From:	Coyne, Terence
To:	McCormick, Andrew (DFE)
Cc:	McMurray, Stephen
Subject:	FW: RHI Judicial Review
Date:	16 March 2017 08:25:33
Attachments:	image001.png JR Feb 2017 (3).DOC

Andrew

Here are Paul's comments.

Regards

Terry

Terence Coyne
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From: McMurray, Stephen
Sent: 03 March 2017 14:16
To: Coyne, Terence
Subject: FW: RHI Judicial Review

Stephen McMurray
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From: Montgomery, Paul
Sent: 03 March 2017 10:03
To: McMurray, Stephen
Cc: McAdams, Jonathan
Subject: FW: RHI Judicial Review

Stephen,

Please see attached revised analysis paper reflecting helpful comments from Shane.

I have also included in Annex B a potentially useful clarification from the 2016 Impact Assessment on Reforms to the Scheme in the rest of the UK that the discount rate is not intended to provide a 12% rate of return to al installations and may change over time

Paul

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

From: Murphy, Shane
Sent: 02 March 2017 17:15
To: Montgomery, Paul; Smith, Alan
Subject: RE: RHI Judicial Review

Paul,

A couple of very minor comments on your paper (which looks the business to me).

Table 3 – should the second row of the table be the "12-20%" band given that the first row is "0-12%" (it currently says "10-20%").

There is a mention of 12% rate of return in real terms when you are explaining things towards the end of the paper – wonder whether the concept of the return being "real" or "inflation proofed" it is worth a mention earlier on.

I can only imagine the effort that went your paper and the endeavours to make it accessible to the non-specialist.

Regards

Shane

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From: Montgomery, Paul
Sent: 01 March 2017 12:52
To: Murphy, Shane; Smith, Alan
Subject: RHI Judicial Review

Shane/Alan,

Following earlier discussion, please see attached updated analysis paper and s'sheet- only change to latter is in respect of the IRR sheet

Grateful for any comments/suggested amends

Paul

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FEBRUARY 2017 JUDICIAL REVIEW

Additional Analysis

Setting of Tariff

1. In common with the parallel scheme operating in the rest of the UK, the NI Non-Domestic Renewable Heat Incentive (RHI) scheme involves the provision of a financial incentive to encourage an increase in the uptake of renewable heat technologies. To this end, the intention was that payments under the scheme would be set at the minimum level required to offset the additional capital and ongoing operating costs of renewable heat when compared with the fossil fuel alternative, as well as providing an adequate return on investment.

2. For accredited installations the RHI pays a tariff for every kilowatt hour of heat energy generated, depending on technology, boiler size and usage. However, medium Biomass Boilers have accounted for the large majority of installations accredited under the scheme and have therefore been the focus of attention.

3. At the initiation of the scheme in NI it was decided that it would not be appropriate to adopt the tariff structure in place for the rest of the UK[1]. Instead, research was commissioned[2] into the best approach for NI, reflecting local market conditions, although based on the same methodology as the rest of the UK- see Annex A. The recommended payment structure identified by the research was subsequently revised[3] following feedback from the consultation process on the scheme. This payment structure involved a single

[1] The fossil fuel alternative was expected to be mainly oil in NI compared to gas in the rest of the UK where there is greater availability of the latter. As oil was more expensive than gas this implied that the level of subsidy, and thus tariff, in NI would be lower.
[2] *Renewable Heat Incentive for Northern Ireland- A Report for the Department of Enterprise, Trade and Investment* (June 2011), Cambridge Economic Policy Associates Ltd and AEA Technology
[3] *A Renewable Heat Incentive for Northern Ireland- Addendum* (February 2012), Cambridge Economic Policy Associates Ltd and AEA Technology

tariff, updated each year by inflation, to be applied to each kilowatt hour of heat generated.

4. The level of tariff was based on a number of different elements including the estimated capital cost of a renewable technology boiler compared with the fossil fuel alternative, as well as the indirect (termed “barrier”) costs such as the construction of storage facilities for the fuel. The tariff also incorporates the additional operating (servicing, repairs, administration) costs for renewable technology, including fuel costs. The tariff was originally set at 5.9p/kWh for medium Biomass Boilers in the 2012-13 financial year, which has subsequently been increased in line with inflation to 6.5p/kWh in 2016-17.

5. A significant difference with the approach in the rest of the UK was the absence in the NI scheme of a tier mechanism to reduce the level of tariff once a boiler had been used for a specified amount of time each year. The tier threshold in the rest of the UK was set at 1,314 hours, equivalent to a 15% load factor (percentage of maximum possible running time). This was estimated to represent a reasonable minimum level of usage for a renewable heat installation used for space heating. The scheme in the rest of the UK subsequently introduced further budget control measures which were not replicated in NI.

6. The importance of the tier can be seen in respect of the cost of a boiler which is the single largest element of the tariff. In the first instance, the single period cost of the boiler is spread out over twenty years in line with the expected payments from the scheme and subject to a discount rate of 12%- see attached Annex B. For a boiler costing £50,000 this implies an annual payment of £6,694 or £134,000 in total over 20 years- see Annex C. The application of the discount factor is intended to provide applicants with a real terms rate of return of 12% i.e. the annual payments will be increased in line with inflation.

7. This annual payment needs to be converted into a per kWh basis in order to be incorporated into the tariff which involves making an assumption about the

assumed annual average level of usage. In setting the tariff in NI it was assumed that boilers would be used 17% of the time, which is equivalent to 1,490 hours or 148,000kWh for a 99kW boiler. For an annual payment of £6,694 this implies a tariff of 4.5p/kWh with other elements making up the remainder of the total tariff.

8. However, if the boiler is used more intensively at 45% of the time (390,000kWh) then annual payments of £17,700 will be received under the tariff, substantially more than the amount required to provide a 12% return on the original investment. In order to address this potential for over compensation, the tier stops payments being made in respect of the capital element of the tariff once the level of usage has breached the point where the estimated additional capital cost and 12% return have been paid.

9. Although the assumption in setting the tariff was that installations would only be used 17% of the time Table 1 below shows that the actual load factor for those installations applying to the scheme before November 2015 is on average 44.5%. In addition, over one quarter of installations are operating more than 60% of the time.

Table 1: Load Factors (%) for Installations which applied to the Scheme before November 2015

Load Factor	% of installations
0-15%	8.5%
15-30%	18.3%
30-45%	23.0%
45-60%	24.6%
60-75%	19.1%
75-90%	6.0%
90%+	0.5%
Average	44.5%

10. There has been reference made in media reports that the primary fault in the scheme was that the tariff was set higher than the price of renewable fuel which incentivised the usage of boilers in excess of the normal operational or commercial requirements. However, it is not possible to identify the impact of

this incentive as, for example; poultry sheds (representing 40% of installations) require three times the level of usage that was assumed when setting the tariff. Furthermore, the cost of increasing the usage of a boiler depends on a range of factors, over and above the cost of renewable fuel. More fundamentally, reducing the tariff to below the cost of renewable fuel would not be sufficient on its own to address the issue of over compensation.

11. The scale of the problem can be seen in the level of RHI payments received by participants in the short period of time that the scheme has been in operation. By the end of December 2016 the RHI installations which had applied to the scheme before November 2015 had on average received RHI payments equal to over 90% of their original capital investment, even though they had over 18 years worth of payments yet to receive. By the start of the 2017-18 financial year it is projected that on average the level of payments received for these installations will be greater than the original capital investment.

Table 2: RHI Payments to date as a % of Original Capital Investment for Installations which applied to the scheme before November 2015

	Dec 16 (Actual) % of installations	Mar 17 (Estimate) % of installations
0-25%	11.3%	8.1%
25-50%	18.9%	15.1%
50-75%	19.9%	16.6%
75-100%	15.9%	15.8%
100-125%	12.6%	13.4%
125-150%	7.1%	9.8%
150-175%	4.8%	7.0%
175-200%	3.4%	4.8%
200-225%	1.7%	3.2%
225-250%	1.8%	1.7%
250%+	2.5%	4.4%
Total	100.0%	100.0%
Average	90.2%	106.3%

Note: may not add to 100% due to rounding errors

12. Table 2 above shows that over one third of the pre November 2015 installations had received RHI payments greater than their original capital investment by December 2015, which is projected to rise to 44% before the

2017 Regulations come into effect. Around 6% of installations have received more than double their original investment.

13. Projecting over the lifetime of the scheme it is estimated that the installations which applied before November 2015 would have received an overall rate of return (IRR) of almost 50% on average, if no change had been made to tariff structure- see worked example of calculation of IRR at Annex D.

14. Table 3 below shows that whilst a small proportion (9.8%) of installations would not have been expected to achieve the 12% target rate of return, because of insufficient boiler usage, 72.7% would have been expected to achieve a rate of return of at least 30% with more than one quarter expected to achieve more than 70%. See Chart E1 in Annex E

Table 3: Estimated Internal Rate of Return for Installations which applied to the Scheme before November 2015 with no change to tariff.

IRR	% of installations
0-12%	9.8%
12-20%	8.2%
20-30%	9.3%
30-40%	12.0%
40-50%	11.2%
50-60%	12.5%
60-70%	11.9%
70-80%	10.8%
80-90%	7.9%
90-100%	4.0%
100-110%	1.5%
110-120%	0.7%
120%+	0.2%
Total	100.0%
Average	49.2%

Note: may not add to 100% due to rounding errors

November 2015 Revisions to Tariff

15. In light of concerns that the level of committed expenditure to the scheme in NI was substantially in excess of the available budget from the UK Government[4], a revised medium Biomass tariff structure for new applicants was introduced in November 2015. This was based on a tiered approach along the same lines as in the rest of the UK, with an additional annual usage cap, but higher levels of tariff- see Annex F for further detail. The tariff band was also expanded from 20-99kW to 20-199kW.

16. The Tier 1 tariff was set at the level previously applied to all usage (6.5p/kWh) whilst the Tier 2 tariff reflected ongoing operational costs. These were estimated by the College of Agriculture, Food and Rural Enterprise (CAFRE) in July 2015.

17. In particular, the cost of Wood Pellets was estimated to be 0.4-0.9p/kWh higher than the alternative of Liquefied Petroleum Gas (LPG), depending on boiler efficiency[5]. Including other operating costs, such as servicing and repairs, increased this differential to 1.0-1.5p/kWh. This was broadly in line with the Tier 2 tariff in the rest of the UK at the time the policy was being developed in the spring of 2015 (1.58p/kWh) leading to the NI Tier 2 tariff being set at 1.5p/kWh.

2017 Regulations

18. The surge in applications received in advance of the change in tariff structure in November 2015 meant that it was necessary to close the scheme to all new applicants in February 2016. However, the projections of costs and budget for the scheme led to the conclusion that this would not be sufficient to ensure the financial sustainability of the scheme.

[4] The combined annual budget for the domestic and non-domestic RHI budgets in NI is calculated as the population based share (2.85% in 2015) of the UK RHI budget.
[5] LPG was chosen as it is the alternative fossil fuel for poultry sheds which are the location for a significant number of RHI installations in NI.

19. In the absence of any additional measures, it was estimated that the scheme would have cost £49.7 million in 2017-18 compared with a budget of £22.3 million. This implied that there would be £27.4 million less funding available for public services, equivalent to in-patient hospital treatment for 7,800 people in the next financial year.

20. In the face of such a significant pressure, there was a critical need for the NI Executive to take further action. In response, the 2017 Regulations will extend the tiered tariff structure to all medium Biomass boilers in 2017-18 i.e. including those installations which applied to the scheme before November 2015.

21. An existing tariff structure was adopted because of the limited amount of time available to secure the necessary approvals and implement an approach that could reduce the cost of the scheme in time for the start of the next financial year. The net cost of the scheme in 2017-18 is expected to be slightly higher than budget (£25.3 million), but will provide a return to participants in line with the original objectives for the scheme.

Table 4: Estimated Internal Rate of Return for Installations which applied to the Scheme before November 2015 with revisions to tariff under 2017 Regulations.

IRR	% of installations
0-8%	11.9%
8-10%	8.6%
10-12%	18.5%
12-14%	30.7%
14-16%	30.4%
Total	100.0%
Average	11.8%

22. In particular, the revised tariff would be expected to provide a 12% rate of return on average for the installations which applied to the scheme before November 2015. In addition, Table 4 above shows that almost one third of the installations are expected to achieve a rate of return of more than 14%-

see Chart G1 in Annex G. There will be no impact for almost all of the applicants to the scheme after November 2015.

23. It is important to note that these estimates do not include the payments received to date, which will increase the rates of return significantly for those installations that have been operating for some time, as in the case of AD set out below. Furthermore, the estimates in Table 4 are based on the assumed capital cost of a Biomass boiler when the scheme was being introduced (£50,000). However, the actual cost of boilers, as reported in the application forms to the scheme was significantly lower, as can be seen again in the case of AD where the average cost was £26,500. This would suggest that the figures set out in Table 4 may represent a significant under estimate.

24. Over the lifetime of the scheme the total level of RHI payments (domestic and non-domestic) is estimated to be £1.2 billion if no action had been taken to control costs. This compares with a projected budget of £0.7 billion, implying a net cost to the Executive of £0.5 billion. However, if the tariff structure for 2017-18, as set out in the 2017 Regulations, is applied in future years, this would allow the RHI payments to remain within budget over the duration of the scheme, whilst still providing a generous return to participants- see Chart H1 in Annex H.

Longer Term Approach

25. The tariff structure for 2017-18 will be comprehensively reviewed later this year to inform the development of a longer term approach for 2018-19 and beyond. Provisional analysis would suggest that this review will result in a lower tariff, highlighting the beneficial nature of the 2017 Regulations to scheme participants. For example, the evidence on the actual capital cost of installations to the scheme would suggest that this element of the tariff (previously based on a higher assumed cost) should be reduced. This is in

the context that the Tier 1 tariff in the rest of the UK is currently 2.95p/kWh[6] compared to 6.5p/kWh in NI.

26. The latest Tier 2 tariff in the rest of the UK is also significantly lower than in NI at (0.78p/kWh vs 1.5p/kWh). The need for regular reviews of this element of the tariff can also be seen through recent changes in market conditions. For example, CAFRE have advised that the price of biomass fuel is currently 0.5-0.8p/kWh lower than when the 1.5p tariff was set. In addition, for those installations where the alternative fossil fuel is oil, the price of home heating oil has increased by over 40% since mid 2015. This would suggest that the Tier 2 tariff is also significantly in excess of the amount required, on the basis of current market conditions.

AD Participation in the RHI scheme

Usage

27. The level of excess payments received by RHI participants under the current tariff structure and the generosity of the planned changes for the 2017-18 financial year can be seen in the case of the co-applicant to the Judicial Review. AD received accreditation on the RHI scheme for two 99kW boilers effective from January 2014 and a further two boilers of the same size from October 2015- see summary Table J1 attached at Annex J.

28. Although AD stated in his application form to the scheme that the first two boilers would only be in operation for 50 hours per week, the actual average level of usage to date has been just under 100 hours per week. As a consequence, the average annual level of heat generated is 510,000 kWh each for these two boilers, based on meter readings submitted by AD. This is in excess of the amount of heat that the CAFRE has estimated as the required amount to heat a poultry shed (388,000kWh). This advice formed

[6] https://www.ofgem.gov.uk/environmental-programmes/non-domestic-rhi/contacts-guidance-and-resources/tariffs-and-payments-non-domestic-rhi

the basis of the 400,000 kWh cap on RHI payments and has been confirmed by Moy Park as being reasonable.

29. Therefore, the meter readings submitted to date would suggest that AD is operating the first two boilers more than the amount required to meet business needs and/or without sufficient regard for energy efficiency.

Payments

30. Up until the end of 2016 AD had received £227,000 in payments under the RHI scheme. This implies that he has already received payment equivalent to more than double his original investment in the Biomass Boilers.

31. On the basis of the previous tariff he was expected to continue receiving £115,000 in payments per annum. Uplifted for inflation over the next 17-19 years, this is equivalent to £2.5 million in total. This suggests that AD would have received an annual rate of return of between 117-187%, if no change had been made to the tariff structure, which is far greater than what could have reasonably been expected. AD has also received over £10,000 per annum in recent years in respect of Common Agricultural Policy (CAP) payments from the NI Executive[7].

32. Under the revised tariff for 2017-18, it is estimated that AD will receive £50,000 per annum in payments under the RHI. This implies that the rate of return on each boiler would be in the range of 22-49%, excluding the payments received to date. This rate of return is higher than the 12% cost of capital because the cost of the boilers purchased by AD is lower than the average assumed when setting the tariff. Including the RHI payments received to date for the four installations is estimated to increase the rate of return to 103-131% as the impact of these high payments is compounded by the operation of the discount factor.

[7] £11,581 in CAP payments in 2014 and £10,434 in 2015.

33. If AD were to receive payments based on achieving a 12% rate of return, in line with the original objective of the scheme, these would amount to around £34,000 per annum (for all four boilers), which equates to around £680,000 over the 20 year period. Taking into account the amounts received to date would suggest that the RHI payments to AD for the remainder of the scheme should be around £25,000 each year, equivalent to half the amount due to be received under the 2017 Regulations.

METHODOLOGY FOR CALCULATING RHI TARIFF- WORKED EXAMPLE FROM 2011 DECC IMPACT ASSESSMENT

In order to set the RHI tariffs the characteristics of the reference installations set out in Annex 3 are combined with the assumptions on the gas counterfactual. In the case of large GSHP these assumptions are:

Costs in 2010 prices	CAPEX	OPEX	Efficiency	Load Factor	Size	Lifetime	Fuel cost	Upfront costs (including admin costs)	Ongoing costs (including admin costs)
Units	£/kW	£/kW/year	%	%	kW	Years	£/MWh	£	£/year
Large GSHP	962	0.7	400%	35%	300	20	150	6,469	66
Gas	68	1.2	90%	20%	525	15	38	N/A	N/A

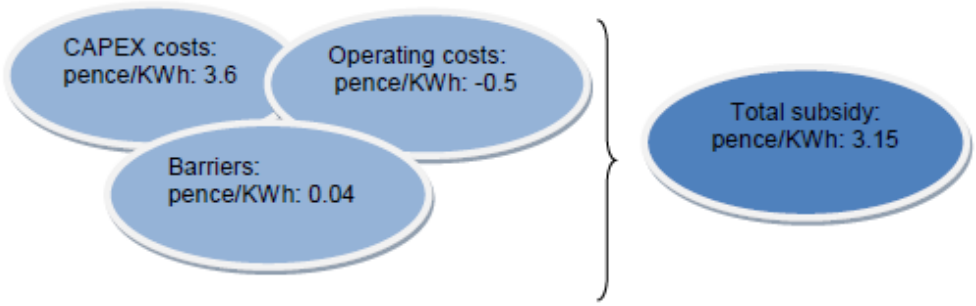
Using these technology characteristics we calculate the following elements of the tariff as follows:

- Compensation for the capital costs: Difference between the conventional and renewable technology while applying a 12% discount rate on this differential over the technology lifetime to calculate the annualised upfront payment.
- Compensation for the operating costs (including fuel costs): Difference between the conventional and renewable technology.
- Compensation for non financial barriers: Barriers associated with the renewable technology under the relevant counterfactual.

This calculation and the components of the tariffs are presented below:

Annual costs in 2010 prices	Annualised Capital cost at 12% rate	Annual operating costs	Annual fuel costs	Annuitized Upfront barrier costs	Ongoing barrier costs
Units	£	£	£	£	£
Large GSHP	£38,637	£210	£34,493	£323	£66
Gas	£5,242	£630	£38,734		
Difference	£33,396	-£420	-£4,241	£323	£66
Renewable technology resource costs	£29,124 (sum of difference row)				

As both installation produce the same output of 920MWh this means that the total subsidy in terms of p/KWh is approximately 3.15p/KWh. These elements are illustrated below in pence/KWh values:



Since the RHI payments for the non-domestic sector will be made on a quarterly basis rather than annually this means that the above tariff can be reduced to reflect the fact that consumers do not have to wait a whole year for their money. At a 12% discount rate the ratio of quarterly to yearly subsidies is 96%. The final tariff for large GSHP is therefore 3p/kWh.

EXPLANATION FOR USE OF 12% DISCOUNT FACTOR

A 12% discount factor was used in the calculation of the RHI tariff in NI (with the exception of solar energy), following the same approach as adopted in the rest of the UK. The March 2011 Department of Energy & Climate Change (DECC) Policy Document, *Renewable Heat Incentive*[8] stated that

> *Tariffs have been calculated on the basis of a required return on additional capital invested of 12 per cent for technologies and fuels except solar thermal. This reflects the fact that renewable heat is still relatively unknown in the UK and that from this low starting position, the renewable heat market needs a kick-start in order to encourage high growth quickly. The Government believes a 12 per cent rate of return represents the likely level of compensation that professional and commercial market participants will look for with this type of investment (i.e. any business considering renewable heat either for its own heat requirement or to produce for sale to others).*

This in turn was informed by research that had been commissioned by DECC, from NERA Economic Consulting and AEA, *The UK Supply Curve for Renewable Heat* (July 2009)[9]. The relevant extract from the research report is set out the box below:

2.4.3. Discount Rates and Cost of Capital
Discount rates are used in the model to calculate levelised costs of the different technologies. Discount rate assumptions therefore affect the relative importance of up-front costs (capex) and future variable costs (opex) in decisions about heating technologies.

One aim of the analysis is make it possible to estimate what subsidy levels may be necessary to reach a specified level of renewable heat output. The discount rates used in the modelling therefore are chosen to represent actual decision rules by individuals and organisations that would be likely to take up a subsidy if offered.

2.4.3.1. Household discount rates
There is considerable uncertainty about the discount rate that would be used by households when considering purchases of renewable heat technologies. As a lower bound on plausible discount rates, some households have access to savings and borrowing (including mortgage) rates at relatively low levels, in the region of 5 percent. At the other extreme, empirical estimates of discount rates for energy-related purchases, as well as survey evidence, suggest significantly higher rates, with estimates in excess of 30 percent not unusual. There also is a wider literature on time preference, documenting high rates of discount in a wide range of situations. As a further complication, empirically estimated discount rates also vary significantly between different demographic groups. On top of this, adoption of renewable heat technologies can entail higher risk to households than tried and tested conventional heating technologies, leading to higher effective rates of discount. Finally, the average tenure of a house is less than half the lifetime of most of the heating equipment considered. The ability of households to continue to benefit from a previous investment in renewable heat equipment upon selling a

[8] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/48041/1387-renewable-heat-incentive.pdf
[9] http://www.nera.com/content/dam/nera/publications/archive1/PUB_Renewable_Heat_July2009.pdf

house is far from certain, which could significantly reduce the realistic required payback period on an investment in renewable heat.

Given the considerable uncertainty about the appropriate domestic sector discount rate to use, we consider scenarios with a range of rates, from a "low" scenario of 8 percent to a "high" scenario of 32 percent. Although the balance of various influences on the discount rate is uncertain, our assessment is that the most appropriate discount rate is probably not at the higher end of this range. One reason for this is that the relevant households are likely to be home owners (or potentially social housing), with access to cheaper credit than many other consumers. Also, the fact that investment would entail entitlement to relatively certain future subsidy payments could aid the development of a loan market at relatively low interest rates, potentially using the subsidy entitlement as security. For most of the analysis we therefore use a "mid-low" rate of 16 percent, with sensitivity analysis using the "low" rate of 8 percent as well as a "mid-high" rate of 25 percent (see section 4.3.3).

2.4.3.2. Non-household discount rates

There also is uncertainty about the appropriate rate for the non-domestic sector. As in the case of households, the pure cost of capital can differ significantly between different sectors and industries, and the appropriate value depends on where renewable heat would be deployed. In addition, in organisations where energy use is not a major focus of business activity, it is common for organisations to account for the (opportunity) cost of using scarce capital and uncertainty of benefits of investment in energy equipment with very stringent payback criteria; for example, a payback requirement of 3 years implies an investment hurdle rate of 33 percent. There also may be some aspects of decisions (such as split incentives) that may be particular to energy decisions.

Just as in the household sector, we therefore use a range of discount rates, ranging between a "low" scenario of 8 percent and "high" scenario of 20 percent to reflect uncertainty about the cost of capital. The "mid-low" rate used as a starting point for much of the analysis is 12 percent, with a "mid-high" rate of 16 percent used for sensitivity analysis alongside the "low" rate[1].

1.This is higher than the weighted average cost of capital for many industries, but in line with some published estimates (e.g., McLaney et al. (2004), McLaney, E, J. Pointon, M. Thomas, J. Tucker, 'Practitioners' perspectives on the UK cost of capital', *The European Journal of Finance*, Volume 10, Issue 2 April 2004, pages 123 - 138). It is lower than the hurdle rates used by many organisations in practice.

It is evident from the narrative above that the 12% discount rate was chosen on the basis of a subjective decision within the wide range of values suggested by the research. This reflects the uncertainty in respect of the level of return required to encourage private sector investment in a less well known technology. However, the subsequent level of demand in the rest of the UK which gave rise to the need for budget controls, as well as the evidence provided by AD in respect of the cost of capital, would suggest that 12% was too high a level for the discount rate. In this context, the NERA/AEA report highlights the significance of the discount rate, estimating that a lower rate would reduce the cost of renewable technology by about 40%.

More recently, the 2016 Impact Assessment in respect of the reforms to the scheme in the rest of the UK[10] highlighted the potential for not all businesses to achieve the implied 12% target rate of return whilst the need to control costs through degression will also impact on the rate of return:

> *Scheme tariffs are not intended to offer a fixed rate of return to all installations for the duration of the scheme. Instead they act as a guide to the rate of return targeted when we set tariffs. There are many reasons why a householder or business may not achieve the above rate of return. For example, there is significant heterogeneity in the building stock and in the operation of renewable heating installations. In addition, the function of degression is to protect budgets, ensure that there is diversity of deployment and value for money, so that over time the actual rate of return may well change.*
>
> Impact Assessment: Consultation Stage IA: The Renewable Heat Incentive: A reformed and refocused scheme (Paragraph 31)

10 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/505132/Consultation_Stage_Impact_Assessment_-_The_RHI_-_a_reformed_and_refocussed_scheme.pdf

EXAMPLE OF CALCULATION OF ANNUALISED COST

In order to calculate a tariff it is often necessary to annualise a single cost into a series of periodic costs. On the principle that costs incurred in the present are of more significance than costs incurred in the future, the periodic costs need to be discounted.

In the case of calculating the tariffs under the RHI scheme, the assumed cost of capital/hurdle rate for investment (12%) is used as the discount factor (1/(1+12%))=0.8929, which is compounded into future years . In the worked example set out in Table C1 below an annual payment of £6,694 is required each year so that the sum of discounted costs over 20 years is equal to the initial capital investment of £50,000.

Table C1: Worked Example of Annualised Cost

	Annual Cost	Discount Factor	Discounted Annual Cost
Year 1	£6,694	0.8929	£5,976.73
Year 2	£6,694	0.7972	£5,336.37
Year 3	£6,694	0.7118	£4,764.61
Year 4	£6,694	0.6355	£4,254.12
Year 5	£6,694	0.5674	£3,798.32
Year 6	£6,694	0.5066	£3,391.36
Year 7	£6,694	0.4523	£3,028.00
Year 8	£6,694	0.4039	£2,703.57
Year 9	£6,694	0.3606	£2,413.90
Year 10	£6,694	0.3220	£2,155.27
Year 11	£6,694	0.2875	£1,924.35
Year 12	£6,694	0.2567	£1,718.17
Year 13	£6,694	0.2292	£1,534.08
Year 14	£6,694	0.2046	£1,369.71
Year 15	£6,694	0.1827	£1,222.96
Year 16	£6,694	0.1631	£1,091.93
Year 17	£6,694	0.1456	£974.93
Year 18	£6,694	0.1300	£870.48
Year 19	£6,694	0.1161	£777.21
Year 20	£6,694	0.1037	£693.94
Total	**£133,879**	**7.5**	**£50,000.00**

The annual cost is then used as the capital element of the RHI tariff. At the 12% discount rate, the total amount of payments over 20 years for the capital element of the tariff is equal to 167% of the original investment even before the inflationary uplifts are included. As the tariff is paid on a quarterly basis, there is a further adjustment of 0.96 when setting the amount of payment per kWh.

EXAMPLE OF CALCULATION OF INTERNAL RATE OF RETURN

The Internal Rate of Return is a commonly used measure of the financial rate of return and is calculated as the discount factor required so that the sum of the discounted cash flows over the lifetime of a project equal to zero.

The worked example set out in Table D1 below is based on an initial capital investment of £50,000, ongoing running costs of £5,000 per annum and RHI payments of £20,000 per annum. This results in an Internal Rate of Return of 29.8% which if applied to the cash flows as a discount factor ((1/1+29.8%) = 0.7705 for Year 1) results in a zero result over the lifetime of the project.

Table D1: Worked Example of Internal Rate of Return Calculation

	Cashflow	Discount Factor (IRR)	Discounted Cashflow
Year 0	-£50,000	1.0000	-£50,000
Year 1	£15,000	0.7705	£11,557
Year 2	£15,000	0.5936	£8,905
Year 3	£15,000	0.4574	£6,861
Year 4	£15,000	0.3524	£5,286
Year 5	£15,000	0.2715	£4,073
Year 6	£15,000	0.2092	£3,138
Year 7	£15,000	0.1612	£2,418
Year 8	£15,000	0.1242	£1,863
Year 9	£15,000	0.0957	£1,435
Year 10	£15,000	0.0737	£1,106
Year 11	£15,000	0.0568	£852
Year 12	£15,000	0.0438	£657
Year 13	£15,000	0.0337	£506
Year 14	£15,000	0.0260	£390
Year 15	£15,000	0.0200	£300
Year 16	£15,000	0.0154	£231
Year 17	£15,000	0.0119	£178
Year 18	£15,000	0.0092	£137
Year 19	£15,000	0.0071	£106
Year 20	£15,000	0.0054	£82
Total	**£235,000**		**£0**

There is not a simple formula for the Internal Rate of Return with iterative attempts made with different discount factors before the sum of discounted cash flows equals zero. For this reason, the common approach is to use a computer spreadsheet programme, with the calculation verified by way of analysis as set out above. As the RHI payments are made each quarter, the cash flows used to calculate the Internal Rates of Return are also on a quarterly basis i.e. 80 quarters in total- see Table J3 below.

Chart E1: Estimated Internal Rate of Return for Installations which applied to the Scheme before November 2015 with no change to tariff.

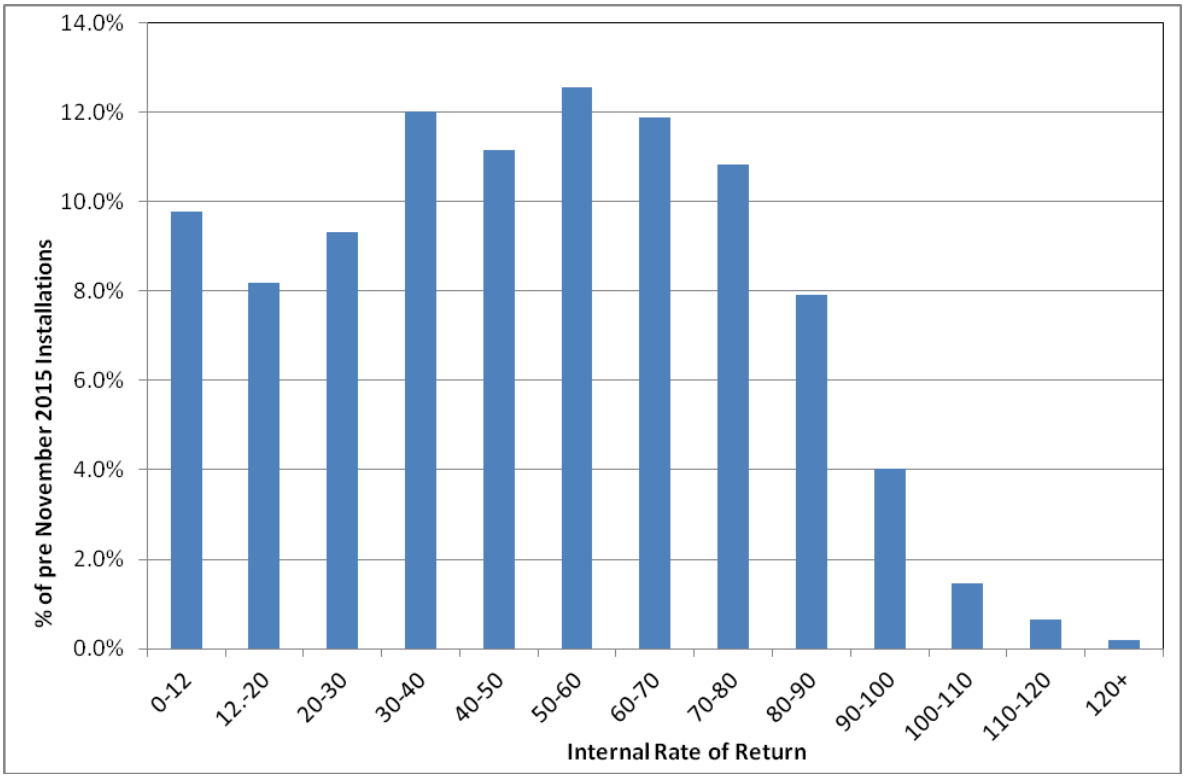


Table F1: Main Elements of 2017-18 NI Non-Domestic RHI Tariff Schedule for Medium Biomass Boilers

Element	NI	GB	Comment
Counterfactual fuel	Oil/LPG	Gas	Significant proportion of boilers in NI RHI are in the poultry sector which uses LPG
Band	Medium (20-199kW)	Small (<200kW)	
Tier 1 Tariff (pence per kWh)	6.5	4.23[1]	Tariff set out in February 2012 CEPA report for 50kW boiler (5.9p per kWh) uplifted for inflation. This was based on annualized capital costs and 12% cost of capital, as well as ongoing operating costs- See Tier 2 tariff.
Tier 1 upper usage limit (hours)	1,314	1,314	Implies load factor of 15%. UK Government 2011 Policy Document, *Renewable Heat Incentive*, stated that this "...represents our estimate of a reasonable minimum level of usage that we would expect from a renewable heat installation used for space heating"
Tier 2 Tariff (pence per kWh)	1.5	1.12[1]	See Table F2 below. Based on additional fuel and other operating costs.
Annual upper usage limit (kWh)	400,000	N/A	Based on analysis provided by CAFRE[2]
Inflationary uplift	RPI	RPI/CPI	Applications to GB scheme after 1 April 2016 will have payments uplifted each year by rate of CPI.
Degression	No	Yes	Reduction in tariff for new entrants once committed level of expenditure breaches specified trigger points.

1. GB Tariffs are for those accredited between 1 October 2015 and 1 January 2016 to align with the initial introduction of the NI tariff used in 2017-18 (November 2015).
2. Typical broiler house in NI used 42k litres of LPG per year equivalent to 277,200 kWh of heat. Using biomass instead would require 30% more heat (365,500kWh), although up to 388,000 kWh may be required depending on the size, age, insulation and type of house.

Table F2: Tier 2 Tariff for Medium Biomass Boilers (July 2015)

	Pellets		Woodchip	
Biomass Boiler Efficiency	**90%**	**80%**	**90%**	**80%**
Biomass fuel cost (p/kWh)	4.16	4.66	3.81	4.28
Biomass other costs (p/kWh)	0.65		0.7	
Biomass total cost (p/kWh)	4.81	5.31	4.51	4.98
LPG cost (p/kWh)	3.79			
Difference	1.02	1.52	0.72	1.19

Source: CAFRE Paper, July 2015

Although the analysis in Table F2 implies that the tariff could be set within a range of 0.7-1.5p/kWh, the actual tariff implemented was at the upper limit. Other costs include electricity, servicing and remedial repairs.

The latest figures from CAFRE suggest that the current fuel cost of Biomass is 3.4p/kWh for both pellets and woodchip.

Chart G1: Estimated Internal Rate of Return for Installations which applied to the Scheme before November 2015 with revisions to tariff under 2017 Regulations.

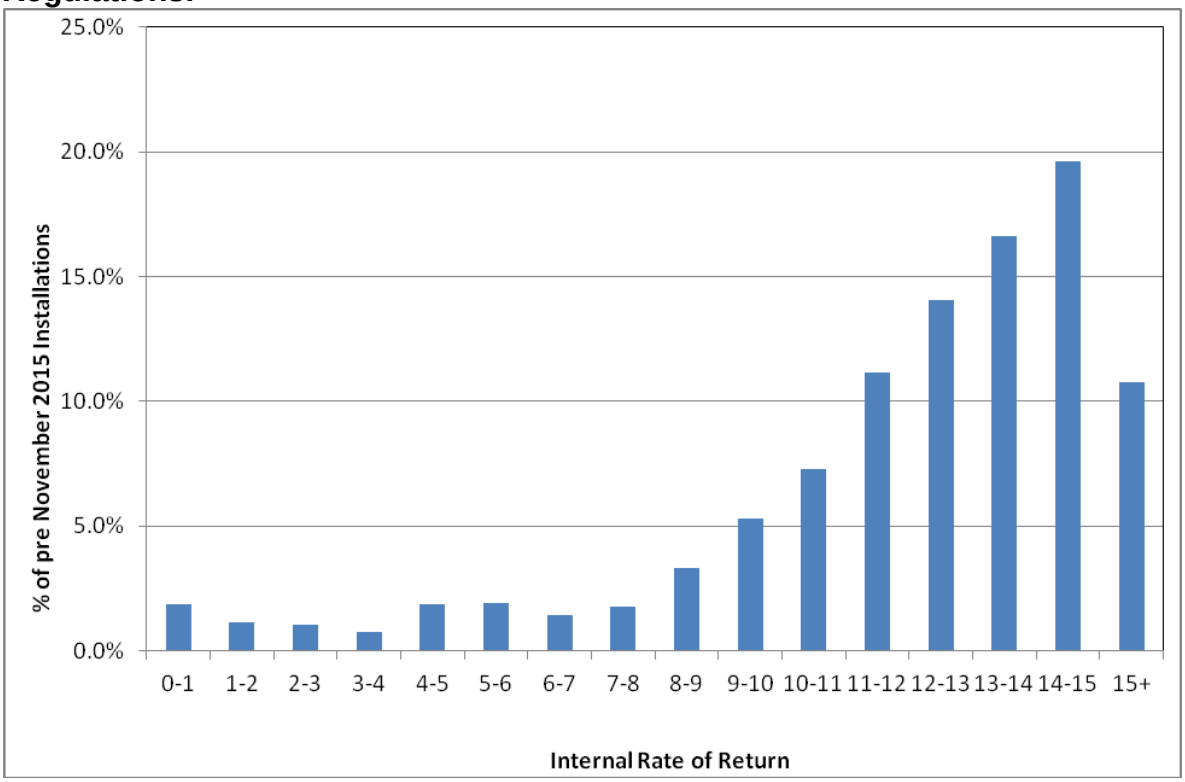
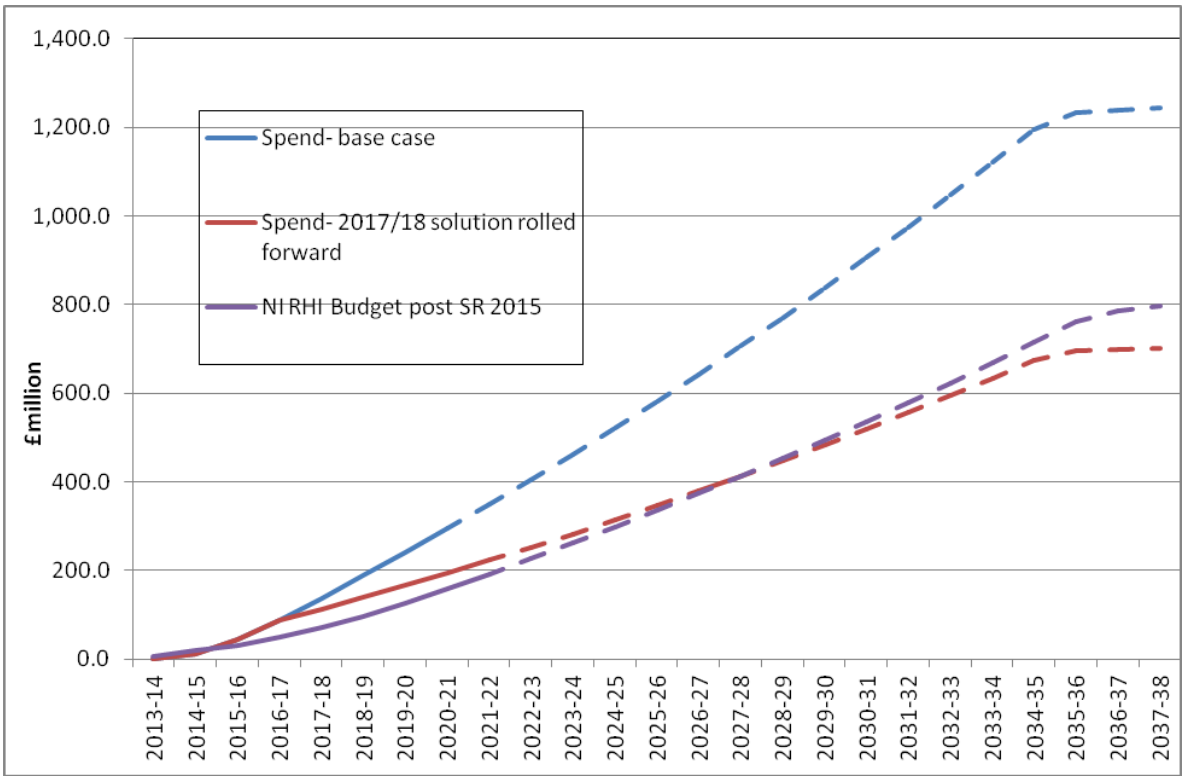


Chart H1: Projected cumulative gross expenditure and Budget for NI RHI scheme.



Note: there is no budget formally in place beyond 2020-21 with both spend and budget uplifted on the basis of the forecast rates of inflation.

Table J1: Summary of Payments Received by AD under the NI RHI scheme

Installation ref Number	NIRHI [redacted]	NIRHI [redacted]	NIRHI [redacted]	NIRHI [redacted]	Total
Boiler size (KW)	99	99	99	99	99
Capital Cost (£)	32,000	32,000	21,000	21,000	106,000
Indirect costs (£)	2,500	2,500	0	0	5,000
Accreditation date	10/01/2014	10/01/2014	12/10/2015	12/10/2015	
Quarterly Meter Readings to date	11	11	4	4	30
Average Annual Heat Usage to date (kWh)	503,780	520,462	409,276	373,302	451,705
Implied hours use per week	98	101	80	73	88
Hours usage from Application Form	50	50	112	112	
Load Factor (actual)	58.2%	60.2%	47.3%	43.2%	52.2%
Payment received to date (£)	86,836	89,723	26,182	23,848	226,589
Payment received to date as % of capital spend	251.7%	260.1%	124.7%	113.6%	204.1%
Average Annual payment (actual)	31,940	33,002	26,417	24,062	115,422
Accruals to end of scheme	610,194	630,484	566,238	515,772	2,322,687
Estimated total payments	697,029	720,207	592,420	539,620	2,549,276
Rate of return- old tariff	117%	122%	187%	163%	138%
Rate of return- new tariff excluding payments to date	22%	22%	49%	49%	32%
Rate of return- new tariff including payments to date	103%	109%	131%	113%	111%
Annual payment (old tariff)	32,746	33,830	26,603	24,265	117,443
Annual payment (new tariff)	12,504	12,504	12,504	12,104	49,617
Annual payment (12% Rate of Return)	9,905	10,072	7,229	6,869	34,076
Additional operating cost of biomass annual (£)	5,038	5,205	4,093	3,733	18,068

Calculation of Average Annual Payment for Boiler 4788 on basis of 12% IRR

Net Investment Cost equals Cost of Boiler (£32,000) plus Indirect costs (£2,500) minus the Cost of Fossil Fuel Alternative Boiler (£3,000) i.e. £31,500

As RHI Payments are made on a quarterly basis the 12% discount factor also needs to be on a quarterly basis (1+12%)^(1/4) i.e. 2.87%.

Based on 20*4 quarterly payments the PMT function in Microsoft Excel records a value of £1,010 which can be checked by applying the 2.87% discount factor to each quarterly cost as set out in Table J2 below which shows the sum of discounted costs equal to the original Net Investment Cost

In addition to the four quarterly payments in respect of the net investment cost (plus 12% return) the RHI annual payment also includes compensation for the additional operating costs for Biomass (£5,038) based on the 1p/kWh differential set out in Table F2 as well as £828 in ongoing barrier costs from the previous CEPA analysis, resulting in a total of £9,905 per annum payment (£1,010*4+£5,038+£828).

Table J2: £1,010 quarterly payments discounted at a quarterly rate of 2.87% over 80 quarters.

	Undiscounted Cost	Discount Factor (2.87%)	Discounted Cost
Quarter 1	£1,010	0.97207	£982
Quarter 2	£1,010	0.94491	£954
Quarter 3	£1,010	0.91852	£928
Quarter 4	£1,010	0.89286	£902
Quarter 5	£1,010	0.86792	£877
Quarter 6	£1,010	0.84367	£852
Quarter 7	£1,010	0.82010	£828
Quarter 8	£1,010	0.79719	£805
Quarter 9	£1,010	0.77492	£783
Quarter 10	£1,010	0.75328	£761
Quarter 11	£1,010	0.73223	£739
Quarter 12	£1,010	0.71178	£719
Quarter 13	£1,010	0.69190	£699
Quarter 14	£1,010	0.67257	£679
Quarter 15	£1,010	0.65378	£660
Quarter 16	£1,010	0.63552	£642
Quarter 17	£1,010	0.61777	£624
Quarter 18	£1,010	0.60051	£606
Quarter 19	£1,010	0.58373	£590
Quarter 20	£1,010	0.56743	£573
Quarter 21	£1,010	0.55158	£557
Quarter 22	£1,010	0.53617	£541
Quarter 23	£1,010	0.52119	£526
Quarter 24	£1,010	0.50663	£512
Quarter 25	£1,010	0.49248	£497
Quarter 26	£1,010	0.47872	£483
Quarter 27	£1,010	0.46535	£470
Quarter 28	£1,010	0.45235	£457
Quarter 29	£1,010	0.43971	£444
Quarter 30	£1,010	0.42743	£432
Quarter 31	£1,010	0.41549	£420
Quarter 32	£1,010	0.40388	£408
Quarter 33	£1,010	0.39260	£396
Quarter 34	£1,010	0.38163	£385
Quarter 35	£1,010	0.37097	£375
Quarter 36	£1,010	0.36061	£364
Quarter 37	£1,010	0.35054	£354
Quarter 38	£1,010	0.34074	£344
Quarter 39	£1,010	0.33123	£335
Quarter 40	£1,010	0.32197	£325
Quarter 41	£1,010	0.31298	£316
Quarter 42	£1,010	0.30424	£307
Quarter 43	£1,010	0.29574	£299

	Undiscounted Cost	Discount Factor	Discounted Cost
Quarter 44	£1,010	0.28748	£290
Quarter 45	£1,010	0.27945	£282
Quarter 46	£1,010	0.27164	£274
Quarter 47	£1,010	0.26405	£267
Quarter 48	£1,010	0.25668	£259
Quarter 49	£1,010	0.24950	£252
Quarter 50	£1,010	0.24254	£245
Quarter 51	£1,010	0.23576	£238
Quarter 52	£1,010	0.22917	£231
Quarter 53	£1,010	0.22277	£225
Quarter 54	£1,010	0.21655	£219
Quarter 55	£1,010	0.21050	£213
Quarter 56	£1,010	0.20462	£207
Quarter 57	£1,010	0.19890	£201
Quarter 58	£1,010	0.19335	£195
Quarter 59	£1,010	0.18795	£190
Quarter 60	£1,010	0.18270	£185
Quarter 61	£1,010	0.17759	£179
Quarter 62	£1,010	0.17263	£174
Quarter 63	£1,010	0.16781	£169
Quarter 64	£1,010	0.16312	£165
Quarter 65	£1,010	0.15856	£160
Quarter 66	£1,010	0.15414	£156
Quarter 67	£1,010	0.14983	£151
Quarter 68	£1,010	0.14564	£147
Quarter 69	£1,010	0.14158	£143
Quarter 70	£1,010	0.13762	£139
Quarter 71	£1,010	0.13378	£135
Quarter 72	£1,010	0.13004	£131
Quarter 73	£1,010	0.12641	£128
Quarter 74	£1,010	0.12288	£124
Quarter 75	£1,010	0.11944	£121
Quarter 76	£1,010	0.11611	£117
Quarter 77	£1,010	0.11286	£114
Quarter 78	£1,010	0.10971	£111
Quarter 79	£1,010	0.10665	£108
Quarter 80	£1,010	0.10367	£105
Total			**£31,500**

Calculation of Internal Rates of Return

Set out in Table J3 below are the estimated cash flows under the old tariff for each of AD's boilers with the Internal Rate of Return at the bottom.

The Quarter 0 cash flow is the Net Capital Investment as set out above. The subsequent cash flows (figures for Boiler 4788 in parenthesis) are equal to the RHI quarterly payments (£32,746/4=£8,186) minus quarterly running costs (£5,038/4=£1,260) and barrier costs (£828/4=£207).

The Internal Rate of Return is on a quarterly basis (21%) which needs to be annualised ((1+21%)^4)-1), resulting in an annual figure of 117%.

Table J3: Net Cash flows for AD Boilers (Old Tariff) (£)

Boiler	4788	4791	16664	16666	Total
Quarter 0	-31,500	-31,500	-18,000	-18,000	-99,000
Quarter 1	6,720	6,949	5,421	4,926	24,016
Quarter 2	6,720	6,949	5,421	4,926	24,016
Quarter 3	6,720	6,949	5,421	4,926	24,016
Quarter 4	6,720	6,949	5,421	4,926	24,016
Quarter 5	6,720	6,949	5,421	4,926	24,016
Quarter 6	6,720	6,949	5,421	4,926	24,016
Quarter 7	6,720	6,949	5,421	4,926	24,016
Quarter 8	6,720	6,949	5,421	4,926	24,016
Quarter 9	6,720	6,949	5,421	4,926	24,016
Quarter 10	6,720	6,949	5,421	4,926	24,016
Quarter 11	6,720	6,949	5,421	4,926	24,016
Quarter 12	6,720	6,949	5,421	4,926	24,016
Quarter 13	6,720	6,949	5,421	4,926	24,016
Quarter 14	6,720	6,949	5,421	4,926	24,016
Quarter 15	6,720	6,949	5,421	4,926	24,016
Quarter 16	6,720	6,949	5,421	4,926	24,016
Quarter 17	6,720	6,949	5,421	4,926	24,016
Quarter 18	6,720	6,949	5,421	4,926	24,016
Quarter 19	6,720	6,949	5,421	4,926	24,016
Quarter 20	6,720	6,949	5,421	4,926	24,016
Quarter 21	6,720	6,949	5,421	4,926	24,016
Quarter 22	6,720	6,949	5,421	4,926	24,016
Quarter 23	6,720	6,949	5,421	4,926	24,016
Quarter 24	6,720	6,949	5,421	4,926	24,016

Boiler	4788	4791	16664	16666	Total
Quarter 25	6,720	6,949	5,421	4,926	24,016
Quarter 26	6,720	6,949	5,421	4,926	24,016
Quarter 27	6,720	6,949	5,421	4,926	24,016
Quarter 28	6,720	6,949	5,421	4,926	24,016
Quarter 29	6,720	6,949	5,421	4,926	24,016
Quarter 30	6,720	6,949	5,421	4,926	24,016
Quarter 31	6,720	6,949	5,421	4,926	24,016
Quarter 32	6,720	6,949	5,421	4,926	24,016
Quarter 33	6,720	6,949	5,421	4,926	24,016
Quarter 34	6,720	6,949	5,421	4,926	24,016
Quarter 35	6,720	6,949	5,421	4,926	24,016
Quarter 36	6,720	6,949	5,421	4,926	24,016
Quarter 37	6,720	6,949	5,421	4,926	24,016
Quarter 38	6,720	6,949	5,421	4,926	24,016
Quarter 39	6,720	6,949	5,421	4,926	24,016
Quarter 40	6,720	6,949	5,421	4,926	24,016
Quarter 41	6,720	6,949	5,421	4,926	24,016
Quarter 42	6,720	6,949	5,421	4,926	24,016
Quarter 43	6,720	6,949	5,421	4,926	24,016
Quarter 44	6,720	6,949	5,421	4,926	24,016
Quarter 45	6,720	6,949	5,421	4,926	24,016
Quarter 46	6,720	6,949	5,421	4,926	24,016
Quarter 47	6,720	6,949	5,421	4,926	24,016
Quarter 48	6,720	6,949	5,421	4,926	24,016
Quarter 49	6,720	6,949	5,421	4,926	24,016
Quarter 50	6,720	6,949	5,421	4,926	24,016
Quarter 51	6,720	6,949	5,421	4,926	24,016
Quarter 52	6,720	6,949	5,421	4,926	24,016
Quarter 53	6,720	6,949	5,421	4,926	24,016
Quarter 54	6,720	6,949	5,421	4,926	24,016
Quarter 55	6,720	6,949	5,421	4,926	24,016
Quarter 56	6,720	6,949	5,421	4,926	24,016
Quarter 57	6,720	6,949	5,421	4,926	24,016
Quarter 58	6,720	6,949	5,421	4,926	24,016
Quarter 59	6,720	6,949	5,421	4,926	24,016
Quarter 60	6,720	6,949	5,421	4,926	24,016
Quarter 61	6,720	6,949	5,421	4,926	24,016
Quarter 62	6,720	6,949	5,421	4,926	24,016
Quarter 63	6,720	6,949	5,421	4,926	24,016
Quarter 64	6,720	6,949	5,421	4,926	24,016
Quarter 65	6,720	6,949	5,421	4,926	24,016
Quarter 66	6,720	6,949	5,421	4,926	24,016
Quarter 67	6,720	6,949	5,421	4,926	24,016
Quarter 68	6,720	6,949	5,421	4,926	24,016
Quarter 69	6,720	6,949	5,421	4,926	24,016

Boiler	4788	4791	16664	16666	Total
Quarter 70	6,720	6,949	5,421	4,926	24,016
Quarter 71	6,720	6,949	5,421	4,926	24,016
Quarter 72	6,720	6,949	5,421	4,926	24,016
Quarter 73	6,720	6,949	5,421	4,926	24,016
Quarter 74	6,720	6,949	5,421	4,926	24,016
Quarter 75	6,720	6,949	5,421	4,926	24,016
Quarter 76	6,720	6,949	5,421	4,926	24,016
Quarter 77	6,720	6,949	5,421	4,926	24,016
Quarter 78	6,720	6,949	5,421	4,926	24,016
Quarter 79	6,720	6,949	5,421	4,926	24,016
Quarter 80	6,720	6,949	5,421	4,926	24,016
IRR (quarterly)	21%	22%	30%	27%	24%
IRR(annual)	117%	122%	187%	163%	138%