tariff changes have refocused the scheme to better align with the scheme objectives. It is therefore important to recognise the significant link between all elements of the RHI policy.

81. In the case of heat pumps, deployment to date has been lower than expected, and significantly lower than its budget allocation. The proposed combination of tariff changes, eligibility changes and the introduction of assignment of rights are designed to improve deployment and the triggers will set in line with our ambition for these changes, subject to market testing.

82. We expect to receive new evidence over the course of the consultation which will influence the budget allocations for various technology groups.

Tariff guarantees

83. Degression and caps described above introduce a level of uncertainty for investors in projects with long lead times, as they are only able to confirm the tariff and therefore income they could receive at the point of project commissioning and investors do not have sight of what tariff they might receive. This means that large projects face an additional barrier.

84. Deployment of large projects such as large biomass, deep geothermal, or biomass CHP has been lower than expected under the RHI to date.

85. Large projects have strong strategic value, for example biomass CHP is one of the most efficient uses of limited biomass resource, they also tend to benefit from economies of scale compared to smaller heat plants.

Policy

86. Large non-domestic installations[9] with long lead times will be allowed to apply for a tariff guarantee, where they will be able book onto the scheme and guarantee their tariff level provided they can give evidence of reaching financial close (the point at which financial decisions for a project are reached) and other eligibility criteria.

87. For those limited technologies and sizes for which a tariff guarantee will be available, the key point for project completion is financial close, after which projects are very unlikely to fail.

88. The current structure of the RHI, where plants can only accredit on the scheme at the prevailing tariff following commissioning does not provide certainty required to finalise financial close. Tariff guarantees are designed to provide income certainty from the RHI at the appropriate stage in the process. Evidence of financial close being reached must be provided before tariff guarantee is granted, and budget effectively committed, to reduce the risk of budget being committed to plants which do not reach project completion.

89. In order to maintain adequate control of spending, we will count the commitment made to plants at the point where the tariff guarantee is granted (i.e. not only at the point in the future where the plant commissions and begins receiving payment). The potential change in deployment profile will be taken into account when setting the degression triggers for plants which can receive a tariff guarantee.

Impact

90. Tariff guarantees will shield investors in eligible projects from the risk of tariff degressions and scheme closure between the period of financing, planning and commissioning the plant. Additionally, it should allow investors in projects to make better long-term decisions about their plant, to invest in the most efficient equipment,

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[9] Deep geothermal; biomethane - all capacities, Large biogas – 600kW and above, Large biomass - 2MW and above; Biomass Combined Heat & Power – all capacities; Ground and Water Source Heat Pumps - >100kW

and to take time to commission the plant without speeding up progress to try and avoid degressions.

91. This should allow large projects with long lead in times to compete on a more equal footing with smaller, rapidly deployable, technologies which to date have made up the majority of RHI installations.

Assignment of rights

92. Within the Domestic scheme, tariff payments can only be given to the owner of the renewable installation or householder. This makes it difficult for finance providers to create finance packages for householders based on the RHI payments, because of the credit risk introduced by payments to householders.

Policy

Table B6: Assignment of Rights Policy decisions

Do Nothing	
RHI would continue to only be paid directly to householders.	
Proposals under refocused RHI	
All Domestic RHI	Enable the rights to RHI payments to be assigned by the householder to a designated third party such as a finance provider.

93. Assignment of rights (AoR) will allow householders to assign their right to RHI payments to a third party that financed the installation, which will open up the scheme to those with limited access to finance or savings – or alternatively for those who do not wish to use traditional finance products for accessing renewable heating systems.

Impact

94. AoR will help consumers with lower credit scores or less ability to access financing, to overcome the financial barrier currently holding back deployment to the least able to pay and make the scheme more accessible to those in fuel poverty. It will allow a wider section of the population to participate in the RHI.

95. The impact of AoR is highly uncertain and dependent on a combination of factors including the change in tariffs proposed for some domestic technologies. However, we would expect AoR to play a role in helping the Domestic RHI achieve the ambitions set out in this impact assessment, based on market intelligence and the financial offer we expect might be offered to consumers.

96. We have also carefully considered the balance between opening up the scheme to be as flexible as possible through AoR and ensuring adequate consumer protection is in place. AoR provides much greater protection to the consumer than some existing finance models, however we will work closely with the consumer codes and MCS as we prepare final policy positions to ensure that there are adequate levels of consumer protection.

Indexation

97. RHI tariffs are increased each year in line with inflation to reflect the change in overall prices. This applies to both tariffs for new participants and tariffs paid to existing participants. The inflation measure used in the scheme to date is the Retail Prices Index (RPI).

Policy

Table B7: Indexation policy decisions

Do Nothing	
RHI payments would be increased each by RPI	
Proposals under refocused RHI	
Installations accredited prior to Apr 2016	No change – existing accreditations would retain yearly uplifts by RPI each year
Installations accredited from Apr 2016	All future yearly uplifts will be done through the Consumer Prices Index (CPI)

98. We propose using the Consumer Prices Index (CPI), following the recommendation of the Institute for Fiscal Studies[10] in an independent review of UK consumer price statistics, which concluded that CPI was a better constructed measure of inflation. The RPI measure had lost its national statistics status because the formula used to calculate average price change does not meet international standards.

99. The policy of linking tariffs to inflation in the RHI is designed to track general price movement, not to follow the costs of installations, and therefore we consider CPI is the more appropriate inflationary measure going forward.

Impact

100. The methodology used in calculating CPI means that it is typically lower than the RPI calculation due to several effects, most notably its treatment of housing and the method of averaging.[11] The lower rate will deliver significant long-term nominal savings as tariff payments will typically be increased by a lower amount compared to the alternative of using RPI.

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[10] http://www.statisticsauthority.gov.uk/reports---correspondence/current-reviews/range-of-prices-statistics.html

[11] Further details are available from the Office for National Statistics: http://www.ons.gov.uk/ons/guide-method/user-guidance/prices/cpi-and-rpi/index.html

101. There has been some stakeholder feedback that RPI is the most relevant for costs associated with renewable heat installations, in particular loan financing. In this case it is likely that the change in indexation method would have some impact on investment decisions using inflation adjusted cash flows. This might affect more sophisticated investments in renewable heat such as financiers operating under AoR, or investors in tariff guarantee projects.

102. Finally, it is worth noting the link with the budget management and degression, a typically lower indexation method would mean that more installations could be supported for the same level of spend.

Proposals for the domestic scheme

103. This section gives an overview of the evidence base for changes to elements of the domestic scheme and impacts of proposed changes. This section focuses on the changes to tariffs, cap levels and the expected qualitative market impact of all changes to technologies combined.

104. The proposed policy changes are summarised below.

Table B8: Summary of domestic policy decisions

<table>
<tr><th>Technology</th><th>Current Tariff</th><th>Proposed Tariff (2015/16 Prices)</th><th>Proposed Cap Subject to consultation</th><th>Additional changes</th></tr>
<tr><td>Air Source Heat Pumps</td><td>7.42p/kWh</td><td>A range between 7.42-10.00p/kWh</td><td>20,000 kWh/yr</td><td rowspan="3">Introduce assignment of rights
Remove the Green Deal Assessment criteria
Introduce support for GSHP micro-heat networks
Potential changes to the payment methodology or other requirements to incentivise improved in-situ performance
Other minor changes detailed in the consultation document</td></tr>
<tr><td>Ground Source Heat pumps</td><td>19.10p/kWh</td><td>Review tariff, offering up to 19.51p/kWh</td><td>25,000 kWh/yr</td></tr>
<tr><td>Biomass Boilers</td><td>5.14p/kWh</td><td>No change</td><td>25,000 kWh/yr</td></tr>
<tr><td>Solar Thermal</td><td>19.51p/kWh</td><td colspan="3">Proposal is to withdraw support for Solar Thermal</td></tr>
</table>

105. All Tariff proposals in this document are in 2015/16 prices. When the revised tariffs are launched they will be adjusted by the appropriate inflation figure.

106. Through-out this Impact Assessment we consider the impact of the domestic heat demand caps as set out in the consultation. An important aspect of the consultation is whether these heat demand caps are at the right level in order to achieve our

scheme objectives and we are seeking views on this. The analysis presented is therefore illustrative.

Methodology Changes and Evidence Updates

107. The principles for tariff setting under Domestic RHI remain broadly the same as in previous tariff setting assessments, which is the aim of compensating the additional costs of installing renewable heat technologies. The main departure is the way DECC thinks about setting a tariff. Instead of creating a supply curve and picking the median installation, we pick the typical reference installation, this is in line with our previous principle of setting support[12,] and set the tariff based on the costs and benefits of a low carbon technology in that household. This is set out in more detail in Box A2.

108. The approach of constructing case studies allows us to better consider the offer to consumers and changes in financial incentives. It additionally enables us to better appraise the impact of the heat demand cap.

109. There have also been a number of updates to the evidence base that is used to determine tariffs. These updates are primarily routine in nature as more evidence becomes available from the operation of the scheme, but can influence our understanding of the level of support needed. The main changes have been:

    a. Cost and performance assumptions – including the capital costs of equipment, and the load factors, for both the renewable and counterfactual technologies;

    b. Fuel Prices –both counterfactual fossil fuel prices and electricity prices faced by heat pumps have been updated in line with DECC publications. The oil price particularly has decreased significantly compared to our previous assessment. For this assessment we use DECC's 2015 projections.[13]

110. Additional information on the details of evidence changes and the impact of the tariff caps is available in the technology specific sections below, as well as in the annexes.

111. As with previous tariff setting analysis we have retained the method of using design performance to set tariffs and used in-situ performance for appraisal. This method helps avoid offering a higher tariff for systems which perform poorly. In our appraisal analysis we use a range of assumptions based on the interim RHPP metering data and the latest report. Further details on this approach can be found in Annex 4.

112. As with previous tariff setting we retain the value for money cap. This is detailed in Box B1.

[12] https://www.gov.uk/government/consultations/renewable-heat-incentive-expanding-the-non-domestic-scheme
[13] https://www.gov.uk/government/publications/valuation-of-energy-use-and-greenhouse-gas-emissions-for-appraisal

113. We would welcome additional evidence over the consultation period which could be used to reach final policy decisions later in 2016. Information in the format set out in Annex 2 would best support the development of final tariffs.

Box B1: **The Value for Money (VfM) cap**

When the non-domestic scheme was launched in November 2011, DECC set out that none of the tariffs should be set above the support provided to offshore wind. This approach was continued when the domestic scheme was launched in 2014.

Paying more than this level was considered not to offer good value for money in terms of contributing to meet the 2020 renewable target. The revised cap level (set in 2014) of 10.0p/kWh represents the direct support cost of offshore wind in 2014/15 from the Renewables Obligation (RO) and also took into account the support received from Levy Exemption Certificates (LEC). The cap is equivalently set at 19.2p/kWh for 7 year domestic tariffs taking into account of the different payment lifetime.

Additional impacts that may affect the support received by offshore wind through the wholesale electricity price (such as the EU ETS) have not been taken into account.

Domestic Heat Pumps

Background

114. The Domestic RHI has supported Ground Source Heat Pumps (GSHP) and Air Source Heat Pumps (ASHP) since its inception in April 2014. Currently, support is provided for all eligible GSHP and ASHP systems that feed into water heating systems and are powered by electricity.

Table B9: Domestic Heat Pump Information

Technology	Original tariffs at support launch (p/kWh)	As of 31st December 2015		
		Current tariffs (p/kWh)	Accreditations of "New" systems[14]	Committed spending (£m)[15]
Air Source Heat Pump	7.30p	7.42p	6,978	£5.83m
Ground Source Heat Pump	18.80p	19.10p	1,452	£6.39m

115. Deployment to date for domestic heat pumps has been steady, however below expectations. This is likely due to financial barriers (upfront costs, low rates of return for smaller systems) and non-financial barriers such as awareness and hassle. The RHI domestic evaluation highlighted that householders were satisfied with their installations, and that access to finance remained a barrier to further deployment.

116. Air and Ground Source Heat Pumps are likely to be strategically important in the long term decarbonisation of heat.

Policy Proposals

117. Under the refocused RHI, ASHP support will be targeted to develop the deployment of systems in smaller homes, while GSHP eligibility will be increased to allow some additional system configurations to receive the Domestic RHI or to be eligible for the Non-Domestic RHI.

14 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/493581/RHI_monthly_official_statistics_tables_31_December_2015.xlsx

15 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/495727/Monthly_Domestic_Forecast_31_December_2015.xlsx

Table B10: Domestic heat pump proposals

Do Nothing	
The current level of support for all eligible ASHP installations is 7.42p/kWh, and GSHPs at 19.10p/kWh (as of January 2016)	
Proposals under refocused RHI	
Air Source Heat Pumps	Review the tariff and the incentive for high performing systems. This could lead to a tariff of between 7.42p/kWh and 10.00p/kWhCap payments at a total annual heat use of 20,000kWh.
Ground Source Heat Pumps	Review the tariff (up to the value for money cap) and the incentive for high performing systems. Expanding eligibility to the domestic scheme to include domestic heat networks with shared ground loops[16]; Capping payments at a total annual heat use of 25,000kWh.
All Heat Pumps	Introduce assignment of rights of RHI payments Further action to improve the performance of heat pumps Remove Green Deal Assessment requirement Continued support for Metering and Monitoring Service Packages.

118. The objective of our review of support for heat pumps is to drive deployment while ensuring we achieve value for money in the scheme and sufficiently incentivise high performing systems. The consultation seeks views on how best to achieve this and this impact assessment looks at the evidence and impact of a higher tariff and the current performance incentives.

119. The tariff setting method remains unchanged from previous analysis. The proposed tariffs are based on achieving a 7.5% rate of return (the target rate of return set in previous consultation) for households with a heat demand of 14,000kWh (equivalent to a 10kW ASHP) and 17,000kWh (equivalent to a 12kW GSHP) This tariff setting process leads to a GSHP tariff above the Value for Money cap, so the proposed tariff is capped at that level.

120. The choice of the reference installation is a judgement based on the size of house, current state of the market and potential over coming years. This choice also offers an appropriate rate of return to smaller households. The size detailed here is larger than the average household, however the target market for RHI remains off-gas grid homes, which do tend to be larger than average.

[16] The consultation proposes that further support for shared ground loops may be within the domestic or non-domestic scheme. For the purposes of assessment we have included them in the domestic scheme under this analysis.
If they were further supported within the non-domestic scheme, then they might achieve other benefits.

121. The level of the cap on payments is a judgement to reduce risks of over compensation for the larger households who can achieve economies of scale in installation costs. The lower the level of the cap, the higher the level of tariff which can be offered and still retain the average 7.5% rate of return.

122. It is likely that shared ground loops will have lower capital costs per installation than single system ground source heat pumps as the drilling and borehole costs are likely to see economies of scale. However there is little evidence for the costs of these systems.[17] Given that the tariff setting process leads to a tariff for single GSHP systems that is over the Value for Money cap, there is relatively low risk of significant overcompensation if the proposed Value for Money tariff rate is offered for shared systems.

Market Impacts

123. An increase in the ASHP tariff and the introduction of assignment of rights could lead to significant growth in the market, emerging market intelligence suggests. This is likely to be more significant for smaller households, who might face greater financial barriers, than those currently taking up the RHI.

124. Increased deployment will result in a higher level of additional carbon savings and renewable heat generated than would have been the case if the scheme were to have remained under its current structure, or closed.

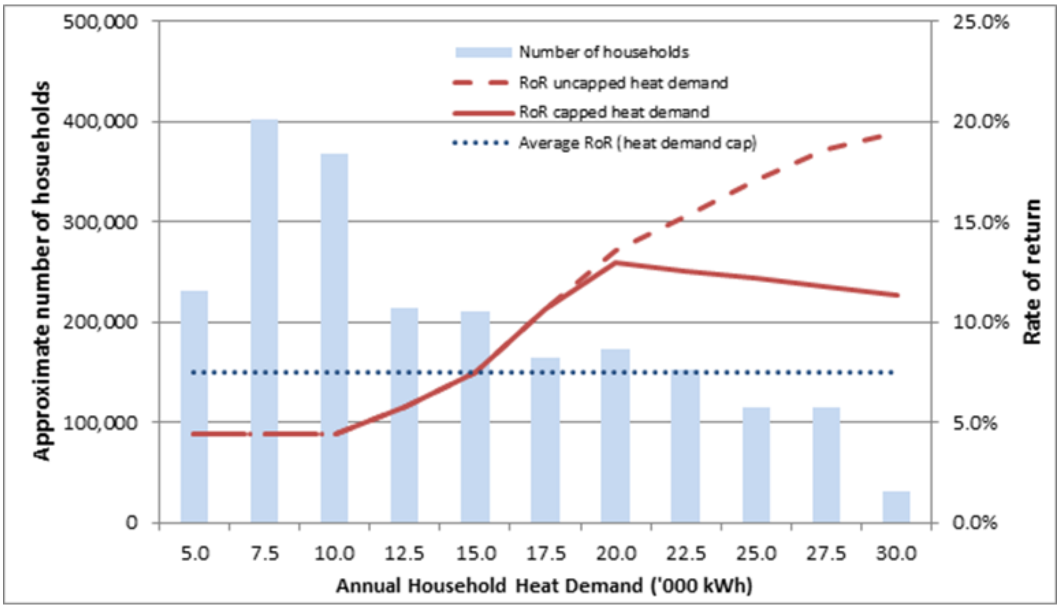
125. The size of the financial incentive offered by the RHI depends on the technology and the size of the household, but is also very uncertain given the variation in capital costs and performance. The financial incentive based on DECC's central assessment of cost and performance is illustrated below.

Financial Incentive offered for ASHP

126. The below analysis used English Housing Survey data, the Energy Performance Certificate energy calculator and DECC's understanding of the cost and performance of low carbon heating systems to calculate the rate of return for variously sized households. This allows us to consider the financial offer being made to consumers and the market opportunity available in England.

[17] There is some market intelligence on potential cost savings through shared systems. Further details can be found in the domestic analysis annex.

Chart B11: Financial returns for ASHPs



127. Chart B11 above illustrates that under a flat tariff structure, expected returns from the scheme increases with household size (red line) and the return on offer if no cap was proposed (dotted red line). This is due to the fact that larger households offer the most cost effective proposition. In addition it sets out the market opportunity (blue bars)

128. Based on current application rates, around 75% of domestic ASHP applicants fall below the proposed cap level. These smaller households could expect a return on their investment in the range of ~5-12.5%.

129. Households above the heat demand cap still retain a rate of return in excess of 10%, while this is below what they would have received without a cap (~20% return for households with a heat demand of 30,000kWh/yr), this is still in excess of the 7.5% target rate of return.

130. The proposed tariff change and cap structure ensures that the average capped rate of return (weighted by household) across our range of households[18] is in line with the target 7.5%.

Financial Incentive offered for GSHP

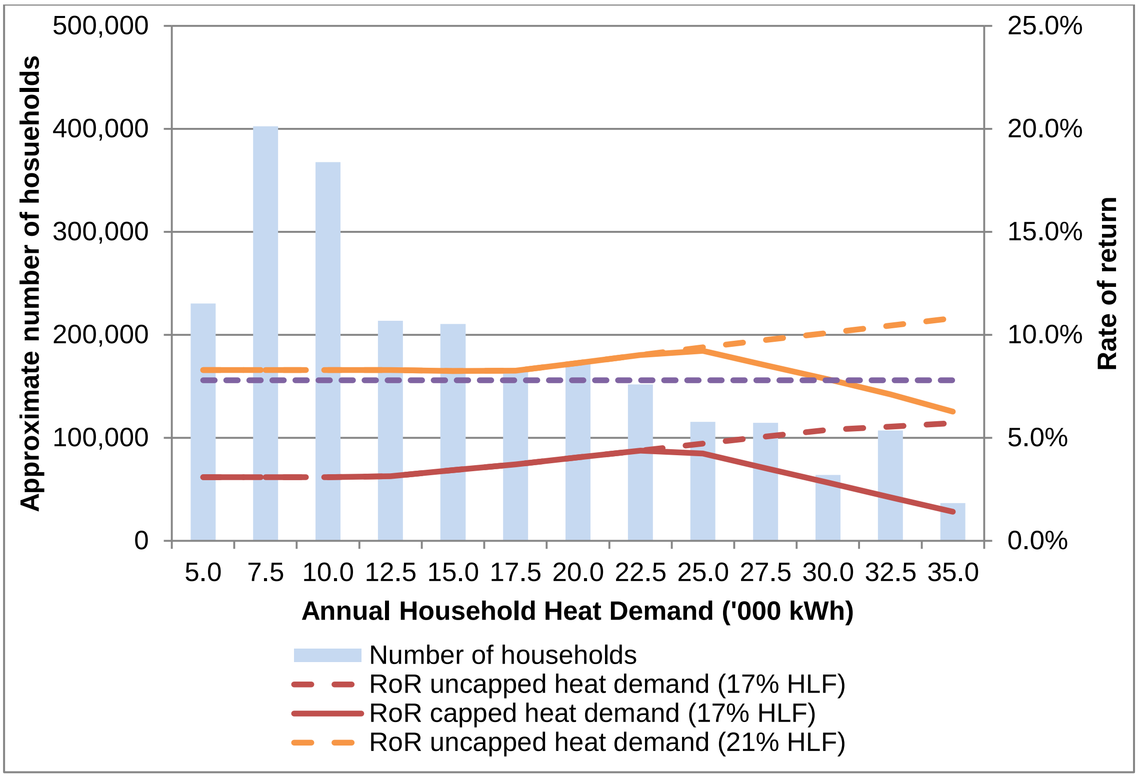
131. The group of households considered most appropriate for the installation of a GSHP system are those with an annual heat demand in the range of up to 35,000kWh. While larger systems do exists these are unlikely to deploy in the domestic sector currently.

[18] Average rate of return is calculated across households that are believed most appropriate and therefore most likely to install ASHPs. This range is comprised of households with an annual heat demand up to 30,000kWh.

132. The below analysis suggests that the expected returns from a GSHP installation is not as heavily influenced by household size compared to ASHP. This is because we anticipate much smaller economies of scale for GSHP compared to ASHPs.

133. The red line on Chart B12 indicates that based on our central assumptions setting the tariff at the value for money cap, the tariff does not offer a 7.5% rate of return to households on average.

Chart B12: Financial returns for GSHPs



134. However, the changes to eligibility for GSHP could incentivise additional households, particularly small households, to come forward under shared ground loop systems. These systems incur lower capital costs and are more cost effective than standard systems. The above analysis indicates that our reference scenario could experience returns of ~7.5% from producing the same amount of heat through the installation of a GSHP shared loop system[19] as cost reductions may reduce the upfront costs.

135. There are further opportunities to achieve the target 7.5% rate of return. The above analysis shows that a 7.5% rate of return is attainable for our reference household if the heat load factor for GSHPs was equal to 21% instead of 17%.

136. The heat demand cap serves the purpose of restricting the level of returns available for large installations that may experience these favourable conditions. The cap

[19] Shared ground loop system assumed to have ~10-15% lower capital costs than standard system.

level for GSHP is set at a higher level than ASHP to ensure that rates of return fall for only the larger systems.

137. Based on the proposals set out in this consultation, we anticipate a market in 2020/21 of approximately 13,700 ASHP and 2,500 GSHP per year. The level of GSHP deployment depends on where shared ground loops are supported (within the domestic or non-domestic scheme)

Domestic Biomass

Background

138. Biomass installations are a low carbon heating technology that have been supported by the Domestic RHI scheme since its inception in April 2014. Currently, support is provided for all eligible biomass systems that use an approved sustainable fuel.

Table B13: Domestic Biomass Information

Technology	Original tariffs at support launch (p/kWh)	As of January 2016		
		Current tariffs (p/kWh)	Accreditations for "New" systems	Committed expenditure (£m)[20]
Biomass	12.20p	5.14p	7,924[21]	£36.36m

139. This level of deployment exceeded expectation and budget allocations, and therefore triggered a series of degressions used to control expenditure. These have gradually reduced the tariff to its current level of 5.14p/kWh as of 1 January 2016 and as a result deployment has fallen from a peak of around 2,800 applications in the final quarter of 2014, to under 700 in the third quarter of 2015. This deployment was driven by the significant financial incentive for some portions of the market. The Domestic RHI evaluation explores the motivations of scheme participants in more detail, it highlighted that there were financial and non-financial enablers of biomass deployment in the domestic scheme.

140. The best uses for biomass which may be limited will tend to be for non-heat uses in sectors which are hard to decarbonise in other ways. Biomass is likely to have a role in heating for parts of the sector which are similarly difficult to decarbonise. This is likely to be sectors such as those with large heat demands in industrial process heating and in district heating schemes.

Policy Proposal and Targeting

141. The proposed action for domestic biomass is to make no changes to the tariff levels, but introduce simplifications to the application requirements and assignment of rights.

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20 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/495727/Monthly_Domestic_Forecast_31_December_2015.xlsx

21 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/493581/RHI_monthly_official_statistics_tables_31_December_2015.xlsx

Table B14: Domestic biomass proposals

Do Nothing	
The current level of support for all domestic eligible biomass installations is 5.14p/kWh as of January 2016.	
Proposals under refocused RHI	
Domestic Biomass	Introduce a cap of payments beyond 25,000kWh/yr, but leave tariffs unchanged Remove Green Deal Assessment requirement Introduce assignment of rights of RHI payments

142. The significant degressions to date for domestic biomass mean that the rate of return offered by the current tariff is significantly less than 7.5%, though the rate of return does vary significantly with the size of systems. In addition the introduction of a cap at the level of 25,000kWh/yr will limit the rates of return available to the largest households.

143. We have considered the following issues in deciding to leave the biomass tariff unchanged:

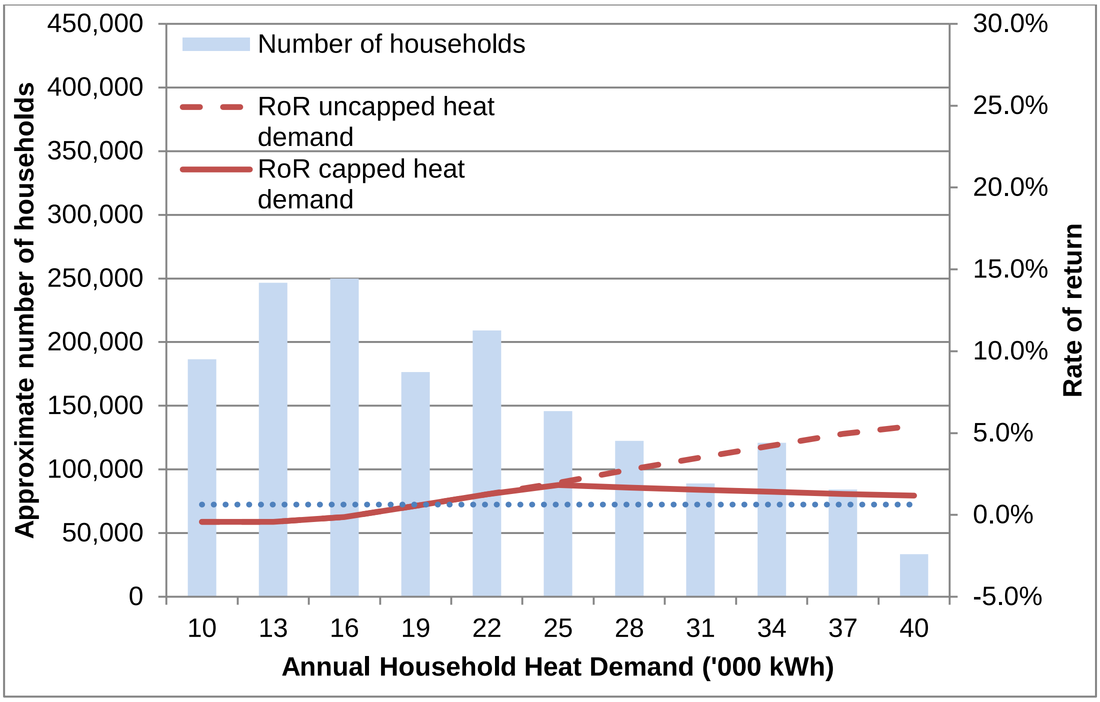
   a. **Affordability** - is a major factor for considering biomass support. To date domestic biomass has deployed significantly more than its original budget allocation (as indicated by the trigger levels) and those levels of deployment are not sustainable. Tariff degressions have slowed deployment and we will continue to monitor deployment under existing tariffs against future expenditure thresholds.

   b. **Comparative Strategic priority** - Biomass plays an important role contributing towards our renewable heat target. There are limited supplies of sustainable biomass, and it is our view that larger installations in the non-domestic RHI represent a comparatively better value for money means of attaining this target. While biomass may have a role for rural off gas grid homes which are hard to decarbonise in other ways, we have chosen to revisit tariffs of other technologies whose markets need to grow significantly to provide a significant contribution towards our carbon targets.

Market Impacts

144. Chart B15 below indicates that with no change to the biomass tariff, the achievable rates of return will be significantly below the target 7.5% for the households in our range. Furthermore, the cap will control the rates of return available for the largest installations.

Chart B15: Financial returns for Biomass



145. These two factors are likely to mean that there would be limited deployment of biomass in the next spending review period.

146. Based on the proposals set out in this consultation, we anticipate a market over the period of the spending review period (2016 to 2021) on the order of 1,000 domestic biomass installations. This is a significant change from the early years of the domestic scheme.

147. Our analysis detailed in the Biomass annex shows that a 7.5% rate of return could be achievable for households in very specific situations, for example:

   a. **Fuel costs -** a reduction in biomass fuel costs by 1p/kW for our reference household would be sufficient in ensuring that they achieve a 7.5% rate of return. This reduction in fuel cost is entirely possible for households that self-supply. .

   b. **Cost Reductions**- some applicants might be able to install a system at much lower costs then we anticipate. Our analysis shows that a 22% cost reduction for our reference household would make a 7.5% rate of return achievable.

148. The key cost and performance assumptions DECC uses for domestic biomass are detailed in Annex 2.

Solar Thermal

Background

149. Solar Thermal is a low carbon heating technology which can make a contribution to the hot water demand of a household in combination with other heating technologies. Eligible systems have been supported by Domestic RHI since its inception in April 2014.

Table B16: Domestic Biomass Information

Technology	Original tariffs at support launch (p/kWh)	As of January 2016		
		Current tariffs (p/kWh)	Accreditations for "New" systems[22]	Committed expenditure (£m)[23]
Solar Thermal	19.20	19.51	2,129	£0.69m

150. Solar Thermal can play an important complementary role in decarbonised heat generation:

- by providing hot water at high temperature that improves the efficiency of low temperature systems - ie heat pumps;
- When allied with biomass boilers they can improve system efficiency by reducing cycling and periods of low utilisation in the summer months;
- They can also play an important role in new build properties which have low space heating demand, but still require significant hot water. This combination of functions suits the operation of Solar Thermal.

151. Deployment to date has been low, totalling 100-200 per month since scheme launch, this is significantly lower than the market peak in 2010.

Policy Proposal and Impacts

152. From scheme experience and a value for money assessment, we feel that Solar Thermal support within RHI does not offer sufficient value for money to continue support.

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22 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/493581/RHI_monthly_official_statistics_tables_31_December_2015.xlsx

23 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/495727/Monthly_Domestic_Forecast_31_December_2015.xlsx

Table B17: Domestic Solar Thermal Proposals

Do Nothing	
The current level of support for all domestic eligible solar thermal installations is 19.51p/kWh. Under the 'do nothing scenario' no changes would be made to this tariff level and the scheme would continue as it is.	
Do Something	
Solar Thermal	Remove support for Solar Thermal from the Domestic RHI.

153. The reasons for low deployment is likely to be because of multiple reasons, including:

    a. **Tariff at the Value for money cap:** The tariff calculated through the tariff setting process exceeds the value for money cap, so even at the maximum level it does not deliver the target rate of return. Even when combined with the energy bill savings which solar thermal can generate, the installation will be unlikely to pay back over the technology lifetime for the vast majority of situations. This could lead to a lack of additionality.

    b. **Competition with Solar PV:** Solar PV can be installed quickly and produces electricity which can be sold back to the grid.

154. Evidence in the RHI domestic evaluation also highlights a greater lack of additionality in this technology group compared to others, with almost half of RHI participants saying that they would have installed the technology anyway. Other technology groups' also have reported high levels of non-additionality – however we expect that these markets will grow significantly over the coming years, reducing this issue over time.

155. Coupled with the underlying reasons for poor deployment and uncertainty about the long term strategic role, particularly comparative strategic value with other technologies means there are significant concerns about the effectiveness and value for money of continued RHI support for solar thermal.

Market Impact

156. The inclusion of RHI support to solar thermal installations seems to have had little impact on the overall solar thermal market, although the market has been affected by that for solar PV. The evidence from the RHI evaluation has been a low level of additionality, with some owner occupiers reporting that they would likely have carried out the installation anyway in the domestic survey.

157. While the RHI evaluation evidence suggests additionality is lower than other technologies (approximately 50% of deployment could be additional), market intelligence suggests that the impact could be greater due to perceived withdrawal of government support for this technology.

Proposals for the non-domestic scheme

158. This section gives an overview of the evidence base for changes to elements of the non-domestic scheme and impacts of proposed changes. This section focuses on the changes to tariffs, cap levels and the expected qualitative market impact of all changes to technologies combined.

159. The proposed policy changes are summarised below.

Table B18: Non-domestic Proposals

Technology	Proposed Tariff (2015/16 Prices)	Additional changes
Solid Biomass Boilers	Simplify tariff set-up at a Tier 1 tariff at 2-2.9p/kWh, and a second tier at 1.8-2p/kWh	Combine Biomass and Biomass CHP into a single trigger set Some small additional changes to align the wording of RHI sustainability criteria with the Renewable Obligation.
Biomethane and Biogas	In the event Government judges that the tariff has fallen too low to stimulate new deployment, we propose to reset the tariff in spring 2017. It will not be set at a level any greater than that available in January 2016 Make no change to the biogas tariff	Continue to fully support biogas from wastes and residues; limiting payments to 0% or 50% biogas from other feedstocks. Remove support for drying digestate
Other Technologies	Keep ASHP, GSHP & Deep Geo tariffs at current levels	No change
Solar Thermal	Proposal is to withdraw support for Solar Thermal	

160. In addition we propose to introduce tariff guarantees for the largest installations.

161. All Tariff proposals in this document are in 2015/16 prices. When the revised tariffs are launched they will be adjusted by the appropriate inflation figure.

Methodology Changes and Evidence Updates

162. The principles for tariff setting under non-domestic RHI remain broadly the same as in previous tariff setting assessments. The main departure is the way DECC thinks about setting a tariff. Instead of creating a supply curve and picking the median

installation, we pick the typical reference installation and set the tariff based on the costs and benefits of a low carbon technology in that property.

163. As discussed in the evidence section of this Impact Assessment the variation and heterogeneity of low carbon heating systems and buildings is a major factor in all evidence in this field. This is particularly true for the non-domestic sector. Further assessment of this variation can be found in Annex 2.

164. Biomethane Injection is a low carbon technology which is fundamentally different in design and function to other low carbon heat technologies supported through RHI. The method for assessing evidence and impacts is therefore different. Further details can be found in the 2014 Biomethane Tariff Review[24].

165. The main departure from previous impact assessments is the treatment of upstream carbon emission abatement from biomethane, particularly the methane abatement from food waste feedstocks. Further detail can be found in Annex 3 on the methodology.

166. There have also been a number of other updates to the evidence base that is used to determine tariffs. These updates are primarily routine in nature as more evidence becomes available over the course of the scheme, but can influence our understanding of the level of support needed. The main changes have been:

   a. **Cost and performance assumptions –** including the capital costs of equipment, and the load factors, for both the renewable and counterfactual technologies;

   b. **Fuel Prices –** including both counterfactual fossil fuel prices and electricity prices faced by heat pumps have been updated in line with DECC publications.

167. Additional information on the details of evidence changes, and the impact of the tariff caps is available in the technology specific sections below, as well as in the annexes.

[24] Biomethane Tariff Review: https://www.gov.uk/government/consultations/rhi-biomethane-injection-to-grid-tariff-review

Biomass Boilers

Background

168. Biomass is a low carbon heating technology that has been supported by the Non-Domestic RHI since the scheme was launched in 2011. Currently, separate tiered tariffs are offered to small, medium and large installations. This policy is known as banding.

Table B19: Non-domestic biomass tariff history

Technology		Original tariffs (p/kWh) 2011	As of January 2016		
			Current tariffs (p/kWh)	Accredited Installations	Committed expenditure (£m)
Biomass boilers	Small (up to 200kW)	Tier 1: 8.94, Tier 2: 2.34	Tier 1: 3.76p, Tier 2: 1.0p	11,755	£134.6m
	Medium (200kW to 1MW)	Tier 1: 5.49, Tier 2: 2.34	Tier 1: 5.18p, Tier 2: 2.24p	992	£52.9m
	Large (1MW and above)	1.0p	2.03p	29	£19.6m

169. One objective of the RHI scheme is to help deliver the UK's target of generating 15% of energy from renewable sources by 2020, as set out in the Renewable Energy Directive (RED) 2009. Under the proposals for reform of the RHI, we intend to refocus deployment to fit the long term vision for decarbonising heating in the UK, while ensuring these target are met in the most cost effective manner.

170. Large biomass systems which deliver process heating or support heat networks have particular long term strategic value, as these types of heat demand are difficult to decarbonise with other low carbon heating technologies.

171. In the non-domestic sector this means shifting deployment to the most cost effective systems such as larger systems (who benefit from economies of scale) as well as systems that operate at high heat loads (often associated with process heating) which offer the best value for money in renewable and carbon terms.

Policy proposals and Targeting

172. In order to maximise the value for money of the RHI we propose a single tiered level of support for all solid biomass installations under the RHI.

Table B20: Non-domestic biomass proposals

Do Nothing	
Under the 'do nothing scenario' no changes would be made to these tariff levels or eligibility criteria, and the scheme would continue as it is.	
Proposals under refocused RHI	
Biomass	Introduce a flat-rate tier 1 tariff of 2.03-2.9p/kWh, offered to all installations regardless of size. Tier 2 tariff set at 2.03p/kWh, applicable to all installations that produce additional heat above 35% of their annual potential. Offer Tariff Guarantees for the largest installations (those with capacities of 2MW or above) Combine all biomass boilers and Biomass CHP into a single tariff for the purpose of budget management.

173. The tariff setting methodology is unchanged from previous tariff setting exercises. The tariff is set on a 4MW plant replacing heating which uses a 50/50 mix of oil and gas. This is because our judgement, based on our market intelligence, is that a 4MW plant is the typical type of plant which may come forward under these proposals. We maintain the approach of offering a 12% return on additional costs, based on previous analysis of the required rates of return for investment.

174. Small and medium sized installations will still be eligible for the scheme, and the tariff may prove attractive for the most cost effective installations, particularly those with low capital costs, or which have high heat load factors. Further analysis can be found in Annex 2.

175. The rationale for this change is centred around maximising the value for money and strategic value of the RHI support to the non-domestic biomass market. We anticipate that the support will be most likely taken up by large systems, who will further benefit from tariff guarantees, which offers certainty about financial support at the right part of the decision making process, at financial close. Further details can be found in the tariff guarantees section of this impact assessment.

176. The tariff support through RHI will offer a significant reduction in the marginal cost of heat for participants and this may incentivise the over-production of heat and in addition may lead to over compensation for the plants with the highest load factors. In order to offer protection against this we propose that a tiered tariff is offered.

Market impacts

177. We anticipate that this may drive the deployment of 60 large installations per year, with some deployment in the sub 1MW plant range, particularly for those installations which operate with high load factors.

178. The combination of changes proposed for solid biomass support is expected to rebalance the scheme towards larger more cost effective plants which also offer more strategic use of scarce biomass resource[25].

179. Although small and medium sized installations may receive a lower average payment to what they are currently receiving DECC analysis indicates that the market will still prove to be attractive for cost effective installations. Further details of this analysis can be found in Annex 2.

180. Combining the budgets of solid biomass and Biomass CHP will minimise the risks of underspend by ensuring that any solid biomass tariff is only degressed if the overall trigger was hit. This allows more flexibility than technology specific triggers and allows the RHI to support the technologies which come forward.

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[25] When considering biomass resource, we are not considering the situation at present, instead we are considering the situation in 2050

Biomethane Injection and Biogas Combustion

Background

181. Biomethane Injection is a low carbon heating technology that has been supported by the non-domestic RHI since it was introduced in 2011. Currently the tariff offered is tiered as a result of the Biomethane Tariff Review in 2014/15.

182. Biogas Combustion is a low carbon heating technology which has been supported for small installations (under 200kW) since 2011 and for medium and large installations since the RHI extension in 2014.

Table B21: Biogas and biomethane tariff history

Technology		Original tariffs at support launch (p/kWh)	As of January 2016		
			Current tariffs (p/kWh)	Accredited Installations	Committed expenditure (£m)
Biomethane Injection		(From 2011) 7.5p	5.87p/3.45p /2.66p	38	£208.5m
Biogas Combustion	Small (up to 200kW)	(From 2011) 7.5p	7.62p	37	£18.7m
	Medium (200kW to 600kW)	(From 2014) 5.9p	5.99p		
	Large (600kW and above)	(From 2014) 2.2p	2.24p		

183. After scheme launch, biomethane deployment and pipeline data showed strong growth, and nearly all plants were larger than the 1 MW reference plant. It was also found that some capital costs showed strong economies of scale leading to overcompensation risks. Since the tiering changes biomethane growth has continued to be strong. The strong deployment has led to several degressions; however there still is a strong pipeline of deployment.

184. This deployment has tended to be plants whose primary feedstock is a crop, such as maize, with 25 agricultural plants and 12 food waste plants as of November 2015. Going forward market intelligence suggests there may be a future contraction of the food waste supply, leading to lower gate fees and shorter contract lengths. In contrast, there is still a high potential for agricultural land to be converted from crops for the food and feed markets, to crops grown for AD production.[26]

[26] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/434098/nonfood-statsnotice2012-10jun15.pdf

185. Biogas and biomethane injection into the gas grid is a potential viable long-term option for heat decarbonisation where it can deliver cost effective carbon abatement. Under the refocused RHI, biogas and biomethane support will be targeted where it can offer the best value for money and carbon savings, and incur a low sustainability risk in relation to land use and ecosystem services such as soil and water quality.

Policy Proposals

186. In order to maximise value for money and carbon savings from biomethane and biogas production, reduce sustainability risks and capitalise on the benefits of the anaerobic digestion of waste, we propose to target RHI payments for new installations towards biogas or biomethane production derived from wastes and residues, and to eliminate payments for drying digestate. A tariff adjustment is proposed for biomethane operators.

Table B22: Biomethane and biogas proposals

Do Nothing	
Biomethane Injection	Under the 'do nothing scenario' no changes would be made to these tariff levels or eligibility criteria, and the scheme would continue as it is.
Biogas Combustion	Under the 'do nothing scenario' no changes would be made to these tariff levels or eligibility criteria, and the scheme would continue as it is.
Proposals under refocused RHI*	
Biomethane Injection	Continue to fully support biomethane from wastes and residues; limiting payments to 0% or 50% for biomethane from other feedstocks. In the event Government judges that the tariff has fallen too low to stimulate new deployment, we propose to reset the tariff in spring 2017. It will not be set at a level any greater than that available in January 2016 Offer tariff guarantees
Biogas Combustion	Continue to fully support biogas from wastes and residues ; limiting payments to 0% or 50% for biogas from other feedstocks. Remove RHI payment for heat used to drying digestate No changes to tariffs

* This is not an exhaustive list of proposed policy changes. Full details of the proposed changes can be found in the consultation document.

187. To inform our proposals we have estimated the carbon cost-effectiveness (the costs incurred to save a tonne of carbon or equivalent emissions) of producing biomethane using different feedstocks in the anaerobic digestion (AD) process. Our analysis, which is set out in Annex 3, indicates that:

a. biomethane from food waste is a highly cost-effective means of abating carbon, at between £25 and £60/tCO2e.[27]

b. agricultural crops by contrast are *not* a cost-effective feedstock for biomethane production, with our estimates between £350 and £600/tCO2e.

c. agricultural wastes, such as manures and slurries, are reasonably carbon cost-effective, albeit much less than food waste, with our estimates lying between £70 and £170/tCO2e (although the upper bound of this range increases significantly to around £600/tCO2e assuming that agricultural wastes deliver minimal upstream emissions abatement).

188. That food waste is estimated to be considerably more cost-effective than agricultural feedstocks is explained by the 'upstream' emissions abatement that is assumed to occur as a result of diverting food waste from landfill, where it emits methane into the atmosphere, to an anaerobic digester. Agricultural wastes are also assumed to produce upstream emissions abatement owing largely to avoided emissions from the storage of slurries and manures, although these are less significant than the upstream abatement from food waste.

189. We have not taken account of any carbon emissions impacts relating to Indirect Land Use Change (ILUC), which is potentially relevant to the use of crops as an AD feedstock. ILUC refers to changes in agricultural land caused by the expansion of croplands for biogas/biomethane production. ILUC can lead to increases in net greenhouse gas emissions (GHG) due to clearance of plants that naturally store carbon during growth. We do not know the extent to which use of crops in AD contributes to ILUC. Insofar as it does – and insofar as this causes increases in net GHG emissions – the carbon cost-effectiveness of crop-based AD will be worse than implied by our analysis.

190. The Biomethane tariff is likely to experience several degressions over the course of the next year as a result of high deployment. This deployment we anticipate will be driven at least in part by the significant number of energy crop plants which are currently coming online based on our market intelligence.

191. DECC's assessment based on deployment levels and market intelligence is that the current tariff (January 2016) is sufficient to incentivise the deployment of food waste based plants. However we anticipate multiple degressions caused in part by significant deployment of crop based plants. In the event Government judges that the tariff has fallen too low to stimulate new deployment, we propose to reset the tariff in spring 2017. It will not be set at a level any greater than that available in January 2016. This is in contrast to the biogas tariff which, as of January 2016 has not been subject to any degressions. Furthermore, aside from the suggested eligibility changes, we will not be implementing any other changes such as those to

[27] This range reflects differing assumptions regarding the extent of 'upstream' emissions abatement (as a result of diverting the food waste from landfill sites) and methane leakage during the anaerobic digestion process. This explains the range around the various carbon cost-effectiveness estimates referred to in this section.

the current tariff. One contributing factor to this decision is the expectation that the main source of income for biogas plants being the FiT tariff.

Market Impacts

192. Going forward, the proposed changes would disincentivise the deployment of agricultural plants which are dependent on a high use of crops and therefore should result in a greater share of the market to utilise wastes and residues.

193. For large plants biogas and biomethane plants, this may lead to a reduction in future deployment rates for agricultural plants, if the local availability of wastes and residues are insufficient to ensure an adequate feedstock supply. If waste and residues are available, it may lead to a feedstock switch or in some cases, it may lead to downscaling plants to better fit with feedstock availability.

194. We do not anticipate key changes to the food waste market as a result of these proposals. We anticipate that the levels of deployment for AD plants processing food waste will be largely dependent on the local availability and gate fee of the feedstock.

195. The current biomethane market sees around 56% of plant being agricultural, with the majority likely to have a significant crop component.

196. Based on our market intelligence assessment of the impact of the tariff and eligibility changes, we anticipate a market for around 15-20 new biomethane plants a year.

Other Technologies

Biomass Combined Heat and Power (Solid Bio-CHP)

197. A dedicated tariff for solid biomass-CHP was introduced into the Non-Domestic scheme at a level of 4.1p/kWh in May 2014. This has increased to 4.17p/kWh in line with inflation. At the same time, we introduced an eligibility requirement that all plants must be CHPQA certified in order to qualify for the CHP tariff.

198. DECC has seen biomass-CHP as strategically important as (i) it is capable of being a more efficient use of fuel (estimated up to 30% more efficient compared to the separate generation of heat and power)[28], (ii) offers greater system-wide decarbonisation, and (iii) has the potential to contribute to long term carbon targets, particularly by decarbonising certain industrial processes for which there are few recognised alternatives[29].

199. Our proposals for Bio-CHP are summarised below. Full details can be found in the Consultation Document.

Table B23: Biomass CHP proposals

Do Nothing	
Under the 'do nothing scenario' no changes would be made to these tariff levels or eligibility criteria, and the scheme would continue as it is.	
Proposals under refocused RHI	
Biomass	Keep the main tariff at the current level, but apply this as a Tier 1 tariff only Introduce a Tier 2 tariff set at 1.8 - 2.03p/kWh, applicable to all installations that produce additional heat above 35% of their annual potential (in line with proposals for biomass heating-only technologies). Offer tariff guarantees for all, or the largest of, biomass-CHP installations Combine all biomass boilers and biomass-CHP into a single trigger category for the purpose of degression. Enhance existing CHPQA criteria to ensure all plants operate efficiently (not covered in this Impact Assessment)

[28] DECC's "UK Bioenergy Strategy"; "The Carbon Plan: Delivering our Low Carbon Future" and "The Future of Heating: Meeting the Challenge"
[29] The Future of Heating: Meeting the challenge: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/190149/16_04-DECC-The_Future_of_Heating_Accessible-10.pdf

200. Market Intelligence has suggested that biomass-CHP also faces significant additional barriers securing investment when compared to other types of CHP. For example, one of the main barriers holding back good quality biomass-CHP is the lack of tariff certainty and the impact felt from potential degressions between the time that financial close on a large project is reached and it being accreditation to the RHI. This is discussed in more detail in the Tariff Guarantee section of this Impact assessment.

201. The impact of tiering on biomass-CHP is uncertain and we are consulting on this proposal - which is designed to deliver even greater value for money under the scheme. Some of the biomass-CHP systems which produce process heat for example may operate at higher load factors than the proposed tiering break so would be adversely affected by this change. We are seeking views on the appropriateness of tiering for CHP as well as the correct threshold.

Non Domestic Heat Pumps

202. The Non Domestic RHI supports Ground Source Heat Pumps (GSHP) and Air Source Heat Pumps (ASHP) installations that feed into water heating systems and are powered by electricity. Air to Air systems are not eligible.

Table B24. Non Domestic Heat Pump Information

Technology	Original tariffs at support launch (p/kWh)	As of January 2016		
		Current tariffs (p/kWh)	Accredited Installations	Committed expenditure (£m)
Air Source Heat Pump	2.5p (2014)	2.54p	117	£0.2m
Ground Source Heat Pump	Small: 4.98p (2011) Large: 3.66p (2011)	Tier 1: 8.84p Tier 2: 2.64p	409	£7.2m

203. Deployment for both ASHP and GSHP has been lower than expected in the December 2013 Impact Assessment.

204. Air- and Ground-Source Heat Pumps will play a key role in decarbonising heat in buildings, particularly those in off grid areas, as outlined in the previous Government's long term heat strategy[30].

205. We are not proposing any changes to the tariff level or eligibility criteria for Non-domestic heat pumps, other than allowing reversible ASHPs to be eligible. We do however propose to offer Tariff guarantees for larger ground and water source heat

[30] Source- https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/48574/4805-future-heating-strategic-framework.pdf

pumps and preliminary accreditation for some types of heat pumps. Further details can be found in the Consultation.

206. We would welcome further views from stakeholders and other market participants about the barriers which exist to these technologies in the heating market, particularly if they have further evidence with regard to the appropriate level of support, or whether other action is needed to unlock greater deployment for these technologies.

207. Our current evidence base on costs and performance is detailed in Annex 2.

Deep Geothermal

208. We are not proposing any changes to the tariff level or eligibility criteria for geothermal heat installations – though we would propose that large deep geothermal projects would be eligible for tariff guarantees.

209. In addition we propose to allocate a smaller proportion of the total RHI budget to Deep Geothermal. This will however still allow deployment of projects identified in our assessment of the potential pipeline.

Solar Thermal

210. We propose to end support for new solar thermal systems through the Non-Domestic RHI (as well as through the Domestic scheme).

211. The high tariff offered to solar thermal offers poor value for money and contribution towards overall objectives, when compared to other technologies supported within the scheme. It is not clear that the RHI will drive the level of investment and sort of innovation required to realise this potential.

212. The Government believes there may be a role for solar thermal systems in the long-term decarbonisation of heating in the UK, particularly in combination with heat pumps, where they may help raise the overall efficiency of heat pump systems.

Section C: Impacts

Summary of Impacts

213. This section of the impact assessment quantifies the costs and benefits of the RHI and changes to RHI proposed in this consultation, this includes renewable heat generated, air quality impacts, carbon savings and resource costs. There is significant uncertainty around many of the assumptions and full detail can be found in Annex 1.

214. The broad methodology for assessing cost and benefits remains unchanged from the December 2013 Impact assessment[31]; we use market intelligence to assess deployment potential and then use assumptions regarding the costs, performance and use to quantify costs and benefits. The major assumption difference is the carbon emission abatement associated with biomethane, where we now take account of upstream methane emission abatement.

215. The assessment contained within this impact assessment looks at two impacts:

   a. **Changes Proposed in Consultation –** This records the impacts of the changes proposed to the RHI from April 2016 onwards. Full details of all the changes are detailed in Section B.

   b. **Total impact of RHI –** For summary purposes the total impacts of the RHI as a whole are summarised. This includes RHI impacts for installations supported between 2011 and March 2016 and the changes proposed in this consultation. In Table C1 these are in brackets.

Table C1: Summary of Key Impacts

Proposed Changes *(Total RHI)*	**2020/21**	**CB4**	**CB5**	**Lifetime**
Nominal Spending (£m)	£556m (£1,139m)			
Renewable Heat Supported (RED definition, TWh)	13.7 (23.7)			
Carbon Savings (MtCO2e)		13.1 - 23.2	13.1 - 23.2	
Net Present Value (Real, discounted, £m)				£831m

[31] RHI Dec 2013 Impact Assessment: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/263581/Impact_Assessment_RHI_Tariff_Review_Extensions_and_Budget_Management_Dec_2013.pdf

216. Further details and breakdowns of these changes can be found in the remainder of this section.

Deployment and Spend

217. The deployment seen under the RHI is critical to quantifying the potential benefits and the costs of RHI and the changes proposed in this consultation. We consider deployment potential in 3 parts to mirror the phases of the scheme:

- deployment in 15/16 (under existing RHI rules)
- deployment in 16/17 (under new triggers and other small scheme changes)
- deployment under the reformed scheme to 2021.

218. It is worth noting that the RHI budget is an overall budget covering both deployment supported by changes proposed in this consultation, but also spending on deployment from the scheme to date. The annual budget in each given year therefore is based on expenditure on any new deployment on top of expenditure from the plants already in the scheme. Therefore, if deployment is lower than budget in previous years there will be additional headroom for new deployment in subsequent years.

Scheme spending on accreditations to the end of 15/16

219. Spending in the current year has significant uncertainties; these will reduce over coming months as accredited installations submit meter readings and particularly new biomethane plants ramp up to their full capacity.

220. Our current market intelligence and emerging data suggests that total spend could be below budget in 2015/16, however for appraisal purposes we will continue to assume spend is equal to budget and results in a total spend in 16/17 of £540m, assuming that biomethane plants continue to ramp up.

221. While this does not directly affect the overall costs and benefits of the changes proposed, it does affect the budget available for change, and therefore the policy decisions which could be made, whilst retaining scheme affordability.

Scheme spending on accreditations to the end of 16/17

222. The scheme in the financial year 16/17 is a transition towards the reformed RHI, which would be launched in 17/18. This means that many of the reforms, such as higher large biomass and ASHP tariffs and the introduction of assignment of rights and tariff guarantees will only have a minor impact on consumer choice.

223. The impact of the scheme in this transition year is highly uncertain as some elements of the market which could receive a lower level of support in subsequent years(medium biomass or crop based biomethane) may come forward in large numbers, but conversely there may be a hiatus.

224. In order to account for this variation we consider two scenarios, spending the budget and a scenario led by our latest market intelligence estimates.

Scheme deployment beyond 2016/17

225. Deployment beyond 2016/17 has a significant degree of uncertainty; we therefore assess three scenarios, spending the whole budget, the current market intelligence indications and a low scenario deployment.

226. The central deployment estimate comes with some upside risk which is managed by degression and as a last resort the cap, but also significant downside risk, where deployment would be lower than set out in this central assessment. This is an important sensitivity because there is significant uncertainty surrounding these estimates and they require three distinct markets to deploy on their central trajectory. We would propose to set this out with a central range for deployment.

High Deployment scenario

227. A high deployment scenario could have a number of different results depending on how it interacts with the budget management system. Under one scenario, increased deployment might be as a result of lower costs, therefore the tariff could still offer a return for decision makers to invest in low carbon heat technologies. This scenario would see degression reduce average tariffs so enable more installations to be supported for the same total spend.

228. Alternatively the cap would be hit resulting in a scheme suspension (more details can be found in the consultation document); we would expect to re-open the scheme in the subsequent financial year, pending a review of the scheme.

229. Because of the variation in high scenarios, and the dependency of how and why degression or scheme cap is triggered, we have not modelled a high scenario separately in this impact assessment.

Summary of Deployment scenarios

230. The below table summarises our appraisal scenarios:

Table C2: Deployment scenarios

Scenario Name	Approach to 15/16	Approach to 16/17	Approach to 2017 to 20201
High	*Limited by degression and the Cap*		
Central: High	Spend Budget	Spend Budget	Spend Budget
Central	Spend Budget	Central Market Intelligence	Central Market Intelligence
Central: Low	Spend less than budget	Central Market Intelligence	Central Market Intelligence
Low	Spend less than budget	Central Market Intelligence	Low Market Intelligence

231. These scenarios have a variety of spend levels associated with them summarised for reference below:

Table C3: Summary spending under scenarios

	2016/17	2017/18	2018/19	2019/20	2020/21
High	*Limited by degression and the Cap*				
Central: High	£640m	£780m	£900m	£1,010m	£1,150m
Central	£593m	£707m	£845m	£989m	£1,139m
Central: Low	£576m	£650m	£735m	£824m	£916m
Low	£536m	£609m	£694m	£782m	£873m

232. The detailed appraisal analysis will be conducted on the central scenario, however we will also summarise the high level conclusions for each of the other scenarios for reference.

Detailed summary of spending and deployment for the central scenario

233. In order to appraise the impacts of the scheme we have to assess the deployment potential. As detailed in the deployment section of this impact assessment we took an iterative approach to determining deployment. As such we have chosen to appraise the scheme on the basis of spending the entire budget allocation over the spending review period.

234. The table C4 summarises the deployment we might expect to see in 2020/21 under these reform proposals. We would welcome stakeholders' own market intelligence regarding the likelihood of this deployment potential.

235. Using this market intelligence, the scheme aims and the affordability constraints we anticipate that the scheme changes proposed in this consultation will lead to projected costs of approximately £556m on new[32] deployment in 2020/21. The largest expenditure is expected to be biomass at £229m, with an increasing share coming from biomethane £197m and heat pumps £128m.

[32] New deployment is defined as any deployment supported after March 2016, when the last spending review settlement ran to.

Table C4: Market Intelligence assessment of scheme deployment potential

Technology	Installations in 2020/21	
Biomass	60 per year 6,800 kW installations and Some small and medium sized systems	HLF: 35%
Biomass CHP	5-12 per year 4,000 kW installations	HLF: 53%
Ground and Water Source Heat Pumps	2,220 per year 30kW installations	HLF: 22%
Air Source Heat Pump	1,000-2,000 per year 40 kW installations	HLF: 22%
Deep Geothermal	1 per year 6,000 kW installations	HLF: 55%
Biomethane	15-20 per year 6,000 kW installations	HLF: 80%
Small Biogas	55 per year 160 kW installations	HLF: 65%
Medium Biogas	16 per year 480 kW installations	HLF: 65%
Large Biogas	24 per year 1,600 kW installations[33]	HLF: 65%
Air Source Heat Pump	13,700 per year 10kW installations	HLF: 17%
Ground Source Heat Pump	2,500 per year 9 kW installations	HLF: 17%
Biomass	Up to 1,000 per year 20 kW installations	HLF: 14%

236. As described above, there is a high degree of uncertainty around the deployment profiles, particularly regarding how markets react to the increased certainty of the RHI continuing, market response during 2016/17 and reaction to the proposals outlined in this consultation.

Table C5: Central RHI scheme expenditure profile over SR period

	Nominal Expenditure in Year (£m)				
	2016/17	2017/18	2018/19	2019/20	2020/21
Biomass	£30m	£74m	£124m	£175m	£229m
Biomethane/Biogas	£15m	£52m	£98m	£147m	£197m
Heat pumps	£6m	£29m	£60m	£93m	£128m
Other	£1m	£3m	£3m	£3m	£3m
Total new deployment *(Non-Domestic / Domestic)*	£53m *(£46/£6)*	£158m *(£132/£26)*	£285m *(£233/£53)*	£418m *(£338/£81)*	£556m *(£447/£109)*
Existing Scheme	£540m	£550m	£560m	£571m	£583m
Total RHI expenditure	£593m	£707m	£845m	£989m	£1,139m

[33] Deployment of large biogas systems particularly depends on the support offered through the Feed in Tariff.

237. Budget caps will apply to the RHI as a whole – both domestic and non-domestic, and both new and existing commitments; in order to best control overspend risk. These are covered in the sensitivity section in more detail.

Renewable Heat Supported by RHI

238. With the level of spending set out above on the various technologies and the tariffs we propose to offer, we anticipate that the scheme will support approximately 13.7TWh of additional renewable heat by 2020/21. This is reliant on the heat supported by the scheme and the efficiency of biomass and heat pumps.

239. Within the technologies there are differences in what renewable energy is defined as for Renewable Energy Directive (RED) purposes. For example in the case of biomass, renewable energy by RED definition is calculated through the application of a renewable heat proportion on total input energy, rather than that of output energy.

240. Due to new evidence being released on heat pump performance during the appraisal process, we have opted to provide two scenarios of renewable heat generated. Further details can be found in Annex 4.

Table C6: Profile of renewable heat generation under the central scenario

	Renewable Heat Supported (Renewable Energy Directive, TWh)				
	2016/17	2017/18	2018/19	2019/20	2020/21
Biomass	0.91	2.66	4.54	6.42	8.30
Biomethane/Biogas	0.33	1.13	2.10	3.07	4.04
Heat pumps	0.04-0.06	0.21-0.30	0.44-0.62	0.67-0.93	0.90-1.25
Other	0.02	0.04	0.04	0.05	0.05
Total new deployment	**1.33**	**4.12**	**7.30**	**10.48**	**13.66**
Existing Scheme *(of which Biomass, Biomethane, heat pumps)*	**10.53 *(7.63, 2.54, 0.35)***	**10.42 *(7.55, 2.51, .35)***	**10.28 *(7.45, 2.48, 0.34)***	**10.15 *(7.35 , 2.45 , 0.34)***	**10.04 *(7.27 , 2.42, 0.33)***
Baseline[34]	**31.14**	**31.14**	**31.14**	**31.14**	**31.14**
Total Renewable Heat	**~43**	**~46**	**~49**	**~52**	**~54-55**

[34] The renewable heat generated outside the RHI. This is sourced from the DUKES 2014 assessment of the level of renewable heat generated in the UK, with the heat supported from RHI netted off. Further details can be found here: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/450069/dukes6_7.xls

Table C7: Renewable Heat under different deployment scenarios

	Renewable Heat Supported (Renewable Energy Directive, TWh) in 2020/21	
	Existing Scheme	Total New deployment
Central: High	10.04	13.12
Central	10.04	13.66
Central: Low	10.04	7.45
Low	9.75	7.45

241. The Central: High scenario delivers a lower level of deployment of renewable heat than the central scenario because it contains more deployment in 2016/17, prior to the majority of scheme changes outlined in this consultation. Deployment after 2016/17 generally offers better value for money and carbon savings than before.

Greenhouse Gas Abatement

242. The greenhouse gas abatement which these proposals might support is dependent on the amount of heat supported by the RHI, the fossil fuel systems replaced and the efficiency of the systems. Full details of the assumptions behind this analysis can be found in Annex 3.

243. Table C9 provides estimates of the carbon savings from RHI deployment over the next three carbon budget periods. There will be some additional benefits over the current carbon budget period up to 2018, but these will be small.

244. These carbon savings represent the lifecycle emission abatement, so as to properly take into account the carbon emissions from biomass.

245. As can be seen a large proportion of the savings arise from biomethane and biogas. This is largely due to the upstream savings arising from the use of the fuels within the creation of biogas. For example, if food waste was not used within the process, it would instead go to the landfill and generate more emissions. This is discussed in more detail within the cost effectiveness section. Within table C9 we have shown approximately how much of the savings are due to these avoided emissions within the brackets.

246. The significant uncertainty associated with upstream biomethane emissions means that we will present the carbon savings as a range, with and without upstream abatement. We will gather further evidence during the consultation as to the appropriate level of carbon savings to report due to this.

Table C9: Profile of carbon savings under the central scenario

	Net carbon Savings (Mt CO_2)			
	CB3 2018-2022	CB4 2023-2027	CB5 2028-2032	Lifetime
Biomass	6.2	7.7	7.7	**30.9**
Biomethane/biogas (of which due to upstream savings)	12.2 (10.1)	15.7 (13.1)	15.7 (13.1)	**62.9 (52.2)**
Heat pumps[35]	1.8	2.5	2.6	**10.3**
Other	0.1	0.1	0.1	**0.3**
Total new deployment	10.1-20.2 (19.2)	13-26.1 (24.8)	13-26.1 (24.8)	**52.2-104.4 (99.2)**
Existing Scheme	14.1 (13.4)	14.3 (13.6)	14.2 (13.5)	**53.4 (50.7)**
Total RHI Carbon Abatement *(of which Non traded)*	**24.2-34.4 (32.7)**	**27.3-40.3 (38.3)**	**27.2-40.3 (38.3)**	**105.6-157.8 (149.9)**

Table C10: Renewable Heat under different deployment scenarios

	Net carbon Savings (Mt CO_2) in CB4	
	Existing Scheme	Total New deployment
Central: High	14.3	24.8
Central	14.3	26.1
Central: Low	14.3	17.4
Low	13.2	17.4

Monetised costs and benefits

247. The Net Present Value of the policy is designed to capture the costs and benefits of the policy decision to society in general. In is made up of three main elements:

a. **Resource Costs –** these present the additional costs to society of householders and businesses, this includes the additional capital and energy costs compared to a fossil fuel alternative.

b. **Air Quality Impacts –** these are the monetised costs or benefits from replacing fossil fuel systems with RHI supported low carbon alternatives. The benefits accrue from reduced emissions of Nitrous Oxides and Particulate Matter.

[35] Varying the performance of heat pumps has a small impact on the carbon abatement potential. Our analysis suggests using the latest RHPP evidence could reduce carbon abatement by ~2%. For simplicity we have just used the higher value here, but further analysis can be found in Annex 4.

c. **Carbon Emissions –** these are the monetised benefits of carbon emission reductions from moving to low carbon alternatives. For this appraisal we look at the lifecycle emissions of fuels given the important part they play for biomass related heating systems.

248. There are other costs and benefits which it has not been possible to monetise, these are summarised below.

249. We calculate resource costs in a similar way to calculating the required tariff, we look at the additional costs of the renewable heating system compared to the fossil fuel alternative, but use a lower discount rate (3.5% as compared to the 7.5%/12% project discount rate) to reflect that some of the rate of return we pay as part of the tariff is not a social cost. The resource cost of renewable heating technologies is very uncertain; we include a sensitivity to illustrate this.

250. The appraisal presented in the section below shows our estimates of the impacts associated with deployment of renewable heat technologies supported on the RHI from the period of 2016/17 through 2020/21 inclusive. The renewable heating systems installed during this period have an assumed lifetime of 20 years[36]. This means that additional deployment up to 2020/21 will continue to have an impact to 2040/41.

NPV Estimates

251. Table C11 provides a breakdown of the Net Present Value (NPV) associated with the additional deployment that the policy changes will bring on up to the end of 2020/21, as well as its main components. The components of the NPV calculation are shown in more detail below, including sensitivities and ranges. NPV calculations are based on discounted values cumulative over the policy lifetime.

252. This NPV is based around our assumed deployment scenario, different deployment levels will generate different NPVs which could further extend the range shown by the sensitivities

Table C11: Central NPV of new RHI deployment – 15/16 prices discounted to 15/16

	Resource Cost	Value of CO_2		Air Quality Costs/Benefits	NPV
		Traded	Non-traded		
Non-Domestic	£5,307 m	£181 m	£4,862 m	£872 m	**£608 m**
Domestic	£565 m	£16 m	£418 m	£354 m	**£223 m**
Total	£5,872 m	£197 m	£5,280 m	£1,226 m	**£831 m**

[36] The lifetime of low carbon heating technology is assumed to be 20 years and is a policy decision made when setting tariffs.

Non-Monetised Costs and benefits

253.In addition to the monetised costs and benefits above, there are several non-monetised costs and benefits detailed below:

a. **Innovation & cost reductions -** By supporting renewable heat deployment DECC expects that costs will reduce and performance may increase over time. Additionally the barriers that customers currently face when thinking about renewable heating such as the risk around unproven technologies and hassle costs will reduce if deployed successfully. These benefits have not been quantified.

b. **Rebound Effect -** For some heat users, installing a low carbon heat technology could lead to an overall lowering of fuel bills. This could lead to an overall increase in energy consumption. This has not been quantified because of the heterogeneity in household responses and the lack of evidence for heating.

c. **Impacts on Electricity Generation -** Some technologies supported within the RHI also support the production of low carbon electricity, specifically solid biomass and biogas Combined Heat and Power. By offering tariff guarantees for some of the largest systems, policy decisions here could also have a marginal impact on the production of low carbon electricity.

Sensitivities

254.There is a significant amount of uncertainty in many elements of this analysis, for reasons previously outlined in this impact assessment. In this section we look at the sensitivity to key changes in assumptions.

a. **Carbon Abatement:** due to system efficiency and carbon intensity variation. Detailed assumptions can be found in appraisal annex. In addition in this scenario we assume there are no upstream savings from biomethane.

b. **Carbon Prices:** variation in the monetised cost of carbon, as detailed in DECC's carbon price projections.

c. **Air Quality:** variation in the monetised cost of NOx & PM emissions. Detailed assumptions can be found in Annex 1: Apprasial Assumptions.

255.The other key sensitivities to consider are variations in deployment potential and resource cost variation:

a. **Resource Costs:** Resource costs represent the additional costs of a low carbon heating system compared to the counterfactual system. The resource costs relative to the subsidy costs will depend on the level of over-compensation present in the market.

This is difficult to estimate given the variation in costs and performance of low carbon heating systems and the heterogeneity of heating uses. We therefore use a modelled estimate of resource costs[37] and an extreme position of resource cost being equal to subsidy cost.

b. Deployment

As discussed deployment estimates are very uncertain and we welcome further thoughts from stakeholders on how much deployment these proposals may bring forward.

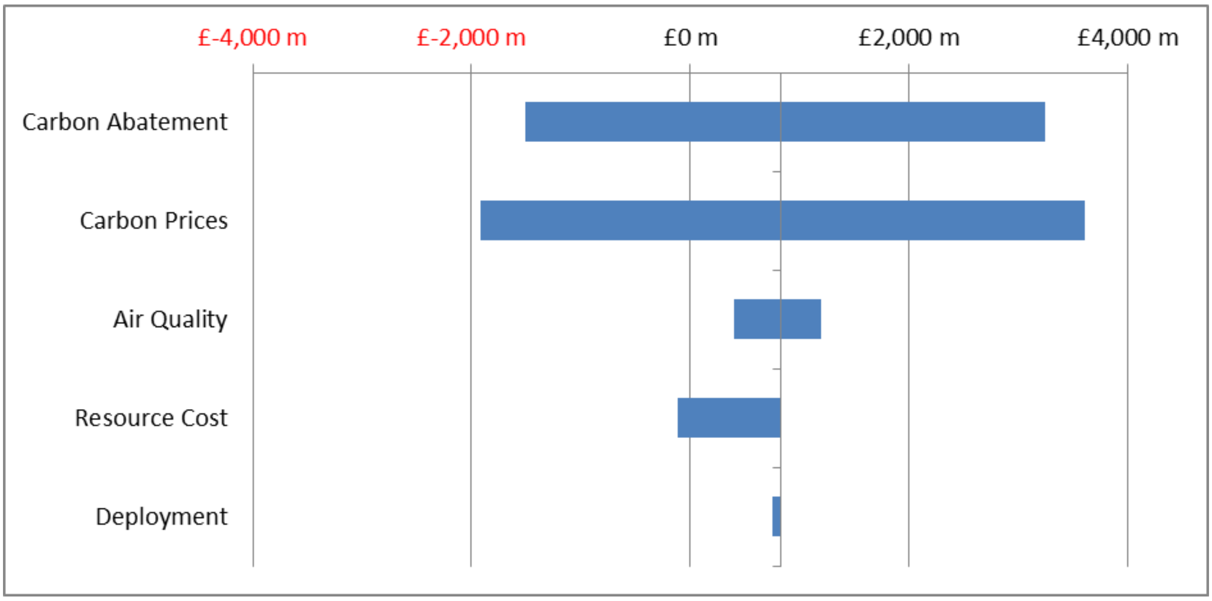
We present here an additional low scenario based on market intelligence

256. The below table and chart illustrate the impact of varying the key assumptions highlighted in this section.

Table C12: Sensitivity to the level of carbon abatement – 15/16 prices discounted to 15/16

	Change in Scheme NPV				
	Carbon Abatement	Carbon Prices	Air Quality	Resource Cost	Deployment
Low	£-2,335	£-2,743	£-427	n/a	£-79
Central	0 (£831m)	0 (£831m)	0 (£831m)	0 (£831m)	0 (£831m)
High	£+2,418	£+2,775	£+362	n/a	£-271
High Resource Costs	n/a	n/a	n/a	£-950	n/a

Chart C13: Sensitivity to the level of carbon abatement – 15/16 prices discounted to 15/16



257. This analysis of the Net Present Value illustrates the significant uncertainty around the monetised benefits the RHI could deliver; in addition it is likely that some of this

[37] These modelled estimates can be found within Annex 1, Table A1.1.

variation is likely to be correlated. For example if installations are of low quality, this is likely to reduce the carbon abatement they will achieve, increase the harmful pollutants associated with air quality and increase the resource cost as they will not last the 20 years assumed.

258. The NPV should therefore be treated with a significant degree of caution

Cost Effectiveness

259. In assessing the RHI, we have two main measures of cost effectiveness to reflect the two different scheme deliverables, renewable heat for the 2020 target, and carbon savings for Carbon Budgets. The RHI's other primary objective of preparing the market for mass deployment is more difficult to quantify, so is considered qualitatively.

a. Subsidy per kWh (p/kWh) of renewable energy towards the 2020 RED target

b. Cost per tonne of Carbon abated (£/tCO2)

Table C14: Lifetime Renewable heat generated and carbon cost effectiveness

	Cost Effectiveness (Lifetime discounted to 2015, £2015)		Nominal Cost per MWh of renewable heat towards RED (£/MWh) in 2020/21
	Subsidy Cost	Resource Cost	
Renewable heat generated (£/MWh)	£20.98	£19.58	£23.50
Carbon Saved (£/tCO2e)	£60.28	£56.24	n/a
Weighted average Non-traded cost of carbon comparator (£/tCO2e)	£54.49	n/a	n/a

260. The overall scheme cost effectiveness under both a renewable heat generated and carbon savings measure has improved from the projections in 2013 (over £150/tCO2e). This is driven by:

a. **Refocusing RHI:** The proposals within this consultation refocus RHI biomass support towards the most cost effective large biomass installations, these installations which benefit from economies of scale have lower subsidy costs and resource costs than small biomass which was the previous dominant technology.

b. **Tariff degressions:** Degressions within biomethane have improved the subsidy cost effectiveness of a significant part of new biomethane deployment.

c. **Biomethane carbon abatement:** By refocusing biomethane support towards foodwaste we improve the level of carbon savings because of upstream emission abatement, which had previously not been counted within DECC analysis.

261. Also included in this analysis is a weighted average of the non-traded cost of carbon for comparison purposes. This illustrates the cost effectiveness of the proposed RHI changes, compared to the projected carbon price.

Biomethane Emissions

262. One contributing factor to the increased carbon abatement is the inclusion of upstream savings within the emission factors associated with biomethane and biogas. In particular this has had a large effect on the emissions from the use of food as a feedstock, as can be seen in the table C15:

Table C15: Biomethane AD Emissions

Emissions (kgCO2e/kWh)	Leakage (kgCO2e/kWh)	Upstream emissions (from use of slurry/manure feedstock) (kgCO2e/kWh)	Upstream emissions (savings from use of food waste feedstock) (kgCO2e/kWh)	Net emissions (kgCO2e/kWh)		
				Food Waste	Crop	Slurry/ Manure
0.113	0.032	- 0.6026	- 0.7486	-0.604	0.145	-0.458

263. These emission figures should be considered in the context of the aggregate effects on the biomethane market that introducing a maximum proportion of eligible crop would produce.

264. As discussed within the biomethane section of the policy options, this change in eligibility would incentivise more food waste plants at the expense of agricultural plants, in particular those plants that were solely crop based.

265. Further detail on the sources of evidence for these conclusions and methodology can be found in Annex 3.

Annex 1: Appraisal Assumptions

1. Within the appraisal of the impacts of the RHI scheme, various assumptions are used to feed into the overall calculations of both spending estimates as well as the components of the schemes NPV.

2. As highlighted within the impact assessment the underlying assumptions on these components are key sensitivities within the analysis performed. The inputs into the calculator to generate these are:
    - Resource cost multiplier (£ per kWh of heat)
    - Damage cost air quality multiplier (£ per kWh of heat generation) – varies from technology to technology
    - Carbon savings multiplier (kg CO_2 per kWh of heat generation).

3. The following tables show the data and its sources that those underlying assumptions have been built on.

Resource Costs Summary

Table A1.1 Social Resource Cost Estimates (2015/16 Prices)

		Social Resource Cost (p/kWh)	Logic
Non-domestic RHI	Biomass Boiler	1.83	Internal DECC Modelling at 3.5% discount rate
	GSHP/WSHP (Weighted Average)	7.24	Current tariff
	Small Biogas	7.62	Current tariff
	Biomethane Weighted Average	4.84	Current tariff
	Medium Biogas	5.99	Current tariff
	Large Biogas	2.24	Current tariff
	Biomass CHP	4.17	Current tariff
	Deep Geothermal	5.08	Current tariff
	ASHP	2.54	Current tariff
Domestic	ASHP	5.20	Internal DECC Modelling at 3.5% discount rate
	Biomass	3.81	Internal DECC Modelling at 3.5% discount rate
	GSHP	10.67	Internal DECC Modelling at 3.5% discount rate

Air Quality Assumptions

4. In order to take account of the net costs on air quality, the calculator includes assumptions on how high the air quality costs incurred by one unit of heat are for each technology. These assumptions are based on:

   a. Emission factors from NAEI (see Table A1.2): These are emission factors for NOx and PM10 that have been sourced directly from NAEI's database and converted, into the relevant units. These emission factors are used for all the non-domestic technologies.
   b. Damage cost values from Defra (see Table A1.3): Non-domestic values use the 'NOx' and 'PM Industry' damage costs which are consistent with Defra's previous work on AQ damage cost calculations. These damage costs are estimates of the costs to society of the likely impacts of changes in emissions. They assume an average impact on an average population affected by changes in air quality. The damage costs we have used come from the IGCB Air Quality subgroup and include values for the impacts of exposure to air pollution on health, morbidity effects, damage to buildings and impacts on materials.

Table A1.2 NAEI Emissions factors (DEFRA)

		NAEI Emission factors	
		PM	NOx
		[kg/kwh]	[kg/kwh]
Renewable Heat Fuel	Biogas	0.000036	0.000863
	Biomethane	0.000003	0.000193
	Electricity	0.000003	0.000108
	Biomass	0.000108	0.000540
Counterfactual Fuel	Natural Gas	0.000003	0.000193
	LPG	0.000003	0.000193
	Coal	0.002110	0.004003
	Oil	0.000435	0.006080
	Electricity	0.000003	0.000108
	Biomass	0.000108	0.000540

Table A1.3 IGCB Air quality damage costs per tonne of emission, 2015 prices

	Air Quality Damage costs in £ per tonne (2015 Prices)		
	[£/t]	[£/t]	[£/t]
	Low Central Range	Central Estimate	High Central Range
Nitrous Oxides (NOx)	£421	£1,052	£1,684
Particulate Matter (industry)	£23,665	£30,225	£34,347

5. The sensitivities are based on the central emission factors from NAEI and high/low damage cost values from Defra. These values are shown in Table A1.3 above. Variation between the Damage Cost values reflects uncertainty about the time lag between the exposure to air pollution and the associated negative health impact. There are no sensitivity tests for domestic RHI technologies.

Carbon Savings Assumptions

6. In order to provide estimates for the carbon savings, it has been necessary to make a number of assumptions within our calculations. These include assumptions about the efficiencies of the technologies, CO2 factors, counterfactual mix and carbon prices.

7. The CO2 factors have been generated by DECC looking at likely mixes of potential sources of biomass and use the biomass sustainability rules to inform the assumption. The range follows the EU LCA methodology and includes land use change at the highest end. For heat pumps and deep geothermal technologies the CO2 factors are obtained from the DECC's calculations toolkit. This approach is confirmed by the RHI engineers. This is the same methodology as used within the previous impact assessments.

8. For biomethane and biogas the emissions factors also now include upstream savings which are further explained within Annex 3.

9. Table A1.4 shows the CO_2 emissions and Table A1.5 shows the efficiency factors. Both these tables also include sensitivities which have been calculated with the central estimates and have been agreed with by DECC engineers.

10. The carbon savings calculations also include an assumption about the mix of deployment against the counterfactual. The counterfactual can make a big difference in terms of the carbon savings. There is a great deal of uncertainty regarding the counterfactual mix and in order to demonstrate this we have assumed a mix of 50% gas and 50% oil. We have carried out sensitivities with 100% oil and 100% gas with the results showing that a higher mix of oil provides most carbon savings and a higher mix of gas provides fewer carbon savings.

11. The calculator assumes carbon prices and sensitivities from the IAG Toolkit. This data also provides the split between traded and non-traded carbon prices.

Table A1.4 CO2 emission values associated with biomass and biogas boilers under the RHI

Technology	CO2 Emission (kgCO2e/kWh)		
	Low Savings	Central Savings	High Savings
Biomass Boilers	0.1330	0.0501	0.0230
Biomethane/Biogas (Including upstream savings)	-0.2608	-0.3084	-0.4159

Annex 2: Analysis and Evidence

Domestic Analysis and Evidence

1. The Impact assessment so far has considered the strategic case behind specific decisions and the conclusions of the analysis conducted. This annex looks in detail at:
    a. Caps in the scheme
    b. Key assumptions used in tariff setting
    c. Sensitivity of the proposed tariffs to changes in key assumptions

Caps in the domestic scheme

2. Final installation and operating costs can vary widely between each project meaning that standard flat-rate tariffs will inevitably lead to varying rates of return for different households. This is particularly true for variation in the size of households.

3. Economies of scale for the costs of installed systems in the domestic scheme means that the greatest returns can be found for those installations which are largest. This could cause two issues:
    a. **Risk of over compensation –** Installations which are largest most frequently take up the RHI and have a rate of return significantly above the target rate, and significantly above those of smaller households
    b. **Large system dominance –** To date larger systems have accrued very high returns and dominated deployment. The introduction of caps aims to control this.

4. In order to mitigate this risk we propose to introduce annual caps to the domestic scheme. This would mean that a household would receive the tariff up to the level of the cap, but would receive no further support for the year if their heat demand was beyond this point.

5. The appropriate level of the cap depends on a number of factors, but seeks to:
    a. Maintain a target rate of return across the housing stock
    b. Allow a balance between over and under compensation in order to offer a fair proposition to all off-gas grid households.

6. The broad trade-off is the higher the cap, the lower the tariff has to be to maintain an average rate of return – so under compensating small householders.

Domestic Biomass Assumptions

7. In this consultation we do not propose to change the level of the biomass tariff. However for reference we include below our assumptions regarding the cost and performance of biomass systems

Input assumptions

8. Table A2.1 below lists DECC's latest input assumptions associated with the cost and performance of biomass systems. These assumptions represent our central scenarios and reflect our latest evidence. For comparison, the range of assumptions used in the original tariff setting exercise is presented as well.

Table A2.1 Domestic biomass input assumptions

Assumption	2014 Tariff Setting	2016 Tariff Proposal	2016 Source
Tariff level (p/kWh)	12.20p	5.14p	Consultation Proposal
Targeting methodology	Median cost off gas grid opportunity	Central reference installation	Policy Assumption
Annual heat demand of target household (kWh/yr)	8,900 – 40,500	24,500	DECC Calculations
Capacity (kW)	7 - 30	20	Policy Assumption
Capex (£/kW)	680 - 1080	850 (695 – 1,110)	Sweett 2013
Opex (£/kW)	6-8	5	Judgement
Design efficiency (%)	85%	84% (72.5% – 90%)	Design Performance PCDB
In-situ efficiency (%)	-	74% (62.5% - 80%)	DECC Judgement
Lifetime (years)	20	20	Policy assumption
Heat Load Factor	8% - 26%	14% (11% – 19%)	Calculated from Scheme Data
Counterfactual technology	Oil	Oil	Policy Assumption
Is the cost of a wet system included in the lifetime cost calculation?	No	No	Policy Assumption
Is VAT included in the capital cost?	No	No	Policy Assumption
Cap level	N/A	25,000kWh/yr	DECC Calculations
Range of households considered	N/A	10,000 - 40,000 kWh/yr	English Housing Survey Analysis
Fuel price series	E4Tech 2010	4.8p/kWh	Sutherland tables

9. Heat load factors have been estimated using scheme data. We would welcome any views you may have on these.

10. The input assumptions used for the counterfactual technology are in line with the assumptions used in previous tariff setting. It is assumed that a potential applicant would consider a 20kW biomass boiler against a 40kW oil boiler, with a capital cost of £159/kW, load factor of 7% and fuel cost of 4p/kWh.

11. Table A2.1 above shows that the technology cost and performance assumptions used are similar to those used in the previous tariff setting exercise.

Tariff sensitivity analysis

12. Analysis shows that the rate of return offered to our reference installation under the proposed tariff would be 2%. However, it is important to highlight that the range of tariffs suggested by the model is highly sensitive to a number of key technology specific cost and performance assumptions. This implies that some projects could deliver higher rates of returns than are being suggested.

13. The key assumptions that drive changes in the returns realised by households are discussed below. DECC modelling suggests that any of the following conditions could enable 20kW biomass installations with a heat demand of 25,000kWh/yr to achieve a 7.5% level of return.

    a. **Fuel prices** The total cost of biomass fuel makes up a significant portion of the total lifetime cost of running the system. Biomass prices are very uncertain and depend on multiple factors. Analysis suggests that reducing total biomass fuel expenditure over 20 years by ~£6000 (24%) would be sufficient to lower the running costs of an installation and generate returns of 7.5%.

    b. **Load factors –** The tariff calculation compares the cost differential between an oil boiler and an equivalent biomass boiler that is expected to meet the households heating demands. A load factor is what percentage of the time a unit is operating at full capacity and this assumption is crucial to derive the tariff. Analysis suggests that installations operating at a 17% load factor opposed to a 14% load factor could achieve a rate of return of 7.5%.

    c. **Capital costs -** A change in the capital cost will alter the cost differential between the two heating technologies and change the expected rate of return on the investment. A lower capital cost for a biomass installation will make it more attractive compared to a conventional technology. Analysis suggests that reducing capex from £850/kW to £670/kW (a 22% reduction), could return 7.5% on the investment.

Domestic Heat Pump Tariff Calculations

Target market

14. The proposed ASHP tariff has been determined by calculating the level of support necessary to compensate the cost of switching from oil heating to an ASHP for smaller sized households. The proposed tariff offers the target rate of return of 7.5% to oil heated households that switch to a 10kW ASHP and have an annual heat demand of 14,000kWh.

15. The proposed GSHP tariff has been determined by calculating the level of support necessary to compensate the cost of switching from oil heating to a GSHP for a central reference household. However the proposed tariff is constrained by the value for money cap and it is therefore set at that level.

Input assumptions

16. Table A2.2 lists the input assumptions of each reference installation used for the calculation of the domestic heat pump tariffs. Aside from ASHP capacity which has been chosen in line with the targeting methodology, these assumptions represent our central scenarios.

17. It should be noted that while the heat load factor for both ASHPs and GSHPs is set at 17% based on scheme data, this is based only on the ASHP data.

18. As GSHP are disproportionately affected by the relative capital expenditure, and given that previous analysis has shown that the tariff is not set at a level to incentivise the median installation, we believe that those installations which do come forward are more likely to be those with high heat load factors and thus more chance of breaking even making the data skewed.

19. We also do not necessarily think that ASHP and GSHP should be differently sized compared to total and peak heat demands, but would welcome any evidence to confirm this or indicate an alternative assumption.

20. Table A2.2 above shows that the technology cost and performance assumptions used are similar to those used in the previous tariff setting exercise suggesting that it is the updated targeting methodology and fuel prices that are driving the change in the tariff level.

Table A2.2 Domestic Heat Pump input assumptions

Assumption	2014 Tariff GSHP	2014 Tariff ASHP	2016 Tariff GSHP	2016 Tariff ASHP	2016 Source
Tariff level (p/kWh)	18.8p	7.3p	19.51p	9.5p	DECC Calculations
Targeting methodology	Median cost off gas grid opportunity	Median cost off gas grid opportunity	Central reference installation	Smaller sized households	Policy Assumption
Annual heat demand of target household (kWh/yr)	4,400 – 35,000	8,700 – 40,000	17,000	14,000	DECC Calculations
Capacity (kW)	4 - 21	2-21	12	10	Policy Assumption
Capex (£/kW)	1750 - 2140	730 – 1250	1,939 (1,430– 2,600)	990 (790 – 1,340)	Sweett 2013
Opex (£/kW)	25	10-12	8	10	DECC judgement
Design efficiency (%)	337%	284%	340% (280% – 410%)	300% (250% – 340%)	Heat Emitter guide[38]
In-situ efficiency (%)	N/A	N/A	Interim RHPP metering: 284% (261% - 327%) RHPP Metering report: 230%	Interim RHPP metering: 251% (218% - 283%) RHPP Metering report: 275%	DECC judgement
Lifetime (years)	20	20	20	20	Policy assumption
Heat Load Factor	12 – 23%	10 – 23%	17%	17% (13% – 22%)	Calculated from Scheme Data and DECC judgement.
Counterfactual technology	Oil	Oil	Oil	Oil	Policy assumption
Is VAT included in the capital cost?	No	No	No	No	Policy assumption
Cap level	N/A	N/A	25,000kWh/yr	20,000kWh/yr	DECC Calculations
Range of households considered	N/A	N/A	0-35,000kWh/yr	0-30,000kWh/yr	English Housing Survey Analysis
Fuel price series	DECC (2013)	DECC (2013)	DECC (2016) Adjusted to reflect the marginal cost of electricity	DECC (2016) Adjusted to reflect the marginal cost of electricity	DECC Standard Assumptions (2016)

38 http://www.microgenerationcertification.org/admin/documents/Heat%20Emitter%20Guide%20final%20A4%20printer%20version%5B1%5D.pdf

Tariff sensitivity analysis

21. It is important to highlight that the range of tariffs suggested by the model is highly sensitive to a number of key technology specific cost and performance assumptions.

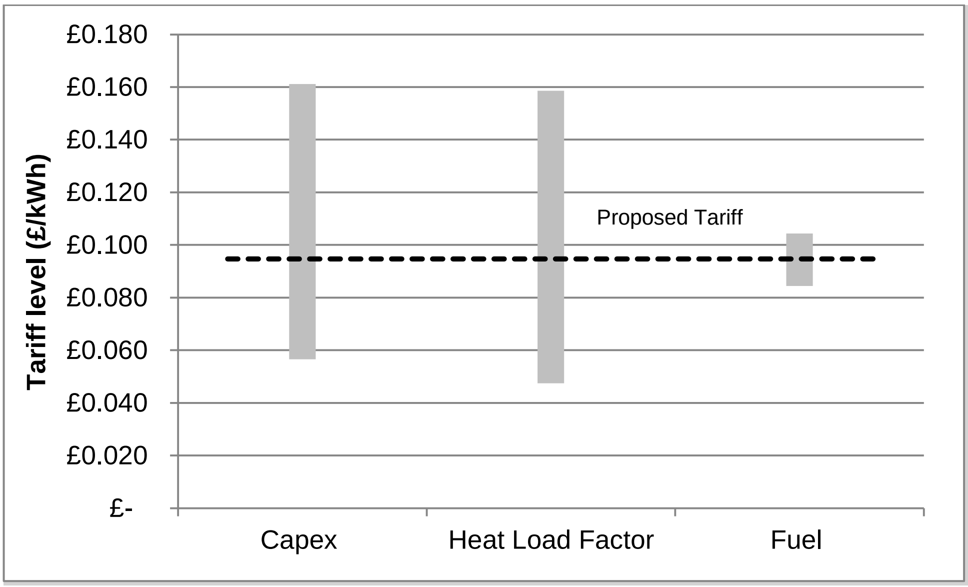
22. To demonstrate these uncertainties high and low scenarios of each key assumption have been explored for our reference installation. The key assumptions driving the tariff levels are discussed below and the range of tariffs they produce are presented in figures A2.3 and A2.4 below.

    d. Fuel prices – Fuel price assumptions were made using the projections provided in the Inter-departmental Analytical Guidance (IAG) toolkit, which were estimated by DECC. Low and high electricity price scenarios have been explored for the renewable heat technology. These price scenarios are listed in the guidance tables. No fuel price change is assumed for the counterfactual technology.

    e. Load factors – ASHP load factor assumptions are constructed using evidence from scheme data. 25% has been added and subtracted from the central value to calculate the high and low scenarios. GSHP load factor assumptions have been created via policy decisions informed by the evidence base. For the purpose of this sensitivity analysis we have chosen to test the GSHP tariff against the 21% load factor implied by the scheme data.

    f. Capital costs – Capital cost assumptions are sourced from Sweett (2013) data. High and low scenarios are constructed through calculating the 10th and 90th percentile of the renewable capital cost distribution data.

Figure A2.3 – Variation in suggested tariff for ASHPs



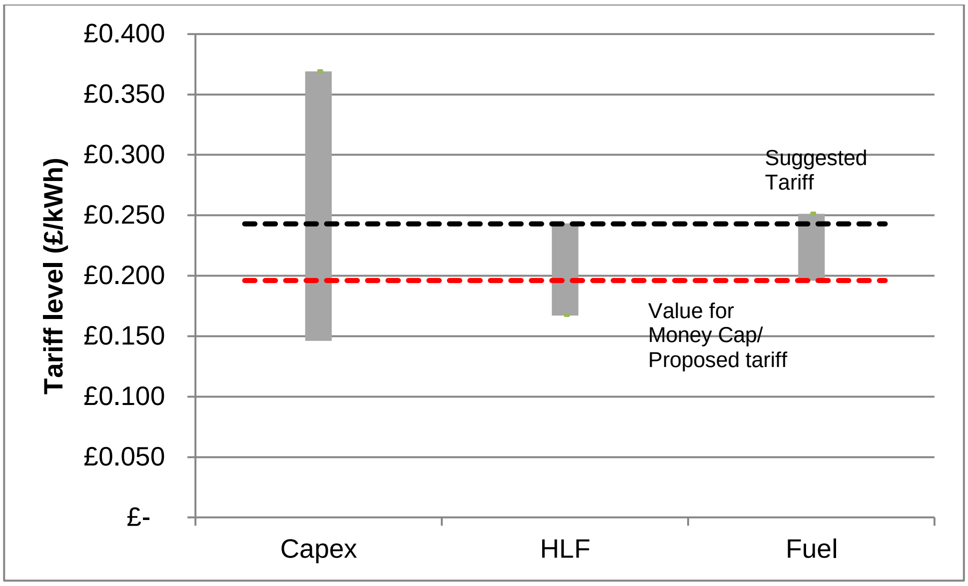
23. Our modelling calculates suggested tariffs equal to the level of compensation required for a household to achieve a 7.5% return on their investment. Given a set

of household characteristics, if the suggested tariff is below the proposed tariff then these households would require less financial compensation than what they could expect from the proposed tariff and therefore could expect a return in excess of 7.5%

24. Figure A2.3 presents a range of suggested tariffs determined by different assumption values. This illustrates that there is a large degree of uncertainty underlying our assumptions indicating that the returns experienced by individual ASHP projects will vary significantly.

25. It can be assumed that any household that experiences capital or fuel costs in line with our low scenarios could expect returns of 7.5% on their investment. Likewise, households that run their system at a heat load factor above the central scenario (14%) could also expect a 7.5% return on their investment.

Figure A2.4 – Variation in suggested tariff for GSHPs



26. The suggested tariff for our reference GSHP installation was modelled at 24p/kWh. However as mentioned, the tariff level that can be offered is constrained by the value for money cap, therefore the proposal is to set the tariff at this level.

27. Figure A2.4 demonstrates that although the proposed tariff will not ensure a 7.5% return for our reference case, the same installation could in fact return 7.5% if it is run at a greater load factor or if it faces lower capital costs (bar area under the red line).

Capital Costs

28. Capital costs for low carbon heating systems vary significantly by size, type of system, type of household and ancillary work required to ensure the system is working well.

29. To date we have used Sweett 2013 data to inform our assessment of the costs associated with low carbon heating technology. Data collected from the RHI, offers the opportunity to update this with self-reported costs data from householders at the stage of application.

30. The capital costs used for tariff setting are supposed to reflect the costs of installing a low carbon heating technology (exc VAT) and any strictly necessary improvements to the household. This data reported by householders may not meet this requirement, however can provide an indication as to whether the Sweett 2013 data collection is relevant for the market today.

31. The decision as to whether to update our assumption will be made by combining the Sweett 2013 evidence, with evidence from the consultation and evidence from scheme participants.

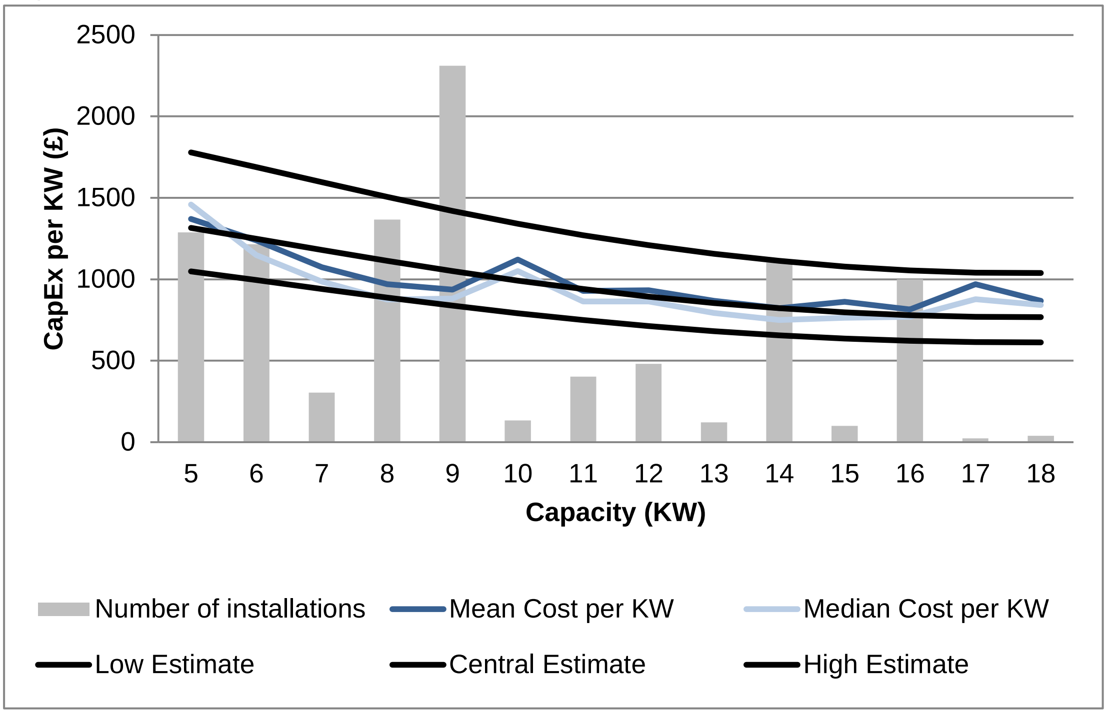
32. We would welcome views on the evidence below and in the associated publication.

ASHP

33. The self-reported data from RHI participants is broadly similar to the data collected by Sweett 2013, with the cost per kW fluctuating around the central assumption.

34. This would suggest that the cost data collected by Sweett 2013 is broadly representative of the ASHP deployment to date under RHI.

Figure A2.5 Scheme data on self-reported ASHP capital costs



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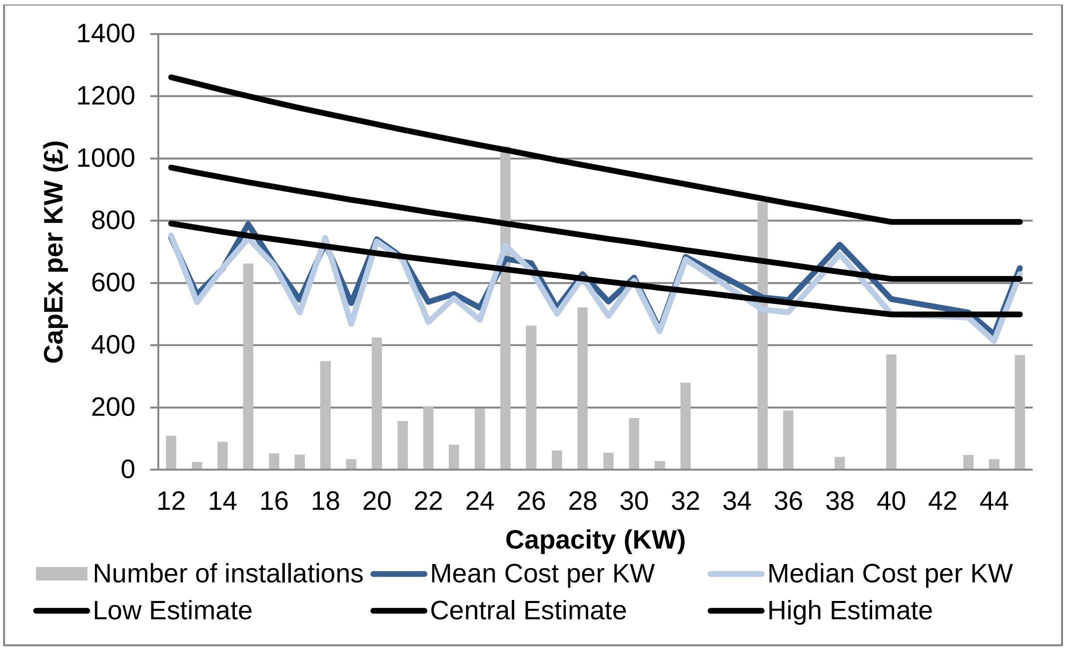
35. The self-reported costs faced by householders who installed biomass boilers are lower than Sweett 2013 found, particularly for smaller systems. In addition there appears to be little to no economies of scale for larger installations.

36. Feedback form industry would be helpful in order to understand the differences identified in this analysis.

Figure A2.7 Scheme data on self-reported Biomass capital costs



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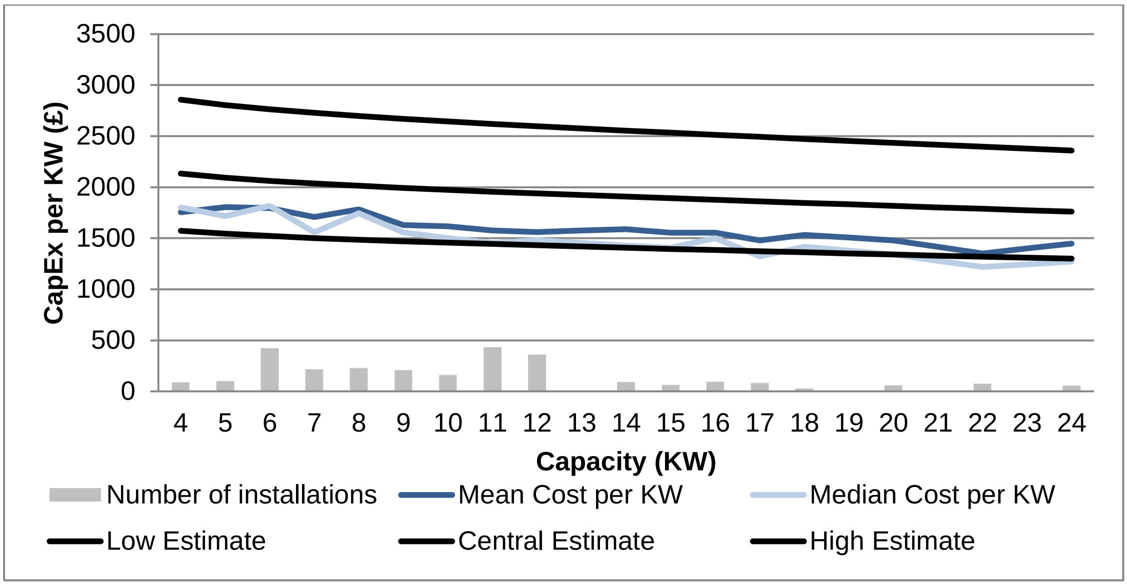
37. The self-reported costs faced by householders who installed ground source heat pumps are consistently lower than were reported in Sweett 2013. This is expected, the decision was made that the GSHP tariff should target borehole installations, not those with horizontal ground loops. Boreholes are likely to face higher costs.

38. From the market intelligence the GSHPs supported within the RHI to date have been a mix between borehole and horizontal ground loops.

Figure A2.9 Scheme data on self-reported GSHP capital costs



Non-Domestic analysis and evidence

39. The Impact assessment so far has considered the strategic case behind specific decisions and the conclusions of the analysis conducted. This annex looks in detail at:
    a. Biomass key assumptions and sensitivities
    b. Heat pumps key assumptions
    c. Biomethane data and variation in the cost effectiveness of feedstocks

Non-Domestic Biomass

Target market

40. The proposed tariff has been determined by calculating the level of support necessary to compensate the cost of switching for large plants that operate on a 50/50 mix of oil and gas. Specifically, this impact assessment considers the level of support necessary to compensate the costs incurred by an oil/gas plant switching to a 4MW biomass boiler.

41. To determine the appropriate tariff we used a Monte Carlo model which looked at the additional costs of a large biomass system and the variation around these assumptions to develop an appropriate range of tariffs for these consultation proposals.

Input assumptions

42. Table A2.11 on the next page lists the input assumptions used for the tariff calculation.

43. The main changes from the tariff setting in the 2013 tariff review are the targeting at a specific plant and also our treatment of the uncertainty surrounding many of the assumptions.

44. This includes a change in the range of heat load factors being used for the low and high scenarios. Previously these were set at 10% - 30%, but are now 15% - 35% which we believe better reflects both the likely range of actual use of large systems as well as better reflecting the aims of the policy change to encourage those systems which can make the most efficient use of biomass. Altering this range has little impact on the median value which has been considered for our central scenario which remains 20%

45. The input assumptions used for the counterfactual technology are in line with the assumptions used in previous tariff setting. It is assumed that a potential applicant would consider a 4kW biomass boiler against a 4MW oil boiler and a 4MW gas boiler, both with capital costs of £70/kW, load factors of 20% and fuel costs of 4p/kWh and 2p/kWh.

Table A2.11 Non domestic biomass input assumptions

Assumption	2016 Tariff Proposal	2016 Source
Tier 1 tariff level (p/kWh)	2.03-2.9p	DECC Calculations
Targeting methodology	Large Biomass	Policy Assumption
Annual heat demand of target installation (kWh/yr)	7MW	DECC Calculations
Capacity (kW)	4MW (1MW– 8MW)	Policy Assumption
Capex (£/kW)	250 (150 – 800)	DECC judgement based on scheme data, AEA data
Opex (£/kW)	10 (6 – 23)	Judgement
Design efficiency (%)	75% (70 – 85)	DECC Judgement
Lifetime (years)	20	Policy assumption
Heat Load Factor	20% (15 – 35)	Calculated from Scheme Data
Counterfactual technology	50/50 oil and gas	Policy Assumption
Tier 2 level	1.8-2.03p	DECC Calculations
Fuel price series	4p/kW	Market Intelligence

Tariff sensitivity analysis – Large biomass plants

46. It is important to highlight that the range of tariffs suggested by the model is highly sensitive to a number of key technology specific cost and performance assumptions .

47. The sensitivity analysis in this section tests how responsive the tariff is to changes in key assumptions that drive changes in the tariff level. These are discussed below.

   d. **Fuel prices –** Fuel costs make up a significant proportion of the total running costs of a project. Reducing the cost of biomass fuel would significantly reduce the level of financial compensation required and therefore under a single tariff structure, could greatly alter the returns experienced.. The central biomass fuel scenario assumes 4p/kW, high and low scenarios assume a 3p/kW and 5p/kW.

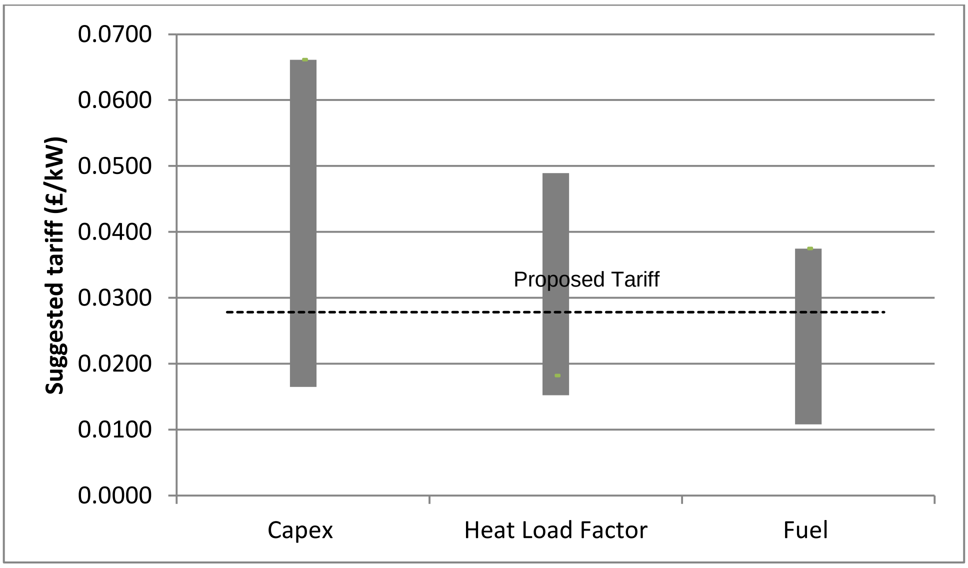
   e. **Load factors –** Load factor assumptions used for tariff setting have been inferred from scheme data. Three alternative load factor scenarios are tested below (10, 30 and 40%), an extreme high scenario is included to capture in our modelling plants that join the scheme and operate at very high load factors. The central scenario assumes large biomass plants operate at a 20% heat load factor.

f. **Capital costs –** Capital costs make up a significant proportion of the total lifetime cost of a renewable heating system, therefore can significantly influence the required level of financial compensation. Capital cost assumptions are established using DECC judgement which considers information from a number of sources. . The central scenario used in the tariff calculation assumes a capital cost per kW of £250/kW for large systems.

48. The first section of this sensitivity analysis focusses on the returns offered to large biomass systems as they are the installations targeted by the scheme.

49. For this consultation a tariff range has been proposed between 2.03 and 2.9p. For the purpose of this sensitivity analysis the proposed tier 1 tariff is assumed to equal 2.78p/kWh.

Chart A2.12 Variation in Large Biomass Tariff



50. Our modelling calculates suggested tariffs equal to the level of compensation required for a plant to achieve a 12% return on their investment. Given a set of plant characteristics, if the suggested tariff is below the proposed tariff then these plants would require less financial compensation than what they could expect from the proposed tariff and therefore could expect a return in excess of 12%.The length of the bars on the above chart shows the range of tariffs suggested by our modelling using high and low assumption scenarios.

51. This chart illustrates that the suggested tariff highly sensitive to these three assumptions meaning that the returns realised will vary significantly by project under the flat tariff that’s being proposed.

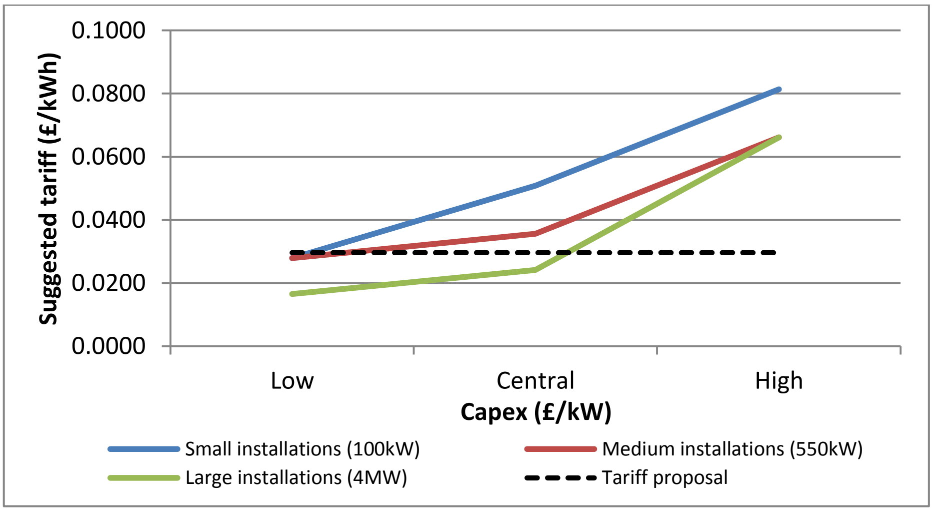
52. For instance, large plants that can source biomass fuel for 3p/kW rather than 4p/kW can expect returns over 12%. Alternatively, plants that run at a heat load greater than 20% or face capital cost less than £250/kW can also expect returns over 12%. In reality we expect only a small minority of plants to experience these cost saving opportunities. The tier 2 tariff reduces the risk of overcompensation towards these types of plants by limiting their potential returns.

Tariff sensitivity analysis – Small and Medium sized biomass

53. Plant 'banding' will not exist under the new tariff structure. Therefore small (<100kW), medium (>=200kW<1MW) and large (>1MW) sized biomass plants will all be subject to the same tariff level.

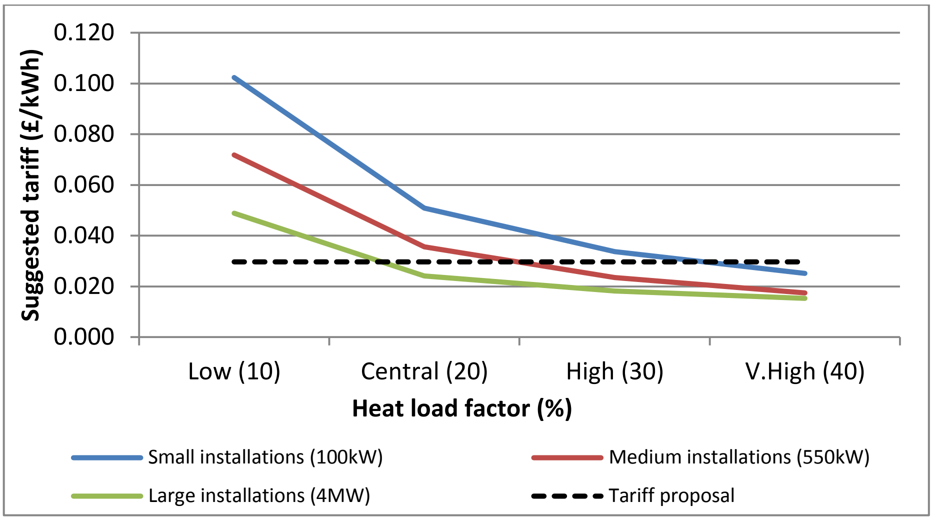
54. Although the proposed tariff has been calculated to encourage the deployment of large systems, as proved above, the returns realised by plants is sensitive to a number of assumptions. In an extension to the above analysis, the sensitivity testing below considers the potential returns available for small and medium sized plants when varying plant characteristics.

Chart A2.13 Incentive for small & medium biomass with varying capex assumption



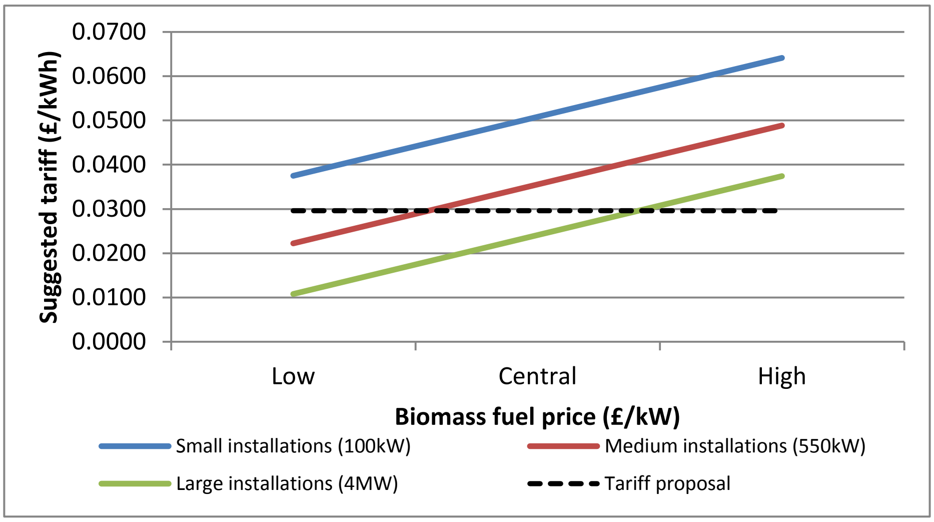
55. Plants that face higher capital costs per kW will require a larger amount of financial compensation therefore a higher tariff level. Assuming that small and medium sized systems face cost similar to our central assumption, they would fail to achieve a 12% return on their investment under our tariff proposal. However, if small or medium sized installations face capital costs more in line with our low scenario (£600/£400/kW rather than £1,000 £800/kW) it is possible that these plants could return 12% on their investment under the proposed tariff.

Chart A2.14 Incentive for small & medium biomass with varying Heat load factor assumption



56. Increasing the load factor of an individual installation would result in the plant producing a greater amount of heat for a given amount of capital, as such plants that run on a higher heat load factor would require a lower tariff level. The suggested tariffs in the figure above show that small installations could return over 12% on their investment if they operate at a 40% load factor, whilst medium sized installations could return over 12% if they operate at a 30% load factor.

Chart A2.15 Incentive for small & medium biomass with varying fuel price assumption



57. Finally Chart A2.15 shows the sensitivity of the tariff between installations attributed to 1p/kWh increases/decreases to the biomass fuel price per kW. This indicates that small installations would have to experience a fuel cost saving in excess of 1p/kWh from the central scenario if they are to realise returns of 12% from the proposed tariff. However, a similar fuel cost saving would be enough for medium sized plants to achieve a return of 12%.

58. In summary, a ‘typical’ 4MW biomass installation does not exist in the market. The cost and performance of installations vary significantly by project meaning that it is very likely that installations will realise capital or fuel costs across the whole range of scenarios mentioned above. Although the tariff has been constructed to target large biomass there will be a group of small and medium sized installations that will return 12% or more on their investment.

Non-Domestic Heat Pumps Tariff Calculations

59. No changes have been proposed to tariff levels offered to non-domestic ASHP and GSHP.

Input assumptions

60. For reference table A2.16 below reflects our current cost and performance assumption data for non-domestic ASHPs and GSHPs.

Table A2.16 Non domestic heat pumps input assumptions

Assumption	2016 ASHP	2016 GSHP	2016 Source
Tier 1 tariff level (p/kWh)	2.54p	8.84p	Consultation proposal
Tier 2 tariff level (p/kWh)	N/A	2.64p	Consultation proposal
Capacity (kW)	175	90	Policy Assumption
Capex (£/kW)	750	1700	Judgement based on Sweett, AEA and scheme data
Opex (£/kW)	12	25	Judgement
Design efficiency (%)	320%	360%	Design Performance PCDB
Lifetime (years)	20	20	Policy assumption
Heat Load Factor	22%	22%	Sweett (2013)
Counterfactual technology	50/50	50/50	Policy Assumption
Is VAT included in the capital cost?	No	No	Policy Assumption
Fuel price series	DECC (2016)	DECC (2016)	Standard DECC assumption

Biomethane

61. The analysis performed within the impact assessment concerning biomethane is distinct from other technologies within the RHI due to fundamental differences within markets and plants. One such difference is the range of emissions from plants types using different feedstock's as a fuel.

62. This primarily arises from the inclusion of 'upstream savings' within feedstock's overall emissions, which subsequently have a large impact on the carbon cost effectiveness of the individual plants.

63. It is for this reason that we include separate sections detailing the methodology of the carbon cost effectiveness analysis performed, as well as the resultant net emissions which include the upstream savings.

Biomethane Tariff Calculations

Target Market and policy assumptions

64. Calculations of the required biomethane tariff follow a different process as compared to other technologies within the scheme, the details of the process can be found within the 2014 Biomethane Tariff Review [Insert Link]

65. To account for the proposed policy decision of limiting the amount of crop eligible for payments, the modelling, assumes a lower proportion of crop used within a reference plant, with the proportion of food waste increasing

66. As within the previous tariff review we assume that the combination of costs for acquiring most feed stocks and the payment producers receive for taking in food waste produces a net cost of zero for feed stocks overall. This blended feedstock cost of zero effectively removes such costs from the calculation so as to capture the fact that developers cannot rely on the revenue received from gate fee.

67. The wider reasoning behind such an approach is the acknowledgement that there still exists some risk of being unable to secure enough food waste feedstock, while at the same time supporting and incentivising a pure food waste plant.

68. The reference plant size is 6MW; this originally was chosen to maintain the first tier tariff in the previous tariff review, with further market intelligence confirming the average size of plants being approximately 6MW.

Cost and Performance Assumptions

69. Table A2.17 below lists the input assumptions used for the tariff calculation. For comparison, the range of assumptions used in the original tariff setting exercise is presented also.

70. Apart from previously discussed assumptions which reflect the change in policy, such as the change in crop proportion and subsequent change in gate fee to maintain a blended feedstock cost of zero, the only change is of CAPEX.

71. The 20% lower CAPEX assumption is based on market intelligence that suggested the original values found within the 2014 consultation were possibly higher then actually experienced which along with further supply chain cost savings and strong deployment levels at degressed tariffs suggested lower CAPEX was appropriate.

Table A2.17 Biomethane Cost and Performance Assumptions

Assumption	2014 Tariff Setting	2016 Tariff setting
Targeting methodology	Pure food waste plants, with some allowance for crop	Pure food waste plants, reduced crop support
Capacity (MW)	1st Tier – N/A 2nd Tier – 12 MW 3rd Tier – >12MW	1st Tier – up to 6MW 2nd Tier – up to 12 MW 3rd Tier – >12MW
Capex (£/kW)	2014 Consultation values	20% Lower
Opex (£/kW)	2014 Consultation values	Same
Feedstock costs (£/t)	Blended feedstock cost: £0	Blended feedstock cost: £0
Average wholesale gas price (£/MWh)	£22.3	£19.3
AD Efficiency	90%	90%
Heat Load Factor	85.5%	85.5%
Counterfactual technology	Natural Gas (Qatari LNG)	Natural Gas (Qatari LNG)

Annex 3: Biomethane Carbon Cost Effectiveness Analysis

Overview

1. To inform our policy proposals for the consultation, we have produced a range of estimates of the carbon cost-effectiveness of anaerobic digestion (AD) for the production of biomethane for injection to the gas grid. By 'carbon cost-effectiveness' we mean the net resource costs incurred to save a tonne of carbon.[39] The remainder of this section provides an overview of the analytical approach taken before presenting outputs from the analysis.

Carbon savings from AD

2. In order to estimate carbon savings from AD, we have assumed that the emissions impact of AD, in terms of CO2e emissions generated per unit of energy produced (i.e. biomethane injected to the gas grid), is no greater than the maximum emissions impact permitted under the UK's biomass sustainability criteria. For our lower bound (optimistic) estimate of carbon cost-effectiveness we have assumed that emissions from AD are 20% lower than the sustainability criteria limit where agricultural feedstocks are used; and 90% lower than the sustainability criteria limit where food waste is used.[40]

> Our approach to estimating carbon savings from AD serves to provide an *indicative* estimate of £/tCO2e saved based on the emissions limits under the UK's biomass sustainability criteria. Insofar as the emissions impact of AD differs from the sustainability criteria limits we welcome further evidence which may help to better understand the carbon cost effectiveness of AD.

3. We assume that there are additional, 'indirect' emissions impacts from AD which relate specifically to the use of the particular feedstock in the AD process rather than its counterfactual use. For agricultural feedstocks (manures and slurry) there is an assumed reduction in net methane emissions due to replacement of fertilisers; while food waste AD results in methane emission savings through diverting food waste from a landfill site (see Box 1, below).

> **Upstream emissions impacts assumptions**
>
> Food waste
>
> We have assumed that food waste AD produces indirect, or 'upstream' emissions abatement, as a result of diverting food waste from landfill where it would emit methane. We have based this assumption on the following:

[39] Including carbon equivalents, namely methane emissions.

[40] The assumption in relation to food waste is based on the belief that the associated emissions relate solely to those from the transportation of the food waste to the AD plant and are therefore negligible.

- A report[41] published Defra, which indicates a value of 350g CO_{2eq}/tonne of organic waste landfilled.

- A (currently unpublished) report by the University of Manchester, which indicates a value of 517gCO_{2eq}/tonne of food waste; and a third-party peer-review of this report, which indicates a value of 430gCO_{2eq}/tonne of food waste.

- A (separate) Defra-funded study which provides a basis for estimating methane and carbon dioxide released in a landfill from a range of wastes including food waste, which yields a value of 320gCO_{2eq}/tonne of food waste, excluding the benefit of electricity produced from captured landfill gas.

- The GHG Inventory has identified that the historic estimate of landfill gas capture rate of 75% used in some of the above studies was optimistic. The inventory projected average methane capture rate over the excepted 18 year economic lifetime of a anaerobic digestion plant is 64.7%

Converting the range of these values, with modified capture rates as appropriate from a *per tonne of food waste* basis to *per unit of energy produced* basis, using our AD plant load factor and throughput assumptions, we consider that, for the purposes of our analysis, a sensible assumption is that food waste AD produces an upstream emissions abatement effect of between 450 and 900gCO_{2eq}/ kWh of energy produced, with a central assumption of 790gCO_{2eq}/kWh.

<u>Agricultural feedstocks</u>

We have assumed that slurry- and manure-based AD produces upstream emissions abatement as a result of the following effects:

- *Avoided fertiliser benefit* – the process of digestion in chemically breaking up the structure of the plants makes the nutrient content of the digestate more available to the crops to be grown on the land. This is a relatively small benefit for the digestion of slurries compared to food waste otherwise destined for landfill which would not be land spread otherwise. Our assumption is based on the University of Manchester study making an assumption in our analysis that slurry-AD produces an upstream emissions abatement effect, specifically as a result of avoided fertiliser benefits, of 2.6gCO_{2eq}/kWh of energy produced.

- *Avoided storage loss* – slurries are normally stored between their generation and the availability of land and staff to spread the material. Slurry storage can use slurry tanks or lagoons, which may or may not be covered. These are significant emitters of methane to the atmosphere. In anaerobic digestion systems the storage of feedstock and digestate and methane produced in the reactor is generally enclosed capture. Hence there is a reduction in emissions. This improves the GHG balance of anaerobic digestion of slurries. We assume that slurry-AD produces an upstream emissions abatement effect owing to avoided storage loss of 600gCO_{2eq}/kWh, with a range from 100 to 1000gCO_{2eq}/kWh, based on

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values cited in the University of Manchester study weighted by data from the 2015 Farm Practice Survey on the prevalence of lagoon and tank based storage systems.

- We have not assumed any difference in emissions between spreading digestate and slurry. Although adequately processed digestate is expected to release less methane on spreading than slurry.

4. We have also assumed an amount of methane leakage in the AD process. Given the impact of assumed methane leakage on the estimated carbon cost-effectiveness, we have produced three sets of results based on differing methane leakage assumptions (see figures 1 to 3 overleaf).

We welcome evidence on the upstream emissions impacts of using particular feedstocks in AD; as well as evidence on methane leakages in the AD process.

5. We have subtracted expected CO2 emissions in the counterfactual in order to arrive at the net emissions from AD. The counterfactual represents our assumption as to how methane would be delivered to the gas grid if not via AD, which is assumed to be Qatari LNG.

Resource costs of AD

6. Our estimate of resource costs of AD plants is based on data in DECC's Biomethane Tariff Model. Resource costs are comprised of capital expenditure, operating expenditure, feedstock costs and finance costs. We have subtracted resource costs in the counterfactual to arrive at net resource costs, for which we have used the IAG Green Book long-run variable cost of gas value, minus the transmission and distribution components.

The dataset underpinning our resource cost estimate is based largely on industry responses to the [2014] DECC consultation on biomethane tariff changes. Insofar as there is new evidence on AD costs, which may support a more accurate estimate of carbon cost effectiveness of AD, we welcome this.

Results

7. Indicative £/tCO2e saved estimates are presented overleaf. The analytical approach differs from the IAG Carbon Cost Effectiveness Calculator[42] in that it does not distinguish between carbon saved in the traded and non-traded sectors (thereby assuming that saving a tonne of carbon has the same benefit to society regardless of where it is saved); and it does not account for air quality impacts. Therefore, while the approach is valid for supporting a comparison of carbon cost-effectiveness across different AD examples, the results should not be compared against carbon cost-effectiveness estimates for other (non-AD) technologies.

8. The results indicate that AD using food waste is considerably more carbon cost-effective than AD using crops, manures or slurries. This result owes largely to assumed methane emissions savings from using food waste in AD rather than allowing it to go to landfill; hence our call for evidence to help validate the assumptions we have used. That we assume food waste AD plant operates receive revenue in the form of gate fees for food waste also explains the result, though this has a much less significant impact on the results.

9. We have not taken account of any carbon emissions impacts relating to Indirect Land Use Change (ILUC), which is potentially relevant to the use of crops as an AD feedstock. ILUC refers to changes in agricultural land caused by the expansion of croplands for biogas/biomethane production. ILUC can lead to increases in net greenhouse gas emissions (GHG) due to clearance of plants that naturally store carbon during growth. We do not know the extent to which use of crops in AD contributes to ILUC. Insofar as it does – and insofar as this causes increases in net GHG emissions – the carbon cost-effectiveness of crop-based AD will be worse than implied by our analysis.

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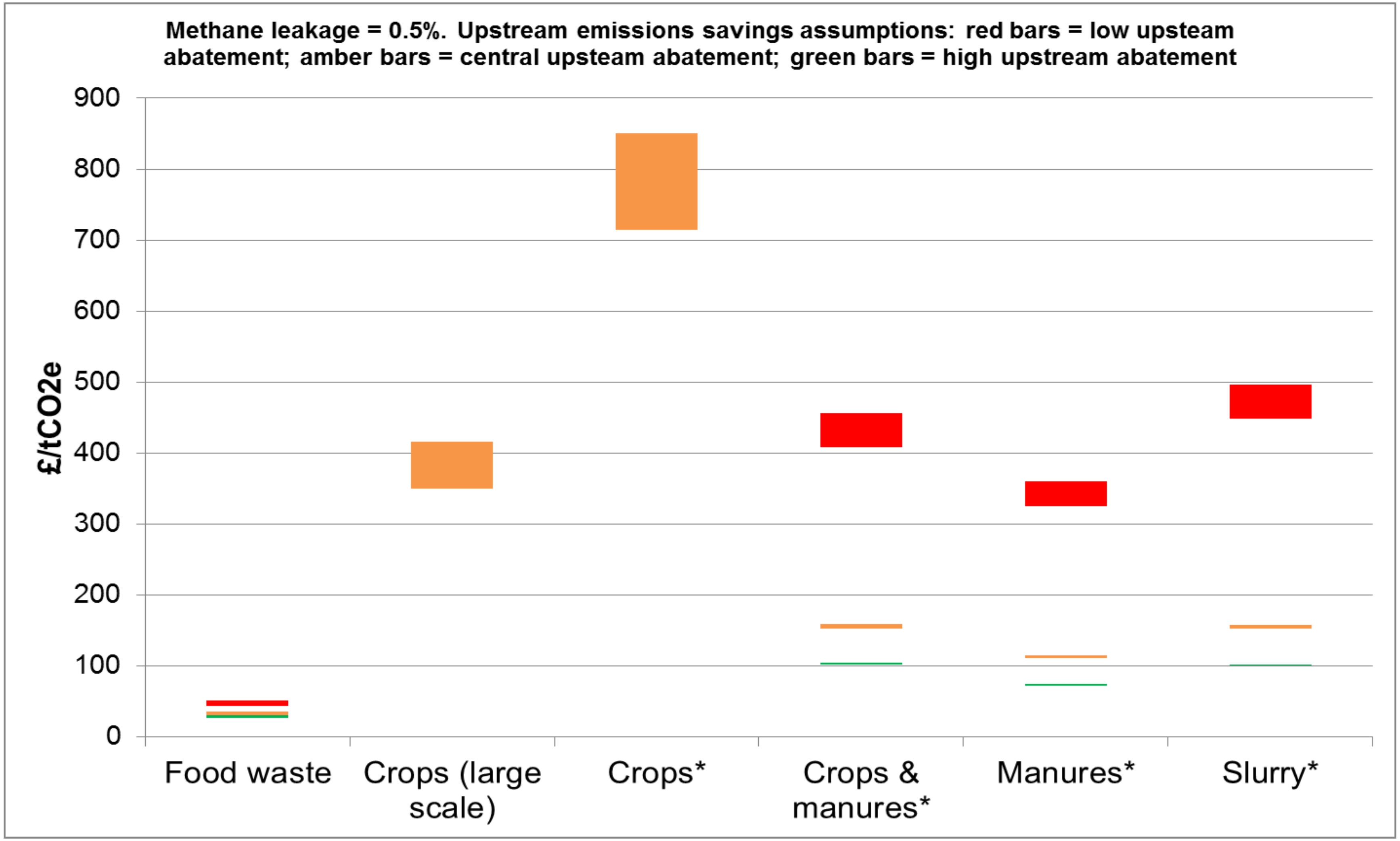
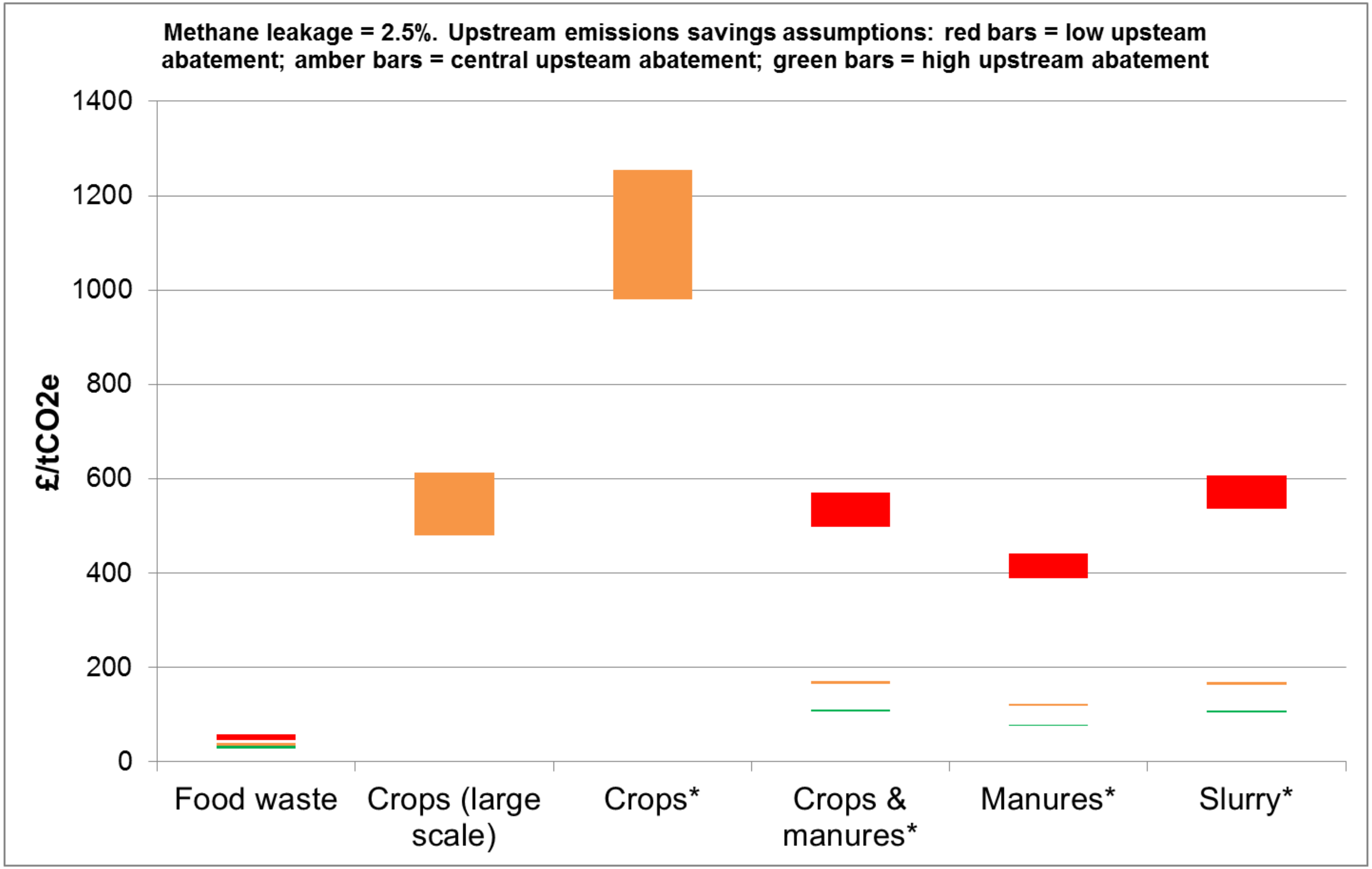
[42] $CE_{NT} = -(NPV - PVC_{NT})/C_{NT}$
I.e. take the negative of the NPV excluding the relevant (either traded or non-traded) carbon benefits value, and divide by the physical carbon impacts.

Figure A3.1: Estimated carbon cost effectiveness of anaerobic digestion for biomethane injection to the gas grid, assuming methane leakages in the AD process are controlled to a minimum.



* based on small scale AD plant (1MWth capacity).

Figure A3.2: Estimated carbon cost effectiveness of anaerobic digestion for biomethane injection to the gas grid, assuming methane leakages in the AD process are limited to 2.5% of total methane produced.



* based on small scale AD plant (1MWth capacity).

Annex 4: Heat pump performance

1. The performance of a heat pump is measured by the amount of heat produced per unit of input energy (electricity). This can vary between each case depending on the design, installation and operation of the system.

2. DECC commissioned monitoring of just over 700 heat pumps installed under the domestic Renewable Heat Premium Payment (RHPP), carried out between 2011-2014, and 21 ground and water source heat pumps installed under the Non-Domestic Renewable Heat Incentive (NDRHI), carried out between 2012-2014, to establish the installed performance of heat pumps and to identify causes of variations in heat pump performance.

3. The main findings from these reports are that the in-situ performance of heat pumps is lower than their design specifications. Specifically, of the systems monitored, up to ~47% of the RHPP ASHPs, ~23% of the RHPP GSHPs, and 43% of non-domestic G&WS HPs had seasonal performance factors lower than 2.5[43] and therefore did not meet the Renewable Energy Directive RED definition of renewable.

4. When using these findings in the context of the RHI, a judgement is required as to how representative these monitoring results are of heat pumps which will be installed under the RHI over the coming years. The monitored RHPP heat pumps were selected so as to be representative of the heat pumps installed under the RHPP and under the Microgeneration Certification Scheme (MCS).

5. The RHPP was the predecessor scheme to the Domestic RHI. We do not have more recent evidence regarding the performance of heat pumps installed under the Domestic RHI but we might expect installed performance to improve somewhat over time as the supply chain became more familiar with the technology and its performance. However, although the available qualitative evidence is also limited it suggests that, between the collection of this data and the start of the Domestic RHI, there is unlikely to have been a step change in the way domestic MCS heat pump systems are designed, installed and operated. The MCS heat pump installer standard, MIS 3005, underwent a significant update in 2011 with version 3.0. The monitored sample includes heat pumps installed both before and after this update. Since then the standard has been updated 5 times, up to the current version, 4.3,

[43] Figures calculated using SEPEMO heat pump system boundary H2, in line with the RED methodology. Boundary H2 includes the electricity used by the source pump/fan and the heat pump itself. Boundary H4, which is usually a more appropriate metric for generating estimates of carbon savings, also includes the electricity used by any back-up heaters and the heating system pump/fan. An SPF calculated at boundary H4 will be lower than at H2 for the same heat pump system. For a fuller description of heat pump see, p16: http://ec.europa.eu/energy/intelligent/projects/sites/iee-projects/files/projects/documents/sepemo-build_final_report_sepemo_build_en.pdf
RHPP figures are calculated using weather corrected data; the non-domestic data has not been weather corrected.

which came into effect in May 2015. However, these subsequent updates have been less substantive.

10. For non-domestic heat pumps the evidence is more limited. The monitored NDRHI units do not include ASHPs and it was not possible to obtain a representative sample of G&WS HPs. In general, we would expect ND HP performance to be different, and in some cases better, than domestic HP performance. However, the limited evidence to date does not support the hypothesis that ND HPs are performing better than domestic HPs. We are currently analysing scheme metering data to assess whether there is a compelling case to amend our assumptions from those originally used, for non-domestic heat pumps

11. Technology cost and performance data is used to calculate the costs and benefits associated with the proposed changes to the scheme. In our analysis to date, all heat pumps are assumed to operate at an in-situ SPF of 2.51 (ASHP) and 2.84 (GSHP)[44] . This performance assumption reflects the average in-situ SPF across the whole stock of monitored RHPP heat pumps and is not weather corrected, as these results were not yet available.

12. The latest RHPP evidence concludes that heat pump performance across the whole RHPP stock monitored averages 2.3 (ASHP) and 2.75 (GSHP). It also concludes that only a portion of the total heat pump stock operate at an SPF of 2.5 or greater; 53% (ASHP) and 77% (GSHP)[44]. For the purposes of calculating the amount of renewable heat contributed by heat pumps operating at an in-situ SPF of 2.5 or greater, it is necessary to observe the average in situ SPF of only those heat pumps that meet the RED performance criteria, which is 2.93 (ASHP) and 3.19 (GSHP)45. These updated values are weather corrected. Table A4.1 below details the differences between our current assumptions and the latest RHPP evidence.

Table A4.1 Current assumptions vs. Latest RHPP evidence

	Current Domestic Assumptions		Latest RHPP evidence		
	In-situ SPF	Heat pumps with in-situ SPF above 2.5	Average in-situ SPF of heat pumps with in-situ SPF above 2.5[43]	Average in-situ SPF of total heat pump stock[43]	Heat pumps with in-situ SPF above 2.5[44]
ASHP	2.51	100%	2.93	2.30	53%
GSHP	2.84	100%	3.19	2.75	77%

13. The impact of these assumptions on the analysis presented in this Impact Assessment is mainly on the renewable energy eligible to count towards the RED, due to the way in which this is calculated. The impact on these assumptions on the carbon savings achieved is negligible.

[44] SEPEMO boundary H4
[45] SEPEMO boundary H2

14. Research publications are planned for Spring/Summer 2016 with the aim to explore the technical reasons for good and poor heat pump performance.

15. In addition to the protections already in place in the RHI, going forward there are measures designed to help raise the performance levels of future systems. Firstly, the EU Energy-related Products Directive was introduced in September 2015 requiring a minimum product performance of 2.5; this will increase to 2.7 from 2017. The Government has also asked Dr Peter Bonfield from the Building Research Establishment (BRE) to chair an Independent Review of Consumer Advice, Protection, Standards and Enforcement for UK home energy efficiency and renewable energy measures. The review is working with industry to identify measures that might lead to performance improvements in future. In addition to these immediate performance improving initiatives, the consultation is investigating what further measures could be implemented through RHI to support the delivery of well performing heat pumps.

Impact on RED Target

16. Reducing the assumed heat pump performance implies that less renewable heat is produced from every unit of heat generated. Under the assumptions we have used to date, all heat which originates from a renewable source (rather than from electricity) is countable towards our RED target meaning that a fall in average performance would have a proportionate and small impact on the amount of renewable heat that is countable towards the RED target. Significantly reducing the proportion of heat pump stock that operate at an in-situ SPF of 2.5 or greater would impact the cost effectiveness of heat pumps because total heat pump expenditure would be spread across significantly less renewable heat.

17. We are keen to improve the evidence base regarding the performance of the different renewable technologies in the field, through any additional evidence supplied during this consultation as well as through further work to strengthen the evidence base. Given the range of uncertainties noted above, two scenarios have been presented in Table A4.2 to estimate the amount of RED renewable heat from the proposed changes to the scheme. Column 1 presents the central estimations using the current performance assumptions; Column 2 presents the central estimations using assumptions based on the latest RHPP performance evidence.

Table A4.2 Summary of RED renewable heat generation for heat pumps, under different performance assumptions

	2020/21 (TwH)	
	Current Domestic Assumptions	Latest RHPP evidence
Total RED Renewable Heat supported from Heat pumps	1.25	0.90

Impact on Carbon Savings

18. A reduction in the assumed heat pump performance would mean that a system would require a larger proportion of electrical input to generate a unit of heat. This would therefore reduce the amount of carbon being saved. The Impacts are detailed in Table A4.3.

Table A4.3 Summary of carbon savings for heat pumps, under different performance assumptions

	Net carbon Savings (Mt CO_2)			
	CB3 2018-2022	CB4 2023-2027	CB5 2028-2032	Lifetime
Heat pumps (Current assumptions)	1.82	2.52	2.62	10.27
Heat pumps (Latest RHPP evidence)	1.77	2.47	2.58	10.10
Percentage Change	-3.14%	-2.01%	-1.26%	-1.65%

19. Changing the proportion of heat pump stock that operate at an in-situ SPF of 2.5 or greater will not affect carbon savings; therefore these estimates are based on the average performance levels of all monitored heat pumps in the RHPP sample.

Reporting Approach and further evidence

20. There is significant uncertainty as to how representative RHPP data will be of the non-domestic RHI and the domestic RHI supported heat pumps. In addition, the consultation sets out suggestions for further supporting the deployment of high performance systems.

21. We therefore welcome views and evidence from stakeholders and experts as to what the in-situ performance of heat pumps is likely to be over the next few years and on how heat pump performance can be improved.

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