Title: Renewable Heat Incentive - Domestic **IA No: DECC0099** **Lead department or agency:** DECC **Other departments or agencies:**	Impact Assessment (IA) **Date:** 18/09/2012 **Stage:** Consultation **Source of intervention:** Domestic **Type of measure:** Secondary legislation **Contact for enquiries: Daniel Newport 0300 068 6023**
Summary: Intervention and Options	**RPC:** Not required

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

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

The renewable heat market is largely developing and has been identified as a sector that could cost-effectively provide around a third of the UK Government's target of 15% of energy from renewables by 2020. A step change in the uptake of renewable heat generating technologies is required to achieve this potential contribution. Currently these technologies are unable to compete financially and there are a number of market failures that prevent their deployment such as the lack of carbon price in the non-traded sector and information asymmetries, as well as barriers such as perceived risks associated with new technologies, and costs of disruption associated with switching. Without government intervention, the private sector is not expected to achieve the required uptake.

What are the policy objectives and the intended effects?

The Renewable Heat Incentive (RHI) aims to drive an increase in renewable heat from the current 2% of total heat demand to a level of 12% by 2020 (as per the 2009 Renewable Energy Strategy). The domestic scheme will aim to incentivise the installation of domestic renewable heating up to the estimated marginal cost of meeting the renewables target. In so doing the RHI will seek to achieve further cost effective deployment of renewable heat, while unlocking positive externalities associated with innovation and demonstration and laying the foundations for mass deployment in the 2020s necessary for the UK's heat strategy and carbon budgets.

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

The preferred option is to award tariffs to compensate households for the difference in lifetime costs (including up-front, running, barrier and financing costs) between the renewable technology and currently used conventional heating technology for the 'median cost' off gas grid opportunity (NB eligibility is not limited to off grid homes). A number of sub-options are put forward for consideration during the consultation, they could be added to the preferred option above. Sub-options are explained in the body of the IA and refer to options for: a) capping tariffs for value for money; b) Incentivising improved performance; c) incentivising installations in new build; d) incentivising deployment through bivalency; e) ensuring longevity of use; f) incentivising social landlords; g) potential further disaggregation of tariffs. Further sub-options including those for social landlords and tariff disaggregation are covered in the body of the IA.

Will the policy be reviewed? It will be reviewed. **If applicable, set review date:** 2015

Does implementation go beyond minimum EU requirements?			**No**		
Are any of these organisations in scope? If Micros not exempted set out reason in Evidence Base.	**Micro No**	**< 20 No**	**Small No**	**Medium No**	**Large No**
What is the CO_2 equivalent change in greenhouse gas emissions? (Million tonnes CO_2 equivalent)			**Traded: -3.7**	**Non-traded: -18.9**	

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 ______________________ Date: 19/09/12

Summary: Analysis & Evidence

Description: Final proposals of renewable heat support for the domestic sector.

FULL ECONOMIC ASSESSMENT

Price Base Year 2012	PV Base Year: 2011	Time Period: 2011-2020	Net Benefit (Present Value (PV)) (£m)		
			Low: -£1,724m	**High:** -£106m	**Best Estimate: -£800m**

COSTS	Total Transition (Constant Price)	Years	Average Annual (excl. Transition) (Constant Price)	Total Cost (Present Value)
Low			8.1	**£226m**
High			122.8	**£3,437m**
Best Estimate			56.4	**£1,580m**

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

Cumulative gross resource costs to society of RHI tariffs over the lifetime of the policy are estimated at around £1.5bn. Estimated air quality impacts of the scheme are estimated to be £0.1bn. These costs are included in the present value calculations.

In addition, estimated subsidy costs, a transfer between taxpayers and consumers, over the same period are approximately £2.6bn.These costs are not included in the present value calculations.

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

The ecosystem impacts, food security impacts and ozone impacts of a reduction in air quality resulting from increased biomass combustion are highly uncertain and have not been monetised.

BENEFITS	Total Transition (Constant Price)	Years	Average Annual (excl. Transition) (Constant Price)	Total Benefit (Present Value)
Low			4.3	**£120m**
High			61.1	**£1,711m**
Best Estimate			27.9	**£781m**

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

Monetised benefits include both traded and non-traded carbon savings. Much of the renewable heat uptake will be outside the EU ETS and will represent additional UK carbon savings.

£116m savings in EU ETS emissions allowances and £664m of non-traded carbon savings.

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

Additional benefits include: Avoided cost of alternative renewables to meet the 2020 target, greater diversification of the fuel mix, improved UK competitiveness in green technologies, innovation benefits and reduced technology costs due to learning from wider deployment.

These benefits have not been monetised and are not included in the present value calculations.

Key assumptions/sensitivities/risks — **Discount rates: 3.5% / 7.5%**

The analysis assumes a private discount rate of 7.5% for the assessment of the required tariffs and projected uptake and a 3.5% social discount rate for the calculation of the net present value of costs and benefits. Assumptions on the private discount rate as well as fossil fuel and carbon price are key drivers of the present value ranges. Changes in the renewable technology costs and performance will also affect the above estimates. Further analysis on technologies could also affect the composition of projected uptake and the associated costs.

BUSINESS ASSESSMENT (Option 1)

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

Contents:

Annexes

Evidence Base

1. **Strategic Overview**

1. The UK is subject to a legally binding commitment to generate 15% of its energy demand from renewable sources by 2020. The Renewable Energy Strategy (published in 2009[1]) found that, on analysis of opportunities across electricity, transport and heat, a suitable contribution from the heat sector was 12% of heat being delivered from renewable sources by 2020.

2. Renewable heat is also a key part of DECC's Carbon Plan[2] and longer-term Heat Strategy, which set out the important role of renewable heat in contributing to the long-term de-carbonisation of energy supply.

3. The Energy Act (2008)[3] made provision for establishing a Renewable Heat Incentive (RHI) subsidy scheme to incentivise investment in renewable heat. In November 2011, DECC launched Phase I of the RHI[4], a set of tariffs targeted at the non-domestic sector.

2. **Rationale for Intervention**

4. The overarching aim of the domestic RHI scheme is to incentivise the cost effective installation and generation of renewable heat to contribute to the heat proportion of the renewables target whilst ensuring the foundations are set to deliver the Heat Strategy and meet future carbon reduction targets cost-effectively.

5. Currently the market for domestic renewable heat is very small, and options such as air source heat pumps (ASHP) and ground source heat pumps (GSHP), biomass boilers and solar thermal are largely unable to compete on cost with conventional heating options such as gas, oil and even electric resistive heating.

6. In addition to cost differences there are a number of non-financial barriers to the uptake of renewable heat. The following describes the rationale for subsidising domestic renewable heating:

2.1. Carbon externality

7. The negative externality of carbon dioxide emissions is not typically reflected in the prices paid by householders for gas and oil heating. Meaning that the burning of fossil fuels for heating in homes is underpriced from a social perspective. This is not true of electricity, which prices in the carbon externality through the EU ETS and the UK's carbon price floor.

2.2. Renewables Target

8. The UK operates under the EU's Renewable Energy Directive (RED) which sets out a legally binding target for the UK of 15% of energy coming from renewable sources by 2020. Although the infraction penalty for not meeting this target is not currently monetised, it is described as being commensurate with the costs of meeting the target[5].

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[1] http://www.decc.gov.uk/assets/decc/what%20we%20do/uk%20energy%20supply/energy%20mix/renewable%20energy/renewable%20energy%20strategy/1_20090717120647_e_@@_theukrenewableenergystrategy2009.pdf

[2] http://www.decc.gov.uk/en/content/cms/tackling/carbon_plan/carbon_plan.aspx

[3] http://www.legislation.gov.uk/ukpga/2008/32/contents

[4] http://www.decc.gov.uk/assets/decc/What%20we%20do/UK%20energy%20supply/Energy%20mix/Renewable%20energy/policy/renewableheat/1387-renewable-heat-incentive.pdf

[5] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:140:0016:0062:EN:PDF

9. Renewable Heat opportunities in the domestic sector are not considered as cost-effective as in the non-domestic sector. However, domestic renewable heating is expected to offer opportunities for renewable energy at or below the cost of offshore wind. Analysis suggests that this is the most likely marginal technology employed at scale to reach the 2020 RED target so is seen as the most appropriate value for money cap. Offshore wind is currently estimated to cost society between 5.7 and 11.9p/kWh (over the baseline cost of electricity generation) over a lifetime of the technology and is being funded under the RO at 2.0 Renewable Obligation Certificates (ROCs) in 2013/14 and 2014/15; 1.9 in 2015/16 and 1.8 in 2016/17. As per the non-domestic RHI a central levelised cost of 8.9p/kWh is used as the RHI proposed cap.

2.3. Dynamic efficiency

10. The Heat Strategy and Carbon Strategy set out the likely need for renewable heat deployment beyond 2020. Domestic heating made up 28% of the UKs 2010 energy demand so will play a key role in putting the UK on a cost-effective decarbonisation pathway to meeting our 2050 decarbonisation target and the UK's carbon budgets. Mass deployment of technologies such as heat pumps is expected to be required from the 2020s, and it is critical that a domestic supply chain exists at sufficient levels to ramp up deployment quickly during this period. Building a sustainable supply chain up to 2020 could reduce pressures and costs of deployment in the 2020s significantly.

2.4. Piloting benefits – positive externalities

11. Domestic renewable heat is currently regarded as a largely unknown market. Deployment to date has been very low in comparison to conventional heating appliances (of the technologies dealt with in this policy, DECC estimates that between 40,000 and 50,000 are installed per year, in comparison to around 1.5m conventional heating systems). Because of this there exist information asymmetries, uncertainties and perceived risks which act as barriers to investment. These are considered to be a key reason for the relatively high rates of return consumers demand on renewable heat technologies. Such barriers can be addressed in part by the provision of information and protection of consumers through standards and guidelines. However it is likely that the deployment and successful application of these technologies will be a key driver in removing barriers across the population. Barriers relating to perceived performance risk, misinformation and uncertainty are likely to fall with deployment and demonstration.

12. Alongside the benefit of a developed and ready supply chain, is the potential positive externality of innovation and improvement of domestic renewable heating. Here, the benefit to society of marginal increases in performance or marginal decreases in costs are not reflected in the price of renewable heating. Given the critical role of domestic renewable heating in long term carbon reduction targets, any such improvements being brought forward in time could result in large benefits to the UK.

2.5. Energy Resilience

13. Renewable technologies add a further non-monetized benefit through diversifying the UK's energy supply, reducing the exposure of the UK to the price of oil and gas through further diversification of energy supply. The domestic RHI will be focused on the off-gas grid areas which are currently heating homes through expensive oil or electric heating options, which expose households to high and volatile energy bills and are generally carbon intensive heating systems.

3. Options Considered

14. A wide range of design options have been considered during the development of the domestic RHI consultation. The options presented here reflect only some of the more favourable options of the broad suite considered. Also presented is a discussion of sub-options (which could apply to any of the main options listed below). Alternative options which were not preferre are presented in Annex 8, also relevant is the section below entitled Payment Period. The preferred option here is intended to offer the best balance between value for money for consumers and certainty for the Government's 2020 targets.

3.1. Option 1: Do Nothing

15. Under this option we would offer no further renewable heat subsidy beyond the end of the Renewable Heat Premium Payments (RHPP) scheme. This is expected to result in very low deployment of renewable heat in the domestic sector.

16. Some renewable heating installations e.g. Air to Air ASHPs (ATA ASHPs) are expected to continue their trend market growth as costs and some deployment will be incentivised through the non-domestic scheme, as part of domestic district heating, which is eligible for non-domestic tariffs. However, the remainder of renewable technologies are expected to experience very low deployment, as current market trends show declines in installation numbers in recent years.

3.2. Option 2: Preferred option – Targeted Off-Gas Grid - 7 year domestic tariffs

17. The preferred option for the RHI is to offer the tariffs in the following ranges to households meeting the RHI eligibility criteria. These ranges indicate the uncertainty inherent in DECC's current data. The top end of each range is set at the level identified by the data presented in the accompanying spreadsheet to this IA, however DECC is working to improve this dataset over the consultation period. This review of evidence may result in tariffs which are higher or lower than those presented here, the range given seeks to present the likely range in which tariffs will fall. For more information on this review and full explanation of data and tariff calculations see Annexes 1 and 2 of this IA.

18. Tariffs have been calculated using 2010 price data which has been inflated to 2012 prices using RPI inflation as set out in the non-domestic RHI, these will be inflated to current prices for the scheme launch in 2013. When inflated to July 2012 prices, the tariffs are as follows:

Table 1: Tariff ranges

	Biomass	ASHP	GSHP	Solar Thermal
Tariff (p/KWh)	5.2 - 8.7	6.9 - 11.5	12.5 - 17.3	17.3

19. No range is presented for Solar Thermal as the 17.3p/kWh cap is lower than both the high and the low of the range identified.

20. This Impact Assessment analyses the impacts of the top range of these tariffs, as these are the values identified by the data set being used to quantify costs and benefits. A change in tariffs would result from a change in that data.

21. These tariffs aim to compensate households for the difference in lifetime costs (including up-front, running, barrier and financing costs) between the renewable technology and currently used conventional heating technology for the 'median cost' off gas grid opportunity. More detail on tariff setting is presented in annex 1.

22. Tariffs will be available to any household meeting the eligibility criteria. This is to ensure that although the scheme is targeted on the off-gas grid because of its high counterfactual costs and, therefore, cost-effective opportunities, it will not exclude part self-funding early adopters, or cost-effective opportunities on the gas grid.

23. Standard tariffs will inevitably lead to varying rates of return to individual householders as the final installation and operating costs will vary with a large number of cost drivers, including: the characteristics of the house, the householders' heating patterns and preferences, the location and geology, the installer and the product installed.

24. This means that economic rents will be accrued by households and possibly installers (and supply chains) with the most cost-effective opportunities. This would be the case with any subsidy regime, or

market in which market participants have heterogeneous characteristics, without case-by-case tariff-setting.

25. By setting tariffs at the targeted median-property, the domestic RHI seeks to ensure that the tariffs are appropriate. At the 50th percentile any inaccuracy in data should result in less extreme under or over-subsidy than it might if tariffs had been aimed towards either end of the range of cost data (e.g. using the median average cost data gives a larger margin for error in both directions, than a tariff set using the extremes of a data range). This is particularly important given the large number of variables and cost drivers, and uncertainty in the market for renewable heat technologies.

3.2.1. Deeming

26. Tariffs will be paid per kilowatt-hour of heat a household is deemed to have generated. Basing tariff payments on deemed instead of metered heat is less costly to administer and does not require the installation of heat meters, which would add £1000 per installation to the resource costs[6]. Tariff payments based on deemed heat generation also help to avoid perverse incentives: they prevent a situation in which households do not mind over-producing (metered) heat, conscious of the fact that they will be reimbursed through higher subsidy payments. On the contrary, deemed tariffs ensure that it is always in the interests of the householder to use their heating equipment as efficiently as possible.

27. On the downside, foregoing meter readings increases the potential for fraud and the uncertainty as to whether the subsidy actually leads to the desired generation of renewable heat. The potential for fraud will vary from case to case depending on the combination of options of conventional and renewable heat technologies a household can choose from. As in the case of bivalency (explained later), consumers with biomass boilers may have incentive to reinstall conventional heating systems but continue to receive RHI subsidies. In this case, the reduction in the benefits to society associated with the substitution from fossil to renewable fuels would be amplified by the opportunity cost of the fraudulent subsidy payment.

28. Using MCS requirements for installation should reduce the opportunity for fraud at this stage, as only accredited installations with proof of purchase/installation will be accepted. Thereafter the scheme will be audited using spot checks, the details of which will need to be decided in final policy design.

3.2.2. Payment Period

29. The preferred option in this consultation is that the subsidy will be paid out over a period of 7 years. This stream of subsidies is shorter than the assumed 20 year life-time of the heating equipment but has the same present value that a 20 year subsidy which compensates consumers for the discounted net cost the renewable heat technology would have. This is explained in further detail in Annex 1.

30. The main motivation for a shorter payment period is to overcome some of the barriers that cause consumers to demand high future compensation in order to make early capital investments. Research suggests[7] that private discount rates may be very high as they capture factors beyond direct financing costs and time preferences, such as implicit barriers, hidden costs, attitude to risk and the opportunity costs of drawing on creditworthiness.

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[6] Based on experience with the Renewable Heat Premium Payment Scheme (RHPP).

[7] It is uncertain how high private discount rates are in total and even whether households use the concept of "discount rates" at all when making consumption decisions. Research provides some indication that consumers' implicit discount rates for energy-related consumption decisions (in revealed and stated preference studies) are very high, well above the rates associated with personal loans or mortgage financing from financial institutions households may have access to.
For a review see Frederick, S, George Loewenstein and Ted O'Donoghue (2002), 'Time Discounting and Time Preference: A Critical Review', *Journal of Economic Literature*, Vol. XL (June 2002), pp. 351–401.]

31. The higher the private discount rate, the higher extended subsidy payments would have to be in order to compensate households for their up-front expenditure on heat installations. Subsidies with upfront payments or short payment periods therefore enable a policy to exploit the difference between private and social discount rates to the public's benefit.

32. The private discount rate of 7.5% used in the modelling for this IA only takes account of extra direct financing costs related to capital and installation expenditure. A shorter payment period has instead been chosen as a cost-effective way to address the other barriers.

33. The longer the payment period of the subsidy, on the other hand, the higher the total number of households that can potentially receive RHI support: Given a private discount rate, a longer payment period stretches out payments allowing the domestic RHI to incentivise more households on a fixed annual budget in any given year.

34. The seven year period[8] therefore reflects a trade-off between consumer preferences for upfront payments and short payment periods and the policy objective to incentivise as many installations as possible while staying within an annual spending limit.

35. Further, many households will require loans to cover the up-front costs of installation. Typically, the RHI tariff will cover both financial and non-financial costs of installing renewable heat. It is expected that on average the RHI tariff (through a 7 year repayment) is around 1/3 related to non-financial costs and 2/3 related to financial costs. Therefore the tariff should be capable of repaying financial costs within 4 to 5 years, a period over which financing is often arranged.

3.2.3. Eligibility

36. To be eligible for the RHI households must meet the following criteria:

    a. Energy Efficiency criteria: households must have a Green Deal assessment and have actioned all 'green ticks' that Green Deal finance is available for.

    b. Microgeneration Certification Scheme: All eligible householders must have had installation by MCS accredited installers. These are industry standards relating to the standard of kit and also to the quality of installation. DECC continues to work with industry on these standards to ensure they re robust in achieving quality systems and consumer protection.

    c. Air Quality and Biomass Sustainability: Air Quality and Biomass Sustainability criteria will apply as per the consultation on the non-domestic RHI which was published on 20 July.[9]

3.2.4. Degression

37. Domestic RHI tariffs will be subject to a contingent degression mechanism similar in design to the non-domestic scheme. See the July consultation for details on non-domestic RHI cost control.[10]

38. To ensure value for money, and that the scheme operates within budget, triggers for tariff degression will be set out in advance. Triggers will be set for individual technologies and there will be an overall cumulative trigger, expressed as the committed annual expenditure on applications received. The percentage degression in tariffs which will occur if these triggers are met will also be set out in advance.

39. The preferred option is that progress against individual technology degression triggers would be assessed on a regular basis (the consultation proposes quarterly or two-monthly) and that degressions

[8] Alternative payment periods were considered. Please refer to Annex 7 for more detail.
[9] http://www.decc.gov.uk/en/content/cms/consultations/rhi_cert_perf/rhi_cert_perf.aspx
[10] http://www.decc.gov.uk/en/content/cms/consultations/rhi_cert_perf/rhi_cert_perf.aspx

of around 5% (though this may need to be higher if consultation evidence points to the need for more flexible tariffs) would occur for each period that a tariff were above its trigger point. These individual trigger points will be set such that they ensure value for money through reductions in tariffs for those technologies which are deploying faster than is necessary to meet 2020 deployment objectives. The rationale here being that if deployment is growing faster than the smooth profile needed, it will indicate that sufficient rents are in the market for supply chains to grow faster than anticipated, and a degression of tariffs should address this.

40. In addition to individual trigger points, a total scheme trigger point would also be established for each period. This would be to ensure that spending does not exceed budget (the proposed individual 5% degressions are considered conservative reductions, which may not act fast enough to react to a substantial bubble in deployment). It is therefore necessary to have an overall trigger which will degress tariffs by an additional percentage if overall spending budget is at risk. The preferred option here is that if this trigger is met then all technologies which are deploying above their own trigger points will be degressed by a further 5%.

41. The details of degression can only be set once a final policy has emerged as this will be required to assess the expected deployment of technologies and the affordability of that deployment. The percentage reductions mentioned above are open questions in the consultation.

3.3. Sub-Options

42. To ensure the RHI incentivises the installation of good quality heating systems which operate to increasing efficiency over time, we are considering the following sub-options:

3.3.1. Sub-option a: Tariff capping

43. The preferred option caps all tariffs at the equivalent of 8.9p/kWh (prices for offshore wind) which, as set out in Annex 2 results in a 7 year tariff of 17.3p/kWh. This means that without the cap, GSHPs would have a tariff of 20.9p/kWh for the median cost property on the off-gas grid supply curve, that tariff is capped at 17.3p/kWh in the preferred option. Although modelling indicates that DECC still expects to see deployment of GSHPs at this tariff level, it may be that the tariff is not competitive enough with the ASHP or Biomass tariffs to provide suitable levels of deployment to achieve the scheme objectives associated with deployment. These being, cost reductions, supply chain expansion, innovation externalities and increases in consumer confidence through successful demonstration. The following sub-option relate to GSHPs:

i. If it becomes evident that GSHPs are not able to compete on the 16p/kWh tariff, DECC could potentially increase the GSHP tariff to 20.9p/kWh (the median cost off-gas grid installation). This would reflect the additional benefits of piloting a technology and achieving deployment, beyond the benefits of the carbon savings and renewable energy contributed by those installations. It may also reflect the fact that a portion of GSHP capital costs can be seen as an investment in longer term renewable heat provision as the costs of replacing GSHPs in future will be lower than the initial cost of installation as for example bore holes will last up to 100 years. This is a benefit particular to GSHPs which is not shared with most renewable technologies. This option could also be justified through evidence that cost reductions are achievable through deployment which will enable degression of the tariff to below the cost of offshore wind.

44. The same situation arises with Solar Thermal, where the cap also binds. As the required tariff is estimated to be much higher than the cap (DECCs current data indicates over 100p/kWh, although stakeholders have indicated that this may be an over-estimate) this consultation is seeking wider views on an appropriate approach to take for Solar Thermal, as an alternative or addition to a straight-forward tariff.

3.3.2. Sub-option b: To incentivise improved performance:

45. To ensure the RHI incentivises the installation of good quality heating systems (in particular heat pumps) which operate to increasing efficiency over time, we are considering the following options:

i. <u>Additional financial support to high performing systems:</u> Under this option, where installations were fitted with suitable metering equipment for proper monitoring of performance, an additional financial support could be given to those installations achieving a certain level of efficiency. This could incentivise both the installation of metering (and hence drive reductions in costs of metering), but also provide additional incentive for the efficient installation and use of equipment.

ii. <u>Raise minimum Standards</u>: Allow energy prices and mandatory standards to incentivise performance. As heat pumps and biomass boilers are expected to have reasonably substantial running costs (at least around as high as a gas boiler in the short term), there is a clear price incentive for consumers to prefer an efficient system. In addition to this, to address the information asymmetry market failure that is likely to put-off consumers from taking up renewable heat, the MCS standards for kit and installation could be tightened over time. This would allow consumers to make well-informed judgements based on mandatory standards for kit and installation and in conjunction with greater provision of information such as the heat emitter guide which allows households to better understand the expected performance of their system (the heat emitter guide gives a look-up table of star ratings for different specifications or heating system).

    This option would include introducing a minimum (possibly rising over time) Seasonal Performance Factor (SPF). This SPF minimum could be estimated on the basis of equipment and system design or measured through metering.

iii. <u>Fund metering</u> – Going further than sub-option ii) to fund a proportion of households to install meters to measure SPFs of their heat pumps would facilitate consumers to hold installers accountable, if systems are not performing well. Heat meters are relatively expensive at the time of writing and consumers may be reluctant to commit their own funds. Economies of scale and innovation in installation methods are likely to bring down the costs of heat meters with increasing demand. Our analysis suggests that an annual improvement of running costs of 0.6% to 2.7% (if one-quarter or all of the homes in the scheme were metered, respectively) would be required for this sub-option to break even in resource NPV terms. This requires a significant year-on-year improvement in performance, but one that isn't unachievable. This is explained in more detail in Annex 9.

3.3.3. Sub-option c: To incentivise new build homes

46. New build is a key opportunity for the roll out of cost effective renewable heating. During the previous consultation on the domestic RHI it was assumed the Part L building requirements would alone drive the demand for renewable heating, however an RHI incentive may be required to ensure new build homes are fitted with renewable heating.

47. The sub-option is to provide a tailored tariff, at least until zero carbon homes become mandatory:
    i. Exclude new build – taking no action could create new properties that will eventually need retro-fitting with renewable heating, at substantial additional cost to society.
    ii. A tailored tariff for new build homes - DECC is proposing to offer an RHI tariff to new build homes to ensure incentives are in place to install renewable heating. New build installation is expected to be much cheaper than retro-fit owing to the absence of disruption costs and the ability to remove a great deal of the capital costs through planned installation and overall heating system design. DECC does not, however currently have enough evidence on which to base a separate New Build tariff. We have separately commissioned research into the costs of different technologies which may help in the setting of future tariff levels. This research is expected to produce evidence on the costs of installing renewable heat technology in new build rather than retro-fitting.

3.3.4. Sub-option d: Bivalency - To incentivise greater take up

48. Bivalency refers to the option to keep or install a back-up conventional heating system to go alongside the renewable system. It is worth noting that at the time of writing, emerging evidence from the Renewable Heat Premium Payment scheme suggests that over 90% of claimants do not require this back up Householders may want to run a back-up for a number of reasons:

    a. A back-up in case of poor performance or break-down of renewable technology. This could act to reduce the risk premium attached to investment in renewable technologies.
    b. To gain peak performance from the overall heating system, it can be more efficient to use back-up boilers to heat water during the summer months for example.

49. Sub-options considered are:

    i. Allow back-up heating systems (bivalency). This is probably most appropriate for heat pumps and solar thermal, where operating costs are expected to be lower than conventional heating systems and so incentives are probably in place to keep using these technologies for the remainder of their useful life (once RHI tariffs cease after the proposed 7 years). Allowing bivalency is likely to encourage a broader group of applicants to come forward. For biomass boilers where running costs are expected to be higher than conventional heating systems, this sub-option poses an issue: there is a danger that incentives would be in place to produce heat using biomass for only 7 years to gain full RHI tariff; but then to switch back to, mainly, using the back-up system. Thus reducing the benefits to society associated with the substitution from fossil to renewable fuels.
    ii. Allow back-up systems except for biomass. As discussed under sub-option i) above, biomass boilers appear to present a risk of under-utilisation (given 7 year tariffs). Excluding them appears to offer a simple solution.
    iii. Allow back-up systems if accompanied by heat metering (and tariff). It is important to ensure that through deeming the RHI does not pay for heat being produced through non-renewable means. In this case metering the output of renewable heat would ensure direct value for money. (NB it would require paying the RHI on the basis of metered heat output - with the deemed heat use acting as a cap on payments to ensure no perverse incentive to over-produce heat). Applicants would be required to purchase a heat meter, currently they are expected to cost around £1000 which is likely to deter some. This option is likely to be most suitable for biomass boilers.

3.3.5. Sub-option e: Tariff longevity: To incentivise the use of biomass kit after 7 years

50. The preferred overall option is to pay tariffs over a period of 7 years (see earlier discussion). However we expect installations to have a technical lifetime of around 20 years. If the RHI ceases incentivising the use of installations after 7 years this leaves prices to incentivise continued use. This is only expected to be a problem for biomass boilers. Biomass prices are expected to be marginally higher than oil. As such, there is potential for incentives to be in place to stop using biomass after 7 years. However, modelling suggests that biomass would have to be 16 to 20 pence per KWh more expensive than oil for this to be worthwhile for consumers, because the price of a new fossil fuel boiler would need offsetting by the fuel savings. This would require biomass to cost around 5 times more than it is currently projected to cost, making this scenario unlikely. Of course, if bivalency were allowed for biomass boilers, any time the short run marginal cost of heating with biomass was above that of the back-up system, a consumer might switch back. The following options are considered:

    i. the RHI tariff could be split such that operating cost differentials (between biomass and counterfactual fuel) were paid over 20 years and only capex and barrier costs re-paid across 7 years. This would ensure an ongoing incentive was available to cover the continuing costs. This might be particularly important to homeowners with an interest in the longer term total-income from RHI; such as those working with third parties for funding;.
    ii. as i) but opex tariff to be reviewed regularly from year 7 onwards. As the future prices of biomass and counterfactual fuels (gas, oil and electricity) are uncertain, DECC could strip out operating costs after 7 years from the current tariffs. This would enable DECC to then set an appropriate

secondary tariff to consumers at the end of the proposed 7 years, to keep using their kit by covering the actual fuel cost differential at that time. This would offer good value for money renewable heating at the time as it would be paying only running costs for equipment that would have already been funded through the RHI.

Total subsidy costs of the sub-options i and ii should be roughly equivalent to the currently proposed tariffs, but may be higher or lower depending on future fuel prices. However sub-option ii) may ensure better value for money for the taxpayer as only the actual fuel cost difference will be paid (although deemed) as opposed to the predicted one, and it is designed to ensure full use of the biomass boiler.

3.3.6. Sub-option f: Social Landlords

51. The preferred option excludes social landlords from eligibility for the RHI tariff. As the proposed tariff compensates at a rate for individual households, DECC believe offering the proposed tariff in this sector will overcompensate Social Landlords and at the scale some of them can operate at this could result in significant profits to the sector. Social landlords do however, offer the potential for a significant contribution to the overall uptake of domestic renewable heat, but given the additional costs of renewable heat compared to fossil fuel alternatives, it is likely that some level of subsidy will be required.

52. We are considering the merits of introducing a domestic RHI tariff specifically to encourage the uptake of renewable heat in social housing. The tariff levels are likely to be lower than those offered direct to households in recognition of the savings available to the sector. The consultation document requests any evidence on the cost reductions achievable through social housing providers relative to individual homeowners to be made available to DECC to assist in this.

3.3.7. Sub-option g: Disaggregation

53. In order to ensure value for money from tariffs DECC is considering whether it is appropriate to further disaggregate tariffs where substantial cost differences occur. A potential opportunity for this is between horizontal array and vertical bore hole heat pumps.

54. A summary of the possible qualitative impacts of each of these sub-options is included in Annex 10.

4. <u>Impacts</u>

4.1. Option 1: Do Nothing

55. As the counterfactual option, there are no monetised costs and benefits associated with option 1. Under this scenario the UK would have to employ other options to meet the renewable target or face the potential for unlimited EU fines incurred from not meeting interim and 2020 renewables targets. There is still expected to be some deployment of renewable heat to 2020 in the absence of further policy intervention. The following deployment, renewable heat and carbon savings are expected to result from cost-effective baseline deployment (predominantly expected from ASHPs) and from some district heating which is projected to service the domestic sector through non-domestic tariffs (District Heating is funded through the non-domestic RHI).

56. More on the uptake and impact modelling methodology can be found in Annex 6.

Table 2: Do nothing deployment

Option 1: Do Nothing	Renewable Heat	Number of Installations	Value CO_2	CO_2 Non-traded	CO_2 Traded
Total	*TWh*	*000s*	*£m (2012)*	*$MtCO_2e$*	*$MtCO_2e$*
2012/13	0.1	1.4	1.6	0.0	0.0
2013/14	0.3	3.1	4.3	0.0	0.1
2014/15	0.6	12.7	8.6	0.0	0.1
2015/16	0.9	20.1	13.3	0.0	0.2
2016/17	1.2	32.7	17.9	0.0	0.3
2017/18	1.5	48.6	22.8	0.1	0.3
2018/19	1.9	70.9	28.3	0.1	0.4
2019/20	2.2	100.4	34.6	0.2	0.4
2020/21	2.6	134.2	41.7	0.3	0.5
Lifetime	55.8	134.2	1110.9	15.1	4.8
Lifetime (discounted)	**55.8**	**134.2**	**622.8**	**15.1**	**4.8**

4.2. Option 2: Preferred option – Targeted off Gas Grid 7 year domestic tariffs

57. The preferred option is expected to generate the costs and benefits shown in the table below, relative to the counterfactual uptake in the table above. The impacts in this table are additional to the results shown above for the counterfactual, such that, for example, where additional renewable deployment as a result of the preferred option is expected to be 3.3TWh, total deployment in the domestic sector by 2020 is expected to be 5.9TWh (3.3TWh plus 2.6TWh baseline deployment). That is not to say that 2.6TWh is non-additional deployment however as much of this is expected to be in renewable technologies for which no domestic tariff is offered.

Table 3: Additional deployment and costs of preferred scenario

Option 2: Preferred	Renewable Heat	Number of Installations	Subsidy Cost	Resource Cost	Value CO_2	CO2 Non-traded	CO2 Traded
Additional	*TWh*	*000s*	*£m (2012)*	*£m (2012)*	*£m (2012)*	*$MtCO_2e$*	*$MtCO_2e$*
2012/13	0.0	0.0	0.0	0.0	-0.1	0.0	0.0
2013/14	0.0	7.0	5.5	1.2	0.1	0.1	-0.1
2014/15	0.1	17.8	17.5	3.9	0.7	0.2	-0.1
2015/16	0.3	33.6	36.1	8.0	2.0	0.2	-0.2
2016/17	0.5	64.7	69.1	15.3	4.6	0.3	-0.2
2017/18	0.9	112.5	124.8	29.3	9.6	0.4	-0.1
2018/19	1.5	181.6	208.2	51.7	17.7	0.5	-0.1
2019/20	2.3	268.3	316.2	81.9	28.3	0.7	0.0
2020/21	3.3	379.6	451.3	120.9	42.4	0.9	0.0
Lifetime	73.2	379.6	3521.2	2715.5	1262.3	18.9	3.7
Lifetime (discounted)	**73.2**	**379.6**	**2,376.1**	**1483.3**	**659.7**	**18.9**	**3.7**

58. An additional 3.3TWh of renewable heat in 2020 is expected to be incentivised through option 2. This is expected to be delivered through 380,000 households installing renewable heat, consisting of the following technologies:

Table 4: Additional deployment under Option 2

000s	GSHP	Biomass	ASHP ATW	Solar Thermal	Total
Additional installations under Option 2	61	64	255	0	**380**

59. In modelling solar thermal the tariff is not expected to incentivise uptake, as it does not cover the costs of even the more cost-effective opportunities (however the model and underlying data does not currently reveal psychological drivers in sufficient detail). In reality we would expect that some solar thermal installations would go ahead as early adopters would use the tariff to offset some of the costs and pay some themselves. We are consulting on the solar thermal tariff, including asking if it is the best way to incentivise solar thermal or whether, for example, a capital grant would be more effective.

4.3. Cost Effectiveness

60. The scheme is expected to cost society £1,483m in resource cost, incentivised through £2,376m of subsidy expenditure. This expenditure is expected to deliver a total of 18.9MtCO_2 savings in the non-traded sector (and a further 3.7MtCO2 savings from the traded sector, though this is a saving on allowances, not an additional carbon saving). The value to the UK of these carbon savings is expected to total £659m (both traded and non-traded). The total carbon cost effectiveness of the scheme is expected to be:

Table 5: Cost per tonne of carbon abated

	Traded C/E	Non-Traded C/E
	£/tCO_2	*£/tCO_2*
Preferred Option	22	94

61. The critical value for money indicator for the domestic RHI is the cost per unit of renewable energy. Both the resource cost and the subsidy cost are shown below. These compare with Weighted Average Discounted Cost Of Carbon (WADC) over the period of £31.4/tCO2 in the traded sector and £44.5/tCO2 in the non-traded sector.

Table 6: Subsidy cost per MWh renewable heat

	Subsidy per MWh	Resource Cost per MWh
	£/MWh	*£MWh*
Preferred Option - undiscounted	51	39
Preferred Option - discounted	34	21

4.4. Air Quality Impacts

62. The air quality costs of policy options assessed in this IA have been calculated using the damage cost methodology[11]. To arrive at an estimated air quality impact this method weighs changes in emission levels of pollutants per sector in a particular geographic area using a specific damage cost value (in £/tonne) for each pollutant. This IA uses damage cost values for two key pollutants: Particulate Matter (PM10) and Oxides of Nitrogen (NOx).

63. The exposure to air pollution has an impact on human health, as well as on the natural and built environment. The damage cost approach takes account of health impacts and impacts on the built environment . Damage cost values for PM10 include health impacts and the soiling of buildings through

[11] For more information and cost values of the Damage Cost approach please refer to: http://www.defra.gov.uk/environment/quality/air/air-quality/economic/damage/

particulate matter. Damage cost values for NOx include health impacts of secondary particulate matter (nitrates). The health impacts cover chronic mortality effects, which consider the loss of life years due to air pollution, and morbidity effects, which consider changes in the number of hospital admissions for respiratory or cardiovascular illness. The cost values do not include the impacts of secondary particulate matter.

64. The damage cost methodology is based on a number of simplifying assumptions and has limitations:

i. Costs of air pollution vary according to a variety of environmental factors, including overall levels of pollution, geographic location of emission sources and meteorology. Damage costs only take these issues into account to a certain degree. Some impacts of air quality changes, e.g. ecosystem and food security impacts or the impacts of ozone, are too uncertain and are not represented by the damage cost values.[12]
ii. The damage cost methodology is based on a generic spatial distribution for each sector of heat generation and lacks any detailed information on where emissions from biomass installations occur.

65. In addition to these assumptions the air quality valuations in this IA are based on a further simplifying assumption: Where a policy option increases the biomass combustion in urban areas all of the increase is assumed to occur in Air Quality Management Areas. This implies a higher abatement cost for NOx (of £29000/ton).

5. Sensitivity analysis

66. Modelling the impacts of RHI tariffs over the lifetime is inherently very uncertain. The domestic RHI seeks to offer tariffs to eligible households to install and generate renewable heat. The market is then free to deliver renewable heat under those tariffs. As such the RHI seeks to harness market efficiency at finding the most cost effective opportunities. In forecasting the impacts of these tariffs DECC uses a sophisticated uptake model, which seeks to replicate the conditions in the market for renewable heat and forecast these out to 2020.

67. Inherently modelling is limited by both the methodology, simplifications and the assumptions it employs. On the supply side this has involved assumptions around:

a. Cost data (for capex, fuel and operating costs)
b. Performance data
c. Supply constraints (constraints on how fast supply can grow of)
d. Variations across different house types of the above assumptions

68. And on the demand side:

a. Methodology (modelling simplifications of real world, such as the number of house types, how supply and demand are matched,)
b. Consumer behaviour (risk and barrier costs, and patterns of boiler replacement)

69. Because these variables fluctuate in the real world (over time and between households) the RHI is an inherently uncertain scheme, especially when forecasting up to 2020. With so many variables, it is challenging to give a strong picture of supply and demand, and that uncertainty grows with each year into the future.

5.1. Cost sensitivities

[12] For a full list of excluded effects please refer to page 6 of Defra's guidelines on damage cost calculations http://archive.defra.gov.uk/environment/quality/air/airquality/panels/igcb/documents/damage-cost-calculator-guidancepaper.pdf

70. In order to demonstrate the sensitivity of Net Present Value (NPV) to assumptions in a clear way, the following sensitivity analysis examines the impact on costs and benefits of a change in renewable capital costs by 20%.

71. If capital costs of renewable technologies are 20% higher than expected, modelling suggests that total resource costs would fall as deployment falls (although the unit cost would rise) and benefits would also fall.

72. In a low capex scenario it is expected that deployment would exceed expectation, leading to higher costs and benefits, at a lower unit cost, but decreasing NPV as the monetized benefits per unit are less than the monetized costs per unit (the avoided cost of using alternative technologies to meet the 2020 Renewable Energy Target has not been included in the NPV calculations).

73. The sensitivity analysis does not include a degression reaction to high deployment as these have not been set out, however in reality this should contain high deployment and therefore the costs of the scheme.

<u>Table 7: Cost sensitivities</u>

NPV £m	High Capex	Central Scenario	Low Capex
Costs			
Resource Costs	225	1483	3181
Air Quality Impacts	1	97	255
Benefits			
Carbon Savings	120	781	1712
NPV	**-106**	**-799**	**-1724**

5.2. Deployment Sensitivities

74. To illustrate the uncertainty the model can capture we have run four deployment scenarios[13] on the potential costs of renewable heating around the preferred option:

    a. <u>Very Low Deployment:</u> What if fossil fuel prices did not rise as fast as expected, while the cost of installing renewable heat was 20% higher than expected?
    b. <u>Low Deployment:</u> What if fossil fuel prices did not rise as fast as anticipated?
    c. <u>High Deployment:</u> What if fossil fuel prices rise faster than expected?
    d. <u>Very High Deployment:</u> What if fossil fuel prices rose faster than expected, while the cost of installing renewable heat was 20% lower than expected?

75. The following tables show the impact on projections of deployment and expenditure of renewable energy deployment, subsidy expenditure:

[13] Fuel price assumptions are from DECC fuel price assumptions and Carbon prices from IAG Carbon Valuation Methodology: http://www.decc.gov.uk/en/content/cms/about/ec_social_res/iag_guidance/iag_guidance.aspx

Table 8 & 9: Deployment sensitivities impact on deployment and subsidy costs

TWh	Very Low	Low	Central Scenario	High	Very High
2012/13	0.0	0.0	0.0	0.0	0.0
2013/14	0.0	0.0	0.0	0.1	0.1
2014/15	0.0	0.1	0.1	0.2	0.4
2015/16	0.0	0.1	0.3	0.6	0.8
2016/17	0.0	0.2	0.5	1.1	1.5
2017/18	0.1	0.4	0.9	1.8	2.5
2018/19	0.1	0.6	1.5	2.8	3.7
2019/20	0.2	0.9	2.3	4.2	5.4
2020/21	**0.2**	**1.3**	**3.3**	**5.9**	**7.3**

£m subsidy	Very Low	Low	Central Scenario	High	Very High
2012/13	0	0	0	0	0
2013/14	1	4	6	10	21
2014/15	2	11	18	29	61
2015/16	5	22	36	64	127
2016/17	9	40	69	121	236
2017/18	14	68	125	205	380
2018/19	23	108	208	320	563
2019/20	34	161	316	477	790
2020/21	47	228	451	665	1037
Lifetime	499	2060	3650	5254	7900

76. The following table shows the resource costs of replacing the renewable deployment in each scenario with the three types of wind generation. The costs of replacing RHI deployment with offshore wind is clearly very high.

Table 10: deployment sensitivities impact on avoided cost of wind generation

£m	Very Low	Low	Central Scenario	High	Very High
Avoided cost of renewables (if offshore R2)	320	1834	4644	8276	10108
Avoided cost of renewables (if offshore R3)	456	2610	6609	11778	14384
Avoided cost of renewables (if onshore)	68	392	993	1769	2161

77. As shown by these sensitivities, modelled deployment is very sensitive to cost assumptions. Although the extremes of this range (very high and very low) are considered unlikely, they highlight the range of uncertainty.

78. On the high side, these figures show the importance of a degression mechanism which can react to such situations to keep deployment and spending in budget and ensure value for money. Under high fossil fuel and carbon prices modelled deployment of RHI measures increases to 5.9TWh, and in conjunction with a 20% fall in capital costs of renewables, rises even further to 7.3TWh.

79. On the low side, these sensitivities highlight the delivery risk to the RHI. Where fossil fuel and carbon prices are lower than expected, the modelled deployment of renewable heat would be lower, as the relative cost of renewables increases. This would result in 1.3TWh of deployment, and if capital costs of renewables were 20% higher than expected as well as the low fossil fuel and carbon prices, deployment

could be as low as 0.2TWh. Although it is not considered appropriate to have an automatic mechanism to increase tariffs, a periodic review system will be in place to potentially adjust tariffs to the latest cost data. As discussed previously, we have commissioned research into the costs of different heating technologies which may mean in the future tariffs need to change to ensure value for money.

5.3. Supply side sensitivity

80. The model employs supply side constraints. In the model these constraints are manifested as a total supply available for each technology in each year (the level of this constraint will be a product of uptake in the previous year, demand in the current year and the maximum achievable growth in any given year). Where demand is greater than supply, the model will constrain uptake to the amount of supply that is available.

81. In the real world markets clearly do not work like this. If demand is greater than supply, we would expect prices to rise until demand met supply, meaning short term profits to the supply side. This would spur new market entrants/investment in supply chain expansion, allowing prices to fall and the greater demand to be met.

82. Our uptake modelling does not capture this complex relationship fully. DECC has tested the supply side assumptions for the preferred option, by allowing the rate of growth to be 20% higher in any year, than under central conditions. If supply was binding in every year, this would allow for around an additional 30-40% deployment through to 2020 (as, for example a supply chain previously growing at 30% per year could now grow at 36% a year).

83. Under these conditions we see 6.3TWh of deployment by 2020, an increase of 0.4TWh over the central scenario. This is a 7% increase in deployment. This is caused by supply being a binding constraint in some early years, so early year deployment grows slightly faster, but towards 2020 we see that supply is no longer binding. This leads to the following impacts:

Table 11 & 12: Deployment and costs and benefits under supply sensitivities

2020 deployment	**central [TWh]**	**20% additional annual growth potential [TWh]**
ASHP ATW	1.38	1.62
Biomass Boiler	1.46	1.55
GSHP	0.53	0.50
Solar Thermal	0.01	0.01

Central (£m)	**Impacts - central**	**Impacts - 20% additional annual growth potential supply**
Resource costs	1483	1685
Estimated carbon savings	781	876

84. The small additional growth allows for ASHPs and Biomass to increase deployment, which leads to a £202m increase in resource costs and a £96m rise in estimated carbon savings.

85. In conclusion, although supply assumptions do impact modelled deployment, they do not appear a major constraint towards total deployment and expenditure, however it does demonstrate the uncertainty over deployment in the early years of the scheme.

86. In final policy design, supply should be constrained by degression, which should act first as a signal to the market that tariffs will fall if deployment is above a certain level and secondly as an automatic mechanism for reducing profitability and therefore the capacity of supply to expand at high rates.

6. Interaction with the Green Deal

6.1. Energy Efficiency Criteria

87. The energy efficiency criteria described earlier (3.3.2) are expected to impact uptake of both the RHI and the Green Deal. While more work will be done to examine this interaction and consultation responses will be key to understanding the interaction, this IA focuses on a qualitative discussion and sensitivity analysis.

a. For households taking up the Green Deal Finance for non-RHI measures anyway, there is the option of using any headroom in their GD arrangements, to part-finance the renewable heat technology (discussed below).

b. For households wishing to take up the RHI, having to take up Green Tick measures (an energy efficiency measure assessed as fundable through the Green Deal) first may have three effects:

   i. some may go ahead with both the Green Tick measures and RHI, incurring the additional barrier cost of the GD assessment, but potentially unlocking benefits of GD. This may increase GD uptake relative to the counterfactual.

   ii. Some may be put off by the additional barrier of the GD assessment, or not be prepared to take up the Green Tick measures and do neither

   iii. Some may do the Green Tick measures and then realise the RHI is no longer as appealing (owing to lower heat load, and drop out).

The preferred scenario assumes these impacts net off and that RHI does not drive higher insulation rates than already estimated by the Green Deal. However, to examine this in further detail, we have conducted sensitivities to test this roll-out of insulation, which suggest that increasing the assumed rate of insulation to account for the possible impact of Green Deal policy leads to very little change in the assumed uptake of renewably heat under the RHI.

7. Administrative costs

88. Until a final policy position and delivery plan is decided upon, it is difficult to estimate precisely what the administrative costs associated with the Domestic RHI will be, as things like staff costs, IT costs will depend on how the scheme is delivered.

89. DECC will be undertaking a detailed exercise with Ofgem to ensure that the scheme is delivered cost effectively, and to ensure that the scheme is designed with these costs in mind.

90. Experience from the non-domestic scheme is that the major administrative cost drivers are the time taken to accredit an application and the number of applications. This in turn is driven by the information required to make an application and the complexity of eligibility for those applications.

91. Other cost drivers will be auditing requirements and the profile of applications (a peak and trough profile will likely increase the required headcount for administering the scheme to cope with busy periods).

92. Costs to consumers, such as the time required to research what a suitable renewable technology may be, have been included in the non-financial barriers of the tariff setting and uptake modelling as well as NPV calculations.

8. Wider Impacts

8.1. Impact on Small Firms

93. The RHI is a voluntary subsidy scheme. Therefore a full Small Firms Impact Test (SFIT) is not undertaken here. However as noted in the February 2010 IA small firms who manufacture or install renewable heat technologies will benefit from the RHI tariffs. We expect that the design of the tariff structure, which differentiates support according to scale, will encourage uptake in the small firms segment as tariff levels should be attractive enough despite potential higher costs of borrowing by this segment (e.g. compared to big firms and industry).

94. Small firms are also expected to benefit from business and job creation opportunities generated from the increased demand for renewable technologies. Currently, a significant proportion of the firms which carry out domestic and other small scale installations are small firms. Therefore, we expect a proportion of the installation and maintenance of the projected uptake to be carried out by small firms.

8.2. Competition Assessment

95. The RHI tariff aims to compensate for the additional costs of the renewable heat equipment and for the higher risks and uncertainties associated with its use compared with conventional heating alternatives.

96. The RHI is expected to have an impact on the competitiveness of the UK in the field of renewable heat technologies, both in terms of manufacturing, installation and maintenance. Firms that currently operate in those segments are expected to see an improvement in their market position relative to the counterfactual of no renewables support. Entry barriers are also expected to be lower than before as the RHI stimulates demand for the technologies and provides demand certainty for new entrants.

97. The RHI tariffs will also have an impact on the competitiveness of renewable technologies amongst each other. As the GSHP and Solar Thermal tariffs are both capped by equivalent cost of offshore wind, the tariffs are not expected to generate the same returns to householders as ASHPs and Biomass Boilers, even though their respective tariffs are higher per MWh generated. So, although the tariffs (through being higher) act to make the GSHP and Solar Thermal technologies more competitive than they would be without intervention, they may remain less competitive than the more cost effective renewable options of ASHP and Biomass.

98. However, as set out in the policy objectives, it is important that a degree of deployment occurs in each of the technologies offered tariffs, as such this consultation requests evidence on the likelihood of deployment given the mix of tariffs and whether any changes to tariffs may be required to achieve this objective (such as the removal of the cap on GSHP tariff or a different approach to Solar Thermal).

99. Finally the RHI is expected to impact on the underlying cost of renewable technologies with two possible opposite effects:

a. Increased support could lead to inflationary pressures on the retail prices of renewable heat equipment while on the other hand

b. Support levels are expected to kick start growth in a very immature UK market promoting economies of scale and technological advance which could drive manufacturing and supply chain costs downwards in the long term.

100. These effects are captured to a certain extent through the future learning rate assumptions that are included in the RHI analysis . Scheduled reviews of the RHI will allow for these impacts to be monitored and better reflected in the scheme going forward.

8.3. Rural Proofing

101. While there is a large degree of uncertainty involved in predicting uptake patterns in terms of geographic location, due to extremely limited historical data, rural populations are expected to benefit particularly from the RHI compared to suburban and urban dwellings because a higher percentage of rural homes are not on the gas grid and rely on more expensive fuels such as heating oil. Our modelling predicts that 145,000 additional renewable heat technologies will be installed by rural households as a result of the RHI. This makes up 38% of all domestic renewable heat installations expected to be taken up due to the RHI, despite rural households only making up 22% of households in the UK.

102. In addition, constraints associated with the use of certain technologies, such as requirement of storage for biomass feedstock used in biomass boilers, or the space requirements for the installation of Ground Source Heat Pumps, mean such technologies are particularly suitable for rural properties. Indeed, 95% of all domestic Ground Source Heat Pumps and 98% of domestic Biomass Boilers are expected to be taken up by rural households.

103. Increased use of renewable energy is also expected to benefit rural businesses involved in the generation of the renewable energy such as the forestry sector, farmers who produce energy crops and biofuels, or who use anaerobic digestion to process agricultural waste. Although we have not quantified these benefits they could add significantly to farm income as prices for biomass and food may rise due to the increased demand for agricultural products. This would also affect rural communities living in the vicinity of the new developments.

104. However for certain technologies the planning system could impose significant constraints, especially in areas of protected landscape, in conservation areas and green belts. However, this is expected to be less relevant for domestic installations than in the non-domestic sector.

8.4. Sustainable Development

105. Renewable Heating is an important step in decarbonising the UK economy towards a more sustainable future. Heat pumps and solar thermal are seen in the UK's Heat Strategy as key long term drivers of decarbonising domestic heat demand.

106. Biomass presents challenges in terms of sustainability. While it is an important tool in meeting the RED target and saving carbon emissions, it may play a diminishing role in the long term decarbonisation of domestic heat demand, as competition on the demand side from many different elements (such as industrial heating demand – for which heat pumps and electric heating may not suffice).

107. As such it is important to ensure that both the biomass used in the scheme is sustainable[14], and that biomass uptake is constrained by degression to ensure that unsustainable growth is not possible.

8.5. Statutory equality duties

108. RHI is a voluntary subsidy scheme which covers a range of renewable heat technologies. Through these technologies a wide range of households with specific needs will be able to access the scheme should they wish to do so. Equality impacts of the scheme should be neutral, considering the possible impacts on the protected characteristics of: age; disability; gender reassignment; marriage and civil partnerships; pregnancy and maternity; race; religion or belief; sex; and sexual orientation, in line with the public sector duty which came into effect in April 2011. All applications for funding will be treated

[14] See RHI Consultation on biomass sustainability: http://www.decc.gov.uk/assets/decc/11/consultation/rhi-certainty-performance/5885-ia-biomass-rhi-cons.pdf

equally and in line with the eligibility criteria which do not discriminate against any of the above protected characteristics. We therefore do not expect the RHI to have any adverse equality effects.

8.6. Justice system

109. Ofgem will be responsible for administering the domestic RHI at its inception. As part of this role it will be responsible for ensuring compliance with the eligibility criteria of the scheme. Where it identifies non-compliance it may decide to take enforcement action. Ofgem will have a range of enforcement tools, including: the power to withhold payments (temporarily or permanently), power to reduce payments, the power to suspend participants and the power to exclude them altogether. These sanctions will be issued by Ofgem and appeals will be heard internally. The courts will not be involved with the process of imposing a sanction. For incidences of fraud, Ofgem will be able to refer the case to the relevant authority to decide whether to prosecute through the criminal courts. Additionally, where a participant has been overpaid and refuses to repay the money, Ofgem may pursue the money through the normal civil debt recovery process. The impact on the judicial system has been deemed as negligible.

ANNEXES

A key part of this consultation is to work with stakeholders to ensure data on costs and performance used to set tariffs is as accurate as possible. A data collection exercise is being launched (reporting in October), which aims to provide a comprehensive update to this data set through examination of evidence from Renewable Heat Premium Payments (RHPP), other government departments and stakeholder surveys and interviews.

In addition, these annexes and the accompanying spreadsheet (which will be published on the DECC website) are intended to demonstrate as fully as possible the data that DECC currently holds and how it has been used to arrive at the indicative tariffs in this Impact Assessment.

DECC welcomes any evidence which could help improve this evidence base over the consultation period. This can be submitted as part of consultation responses or separately. We will also be approaching stakeholders as part of our wider engagement at events during the consultation period to get direct feedback on evidence.

Annex 1 – Input Assumptions

In setting tariffs DECC has used a large dataset of performance and cost data for a large number of house types. This data is disclosed in full in the accompanying spreadsheet to this IA, and these annexes are intended as a guide to that data and how it is used. Throughout, a single example has been chosen to help illustrate the methodology.

House Types

Firstly the housing stock is split over the following characteristics:

Counterfactual* Fuel	Sector Sub-Segment	Location	Building Age & Insulation Type
Electricity Gas Non-net Bound	Detached Flat Other House	Urban Rural Suburban	Solid Wall (insulated) Solid Wall (uninsulated) Post 1990 (insulated) Post 1990 (uninsulated) Pre 1990 (insulated) Post 1990 (uninsulated) New Build

*counterfactual implies that this is the most cost-effective non-renewable technology available to the household.

Example: Here we present the example of an insulated pre-1990 detached property which is in a rural setting has oil as the counterfactual fuel and wants to install a biomass boiler in 2013.

Input Data

For each technology and for each of the combinations of housing characteristics listed above, the spreadsheets list DECC's assumptions on the following (for both the renewable technology and the existing 'counterfactual' technology).

These assumptions are largely taken from work carried out for DECC by AEA. The input assumptions in the accompanying spreadsheet are labelled by source. The majority are taken directly or derived from AEA data, however in places adjustments have been made such as a review of efficiency assumptions by DECC. For more information on how data was derived see AEA report published on RHI webpage.

- Capex per kW
- Fixed Opex per MWh
- Efficiency
- Capacity
- Lifetime
- Annual heat output
- Technical Potential

In addition to these the spreadsheet details, again for each technology and combination of housing characteristics DECC has listed the following estimates:

- Fuel Cost per MWh
- Upfront Risk (implicit) Barriers per MWh
- Upfront Hassle (explicit) Barriers per MWh
- Ongoing Hassle (explicit) Barriers per MWh

These costs are shown as levelised values (the present value divided by the lifetime output of the technology). More detail on how barrier values have been arrived at can be found in annex 3.

The levelised fuel cost has been generated according to the profile of energy use and DECC carbon and fuel price projections over the lifetime of the technology. An explanation and link to details of DECCs fuel price projections can be found Annex 5.

Also shown as an input assumption is the technical potential of each technology for each combination of house type. This has been generated using DECCs Updated Energy Projections (UEP) data, English Housing Survey Data and AEA's assessment of suitability (which can be found in the AEA report to be published on the RHI webpage). These have been used to generate an estimate of the number of houses of each type, the amount of heat used in those houses over time, and the percentage of each house type which is suitable for each technology.

Finally, as costs and performance are being considered over a 20 year period, and DECC projects household energy to fall over this period, an adjustment factor has been calculated which adjusts down the average energy use of the house, to reflect that insulation standards are expected to be higher once Green Deal Green Ticks have been actioned.

Example: For a pre-1990, domestic, detached property which is in a rural setting has oil as the counterfactual fuel and wants to install a biomass boiler in 2013, the following data is used (all costs are in 2012 prices).

Characteristics of Biomass Boiler	
Capex (£/kW)	699.43
Opex per (£/MWh)	11.81
Efficiency	85%
Capacity of boiler (kW)	15
Lifetime of boiler (years)	20
Annual heat output (MWh)	26.99
Fuel Cost (£/MWh)	68.79
Technical Potential (MWh)	72,703
Characteristics of Existing Oil System	
Capex (£/kW)	141.87
Opex per (£/MWh)	8.03
Efficiency	93%
Capacity of existing system (kW)	20
Lifetime of existing system (years)	15
Annual heat output (MWh)	26.99
Fuel Cost (£/MWh)	67.90
Net Cost of Barriers	
Net Levelised Upfront Implicit Barriers (£/MWh)	9.02
Net levelised upfront explicit barriers (£/MWh)	3.31
Ongoing Hassle (explicit) Barriers (£/MWh)	1.41

Other Inputs	
Technical Potential (MWh per year)	72,703
Efficiency Factor	94%

Annex 2 – Tariff setting methodology

The methodology that DECC has used to calculate tariffs is to identify the amount of subsidy per kWh required to compensate for the difference between the lifetime costs of renewable heating technologies and the lifetimes costs of counterfactual technologies, paid over 7 years. We have carried this calculation for each technology and each house type, which can be found in the accompanying spreadsheet. These calculations are described in detail and worked through using our example of a biomass boiler below.

Please Note: there are some exceptions where this methodology is slightly different for example for Solar Thermal, no counterfactual capex is considered. For electric heating the cost of water heating is added to the counterfactual. These differences are shown in the spreadsheet calculations.

1. Calculating a levelised cost

In setting tariffs DECC has calculated the levelised cost, and the tariff required to offset additional costs, for each technology in each house type.

The spreadsheet shows these calculations.

The levelised cost of a renewable technology is the present value of all costs and benefits of the renewable technology divided by the lifetime energy output of that technology. This gives a cost figure expressed in £/MWh, which essentially demonstrates the cost of producing a unit of energy using that technology, by spreading out all the associated costs across all the heat produced.

The net levelised cost of a renewable technology is the levelised cost of the renewable technology minus the levelised cost of the counterfactual technology.

In calculating RHI tariffs we have examined this net levelised cost as we aim to compensate for the additional costs of installing renewable heat only, for households that need to replace their existing heating equipment.

In calculating a levelised cost DECC has assumed an average cost of capital of 7.5%.

The spreadsheet, and the example below, detail the calculation further.

Example: For the biomass boiler, using the values in the table in Annex 1, the levelised cost is calculated as follows:

First the heat output of the boiler is adjusted to account for increases in efficiencies of the property (e.g. insulation) resulting from Green Deal ticks. This is shown below:

$$Adjusted\ Heat\ Output = Annual\ Heat\ Load * Efficiency\ Factor \qquad (1)$$

$$Adjusted\ Heat\ Output = 26.99\ * 0.94 = 25.33MWh \qquad (2)$$

Following this the annuitised capital expenditure is calculated over the lifetime of technology using equation 3 and a discount rate equal to the cost of capital, 7.5%.

$$Annuitised\ Capex = \frac{Upfront\ Capex * Discount\ Rate * (1 + Discount\ Rate)^{Lifetime}}{(1 + Discount\ Rate)^{Lifetime} - 1} \qquad (3)$$

$$Annuitised\ Capex = \frac{699.43*0.075*(1+0.075)^{20}}{(1+0.075)^{20}-1} \quad = £68.61/kW \tag{4}$$

From this the levelised capital expenditure (capex) of the biomass boiler can be calculated.

$$Levelised\ Capex = \frac{Annuitised\ Capex * Capacity}{Heat\ Output} \tag{5}$$

$$Levelised\ Capex = \frac{68.61 * 15}{25.33} = £40.63/MWh \tag{6}$$

The same calculations are carried out to calculate the capital expenditure of the counterfactual technology.

$$Adjusted\ Heat\ Output = 26.99 * 0.94 = 25.33MWh \tag{7}$$

$$Annuitised\ Capex = \frac{141.87*0.075*(1+0.075)^{20}}{(1+0.075)^{20}-1} = £16.07/kWh \tag{8}$$

$$Levelised\ Capex = \frac{16.07 * 20}{25.33} = £12.69/MWh \tag{9}$$

If the technology had a counterfactual fuel of electricity additional calculations would need to be carried out relating to the introduction of a wet heating system and because modelling in some instances assumes that if, for example, electric heating could be replaced by a biomass boiler, it could also have been replaced with a gas or oil boiler, and as such, these should form the counterfactual cost. These steps can be found in the "Upfront CF Capex" sheet of the spreadsheet.

Using the values from the table in Annex 1, the total costs of the biomass boiler and the counterfactual (CF) technology, per MWh, are calculated below.

$$Capex\ \&\ Operating\ Costs = Levelised\ capex + Opex + Fuel\ cost \tag{10}$$

$$RH\ Capex\ \&\ Operating\ Costs = 40.63 + 11.81 + 68.79 = £121.24/MWh \tag{11}$$

$$CF\ Capex\ \&\ Operating\ Costs = 12.69 + 8.03 + 67.90 = £88.62/MWh \tag{12}$$

We then need to calculate the net cost which is the difference between the total costs. In calculating the net costs we also need to consider the non-financial barriers associated with installing the renewable heat technology and the counterfactual.

For the biomass boiler the net upfront explicit barriers (e.g. admin burdens, demand side barriers and inconvenience to the household) are calculated to be £3.31/MWh. The upfront implicit barriers (e.g. perceived risk barriers) are £9.02/MWh. These have been calculated using a rate of return of zero, as they are non-financial costs and as such, no cost of capital should apply to them. More detail on barriers can be found in Annex 3.

The ongoing explicit barriers for the renewable technology are the recurring admin and demand side barriers. For a biomass boiler in this specific house type this is estimated to be £1.41/MWh

The net cost is then calculated as follows:

$$Net\ Cost = Levelised\ RH\ Cost - Levelised\ CF\ Cost + Levelised\ Barriers \quad (13)$$

$$Net\ Cost = (121.24 - 88.62) + 3.31 + 9.02 + 1.41 = £46.34/MWh \quad (14)$$

2. Calculating the required tariff

We then convert the *net cost* into a *required tariff.* This means taking the *present value* of the *net levelised cost* and annuitizing again, this time over 7 years so that 20 years worth of costs are paid over 7 years. This calculation is detailed below:

The present value of the cost over the lifetime of the technology is calculated using a discount rate of 7.5% over the length of the lifetime of the technology, 20 years.

$$\text{Present Value} = \sum_{i=1}^{lifetime} \frac{Net\ Levelised\ Cost}{(1+discount\ rate)^i}$$

$$Present\ Value = \sum_{i=1}^{20} \frac{46.34}{(1.075)^i} = £472/MWh \quad (15)$$

To calculate the cost each year over the length of the subsidy, the present value of the cost is then annuitized using a discount rate of 7.5% and lifetime of the subsidy, 7 years.

$$Required\ Tariff = \frac{Present\ Value * Discount\ Rate * (1+Discount\ Rate)^{Subsidy\ Length}}{(1+Discount\ Rate)^{Subsidy\ Length} - 1} \quad (16)$$

$$Required\ Tariff = \frac{472 * 0.075 * (1.075)^7}{(1.075)^7 - 1} = £89.19/MWh \quad = 8.9\text{p/kWh} \quad (17)$$

3. Establishing a Cost Curve

Having established the required tariff for each house type, the next step is to establish a cost curve for 2013. For this we use the technical potential of the renewable technology. The technical potential is the number of the households of each house type which will be replacing their heating system in 2013 for each house type, multiplied by the proportion of that house type which is considered suitable for that technology and the average heat use of each house.

For each technology, we take all the *required tariff* data, for all the different house types, and match them with the technical potential for that house type[15]. For the domestic scheme we only include house types which are not on the gas grid, as the tariffs aim to reward the median cost of off-gas grid opportunities.

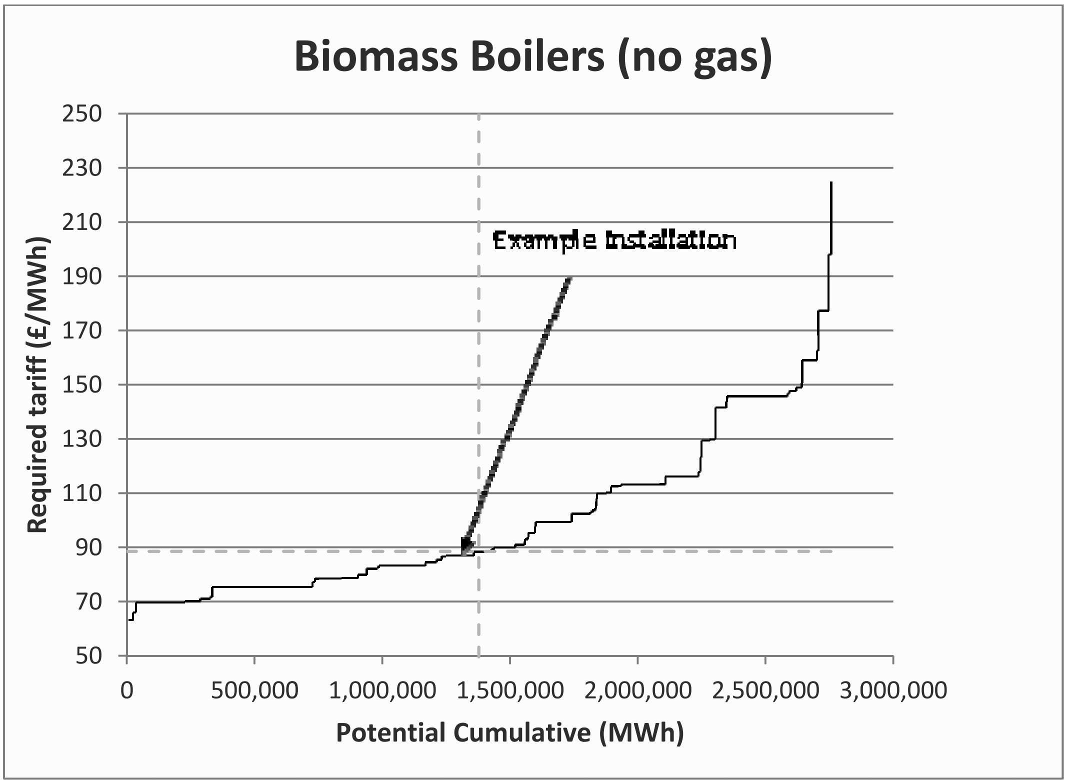
We order this data by the net cost, so the lowest cost opportunities are first, and plot this with the cumulative technical potential to form a cost curve.

Example: For Biomass Boilers we take the net cost in 2013 and technical potentials for all house types which do not have gas as the counterfactual fuel and could install a small biomass boiler. We then order the data in terms of net cost, with the lowest net cost (and therefore the most cost effective) technology

[15] This is a slight simplification to the more detailed methodology which excludes barrier costs when deriving the cost curve and adds them back in for the final tariff calculation. For this worked example we have not included these steps, but it makes only a very marginal difference.

first and the highest net cost last. The technical potential is then converted to cumulative figures by considering the technical potential of all the house types which have a lower cost.

The cost curve for all small biomass boilers is shown below.



The steps in the curve are different house types. The length of the step is how much renewable heat could be produced by that house type and the height of the step indicates it's cost per MWh.

The arrow on the graph indicates where our worked example is on the curve.

4. Setting the Final Tariff

The tariff is then taken as the median cost opportunity. This is the net cost half way along cost curve which refers to the cost associated with half the technical potential of that technology.

The maximum subsidy rate over a subsidy length of 7 years is set at £173/MWh (explained below), the 7 year equivalent of the levelised cost off-shore wind (£89/MWh). This cap applied to Solar Thermal in the non-domestic scheme and has been identified by DECC as the likely marginal technology required to meet the 2020 renewables target. If the median net cost (the point halfway up the cost curve) is greater than £173/MWh then the capped subsidy is used.

For the small biomass boiler curve, the 50th percentile is at 1,387GWh which and corresponds to £82.4/MWh. As the median value on the cost curve is below £173/MWh we use this is the tariff for all small biomass boilers.

For our example, the biomass boiler is very close to the median point on the cost curve, which means that almost all of the additional costs of installing the boiler in that house type will be compensated by the proposed subsidy.

5. Explanation of the capped tariff

The maximum subsidy rate is set at £89/MWh over the lifetime of the technology (the levelised cost off-shore wind). If the sum of the net renewable heat costs (capital costs, ongoing costs and barrier costs levelised at a discount rate of 7.5%) is greater than £89/MWh then the capped subsidy is used

The tariff which is required to subsidise a technology with an £89/MWh levelised cost, over 7 years is then calculated.

First the present value of the lifetime costs is calculated using a discount rate of 7.5% over the length of the lifetime of the technology, 20 years. This is the present value of the total amount of subsidy paid out considering the lifetime of the technology. For the capped cost of £89/MWh this equals £917/MWh

$$Present\ Value = \sum_{i=1}^{Lifetime\ of\ technology} \frac{Levelised\ cost}{(1+Discount\ Rate)^i} \quad (18)$$

$$Present\ Value = \sum_{i=1}^{20} \frac{89}{(1.075)^i} = £917/MWh \quad (19)$$

The present value of the subsidy is then annuitized using a discount rate of 7.5% and lifetime of the subsidy, 7 years. For the capped subsidy this results in £173/MWh

$$Payment\ per\ Period = \frac{Present\ Value * Discount\ Rate * (1+Discount\ Rate)^{Length\ of\ Subsidy}}{(1+Discount\ Rate)^{Length\ of\ Subsidy} - 1} \quad (20)$$

$$Payment\ per\ Period = \frac{917 * 0.075 * (1.075)^7}{(1.075)^7 - 1} = £173/MWh \quad (21)$$

Annex 3 - Barrier Cost Data

Barrier costs include an assessment of the following:

Implicit 'Risk' barriers: under the RHI householders will be committing to large upfront costs for heating equipment which, at least in the early years of the scheme, is largely unknown to the vast majority of householders. As such households are expected to require compensation for risks of installing renewable heating systems. These risks barriers have been assessed to imply an additional barrier of up to 70% of the difference in capital costs of renewable and conventional technologies*. In turn these risks include (the average proportion of the risk barrier cost shown in brackets):

1. Performance risk: the technologies may not provide the savings, or the heat, the household expects (around 45%)

2. Risk of access to subsidies: the risk of uncertainty over government policy, or whether householder may move or become ineligible (25%)

3. Risk to house value: the risk that the value of the property may fall as potential buyers are put off by heating systems they do not understand (15%)

4. Risk of unforeseen price changes: for example risk of price rises (and access to) of biomass pellets, which may be seen as less stable than other more mainstream fuels. Or that fossil fuel prices were not as high as they had expected. (15%)

It is expected that these risks will fall over time as deployment becomes more common, and the scheme more established, allowing tariffs to be degressed to account for this.

In addition, we include estimates of hassle and physical barriers such as time costs and space loss, based on studies by Enviros and element energy. Analysis also shows that investors could face significant non-financial barriers when deciding whether to invest in renewable heat (e.g. the hassle of taking fuel deliveries for biomass boilers, or associated storage space). Such costs are included in the RHI model and are based on analysis conducted by Enviros Consultants in this area[16].These are typically higher for technologies that take up lots of indoor space, such as biomass boilers and some heat pumps, and typically range from between 2% and 15% of the difference in capex of renewable and counterfactual technologies, though some are assessed to have negative barrier costs as they save space.

*This assessment has been carried out by DECC and Nera and is based on estimates of hurdle rates and pay back periods required to invest in renewable heat, isolating the "risk premium" charged.

[16] Enviros Consulting (2008), *Barriers to renewable heat part 1: supply side*, report for BERR

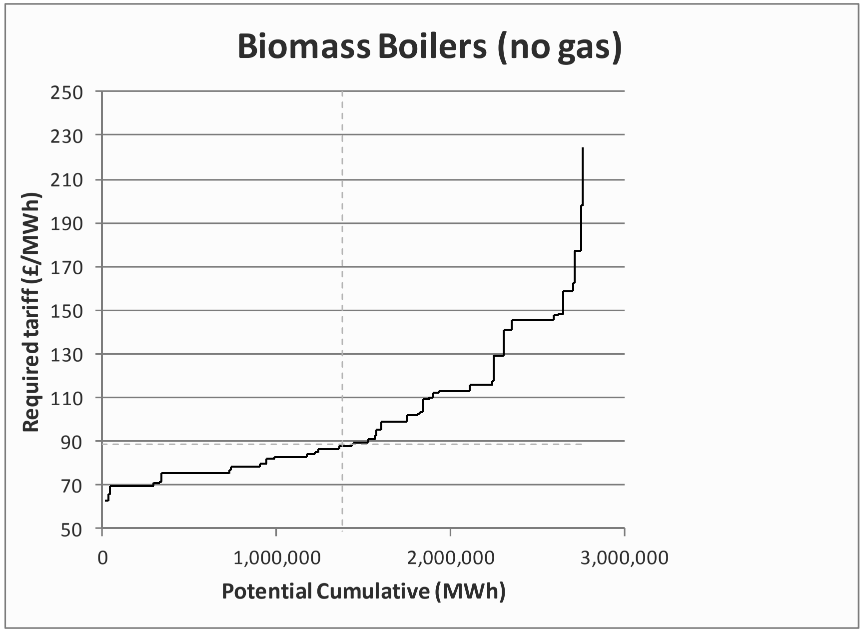
Annex 4 – Cost Curves

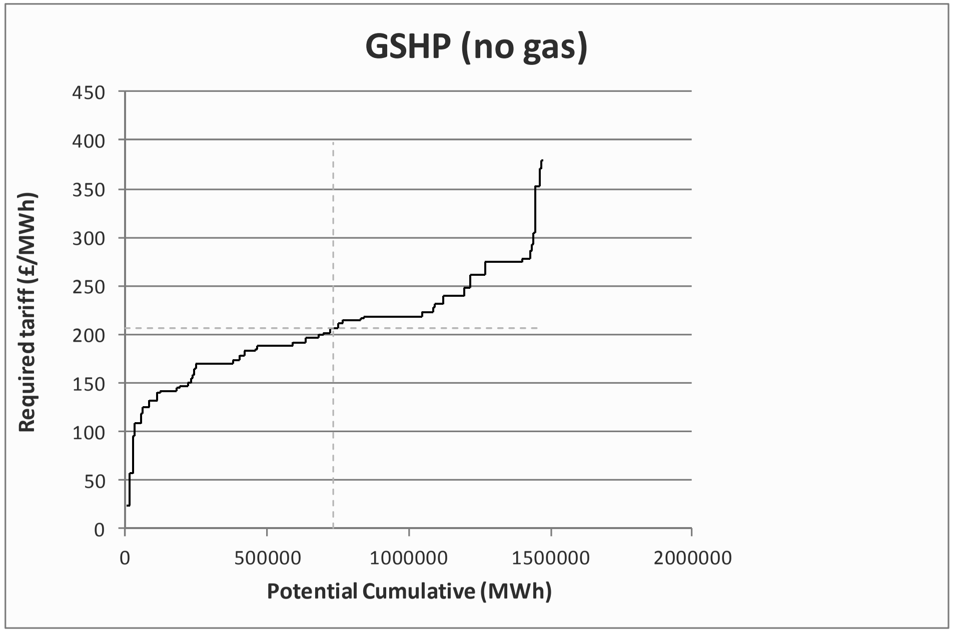
The following are the estimated cost curves for all opportunities, with costs displayed as tariffs (condensed into 7 year payments).

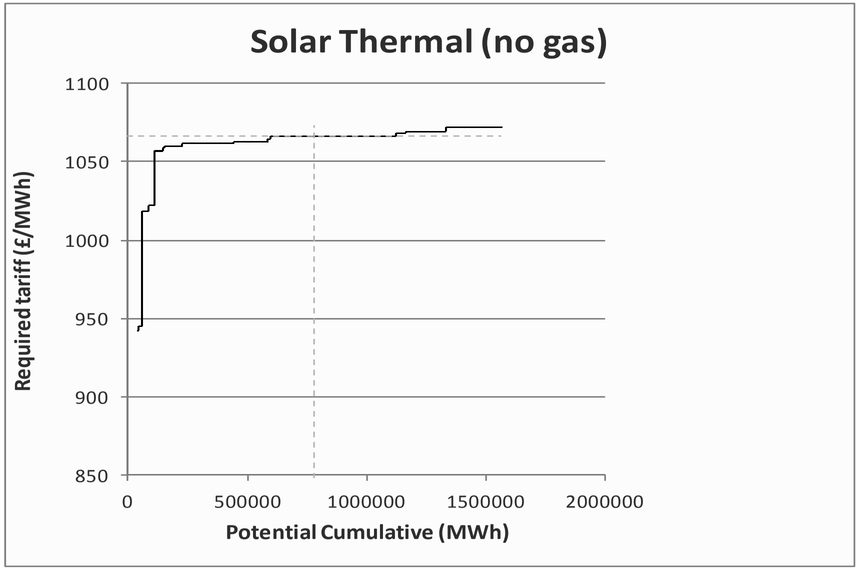
Each graph represents the potential MWh of renewable heat that could be incentivised at each price in 2013 (first year of the scheme). The dotted lines show the cost and position on the cost curve of the 50^{th} percentile (the median cost opportunity) for firstly the off-gas grid opportunities and secondly the full UK housing stock potential.

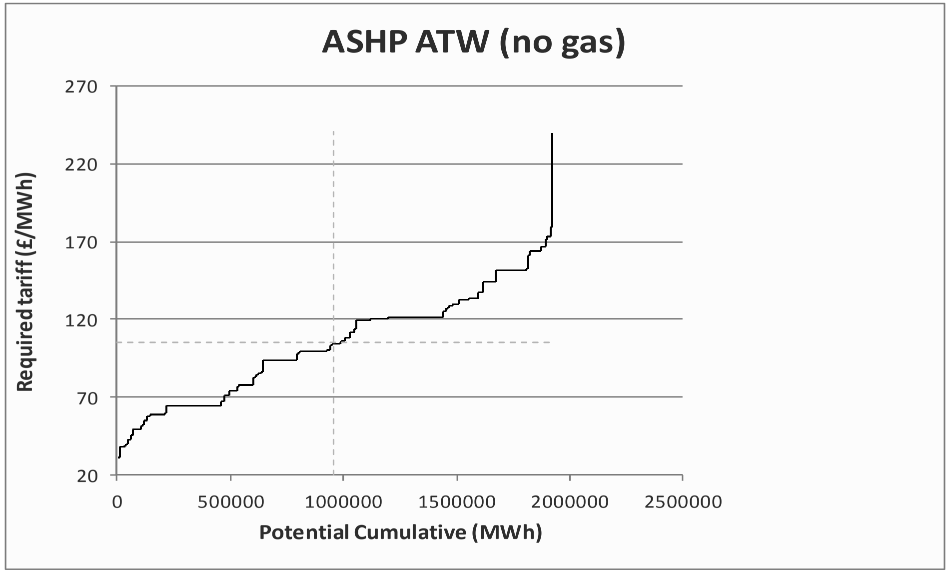
The graphs show the tariffs which would apply if the various constraints of an off-gas grid based tariff and the marginal cost of the renewables target did not apply (e.g. the tariff of GSHP would be 19.3p/kWh (£193/MWh) were it not capped at 16p/kWh.

Off-gas grid curves



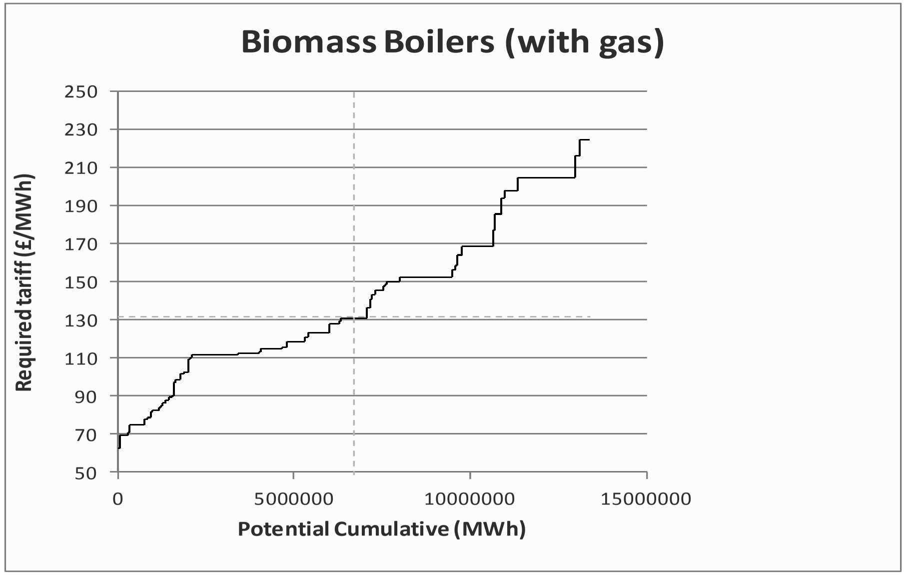


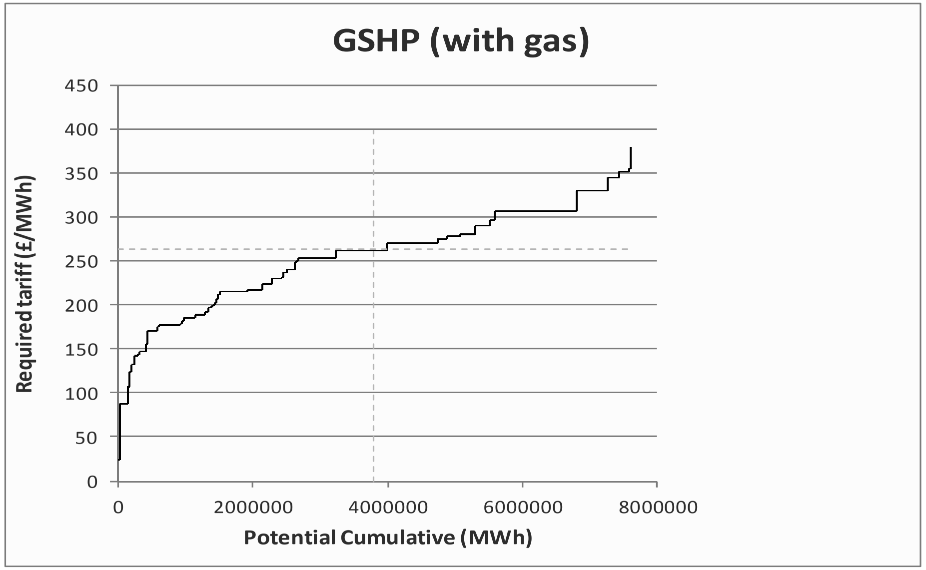


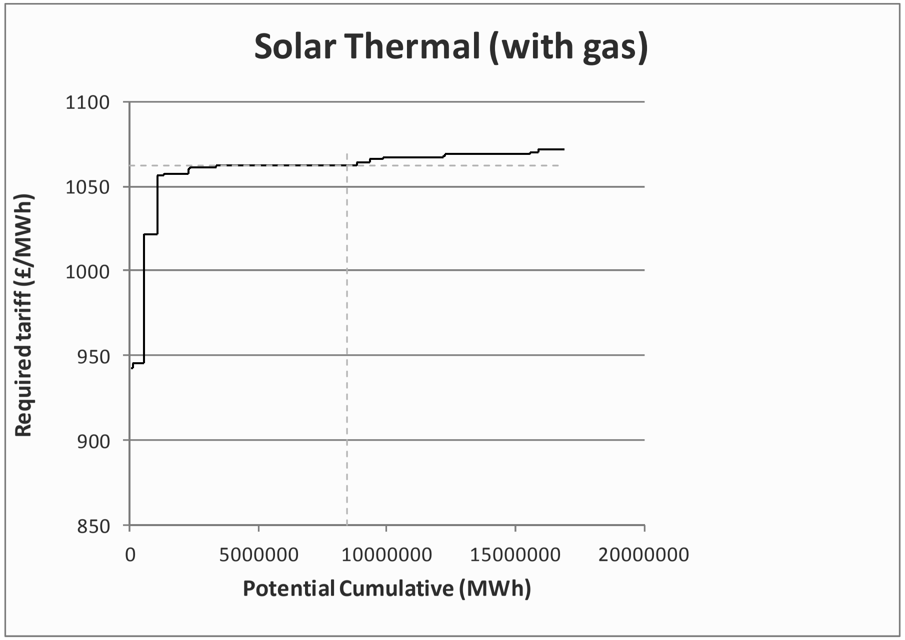


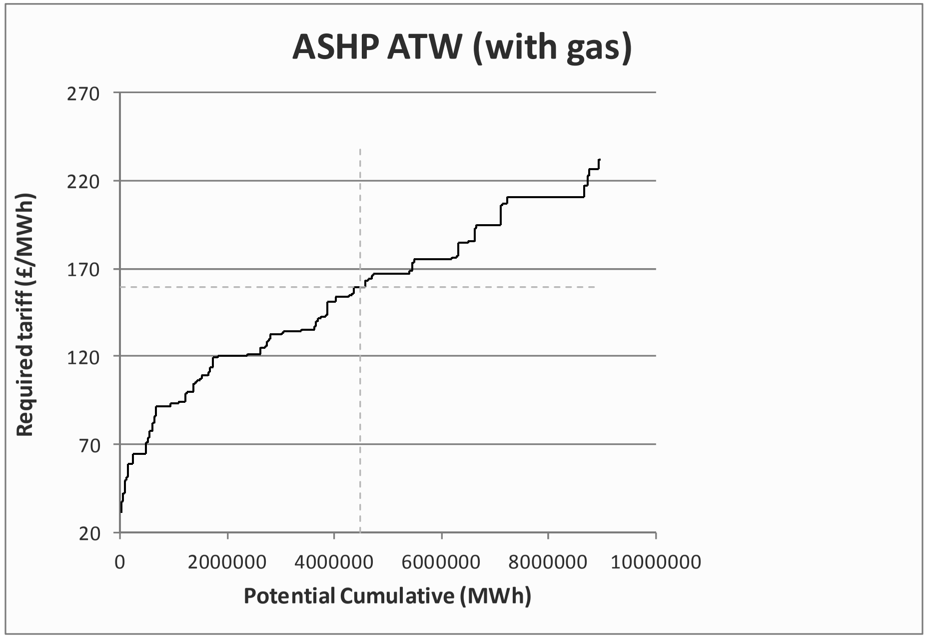
Full housing stock curves

The following curves demonstrate the tariffs that would be appropriate if the scheme were to focus on the median cost opportunity in the entire housing stock rather than the cost-effective off-gas grid opportunities. As such, unlike the above curves which only examine opportunities off the gas grid, the curves below examine all opportunities, including those on the gas grid. All tariffs would be substantially higher. Current tariffs are only expected to offset costs fully for the cost-effective minority of households.


Biomass Boilers (with gas)
Required tariff (£/MWh)
250
230
210
190
170
150
130
110
90
70
50
0
5000000
10000000
15000000
Potential Cumulative (MWh)


GSHP (with gas)
Required tariff (£/MWh)
450
400
350
300
250
200
150
100
50
0
0
2000000
4000000
6000000
8000000
Potential Cumulative (MWh)


Solar Thermal (with gas)
Required tariff (£/MWh)
1100
1050
1000
950
900
850
0
5000000
10000000
15000000
20000000
Potential Cumulative (MWh)


ASHP ATW (with gas)
Required tariff (£/MWh)
270
220
170
120
70
20
0
2000000
4000000
6000000
8000000
10000000
Potential Cumulative (MWh)

Annex 5 - sensitivity assumptions

Fuel prices

Fuel price assumptions were made using the projections provided in the Inter-departmental Analytical Guidance (IAG) toolkit, which were estimated by DECC and are regularly reviewed and updated, and can be found at http://www.decc.gov.uk/en/content/cms/about/ec_social_res/iag_guidance/iag_guidance.aspx. Sensitivity analysis on fuel prices was carried out using the 'high' and 'low' scenarios listed in the guidance tables which can be found there.

Annex 6 - uptake modelling

Approach to assessing costs and benefits

The RHI analysis has been carried out using an economic and technical model built by independent consultants (NERA). The model was designed to test possible renewable heat deployment levels under different supply and demand side growth assumptions and to enable testing of various tariff designs (e.g. different tariff levels, tariff bands or tariff lifetimes) and the impact of alternative policy designs on key metrics (e.g. uptake of renewable heat, subsidy and resource costs, CO_2 savings, etc.).

The below diagram outlines at a very high-level how the model works, and what the key inputs and outputs are. More information can be found in the NERA 2009 and 2010 supporting reports that are referenced in the summary sheets:

Key input assumptions

- Technology costs, performance and suitability characteristics – both renewable and conventional.

- Fuel costs – both renewable and conventional.

- The hurdle rate required by investors to invest in renewable heat (discount rate). for the domestic sector this has been split into a cost of capital and risk barriers

- Assessment of non-financial barriers to the deployment of renewable heat, and the cost of overcoming them.

- The capacity of supply chains in the renewable technology markets and the extent to which they could develop between now and 2020.

How the model works

Tariff levels are set using the principle of a reference installation for each technology band. The final tariffs are based on the difference between the cost (capital and operating) of the renewable and relevant counterfactual technology for each reference installation, taking into account non-financial and risk barriers and a Rate of Return on financial costs.

The model then determines potential uptake rates across all segments, based on economically optimal behaviour, once supply side constraints and demand side considerations are taken into account.

Key outputs

- Projected number of installations taken up in the commercial/public, and industrial sectors.

- Renewable heat delivered (TWh) and the fossil fuels displaced.

- Carbon saved (MtC02).

- Resource cost.

Modelling the uptake of tariffs is conducted through the following steps:

Demand:

The likely future Demand for renewable heat is driven by calculating for each house-type, for each technology, the net cost of installing and using renewable heating including barriers and financing costs. A distribution of financing costs is used for each house type to reflect the variation of individual circumstances.

Householders are assumed to consider Renewable Heating as their current system reaches the end of its life (which is in line with the long-term trend in heat system replacements- roughly once every 15 years). These opportunities (where boilers are nearing the end of their life, are the most cost-effective opportunities and hence the target of the RHI).

For each house category the renewable technologies are ranked in terms of the their net costs after tariffs are taken into account and demand for each technology is determined by how many properties have profitable opportunities.

Demand for each technology changes each year as costs/fuel costs change/heat demand. For example demand for GSHPs rises as capital costs are expected to fall and fossil fuel prices rise.

Supply:

Supply of each technology is constrained by the size of the supply chain (in reality this will likely be constrained by trained labour (both installing and designing systems), equipment (such as large drilling equipment) and the manufacture of products) which can grow each year, but there is a maximum growth rate achievable for each technology (derived by AEA as the likely maximum at which supply chains can afford to expand, given training, equipment purchasing, admin and uncertainty). The amount the supply chain grows is a function of the number of installations in the previous year, up to the maximum growth limit. Therefore supply in each year is finite.

Market Clearing:

The model then matches demand with supply, with demand switching to second choice technologies if necessary (in the real world this would happen because prices of the most demanded technologies would rise with demand).

This calculates the expected deployment in that year. For that deployment the model then works out how much heat is produced/money spent/carbon saved etc.

Annex 7 - Peer Review

The RHI model was built by Nera Economic Consulting to predict uptake of renewable heat under certain tariffs. It uses inputs based on advice from AEA as described later.

In February 2012 it was peer reviewed by Professor Derek Bunn (a leading energy economist from the London Business School) and received a good review, highlighting the inherent difficulties but calling it in line with "best practice" modelling. Modelling is based on forecasting the demand and supply for each technology in each year. The following is a summary of observations highlighted in the peer review

1. Model is used as an uptake calculator rather than a model to identify subsidy payments which will achieve, say, target delivery at minimum cost.
2. AEA data is a reasonable and credible source, and the model is able to adapt to the need for continuous updates to data.
3. The bottom-up approach is a key strength of the model and is comparable to best practice around the world.
4. The model assumes a fixed rate of replacement of heating systems (the amount which are replaced with renewables is endogenous), but this replacement rate is not altered by the RHI. The key question is – is the RHI expected to be a passive incentive to make a renewable replacement decision in the normal course of events or will it accelerate replacement of old technologies? This may result in a an underestimate of take-up.
6. Supply chain growth constraints – may be over-constraining if rates of return are high and other green economic stimulus successful. If supply is binding then privately cost-effective installations may be crowding out socially cost-effective ones.
7. Model assumes end-users make decisions – existence of intermediaries could reduce rate of return required and therefore uptake could be higher.

Professor Bunn's conclusion is as followed:

"This is an impressive model and appears to be fit for purpose.

It integrates a large segmented end-user database with a useful assessment of renewable heat technology penetration. The uptake model is necessarily subject to substantial behavioural uncertainty and would benefit from further social research, experiences and analogies from elsewhere. Nevertheless, its design is a good investment for the future, as new information and insights can be readily included on the Excel platform.

The methodological approach is state of the art, and its design benchmarks well against similar models around the world.

In the practical context, it is not very easy to use and would benefit from a more explicit self-starter user guide. Extra graphical outputs, risk analysis and the identification of any supply constraints may be of value to DECC in future versions.

Systematic biases in the model relate mainly to exogenous assumptions that may be adaptive to the RHI. Thus, supply may expand and resistance to investment may reduce as and when the RHI begins to make an impact. If supply constraints become tighter in the future, the heuristic way in which these feed through to satisfying the demand segments may need to be re-evaluated. None of these concerns appear to be material for the current implementation of the model, however."

Annex 8 – Alternative Options

The following is a discussion of the options that have been considered but not preferred since the 2010 RHI consultation first proposed a domestic RHI scheme.

Alternative Options Considered:

In 2010 DECC consulted on an RHI which included domestic tariffs calculated with a 16% rate of return on the median cost installation cross the entire housing stock, paid over the estimated lifetime of each technology.

At the time, this resulted in the following tariffs:

p/kWh (2009 prices)	**Biomass**	**GSHP**	**ASHP**	**Solar Thermal**
2010 Consultation tariffs	9.0	7.0	7.5	18.0
Years tariff paid for	15	23	18	20

This tariff structure was not taken forward due to concerns over value for money and appropriateness of tariff design. During the development of this consultation the following options were considered.

Alternative 1: 20 year tariffs designed for median cost house

DECC has since updated assumptions on the cost, performance and lifetime of domestic technologies.

One option considered was to set domestic tariffs on the same basis as tariffs in the non-domestic scheme. Setting tariffs estimated at compensating for the median cost opportunity of the entire housing stock, paid over 20 years, for each technology but capping tariffs at 8.3p/kWh (the cap applied to solar thermal in the non-domestic scheme as an estimate of the marginal cost of meeting the renewables target , which in 2012 prices is inflated to 8.9p/kWh). This methodology would generate the following tariffs:

p/kWh (2010 prices)	Biomass	GSHP	ASHP ATW	Solar Thermal
Do Nothing	6.2	8.3	8.3	8.3

This option was not preferred as it was considered to create a large legacy for DECC without commensurate attraction to consumers. Also it appears in consistent with the Heat Strategy[17] which set out that the early focus of deployment for renewable heat should be the off-gas grid sector of the housing stock. These properties face higher energy bills and energy price uncertainty, so are more cost-effective opportunities for renewable heating.

Further, as GSHP, ASHP and Solar Thermal were capped by the 8.3p/kWh limit in this option, the biomass tariff, relatively, becomes more generous. Because of this, modelled uptake switched away from GSHPs to Biomass Boilers, to the extent that GSHPs could not compete with Biomass. A key aim of the RHI is to drive learning and innovation in renewable heating technologies, so it is important not to set tariffs which "crowd out" other technologies.

In addition, 20 years was considered too long a period to pay domestic tariffs over. A shorter time period was preferable as

i. Householders are unlikely to make investment decisions over 20 years, so may discard immediately a tariff which aims to repay capital costs over such a period.

[17] http://www.decc.gov.uk/en/content/cms/meeting_energy/heat_strategy/heat_strategy.aspx

ii. Reducing the period over which tariffs are paid, reduces the risk householders perceive over receiving their subsidy, as it will be paid to them over a shorter period, there is less chance of anything going wrong. This is expected to reduce the risk premium implicitly charged by households in deciding whether to undertake the RHI. DECC estimates that reducing tariff periods from 20 to 7 years could reduce risk premiums by around 12%.
iii. Paying over shorter periods allows the UK to exploit the difference in cost of capital between government and households. Typically government can borrow at lower rates that householders, so the shorter the tariff period, the lower the total borrowing costs, as the high (assumed here to average 7.5%) borrowing costs of households are paid for a shorter time period.

In summary, on analysis of this option, it was decided that tariffs should be aiming to compensate for the additional costs, barriers and risks of off-gas grid properties installing renewable heat, and should be paid over a short time period.

<u>Alternative 2: Capital grant options</u>

On that basis DECC considered the option of offering subsidy on the basis of an up-front grant, aimed at compensating for the additional costs, barriers and risks of the median cost household installing renewable heat.

This option avoids the government compensating households for high borrowing costs and further reduces the subsidy risk facing households. It is also likely the simplest subsidy for consumers to understand and make decisions on.

This option was not preferred on the basis that it was not affordable in the short run and was high risk.

As a capex grant brings costs to government forward, it was expected to put strain on DECCs current Spending Review settlement. Further, this option would mean cost projections would be highly volatile. The RHI currently operates within fixed annual budgets and a capital grant system would pose difficulties for the successful operation of budget management through degression.

Capital grants condense the 7 year tariff into an upfront payment. As such if a new accreditation was added to the scheme half way through the year, a grant scheme would add around 10 times more to in-year expenditure than a 7 year tariff. Thus, relative to a tariff scheme costs could escalate extremely quickly, meaning any bubble in installations would risk DECC breaching budgets (for more information on budget management see http://www.decc.gov.uk/en/content/cms/meeting_energy/renewable_ener/incentive/budget/budget.aspx)

Finally, this option was considered high risk in terms of heat delivery. If consumers are paid in full up-front, there is no ongoing incentive to keep using renewable heating for the full lifetime of the measure. This is considered to be less of a problem where the introduction of the renewable measure results in a bill decrease (as consumers would be likely to wish to continue using the cheaper equipment). However, for biomass boilers and some heat pumps, where fuel savings are more marginal, or negative, this poses a problem as incentives may be to install RHI technologies, but then replace them early or simply not use them.

In order to try and overcome this, DECC examined the possibility of setting tariffs as an up-front grant designed to compensate for upfront costs, and an ongoing tariff designed to cover for ongoing costs. This would have the advantage of ensuring some incentive to continue generating renewable heat persisted through to 2020.

However, the majority of the costs still lay upfront and this option was rejected as above for being too expensive during the early years and too difficult to control expenditure within budget using degression.

Further, both these options could have very high short term cost implications resulting from existing installations which have been installed since 2009 and may be eligible (at least partially) for the RHI. It is not known how many such installations may be eligible for the RHI but it could cause a significant upfront cost to the scheme if subsidy was paid in grant form.

Further Alternatives:

Other alternatives were considered, including:

i. Extension of RHPP – this option was not considered able to deliver the level of renewable heat required to achieve the schemes objectives, unless grants were very high, at which point the problems described above for capital grants apply.
ii. Off-gas grid restriction of eligibility - this option was not preferred as, although the off-gas grid housing stock generally offers the best value for money opportunities for renewable heat, and therefore is a suitable market to aim the policy at, if individual households on the gas grid have cost effective opportunities, or are willing to part fund installations, it is efficient to allow them to access the RHI.
iii. Other periods of tariff length were considered and modelled including 5 year tariffs and 10 year tariffs. 7 year tariffs have been favoured as they offered the best balance between short run affordability and reducing cost/risk and being appealing to consumers. The way in which tariff structures affect consumer decision making is the focus of ongoing research by DECC which will be continued during this consultation.

Annex 9 – Analysis of option to fund metering

We have looked at 3 scenarios – that 25%, 50% and 100% of homes in the Domestic RHI are metered – and assume a metering cost of £1,000 per installation[18]. Additionally, for each of these scenarios, we have also looked at two scenarios for metering costs, one in which they remain constant and one in which metering becomes cheaper as more meters are put in, at a rate of 2% per year.

In order to illustrate whether metering is likely to offer good or bad value for money in the absence of much information on its likely impact, we have estimated the benefits required for the scheme to break even, in the form of reduced running costs of new installations. Running costs refer to both operating & maintenance and the costs of the electricity to run it. So reductions in these costs can be interpreted as increased performance of heat pumps due to more informed installation and use of heat pumps.

In the table below, the costs only include the £1,000 per metering installation, discounted at a an annual rate of 3.5% for the year of installation. We then estimated the reduction in running costs that would provide an NPV equal to these costs.

As the table below shows, where ¼ of homes are metered, an annual reduction in running costs of 0.6 - 0.7% (depending on whether metering costs fall or not) is required. Where 100% of homes are metered, this figure increases to a 2.5 – 2.7% reduction.

	Scenario 1: 25% metering		**Scenario 2: 50% metering**		**Scenario 3: 100% metering**	
	Constant metering costs	**Metering costs decrease 2% per year**	**Constant metering costs**	**Metering costs decrease 2% per year**	**Constant metering costs**	**Metering costs decrease 2% per year**
Costs	£89m	£80m	£179m	£160m	£359m	£321m
Yearly improvement in running costs required to break even	0.7%	0.6%	1.3%	1.2%	2.7%	2.5%

[18] Based on experience with the Renewable Heat Premium Payment Scheme (RHPP).

Annex 10 – Summary of sub-options

We have looked at each of the sub-options under the following criteria:

- Effect on risk of reversion to fossil fuel technology after end of tariff period
- Effect on change in take-up projections
- Effect on RHI cost-effectiveness

For each category, a '+' indicates a positive effect and a '-' indicates a negative effect, Multiples '+'s or '-'s indicates a bigger expected effect.

Sub-option	Effect on risk of reversion	Effect on risk of change in uptake projections	Effect on Risk to cost-effectiveness
a) Improved performance			
i) Improve standards	+	+	+
ii) Fund metering	+	Shouldn't affect uptake as funded by Govt	Discussed in annex 8
b) To incentivise new build homes			
A tailored tariff for new build homes	Not relevant	+	TBD
c) Bivalency			
i) Allow back-up systems	- -	++	Unclear
ii) Allow back-up systems except for biomass	-	+	Unclear
iii) Allow back-up systems if accompanied by heat metering (and tariff)	-	+	Unclear
d) Tariff longevity			
i) Split tariff between 7 year capex and barriers tariff and 20 year fuel and opex tariff	+++	Unclear	
ii) Same as ii) but opex tariff to be reviewed regularly after 7 years	+++	Unclear	
e) Social Landlords			
Include social landlords in the Domestic RHI but with a lower tariff	Not relevant	+	TBD

f) Disaggregation			
i) Further disaggregate tariffs where substantial cost differences occur	TBD	TBD	TBD