Delivering a Renewable Heat Incentive for the Republic of Ireland

irish bioenergy association

August 2015

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Irish Bioenergy Association (IrBEA)

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Errol Close, Assistant Principal Officer DCENR, Michael Doran of Action Renewables, Jacqueline Balian, formerly of Ofgem, and David Hourihane, Managing Director SDCL Ireland, gave generously of their time to present at our workshop and provided other inputs.

Many thanks to Tom Bruton, Principal of BioXL, for his professionalism and patience in undertaking the analysis and compiling this report. Managing the sometimes conflicting desires of members of even a small group can often prove challenging but the Group engaged in open and honest dialogue to take all views on board and to deliver a report that goes as far as possible to address the needs related to a successful implementation of an RHI scheme.

Matthew Clancy of SEAI assisted the workings of the Group by giving an insight into the methodology used by SEAI in developing their Renewable Heat document and is thanked for this input.

The RHI Group and its members look forward to continuing our close working relationship with DCENR and SEAI as the process to introduce an RHI develops.

Finally, we are grateful for the time and funding provided by the members of this IrBEA RHI Group, without which this report could not have been prepared.

Foreword

Joe O'Carroll
Chairman
IrBEA RHI Group

Many IrBEA members have been active in recent years developing biomass projects supported by renewable heat incentive schemes in other EU Member States, so it is a very welcome development that DCENR has recently announced the intention to bring a similar scheme to fruition in Ireland. This process has started with the first consultation paper in circulation at the time of publication of this IrBEA report.

The indication that all biomass projects commissioned from July 2014 will qualify retrospectively for the scheme is particularly welcomed and it is encouraging that DCENR took on board IrBEA's observation in this regard. This introduces some level of clarification for the industry and allows project planning to commence, even though final purchasing decisions are unlikely to be made until the tariff structure is fully known. For this reason, IrBEA is proposing that the scheme design avoids the use of "banding" which would introduce a distortion to the market and instead recommends a 2-tier tariff that would be applied to all installations, regardless of size.

This IrBEA report is the culmination of a concerted effort by the IrBEA Management and Executive Committee to ensure that the organisation plays a leading role in shaping a Renewable Heat Incentive (RHI) for Ireland. It is the beginning of an IrBEA process that will see the association putting the full force of its members behind the scheme to ensure that it is implemented in a manner that both maximises its effectiveness and delivers value for money for taxpayers and heat consumers.

However, it is vitally important that the pending RHI is not seen as a panacea for the renewable heat industry. IrBEA has repeatedly called for the introduction of zero- and low-cost policy instruments to create an environment in which renewable energy, particularly biomass, can reach its maximum potential.

While the renewable energy sources (RES) targets are the current focus, the potential of renewable energy in Ireland should not be curtailed by external targets. The EU targets were set at a much earlier point in our knowledge of the global climate change challenge. It is now clear that due to previous inaction, the targets for decarbonising the global economy must be elevated. Our efforts to promote energy efficiency and renewable energy must be intensified and it is lamentable that it is only in 2015 that we are seeing the start of a real effort to incentivise the generation of heat from renewable sources.

It is noticeable that initiatives such as the Climate Group's RE100 are making it clear that corporate entities are setting their own renewable energy targets at far more determined levels and timelines than governments. Many multi-national companies want to achieve 100% renewable energy by 2020 across all of their sites. A high proportion of these companies has operations in Ireland and/or are considering further investment. It is estimated that the planned data centres alone will increase power demand within the Irish State by up to 900MW with all of the companies involved wanting to procure power only from renewable sources.

This increased demand for renewables was not factored into the RES targets and underlines the need for Ireland to have ambitions far beyond our current commitments.

- The policy instruments that need to be introduced in tandem with the proposed RHI include:
- Public procurement mandates to all public sector estate managers to switch to renewable energy sources. Despite the nation's renewable heat targets, many public bodies continue to show a lack of leadership by continuing to deploy finite capital budgets to purchase fossil fuel boilers and CHP systems. There should be an immediate ending of this practice and then a rolling programme introduced to retrofit existing fossil fuel systems with renewable energy technologies. This has been done successfully in Denmark.
- The State Company responsible for gas networks should be refocused to deal with a wider definition of energy networks to include district heating. District heating is a key enabler for more efficient use of all energy sources and the current cost benefit analysis tools used when considering extensions to the gas network are not broad enough to take in the full positive impact of using local, renewable energy sources.
- Underlining the RHI aspiration is the assumption that sufficient biomass resources will be available at the correct price and specification. Many studies have been conducted to quantify the production potential from the private forests of Ireland and although there is increasing harvesting activity in that sector, the recommendations of the recent COFORD report (March 2015) from its Wood Mobilisation Group need to be implemented in full to ensure that fuel availability is not a constraint to the development of the sector. The proposed initiative involving a joint venture between Coillte and Bord na Móna (so-called BioEnergy Ireland), needs to either be developed or taken off the agenda as the overhang of this proposal is curtailing private sector investment in the industry.

Returning to the proposed RHI, this report clearly outlines that in order to hit our RES-H targets, not only do we need to encourage users of LPG and oil to switch to renewables, we also need to make the scheme sufficiently attractive to encourage switching from natural gas. For this reason, the use of gas as the counterfactual fuel is justified and further underlines the need to cease investment in intensifying the gas network.

Encouraging current gas users to switch away from gas while using the state company to fund the creation of further gas networks makes no economic or environmental sense, irrespective of the outcome of the narrow cost benefit analysis carried out to justify gas network investment.

The early signals regarding the exclusion of Emissions Trading Scheme (ETS) sites from the proposed RHI scheme are not conducive to the RHI achieving its targets. Many ETS sites have thermal load profiles suitable for the deployment of reasonably large biomass systems and the companies involved are largely export focussed. It is clear that competitors in neighbouring jurisdictions can participate in the ETS and also benefit from RHI eligibility. Any exclusion of these companies from an Irish RHI scheme would put them at a competitive disadvantage and should be avoided.

The full exploitation of the development of our biomass resources has the potential to deliver significant job creation, economic activity and environmental benefits, particularly in rural Ireland. Introducing the scheme in the manner outlined in this document will fast track the delivery of this potential and we look forward to working with all stakeholders to ensure its timely and successful implementation.

About the Irish Bioenergy Association

IrBEA (www.irbea.org and www.irbea.ie) was founded in 1999. Its role is to promote the bioenergy industry and to develop this important sector on the island of Ireland. The association's main objectives are to influence policy makers to promote the development of bioenergy, and to promote the interests of members. Improving public awareness, networking and information sharing, and liaising with similar interest groups are other key areas of work in promoting biomass as an environmentally, economically and socially sustainable energy resource. The organisation is a self-governing association of voluntary members and is affiliated to AEBIOM, the European Biomass Association, and EBA, the European Biogas Association.

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Introduction

The Irish Bioenergy Association (IrBEA) welcomes the intended introduction of a Renewable Heat Incentive (RHI) by the Department of Communications Energy and Natural Resources (DCENR), and is pleased to present its analysis and initial recommendations for RHI policy formation.

The Irish Bioenergy Association (IrBEA) is an industry association with over 150 members representing the Bioenergy industry on the island of Ireland. The IrBEA Renewable Heat Group commissioned a paper with the aim to identify critical issues for its members and make findings and recommendations to DCENR during the development of a renewable heat incentive (RHI) scheme.

The scope of work considered at present has been limited to commercial solid biomass heating applications. There are separate IrBEA groups dedicated to biogas/AD, biomass domestic fuels, energy crops and biomass power generation.

The report (and recommendations) incorporates industry consultation and represents a coherent and robust appraisal of the options for an RHI with industry support.

As of writing there are no details of the RHI scheme proposed for 2016 implementation. The pace of policy development is a cause of concern to the bioenergy sector, as little or no activity is progressing in the absence of clarity on an RHI scheme.

An early market signal is required, due to the learning curve and time lag in delivering a scheme. Lead times for some larger biomass heating projects can count in years, rather than months, especially if planning or environmental permits are required. IrBEA has welcomed the Government announcement of a “grandfathering” date for eligibility to an RHI scheme to allow projects to progress through the design and planning phases as scheme details are finalised. However further clarity on tariffs and eligibility criteria is required at the earliest stage.

The primary motive behind the proposal to introduce an RHI is to meet Ireland’s 2020 Renewable Energy targets. While this is a useful short-term focus and a trigger for action, RES-H policy should be designed with growth and delivery expectations beyond 2020 in mind.

There is a need, acknowledged by DCENR, for policy stimulus to deliver additional renewable heat. The shortfall to achieving 12% RES-H (the target set for 2020) is estimated by SEAI to be 200 ktoe.

Apart from the requirement for RES-H, there are many additional benefits to investment in biomass heating. Meeting the 2020 targets would support around 240 new full-time jobs, as well as 120 man-years during the construction phase. The growth of an RES-H sector would help the biomass supply chain to mature and stimulate regional demand for forest thinnings, energy crops and other sources of biomass.

International and National Precedent Schemes

There are relatively few examples of pure unit-based heat incentives. In considering a scheme design IrBEA has looked principally to the NI and UK experience, and a similar French scheme.

Some of the key learnings from the UK schemes can be summarised as follows:

- The schemes work, with imperfections
- "Grandfathering" has helped generate early action and maintain a degree of market confidence while the RHI was in formation (2 years in the UK)
- Despite the success of delivering 1.5GW of biomass thermal capacity, the scheme is behind target. It takes some time to build momentum, and there is a learning curve for all stakeholders
- Degression works as a cost control mechanism and also encourages timely applications

There have been a number of schemes in Ireland to incentivise renewable heat. The most relevant of these was the Reheat Scheme, which ran from 2007 to 2011, and supported 78MW of biomass heating at 204 boilers. The median installation size under this scheme was 165 kW. In total there were only 8 applications supported above 1,000 kW.

A smaller Bioheat Scheme ran prior to the Reheat Scheme, and resulted in 17 installations, with a median size of 175 kW.

Heating Market Context

A top-down analysis of SEAI 2013 energy balance statistics was carried out. This clearly indicates that natural gas is the dominant heating fuel in industry and commercial/public service buildings (44% and 54% respectively of sector overall heat demand). It is only in the residential sector that oil meets the largest part of heat demand (44%), and this is shrinking over time with energy efficiency or switching to renewable resources or natural gas.

The cost of fossil fuels has fallen substantially, which makes biomass heating less competitive. The cost of natural gas is marginally below the cost of wood chip fuel at present, excluding any consideration of higher capital or O&M costs.

Where natural gas is available to consumers, this is the fuel of choice, not only for cost reasons, but it is a far more convenient fuel, without the need for additional space, fuel storage, installation or design complexity entailed with solid fuel systems.

New boiler sales are picking up at present from a low base. This presents a good window of opportunity to consider renewable heating, which early policy implementation would capture. It is of note also that 80% of commercial boiler sales are retrofit rather than greenfield installations.

A range of data was used to estimate the potential heat market by fuel. The scenario selected for estimating a realistic upper limit to market potential, is where 1 in 4, or 25% of eligible market participants would respond to an RHI policy signal. Due to the proposal by DCENR that an RHI would focus initially on non-ETS installations, a large part of the industrial market demand is excluded.

The results of this market analysis are presented in the table below. It clearly shows the potential for renewable heat applications is likely to be limited to 109 ktoe if natural gas remains the fuel of choice. Tariffs must be competitive with natural gas if an additional 200 ktoe are to be delivered by an RHI.

Table: Analysis of potential market size for renewable heat policy signal

Thermal Demand in ktoe non-domestic sectors 2013/2014	25% market share (non-ETS)
LPG	22
HFO	3
Gasoil	65
Kerosene	19
Subtotal (excluding Natural Gas)	**109**
Natural Gas	172
Total	**281**
Renewable heat gap to 2020 target	**200**

Public and commercial buildings will be important target sectors for renewable heat, especially in light of the proposal initially to exclude the traded emissions sector. Electrically powered HVAC systems have emerged as a very large part of the commercial sector, especially retail and office space. This significantly reduces the potential market size for renewable heat in the commercial sector.

The market research (and the exclusion of ETS sites from current proposals) indicates that opportunities are likely to be in the lower end of commercial boiler size ranges. The majority of commercial boiler sales at present are for modular gas boilers of between 44kW and 100 kW capacity, often installed in series to meet larger loads. There remain good opportunities to deliver renewable heat at industrial scale.

Heat Incentive Modelling

There is complexity in arriving at a suitable tariff for an RHI. It is not possible to design a scheme that takes account of all variables across all technologies in a completely consistent and objective way.

BioXL, in consultation with IrBEA members, has produced a working model to capture the cost differential between biomass and fossil fuel boiler installations. The model is an adaptation of the Northern Ireland RHI tariff modelling. A distinct variation from the DETI methodology is that counterfactual capital costs have not been included. In order to progress towards 2020 RES-H targets, the market reference should not be to displace fossil fuel boilers at the end of their useful life. This approach would not deliver any meaningful level of renewable heating.

The following representative biomass boiler installations were chosen for cost modelling:

- A 100 kW wood pellet fuelled boiler, supplying heating and domestic hot water (DHW) to an office building
- A 400 kW wood pellet fuelled boiler, supplying heating and DHW to a hotel
- A 1,000 kW wood chip fuelled boiler, supplying heat to a retail complex or similar
- A 3,000 kW wood chip fuelled boiler, supplying process steam to an industrial user
- An 8,000 kW wood chip fuelled boiler, supplying process steam to an industrial user

BioXL carried out a survey of industry suppliers for both fossil fuel and biomass installations to obtain current capital and operation and maintenance costs. The findings show that there is a capital investment at least 5 times greater for biomass than for an equivalent gas installation. There are, in addition to the visible capital costs, many hidden costs and site-specific anomalies that arise for biomass, and an addition of €20/kW installed was made to attempt to reflect these.

Fuel input prices are a critical variable. The SEAI quarterly commercial fuel cost survey from January 2015 was used. This data is imperfect, and IrBEA recommends the development of a more robust methodology for this. Oil and LPG are at their lowest price level in five years – a very challenging environment in which to develop renewable heating solutions. In particular the increasing attractiveness and sliding scale of tariffs for larger consumers of natural gas makes it the fuel of choice for many applications.

The modelled price differential between biomass and natural gas as counterfactual fuel across a range of reference sizes has been calculated on an annualised basis and is shown in the table below. These costs have been used in arriving at recommendations for support.

Table: Recommended annualised incentive required for biomass heating at modelled reference system sizes

Reference system size kW	Biomass fuel modelled	Counterfactual fossil fuel	Annualised incentive required
100	Wood pellet	Natural gas	€12,949
400	Wood pellet	Natural gas	€53,346
1,000	Wood chip	Natural gas	€88,511
3,000	Wood chip	Natural gas	€308,788
8,000	Wood chip	Natural gas	€761,184

Some sensitivity analysis was carried out, which identified load factor as a key variable in arriving at a level of required support to make biomass competitive. Other factors such as discount rate and discount term were less critical to the outcome of the modelling.

<u>Design of Support Mechanism</u>

To the extent possible, the scheme needs to be inclusive across renewable heating technologies and fuels, although these findings apply only to solid biomass heating.

Any RHI tariff must be pitched at an attractive level to surmount the barriers to choosing a renewable heating system. Setting up a scheme with only marginal benefit will lead to low uptake and result in a requirement for more aggressive supports at a later date.

The key attributes of a successful scheme are:

- Robust eligibility criteria
- Simple application and approval process
- Positive uptake
- Low ongoing administration burden (on applicants and administrators)

IrBEA is recommending a 15-year tariff scheme with quarterly settlements. Tariffs should be revised annually in line with the consumer price index.

A banding approach (based on boiler size) similar to the UK was initially considered alongside a tiering approach (based on unit output). After considering the limitations and pitfalls associated with the UK approach, and consultation with IrBEA members, it was agreed to recommend the tiering approach.

The tiering approach entails fixing tariff levels for incremental steps of increasing system heat output. The target is to deliver the modelled annual support level requirement through this type of system.

After a number of iterations with different tiering levels, the optimum system to deliver the modelled support required at the reference size involves a 2-tier system, with different payments above and below annual output of 1,000,000 kWh.

Table: Recommended Tariff tiers for RHI implementation

Tier	Tariff tiers	Proposed Rate	Maximum tier payment
	kWh/year	**c/kWh**	**€/year**
Tier A	<= 1,000,000	7.6	76,000
Tier B	> 1,000,000	2.0	N/A

Applied examples at the reference installation sizes are presented below.

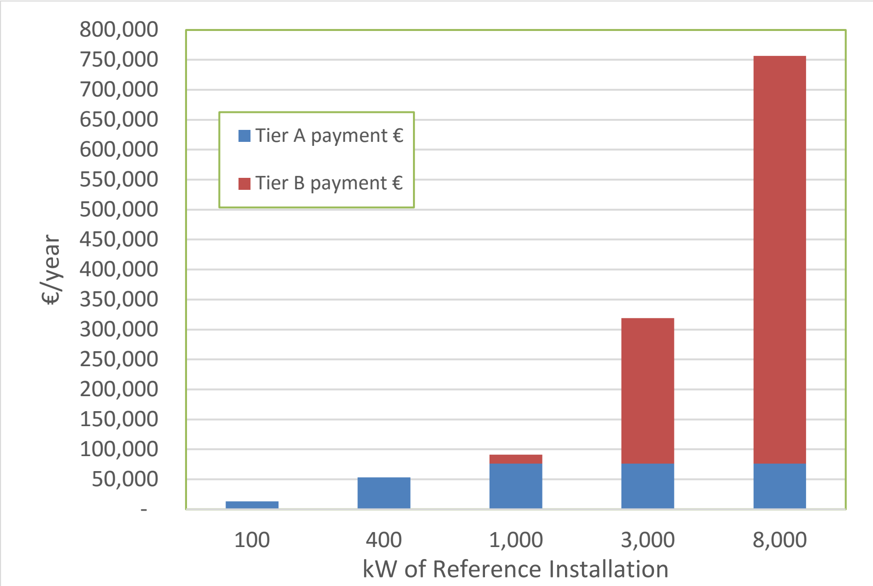

Figure: Example of payments by tier for reference boiler sizes

From a technology view, provision should be made not just for hot water systems, but also steam, hot air or other means of supplying heat.

Fuel Supply Chain

Members of IrBEA supply a wide range of renewable fuels. IrBEA does not recommend a prescriptive approach on fuel types. There are a wide variety of sustainable fuels and technologies available which should not be excluded from RHI market support.

Mobilisation of both the state and private sector forestry resource is critical to delivering new fuel sources. Thinnings from private forestry has proved difficult to mobilise without local demand and an RHI presents a great opportunity to stimulate local fuel supply. IrBEA fully supports the 40 recommendations set out in the COFORD report 'Mobilising Ireland's forest resource' to meet future demand for fibre.

IrBEA recommends that participation in an externally audited certification scheme, such as the Wood Fuel Quality Assurance (WFQA) Scheme, be a mandatory condition of wood fuel supplied to an RHI-supported system.

Sustainability criteria should be proportionate but also allay any concerns about non-sustainable sources of material. Sustainability criteria should be fully harmonised with EU legislation.

It is also necessary during policy formation to consider the impact of imports and cross-border trade on the island of Ireland.

Industry Role

IrBEA recognises that the industry has a key role and responsibility in delivering best-practice in renewable heat and fuel supply. There is a need for excellence right across the supply chain, including fuel quality, fuel sustainability, system design, installation quality, maintenance and post-installation support. IrBEA has a good track record in delivering industry initiatives and is committed to showing leadership in the bioenergy sector as shown through the activities outlined below:

- IrBEA operates the Wood Fuel Quality Assurance (WFQA) Scheme and is committed to further development, promotion and upholding the value and credibility of this scheme.
- Quality control of boiler and fuel store installations needs to be monitored on an ongoing basis. IrBEA works to uphold the professional standard of installations, in key areas such as health and safety, emissions and system design. IrBEA has previously run boiler training programmes for engineers and installers and is committed to increasing delivery of industry events and more diverse training to address any skills gaps as the RHI is rolled out.

Further Recommendations

In addition to recommendations summarised above, a number of further recommendations are made. It must be kept in mind that an RHI policy alone will not deliver a significant level of market development – the policy and economic environment for biomass heating projects has been poor with virtually no market activity over the last 5 years. Support and commitment of government and its agencies to develop all aspects of the bioenergy supply chain is required.

The significant socio-economic benefits of biomass heating should be included in any assessment of the impact of an RHI policy.

The exclusion of ETS sites removes a number of opportunities of scale, and these opportunities should be included within an RHI design.

During this critical scheme design stage, it would be very appropriate for DCENR to commit additional time and/or resources to the development of an RHI policy. Due to the expected additional administration requirements of a scheme, IrBEA recommends that the CER or other government agency be tasked with its operation.

There is a need to facilitate enabling technology, especially district heating and thermal energy storage. District heating is an expensive long-term infrastructure investment and likely needs separate policy supports.

1 Introduction

The Irish Bioenergy Association (IrBEA) welcomes the intended introduction of a Renewable Heat Incentive (RHI) by the Department of Communications Energy and Natural Resources (DCENR), and is pleased to present its analysis and initial recommendations for RHI policy formation.

Irish consumers can benefit from bioenergy by displacing fossil fuels with biomass fuels and maintain competitiveness. Reducing Ireland's reliance on fossil fuel imports, reducing greenhouse gas emissions and improving domestic fuel security are key benefits to the Irish economy supported by bioenergy.

The bioenergy sector also stimulates rural development and local job creation, through the many jobs required in fuel supply, systems installation and operation and maintenance. The sector also provides a valuable local market for the growing private forestry resource and a market opportunity for growers of dedicated energy crops.

1.1 About the Irish Bioenergy Association

IrBEA is an industry association with over 150 members representing the bioenergy industry on the island of Ireland. IrBEA seeks to increase understanding of issues related to biomass supply chains used to generate energy in the form of heat, electricity and motion. The main objectives of the association are to influence policy makers to promote the development of bioenergy, and to promote the interests of its members. Improving public awareness, networking and information sharing, and liaising with similar interest groups are other key areas of work in promoting biomass as an environmentally, economically and socially sustainable energy resource.

Overall direction is provided by the management committee which comprises 15 members from all parts of the bioenergy industry.

IrBEA operates a group structure where different parts of the bioenergy industry collaborate on topics such as transport biofuels, wood energy, biogas/AD, domestic biomass fuels, energy crops and biomass power generation.

IrBEA established a dedicated group working on renewable heat in January 2015.

1.2 Background of Paper

The IrBEA Renewable Heat Group commissioned a paper with the aim to identify critical issues for its members during the development of a renewable heat incentive (RHI) scheme.

The paper was prepared by Mr Tom Bruton, principal consultant with BioXL Sustainable Energy Consultants. Tom is a Chartered Engineer and bioenergy industry expert.

A steering group was appointed from the IrBEA membership to oversee this and other work related to the proposed RHI.

The scope of work considered at present has been limited to commercial solid biomass heating applications.

This paper's target audiences are:

- Circulation to the members of the Irish Bioenergy Association for consultation on a Renewable Heat Incentive (RHI)
- Subsequent submission to DCENR for consideration in development of an RHI
- Utilisation for IrBEA workshops and training events on the proposed RHI
- Information for public communications and media outlets

The objective of the paper are:

- To review international and national precedent policies to inform the development of an RHI in Ireland
- To provide background research on the Irish heating market
- To prepare using independently sourced industry data a suitable tariff model for consideration of an RHI
- To make general recommendations regarding RHI policy development

The report (and recommendations) has incorporated a strong element of industry consultation and represents a coherent and robust appraisal with industry support. A draft of this final report was distributed to all IrBEA members for consultation in June 2015. A workshop was held in May 2015 where the findings were outlined to 50 IrBEA member organisations and individuals.

Separate workshops were held with the IrBEA management committee and the IrBEA Renewable Heat Group. A series of meetings were convened also to engage directly with IrBEA stakeholders.

2 Policy Context

2.1 Government announcement on RHI

An announcement from DCENR on the RHI was contained in the October 2014 Draft Bioenergy Plan[1]. DCENR had previously launched a consultation in May 2013 and held a public forum in August 2013 to discuss a new Bioenergy Strategy.

As of writing there are no details of the RHI scheme proposed for 2016 implementation. The pace of policy development is a cause of concern to the bioenergy sector, as little or no activity is progressing in the absence of clarity on an RHI scheme.

There is a need acknowledged by DCENR for policy stimulus to deliver additional renewable heat. This is mirrored by the findings of an EU Tracking Roadmap[2] prepared in 2014, where it was noted that Ireland is currently experiencing less deployment of bioenergy applications than planned and that previous support programmes had expired and not been replaced.

[1] http://www.dcenr.gov.ie/Energy/Sustainable+and+Renewable+Energy+Division/Draft+Bioenergy+Plan.htm
[2] http://www.keepontrack.eu/contents/publicationseutrackingroadmap/kot_eutrackingroadmap2014.pdf

Below is the text from the draft Bioenergy Plan, where an RHI demand-side measure is proposed:

> "…estimates by SEAI show that current policies will not deliver 12% renewable energy in the heat sector by 2020, indicating that additional action is required. The estimated shortfall will be in the region of 2 to 4 percentage points of the 12%, equating to approximately 200 ktoe or 2,300 GWh. This represents about 1 to 2 percentage points in terms of the overall national target of 16% mandated to Ireland under the 2009 Renewable Energy Directive. Analysis of various options, including increased carbon taxes, indicated that the option with the least modelled cost is an appropriately focussed RHI. This would provide stability and long term security for investors, ensure better value for money for consumers, and have a significant positive impact on non-ETS sector emissions. It is proposed, subject to State Aid clearance from the European Commission and further Government approval once the scheme is designed, that the Minister for Communications, Energy and Natural Resources introduce from 2016 an Exchequer-funded incentive scheme for larger non-ETS industrial and commercial renewable heating installations. The scheme will be designed to reward users for each unit of renewable heat used from sustainable biomass, and to deliver the additional heat required in the context of meeting 12% of heat demand from renewable sources by 2020. The scheme will be kept under review to assess its effectiveness."
>
> *Responsibility: DCENR Timeline: 2016*

2.2 Beyond 2020

The primary motive behind the proposal to introduce an RHI is to meet Ireland's 2020 Renewable Energy targets, as legislated for in adopting binding EU agreements to meet 16% RES by 2020.

The policy focus (among industry stakeholders and policy makers alike) seems to have shifted away from the rewards of climate change action, to focussing on potential fines and the consequences of failure to deliver RES-H as part of the 2020 commitments.

While this is a useful short-term focus and a trigger for action, RES-H policy should be designed with growth and delivery expectations beyond 2020 in mind.

EU leaders reached agreement on a new Climate and Energy Policy Framework for 2030[3] at the October 2014 European Council meeting in Brussels. The agreement commits the EU to:

- reducing greenhouse gas emissions by 40% by the year 2030, compared with 1990 levels
- a target of at least 27% for renewable energy and energy savings by 2030

Renewable heat, and bioenergy in particular, has the capacity to deliver future decarbonisation policy, while also encouraging direct investment within the Irish economy, creating jobs and improving energy security for Irish citizens.

The planned introduction of an RHI should stimulate increased demand for woody biomass in all its forms, resulting in increased mobilisation of the private sector timber resource.

[3] http://ec.europa.eu/clima/policies/2030/index_en.htm

2.3 Socio-economic Benefits

Previous analysis commissioned by SEAI and IrBEA[4] produced employment multipliers and investment indicators for delivering bioenergy within the context of the 2020 RES targets.

Based on the addition of 200 ktoe of RES-H (assumed to be mainly biomass), it is possible to use the indicators from this socio-economic study to arrive at the incremental economic activity, investment and job creation associated with an RHI (in 2012 prices).

- New investment in biomass heating of over €220m
- Annual spend of over €77m on operation and maintenance
- 120 man-years in temporary construction jobs
- 240 full-time equivalent permanent jobs

Based on an equal mix of oil and gas displacement, the emissions factor associated with fossil fuel displacement by RES-H would be 2,730 t of CO_2-equivalent per ktoe of fossil fuel displaced.

The displacement of 200 ktoe of fossil fuels would abate 546,000 tonnes/annum of CO_2-equivalent.

There are many additional social benefits of stimulating the bioenergy sector, which are outlined in the previous socio-economic study, in SEAI's Bioenergy Roadmap and also restated in DCENR's draft Bioenergy Plan.

One of the more important benefits often overlooked is the benefit to the agriculture and forest industries. There are many new private forest plantations requiring thinnings. Many farmers have invested also in energy crops, and in some cases are left with no local market for the harvested crop. It can be expected that the growth of a renewable heat sector would help the biomass energy supply chain to mature and stimulate regional demand for forest thinnings, energy crops and other sources of biomass.

2.4 Sustainability Criteria

Sustainably produced biomass will play a key role in the EU's transition from a fossil-fuel based economy to a low carbon economy. The European Commission has issued non-binding recommendations on sustainability criteria for biomass[5]. EU Member States are encouraged to monitor the origin of all biomass consumed in the EU to ensure its sustainability and to devise appropriate schemes to support the development of local sustainable biomass supply chains. The adoption of a harmonized cost-effective sustainability approach would further encourage the mobilisation of private sector forestry and the establishment of sustainability. These criteria should be considered as part of the initial RHI scheme design.

[4] http://www.irbea.ie/images/documents/Reports_Publications/socio-economic%20report.pdf
[5] https://ec.europa.eu/energy/sites/ener/files/2014_biomass_state_of_play_.pdf Commission working document

2.5 Information Gaps

The announcement of an RHI in Ireland raises many questions. An analysis and cost-modelling of an RHI scheme and heat policy options has been published by SEAI[6]. This was not published in time to fall within the scope of this present draft. IrBEA had requested publication of this a number of times.

In terms of the work undertaken by the Irish Bioenergy Association, there are a number of areas with incomplete data or inadequate information.

For example, SEAI's quarterly commercial fuel cost surveys are the only independent source of pricing data, but are considered by most industry stakeholders to require far more robust data collection and reporting methodology to be considered fit for purpose. It is the view of IrBEA that wood chip prices are marginally, but consistently under-estimated. IrBEA is willing to work with SEAI to develop a more accurate methodology reflective of market reality.

There is ongoing work on profiling the energy market, including thermal energy use. SEAI have undertaken some excellent work, but the depth of understanding of the thermal energy market is still insufficient.

It is difficult to assess the full impact of an RHI policy on the timber sector. An improved understanding of supply and demand modelling would give all stakeholders greater confidence in the implementation of an RHI – particularly the current users of biomass fibre. These include existing energy and non-energy users who will not be eligible for a RHI on their process.

[6] http://www.seai.ie/Publications/Statistics_Publications/Energy_Modelling_Group_Publications/Renewable-Heat-in-Ireland-to-2020.pdf

3 International Precedent

There are relatively few examples internationally of pure unit-based heat incentives. The IrBEA view remains that in the long term, progressive carbon taxation has been demonstrated as the most effective tool in incentivising investment in biomass heating. Carbon taxation has been particularly successful in Denmark and Sweden in encouraging widespread substitution of fossil fuel with biomass. Notwithstanding this longer term aim, a renewable heat incentive will certainly help kick-start the market and move towards 2020 and 2030 climate change action goals. It is recognised that an appropriately focussed RHI is the policy option with the lowest likely cost, as compared to broad-based taxation policies.

There is a lot of further detail and commentary available about the UK Schemes and the French Renewable Heat Fund in Appendix 2.

3.1 UK Schemes

The UK regions, including Northern Ireland, have introduced an RHI. The RHI in the UK regions has had a successful first few years. The overall scheme has been responsible for delivering over 1.5 GW of installed biomass thermal capacity. Notwithstanding the success, the scheme uptake has been below initial uptake projections and is behind the original delivery targets.

The schemes differ quite substantially by region and incentive level. Key differences between the schemes (from a biomass perspective) are:

- Different banding
- No tier payments in NI
- No degression in NI – though intention is to bring it in

The mainland UK scheme was legislated in 2011, but was open to installations commissioned after July 2009 (commonly referred to as “grandfathering”). It has undergone a number of revisions since.

In Northern Ireland, a non-domestic scheme was first introduced in 2012, but a further expansion of it is currently under consideration (Phase 2). In October 2014, an additional domestic scheme was launched.

Some of the key learnings from a review of the schemes can be summarised as follows:

- Both schemes work, with imperfections
- Degression[7] works as a cost control mechanism for the exchequer and also encourages applicants to apply in a timely manner (ahead of planned upward or downward degressions)
- Despite their success, the scheme is behind target and budget. It takes some time to build momentum – there is a learning curve for all stakeholders
- “Grandfathering” has helped generate early action and maintain a degree of market confidence while an RHI was in formation

[7] Degression is often misconstrued as downward only movement – in some categories in the UK degression has led to increased tariffs where scheme uptake has been insufficient.

- The rules around 99kW (in NI) and 199kW (in UK) have led to a disproportionate uptake in this category, with many examples of small boilers installed in series on a single site. Site definition and rules around series installation of boilers need to be carefully considered
- Neither scheme has been successful as yet in stimulating larger-scale boiler installations or CHP (1MW+). Changes were proposed to address this by introducing revised tariffs in UK and NI
- In modelling of the UK RHI schemes, it has been found (with the benefit of hindsight) that gas is the counterfactual fuel that needs to be displaced
- There is a significant administration factor in terms of system accreditation and processing The complexity of the scheme (not least the range of technologies, bands and tiers) has required an administrative function within OFGEM
- Industry knowledge and skills gaps exist, especially when it comes to the complexities of metering renewable heat

3.2 French Renewable Heat Fund

The French Renewable Heat Fund was introduced in 2009, and is managed by ADEME[8] (Energy and Environment Agency). During the period 2009-2013, the Heat Fund spent € 1.12 billion to support approximately 3,000 installations and total production of 1.4 million toe (tonnes oil equivalent). The fund supports solar, geothermal, waste heat, district heat, biogas and biomass heating applications.

It is not strictly a unit-based scheme, as it rolls up 20 years of payments into the first 3 years of verified heat output.

As a solution for the Irish context, it would appear to focus on too narrow a market segment, and be quite administrative and heavily managed by ADEME.

[8] www.ademe.fr

4 National Precedent

4.1 Refit 3

Refit 3 is a current price support for various bioenergy technologies, including solid biomass combustion and CHP applications.

Refit 3 took about 3 years to legislate for and implement.

4.1.1 Tariff setting

The proposed tariffs were based on techno-economic modelling by DCENR. As was the case for Refit under wind and other technologies, calculations were prepared for the levelised cost of energy over 15 years, using a discount rate of 12% on future revenue streams, which is deemed appropriate for renewable energy technologies by DCENR. This modelling process was not considered a particularly transparent process, and there are concerns within the industry that ultimately the rates are not pitched at the right level to get sufficient renewable bioenergy projects financed and operational.

The modelling results are shown below (Table 1). These were accepted under state aid rules in October 2011[9].

Table 1: Refit3; Levelised cost of energy over 15 years (DG Competition 2011)

Technology	Capex €/KWh$_e$	Opex €/kWh$_e$	Fuel €/Kwh$_e$	Heat €/kWh$_e$	Other Revenue €/kWh$_e$	Levelised Cost €/KWh$_e$
AD CHP < 500	€0.14	€0.11	-€0.05	-€0.02	-€0.03	€0.15
AD < 500	€0.13	€0.10	-€0.09	€0.00	-€0.03	€0.11
AD CHP > 500	€0.12	€0.25	-€0.18	-€0.06	€0.00	€0.13
AD > 500	€0.11	€0.16	-€0.17	€0.00	€0.00	€0.10
Biomass CHP < 1500	€0.07	€0.03	€0.16	-€0.12	€0.00	€0.14
Biomass CHP > 1500	€0.05	€0.02	€0.11	-€0.06	€0.00	€0.12
Biomass combustion (Residues)	€0.004	€0.01	€0.07	€0.00	€0.00	€0.085
Biomass combustion (Energy Crops)	€0.004	€0.01	€0.08	€0.00	€0.00	€0.095

4.2 Reheat and Bioheat Schemes

There have been a number of targeted schemes to incentivise renewable heat. The most relevant of these are the Reheat Scheme, and the Pilot Bioheat Scheme. A Pilot Miscanthus Scheme was also opened for a short time. About 6,000 domestic biomass installations were also installed under the Greener Homes Scheme.

4.2.1 Reheat Scheme

The SEAI Reheat Scheme was launched in March 2007 (by Noel Dempsey, Minister for Energy). It was targeted at biomass, solar and geothermal heating in commercial, industrial, public and community facilities. The initial funding allocated to the scheme was €26m, with a target to support investment

[9] http://ec.europa.eu/competition/state_aid/cases/241164/241164_1267430_98_2.pdf

in 230 MW across 700 individual projects. The scheme closed in 2011. The scheme supported 78 MW of biomass heating installations at 204 boilers. The scheme also supported 85 heat pump installations with total capacity of 5.1MW. A further 242 solar thermal installations were supported, mostly for small scale applications.

The scheme offered capital grant contribution of up to 30% of eligible costs. Predetermined maximum cost bands for biomass installations were included as shown below (Table 2). These do not accurately reflect the cost of biomass heating installations, and were used as a cost cap mechanism.

Table 2: Maximum Allowable Capex bands under SEAI Reheat programme

Maximum Capacity Costs for Biomass Boilers	
Plant scale ranges kW	Maximum Capacity Cost €/kW
≤20 kW	€1,500 / kW
>20 kW and ≤ 50 kW	€650 / kW
>50 kW and ≤ 250 kW	€500 / kW
>250 kW and ≤ 500 kW	€350 / kW
>500 kW and ≤ 1000 kW	€250 / kW
>1000 kW	See Below (€150 / kW)

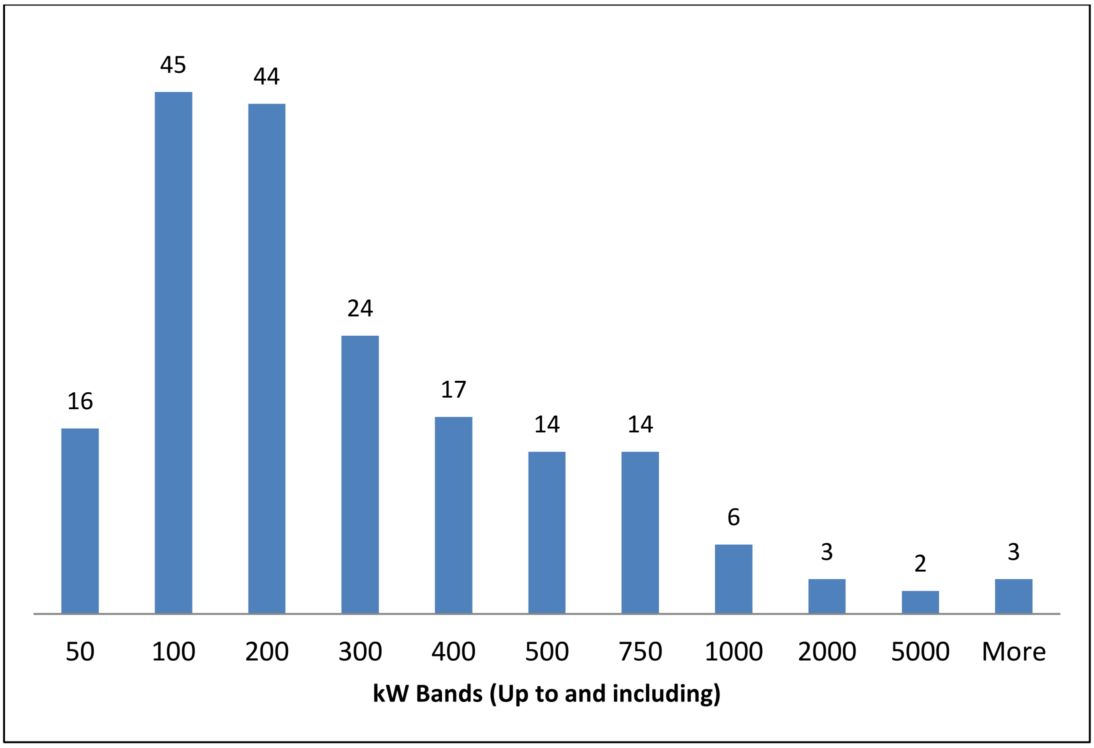

Figure 1: Frequency of Biomass Boiler Installation Size under SEAI Reheat Programme

It is worth summarising some key learnings of this scheme. As can be seen above (Figure 1), the typical installation size was low. The smallest installation was 16kW. The median size was 165 kW.

The largest unit supported under the scheme was an 8,500 kW boiler at Laois Sawmills. In total there were only 8 applications supported above 1,000 kW.

It is evident also that the banding for capital cost ceilings (and associated maximum grant amount) had some impact on sizing of systems.

While there were, and continue to be, many skilled and experienced operators throughout the supply chain, there is evidence to suggest that there were some poor quality installations.

The Irish Bioenergy Association undertook a survey of a number of installations[10] and found a number of systems not operating for different reasons including the following:

- Site no longer commercially operational (e.g. vacant hotel)
- Availability of low-cost and convenient natural gas as an alternative
- Poor quality installations
- Technical problems with fuel supply

4.2.2 Pilot Bioheat Scheme

The “Pilot Bioheat Boiler Deployment Programme” was a sub-programme of measured support under the Renewable Energy RD&D Programme to stimulate the biomass heat market. It aimed at providing capital grant support for the installation of a number of biomass boilers for large buildings and small industrial sites around the country. The scheme was introduced in 2005 with a budget of €150,000 and a target to fund about 10 installations.

The programme suggested boiler systems typically rated between 60kW and 1,000kW fuelled by wood pellets and/or wood chip. It proposed to offer support of 25% of the capital costs involved in biomass boiler and fuel storage purchase and installation.

A suggested range of investment costs were provided as a guide to applicants. For qualifying boilers rated at 60kW, the investment cost was estimated to be up to €500/kW, including fuel storage. For qualifying boilers rated at 1000kW, the investment cost was expected to be up to €250/kW, including fuel storage. For qualifying boilers between these sizes a linear interpolation was proposed to assess investment cost.

The scheme resulted in 17 installations of between 100 kW and 5,200 kW, and a total supported capacity of 10,450 kW. The largest installation closed down shortly after installation (closure of Atlantic Industries), so in practice only 5,250 kW of operational capacity was installed under the scheme. The median size (excluding Atlantic Industries) was 175 kW.

[10] A review of the Operation of Commercial Woodchip Boilers in Ireland; Irish Bioenergy Association, Biomass Trade Centre 2 project; June 2013

5 Irish Heating Market Context

An analysis was carried out of the SEAI 2013 Energy Statistics and is presented in Appendix 3. A summary is shown in Figure 2 below. This analysis indicates that natural gas is the dominant heating fuel in industry and commercial/public service buildings (44% and 54% respectively of sector overall demand). It is only in the residential sector that oil heating is responsible for a larger proportion (44%) of homes, and this proportion is shrinking over time, as people switch their homes to either renewable resources or natural gas heating.

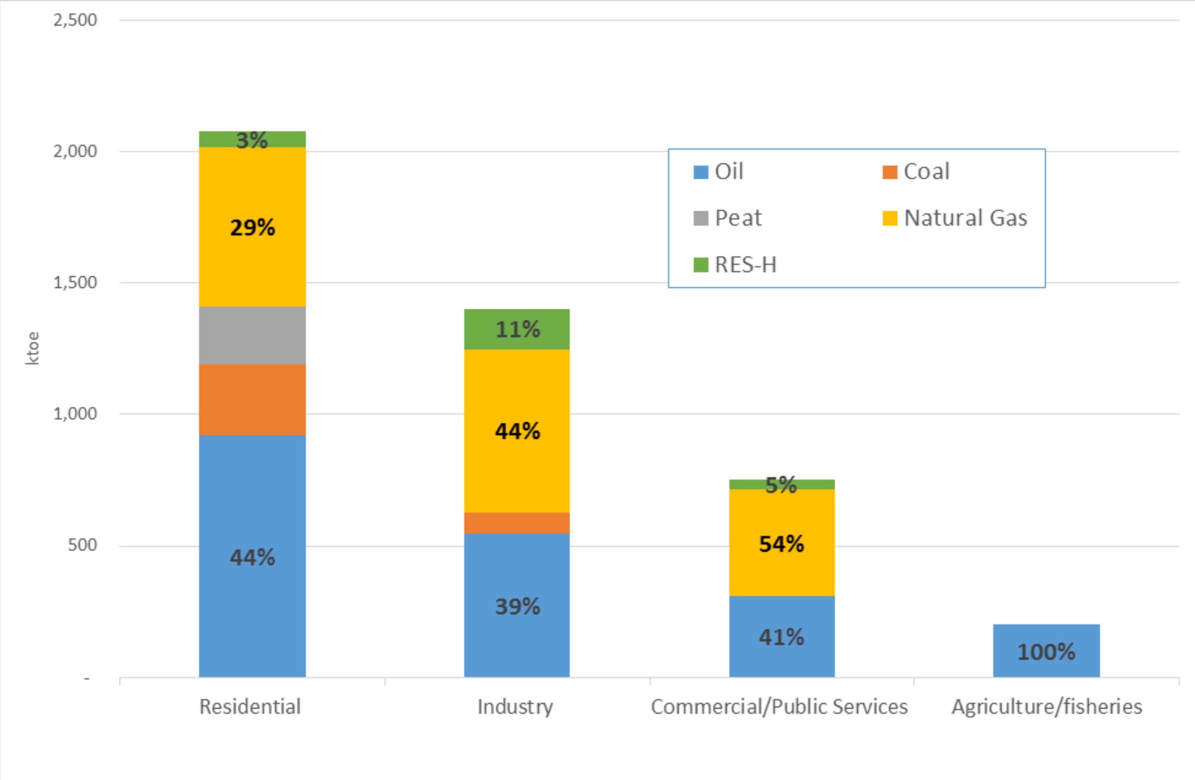

Figure 2: SEAI 2013 Thermal Energy Balance (Adapted) by Total Final Consumption of Fuel

Locally sourced, indigenous biomass fuel has historically been more competitive in price than traditional fossil fuels, such as heavy fuel oil or LPG but the relatively high cost of the biomass boiler technology presents a significant barrier to capital investment. In 2015 the price of fossil fuels has fallen which now increases the payback period required for the biomass capital investment. Natural gas for industrial users is at present marginally cheaper than biomass - making any business case for large scale capital investment challenging when gas as the alternative fuel is available. For this reason, in recent years the industry has focussed on opportunities off the gas-grid, but with limited success.

The idea that biomass works only in rural locations off the gas-grid is a myth that is not borne out in practice. In commercial/public services applications, Dublin has 13 MW of capacity installed as of 2013[11] according to a report prepared by BioXL for Codema, Dublin's energy agency. Many of these installations are in locations where natural gas was available, but the facility owner opted for

[11] http://www.codema.ie/images/uploads/docs/Renewable_Energy_Report.pdf

biomass heating. In many instances this was motivated by environmental and social considerations, as much as financial pay-back considerations. Very few installations have happened over the last 5 years either on or off the gas-grid, due to the absence of any financial support to encourage a renewable heating technology choice.

It is worth noting that under the Greener Homes Scheme, Dublin and Cork were the leading counties for the number of biomass boiler installations in domestic housing. This would indicate that even in urban locations many home owners were willing to invest in renewable heating installations as an alternative to natural gas heating. The domestic market continues to represent a significant opportunity for the bioenergy sector. While it is not intended to include domestic scale installations within a RHI policy at this stage, IrBEA has a working group active on residential fuels and is working on policy initiatives to support this important part of the market.

5.1 The 2020 RES-H Target

The RES-H target of 12% by 2020 was set out in the 2007 Government white paper on energy policy. It is a non-binding sub-target of an overall RES target of 16% by 2020. It is useful to consider what this means in absolute numbers, based on the current situation and projected thermal energy demand scenarios forecast by SEAI.

According to SEAI[12], in 2013, 5.7% of thermal TFC, or 255 ktoe was met by renewable heat (RES-H). Between 2000 and 2013 RES-H grew slowly from 2.4% to 5.7% of thermal energy TFC. This growth, dominated by biomass, is mostly due to increased use of wood waste as an energy source in the wood products and food sub-sectors of industry. Outside of these examples, the renewable heat sector remains largely undeveloped.

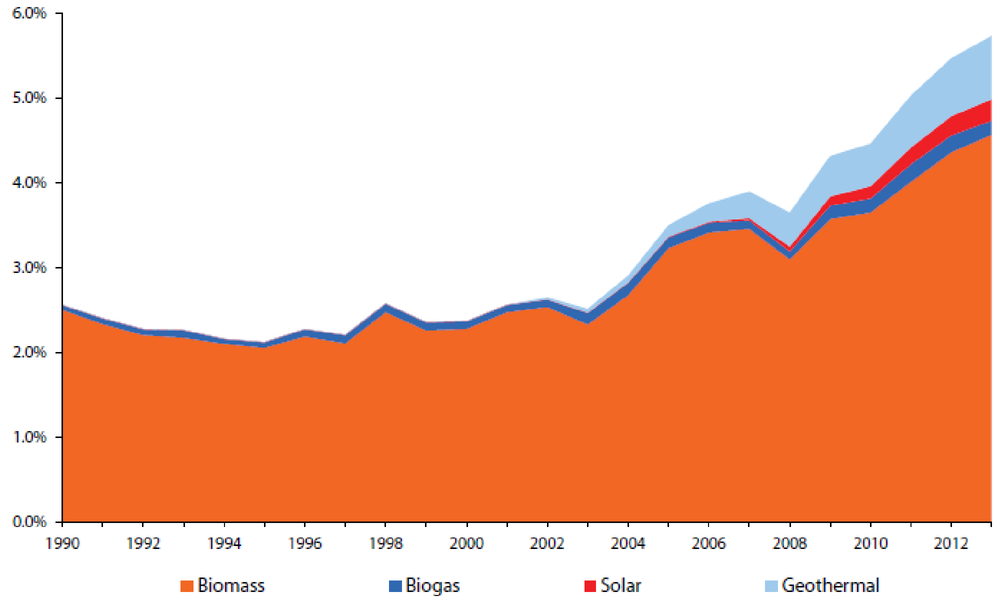

Figure 3: Development of Renewable Fraction of Thermal Energy (SEAI)

12 http://www.seai.ie/energy-data-portal/

The 2020 energy projections made by SEAI are subject to ongoing revision, for various reasons. These include fluctuations in economic activity, policy or taxation changes, or adjustments of existing policy impacts. The most recent published forecasts for 2020 were completed in 2011[13]. A number of scenarios were modelled by SEAI based on different macroeconomic factors, but also based on aggressive and pessimistic assumptions about deployment of low-carbon technologies.

The NREAP/NEEAP[14] scenario projected a 4,126 ktoe thermal TFC by 2020. The 12% RES-H target would require 495 ktoe of RES-H by 2020 under this scenario. An exploratory risk scenario projects a higher thermal TFC of 4,589 ktoe, due primarily to a reduced implementation of energy efficiency measures. The 12% RES-H target would require 551 ktoe of RES-H by 2020 in this scenario.

Most recently in the DCENR Draft Bioenergy Plan[15], the challenges in meeting the RES-H 12% target are discussed. The report indicates that "… current policies… will not deliver 12% renewable energy in the heat sector by 2020. This clearly indicates that additional action is required. SEAI estimates that the shortfall will be in the region of 2 to 4 percentage points of the 12%, equating to approximately 200 ktoe."

5.2 Commercial Boiler Sales

Market research undertaken for an IrBEA member company has provided useful data on the current state of the commercial boiler sales market, a redacted form of which is presented here. The definition of a commercial boiler is a unit above 44 kW rated capacity.

Where natural gas is available, this is the fuel of choice. There has been an accelerated trend towards cascading of smaller sized natural gas or LPG fired boilers. These are typically either wall-hung or floor-mounted condensing boilers, in the 45 to 100 kW output range. A number of these can be installed in sequence to meet loads of anywhere up to 500 kW or even up to 1MW. The reasons for this trend are many, including:

- the ability to quickly source, install and commission modular units
- flexibility with regards to space
- no need for specialised designs for flue or other system components
- no need for additional installer/commissioner training
- the flexibility to meet seasonal or part-loads

Table 3: Market Research Supplied by IrBEA Member

Commercial boiler (>44kW)	2013 Sales Estimates	2018 Projections
Gas floor-standing (condensing)	135	200
Gas wall-hung (condensing)	820	1,600
Jet Burner (condensing)	690	820
Grand total[16]	1,665	2,620

13 http://www.seai.ie/Publications/Statistics_Publications/Energy_Forecasts_for_Ireland/Energy_Forecasts_for_Ireland_for_2020_-2011_Report.pdf

14 NREAP = National Renewable Energy Action Plan; NEEAP = National Energy Efficiency Action Plan; Scenario assumes measures outlined in these 2010 policy documents fully implemented.

15 Note includes some non-condensing boilers, which represent very small declining part of market

16 Note includes some non-condensing boilers, which represent very small declining part of market

New boiler sales are picking up slightly from a low base, as construction activity increases. This presents a good opportunity to consider renewable heating installations. Early policy implementation would be useful to capture this opportunity as construction activity picks up.

The largest segment within the commercial boiler market is modular gas-fired boilers (either wall-mounted or free standing), a trend that is expected to continue. Although an increase in boiler sales is expected, this does not necessarily translate into an increase in absolute kilowatts installed. The trend towards cascading leads to a greater number of smaller sized boilers. Using biomass fuels would entail reversing this design trend, in favour of larger, more customised designs.

Where the nature of the load dictates, or natural gas is unavailable, larger boiler units with jet burners will continue to be installed. It is difficult to fix a particular size of boiler output for this category. The market leader in the jet burner segment has a wide range of units ranging in output from 30 kW up to 1,450 kW. These can be fired on oil, LPG or natural gas. In considering market development, it seems more likely that some of the 820 projected units sold in this category would be candidates for renewable heating solutions.

It is also of note that only 20% of boilers are installed as new-build. 80% of boilers are retrofits or replacement boilers.

5.3 Profiling of Commercial/Industrial Heating Sector

A range of data has been used to collate a profile of thermal energy use by fuel, and the potential market.

Due to the proposal that an RHI would focus initially on non-ETS installations, an estimation of ETS use was made (in the absence of independent statistical data). This allocated the known portion of industrial use, and assumes that 75% of this is used in ETS sites, except in the case of HFO, where a much higher proportion of ETS sites (85% of all HFO use) are assumed, and for kerosene, a much lower proportion is assumed (15% of non-domestic kerosene).

The scenario selected for estimating a realistic upper limit to market potential, is where 1 in 4, or 25% of eligible market participants would respond to an RHI policy signal. Where natural gas is excluded, these calculations indicate that this would represent 109 ktoe of fossil-fuel displacement. If 25% of eligible gas users consider a switch, this would represent a further 172 ktoe of potential fossil fuel displacement.

These numbers are based on historic use and do not take account of future energy-efficiency measures, or a shrinking overall thermal energy market by 2020.

Table 4: Analysis of potential market size for renewable heat policy signal

Thermal demand in ktoe non-domestic sectors 2013/2014[17]	Market size (incl ETS)	Market size (excl ETS)	25% market share (non-ETS)
LPG	125	90	22
HFO	54	10	3
Gasoil	363	260	65
Kerosene	85	75	19
Subtotal (excluding Natural Gas)	627	435	109
Natural Gas	1,027	688	172
Total	1,654	1,123	281
Renewable heat gap to 2020 target			**200**

5.3.1 Industrial Sector

The industrial sector comprises two distinct groups – the traded emissions sector and non-traded sector. The Emissions Trading Scheme (ETS) provides in theory a carbon price signal to large industrial users to reduce emissions through efficiencies or fuel displacement. Under the scheme, carbon has a nominal value only, but this is seen as an existing form of government support.

The majority of industry users in Ireland are members of SEAI's Large Industry Energy Network (LIEN). There are 166 members of LIEN, and membership implies spending of over €1m per year on energy. Virtually all of the ETS sites are members of the LIEN.

Excluding the larger power generation sites (e.g. ESB, Bord Na Mona, Viridian etc...) there are 77 sites registered for the ETS.

While there are some who use biomass already, and several who could consider it, there are a number of challenges to the assumption that all of these sites can consider biomass for the following reasons:

- Many sites are on the gas network (and increasing year on year)
- There is no distinct load profile. Some have seasonal load profiles, or high variation in thermal demand
- Some, such as cement sites, will find it difficult to reach required temperatures due to technical limitation of biomass. Others may have logistical difficulties with biomass
- Some ETS sites have already invested in gas CHP installations and will be unlikely to abandon that investment

[17] Based on NORA levy statistics for 2014 for HFO, Kerosene, Gasoil; Assumes 90% kerosene for domestic use; LPG data from SEAI 2013 Energy Statistics

5.3.2 Commercial Sector

During 2014 SEAI commissioned an extensive survey of commercial building stock[18]. The findings of this reveal the very high extent of electric heating in the commercial sector.

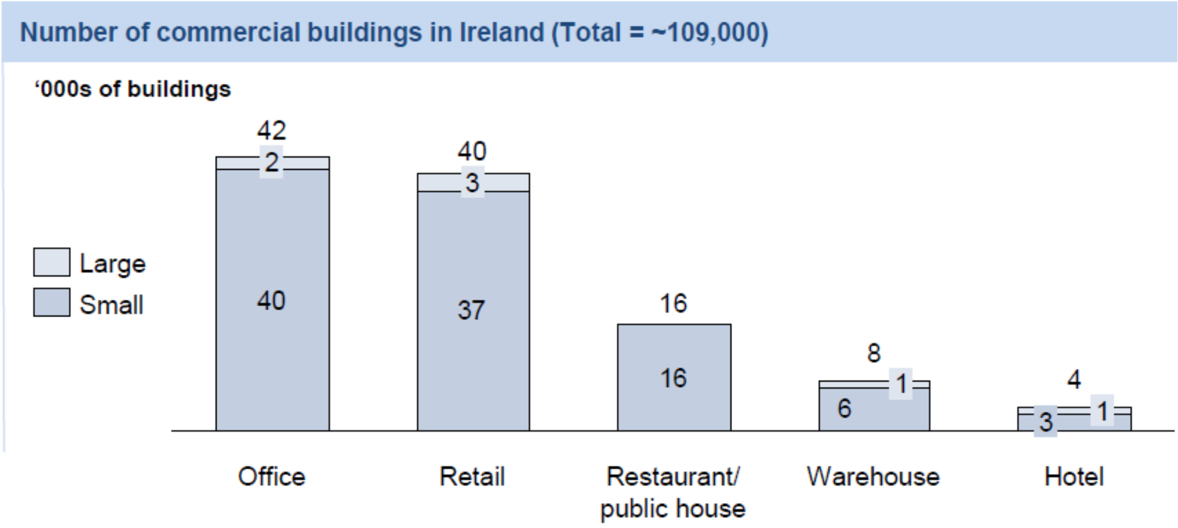

Figure 4: Estimate of Commercial Building Stock (SEAI 2014):

A survey was carried out on a sample of 1,500 of these buildings. This revealed that the vast majority of the 40,000 retail premises are electrically heated, and over half of the office and restaurant/pub building categories are also electrically heated.

Tying in with anecdotal industry experience, the hotel sector has the largest proportion of fossil fuel boilers, and would be an obvious beneficiary of any renewable heating incentive.

There would be no reason to preclude any one sector though, as despite the prevalence of electrical heating, there are significant opportunities within all categories of commercial buildings for renewable heating. Indeed there are several existing examples of large retail units (IKEA, Charlestown shopping centre), offices and warehouses (Viking Direct, The Pallet Network) already heated by biomass. According to the SEAI survey of building stock there are about 3,000 large retail units (where large is defined as > 1,000 m^2 footprint) and 2,000 large office units.

[18] SEAI 2014: Extensive Survey of Commercial Buildings Stock; Element Energy & The Research Perspective;

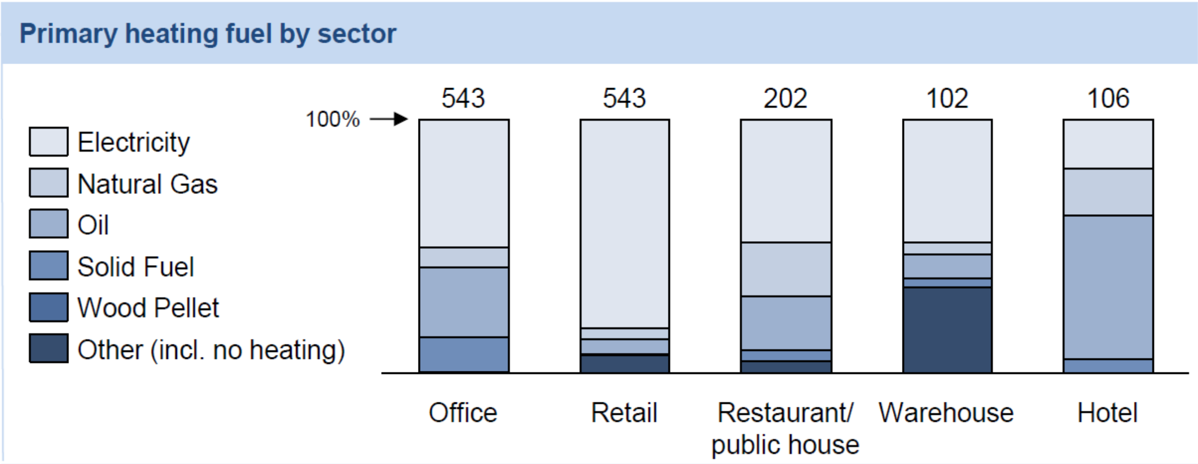

Figure 5: Primary Heating Fuel Survey of Commercial Building Stock (SEAI 2014)

5.3.3 Public Sector

According to analysis of SEAI data (above) there are 338 ktoe of fossil fuels used for heating buildings in the delivery of public services, some of whom can consider a switch to RES-H.

There are over 250 state bodies and agencies in Ireland. The public sector is a key target market for an RHI, especially in light of the proposal to initially exclude the traded emissions sector.

There are a number of biomass heating installations already installed in public buildings, including a 2MW wood pellet heating installation contributing alongside natural gas to the heating of Dáil Eireann and the adjacent Department of Agriculture building in Kildare St, Dublin 2.

Some of the key energy users in the public sector are listed below, and should be given high priority in targeting any RHI programme:

- The HSE spends over €80m per year on energy and is one of the largest users in the country
- The Justice and Defence forces spend over €8m per year on heat and electricity
- Each local authority manages a large estate of buildings including leisure centres, staff offices, libraries, theatres and other public service buildings
- The Department of Education manages an estate of 3,300 primary and 729 secondary school buildings
- The OPW manage the 16 government departments and the vast majority of civil service buildings, including Garda buildings. The OPW manages over 1 million m^2 of floor space and over 2,000 buildings

There is some data available through SEAI, especially through sharing of regulated energy sales (gas and electricity) through the National Public Sector Energy Database. According to SEAI's public sector energy report[19], the aggregate energy consumption through the 2,400 natural gas GPRNs[20] amounted to about 1,500 GWh in 2010. A single GPRN could be serving anything from a small building to a leisure centre or complex of public buildings attached to a heat network. The average annual use is 625,000 kWh per gas connection (a median figure for this would be informative).

[19] http://www.seai.ie/Publications/Your_Business_Publications/Public_Sector/Energy_Use_in_the_Public_Sector.pdf
[20] Gas Point Registration Number – Unique number for each point connected to the gas network

A simplified assumption, using a 20% load factor, implies that the average heat load is 356 kW for gas-connected public buildings. However a number of large-use sites with high load factor gives a high average and it is likely that the median size heat load is a good deal lower than this. Nonetheless this is helpful in giving an indication of any heat demand threshold that might exclude a substantial proportion of public sector buildings.

There are many challenges to implementation of RES-H in the public sector, including, but not limited to:

- Competition between energy efficiency and fuel switching. Public sector have a target of 33% energy savings by 2020 from a 2009 baseline year
- Challenges of public procurement, especially long-term energy procurement, something which is being addressed through a national framework. Local energy supply contracts (LESC) can be instrumental in supporting RES-H in public sector
- Motivation for energy measures is a challenge in public sector – it is not always apparent who "owns" the benefits and takes responsibility for achieving them

6 Modelling a Heat Incentive

There is complexity in arriving at a suitable tariff for an RHI. It is not possible to design a scheme that takes account of all variables across all technologies in a completely consistent and objective way.

BioXL, in consultation with IrBEA members, has produced a working model to capture the cost of both biomass and fossil fuel boiler installations.

The UK and NI schemes went through extended research and public consultation to arrive at a workable scheme. Even then, it has been necessary in each case to periodically review and amend the scheme.

Experience in the UK has shown that it is better to set rates at a level that can slightly over-incentivise some parts of the market. The option exists to adapt or amend as necessary, while still making progress on delivery of RES-H. This is much preferable to a scheme with marginal economics and low uptake. This would inevitably result in a scheme revision and a need for much more aggressive supports at a later date to catch up on lost ground.

Despite the attractive rates on offer for some technologies, uptake on the UK scheme has been below target. Tariff reviews and degressions are being used as a means to adjust the scheme.

6.1 Tariff methodology

As part of this review, IrBEA has decided to reproduce an adaptation of the NI RHI tariff modelling. It is difficult to reproduce exactly the DETI modelling, which took a number of years to finalise. It is not the intention or recommendation to exactly replicate the NI scheme, but simply to understand and derive appropriate tariffs for different boiler size ranges.

A distinct variation from the DETI methodology is that counterfactual capital costs have not been included in the modelling (see boiler capital costs below).

There are several critical variables in the RHI input modelling, including:

- Biomass installation capital costs (at a range of reference sizes)
- Counterfactual fuel choice
- Operating costs for each system
- Efficiency for each system at reference sizes
- Load factor for each system at reference sizes
- Discount rate (12% used for all commercial cases)
- Method of calculating annuitized capital costs
- Biomass fuel choice
- Fuel cost assumptions
- Assumed upfront and ongoing barrier costs associated with biomass

In this section, these variables are considered in more detail, and the assumptions behind cost modelling are explained.

6.1.1 Reference Boiler Sizes

Without prejudice to any particular systems, fuels or technologies, the following representative type of biomass boiler installations were chosen for cost modelling:

- A 100 kW wood pellet fuelled boiler, supplying heating and domestic hot water to an office building
- A 400 kW wood pellet fuelled boiler, supplying heating and DHW to a hotel
- A 1,000 kW wood chip fuelled boiler, supplying heat to a retail complex or similar
- A 3,000 kW wood chip fuelled boiler, supplying process steam to an industrial user
- An 8,000 kW wood chip fuelled boiler, supplying process steam to an industrial user

6.1.2 Boiler Capital Costs

BioXL carried out a survey of a number of IrBEA members and industry suppliers. There is no standardised installation. A sample of the kind of data we requested is:

"Supply and fit 250 kW LTHW wood chip fired boiler for supply to nursing home. Include for fuel storage, new flue, and for some mechanical and electrical work to integrate into an existing building."

The results are plotted in the graph below for the 10 examples for biomass boilers, and 5 examples for gas boilers. The benchmarks used in Northern Ireland for assessment of RHI costs are also included for reference (converted to € @ £0.73).

The findings are straightforward, but worth stating and they enable cost curves for modelling of a heat incentive.

- The cost differential between biomass and fossil fuel jet burner systems is graphically demonstrated. There is at least a 5 x greater capital investment required for biomass heating
- There are economies of scale as the kW installed increases. This is more pronounced for biomass than for fossil-fuel systems

- It is challenging to obtain a sample size of consequence in the Irish market, particularly at larger scale boiler applications
- The modest sample available shows costs below the Northern Ireland benchmarks
- There are many hidden costs and site-specific anomalies which (as for all benchmarking exercises) necessitate the warning not to extend their use beyond their purpose - high-level policy estimates

IrBEA is not including the counterfactual (gas boiler) capital costs in the RHI incentive modelling. The reasons for this are:

- The interpretation of the market reference price under state-aid guidelines should not include for the cost of replacing an existing fossil fuel boiler
- Due to the urgent need for action in the short term to meet 2020 RES-H targets, the market reference should not be to displace fully depreciated fossil fuel boilers at the end of their useful life. This will not deliver any level of meaningful market penetration for renewable heating technologies.
- The existing boiler market is dominated by retrofit – greenfield sites only account for 20% of all commercial boiler sales

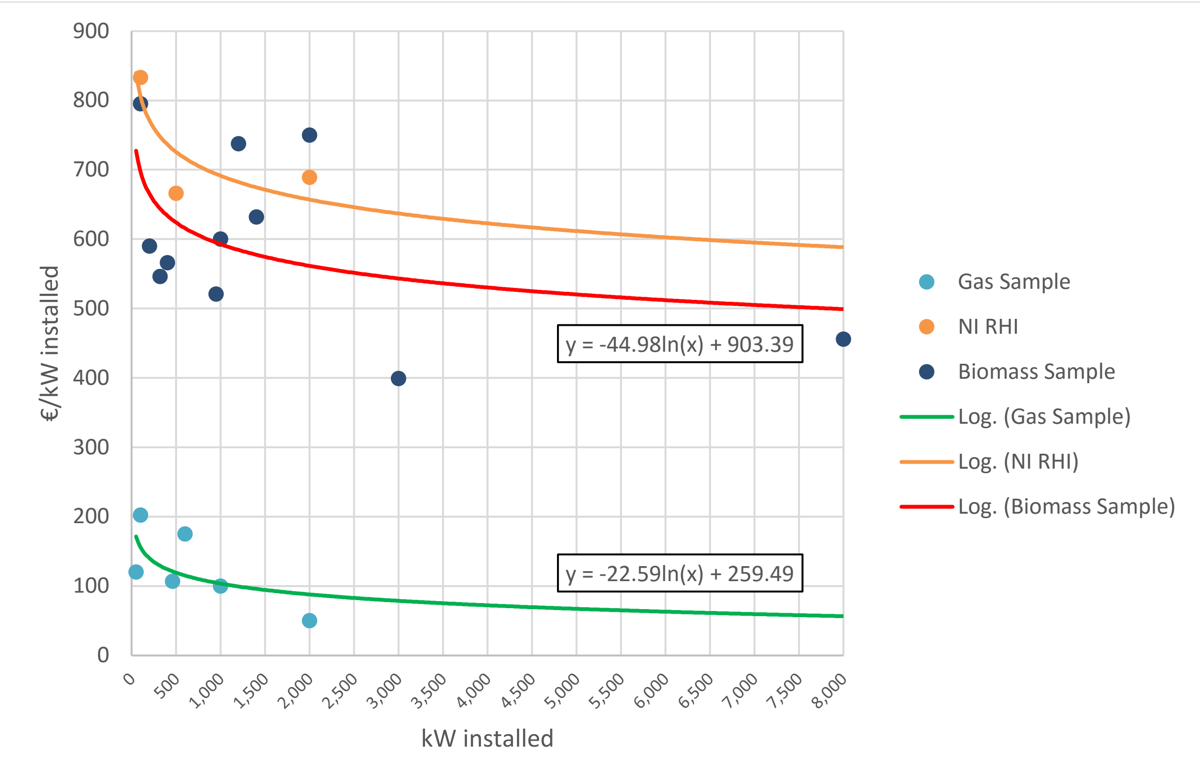

Figure 6: Capital Cost Curves - Biomass Boiler; Gas Boiler; NI RHI Benchmark

6.1.3 Hidden Costs

There are many hidden and nuisance costs associated with biomass installations that are difficult to quantify. These might typically include:

- Any new land or site footprint required. This is rarely included by the host site
- Any additional rates or insurance payable on the new build
- Potential planning and in certain cases industrial licensing
- Feasibility and design costs
- RHI administrative and compliance costs – expected to include metering and reporting

In an attempt to capture these hidden costs, a figure of €20/kW installed was estimated for hidden barrier costs and added to the biomass capital investment. This is in line with the methodology employed in NI and the UK.

6.1.4 Boiler Operating Costs

The main costs to consider here are maintenance, electricity, and in the case of biomass, ash disposal.

While undertaking the capital cost survey, the maintenance costs were also sought for biomass boilers. For fossil fuel boilers, the reseller is much less likely to be the same entity that ends up providing maintenance services, so this data was not captured.

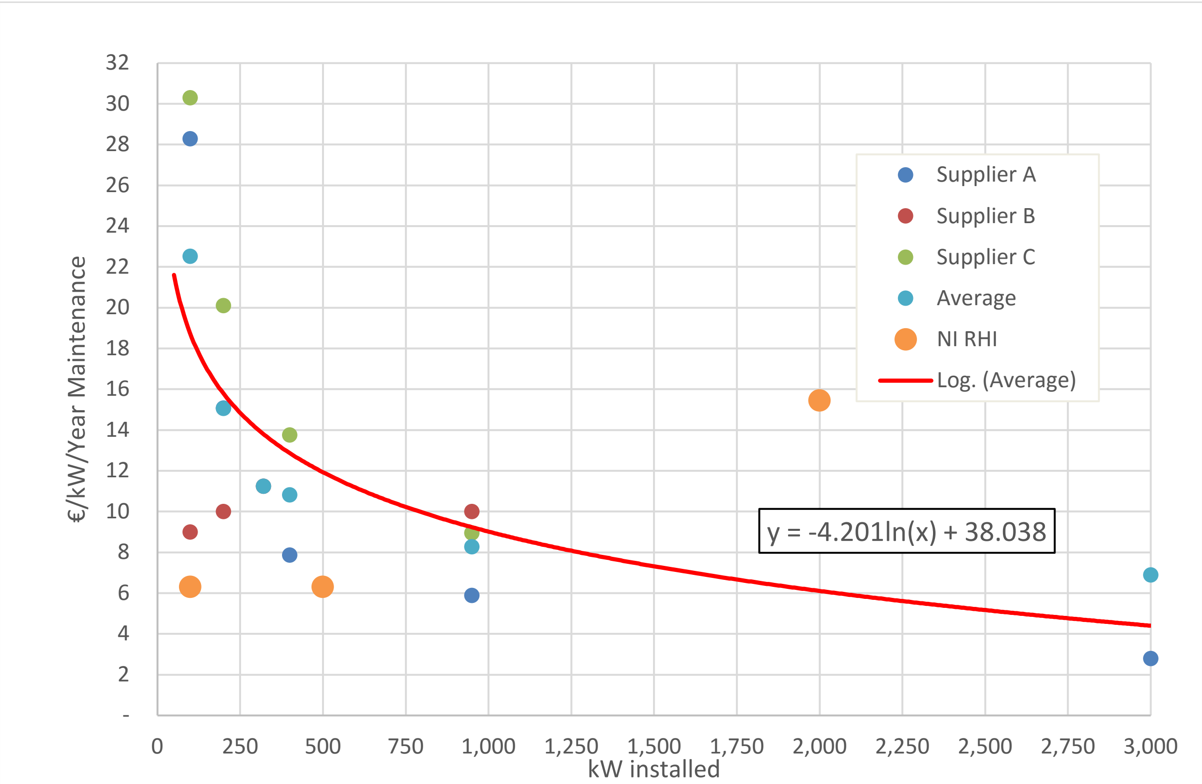

Figure 7: Biomass Boiler Maintenance Survey - Cost Curve

To the above, electricity and ash disposal cost must be added. This was done with regard to the reference size examples selected, and the model inputs are shown in the table below.

The electrical power consumption is assumed to be 4% of the thermal kW load for biomass and 1% of the thermal kW load for gas. The running costs are directly correlated with load factor, hence the increase in running costs for the 3,000 kW example. For gas boiler maintenance a simple 3% annual maintenance factor was applied to the capital cost estimate.

Table 5: Annual Boiler System Operating Cost Estimates

Reference Installation Size (kW)	Annual operating cost (excl. fuel) €/kW/Year- Biomass Boiler	Annual operating cost (excl. fuel) €/kW/Year- Gas Boiler
100	26	6
400	20	5
1,000	16	5
3,000	22	7
8,000	18	6

6.1.5 Fuel Costs

The choice of counterfactual fuel for the Irish market context should be natural gas. In the targeted industrial and commercial sectors, natural gas is the dominant fuel and delivers 44% and 54% of thermal heat requirements respectively.

The SEAI quarterly commercial fuel cost survey is used as the only source of independent cost data, but with the following observations on the SEAI data quality:

- Based on limited survey data
- Excludes client discounts and rebates
- Excludes standing charges
- SEAI continue to report in VAT inclusive prices – this has been removed for analysis
- Wood fuel prices in particular are questionable due to the fragmented and immature market
- IrBEA market data would indicate delivered wood chip prices slightly higher than SEAI data

The January 2015 SEAI commercial costs[21] were used, as in table below. SEAI prices are for gross fuel supply, and not actually for metered heat supply. In the context of an RHI this terminology is confusing. Where possible the use of kWh units should be restricted to describing output from a heat generating unit, and perhaps gross fuel pricing should be in MJ units.

The cost of natural gas is banded based on consumption, with larger users paying a lower price. It can be expected that larger users of wood fuels, oil or LPG products would also benefit from economies of scale or price competition, but this is not captured.

[21] http://www.seai.ie/Publications/Statistics_Publications/Fuel_Cost_Comparison/

Table 6: Fuel Input Prices SEAI January 2015

Fuel	SEAI Cost c/kWh (input)
Wood chip < 10,000 t/year	3.54
Wood chip > 10,000 t/year	2.83
Wood pellet < 10,000 t/year	5.09
Wood pellet > 10,000 t/year	4.07
Heavy Fuel Oil	5.15
Light Fuel Oil	6.02
Gas oil	6.91
LPG	7.56

Notes:

1. 13.5% VAT has been deducted
2. wood chip is delivered cost at 35% moisture content (wet basis)
3. wood pellet is for bulk delivery at 10% moisture of EN+ pellets
4. LPG is for bulk delivery of > 3 tonnes
5. LFO is used in the model to represent kerosene or other light fuel oils
6. For wood chip and wood pellet volumes above 10,000t/year a bulk discount of 20% has been applied

Table 7: Natural Gas Price Bands SEAI January 2015

Natural Gas Customer band	SEAI Cost c/kWh (input ex VAT)
< 278 MWh	5.29
> 278 MWh and < 2,778 MWh	4.42
>2,778 MWH and < 27,778 MWh	3.98
> 27,778 MWh	3.10

It is of course relevant to consider longer-term trends. The SEAI quarterly costs for wood pellet show an increase of almost 50% in pellet price over the period 2009 to 2015 (not inflation-adjusted). Over the same period, wood chip price increased by 10% (not considering inflation).

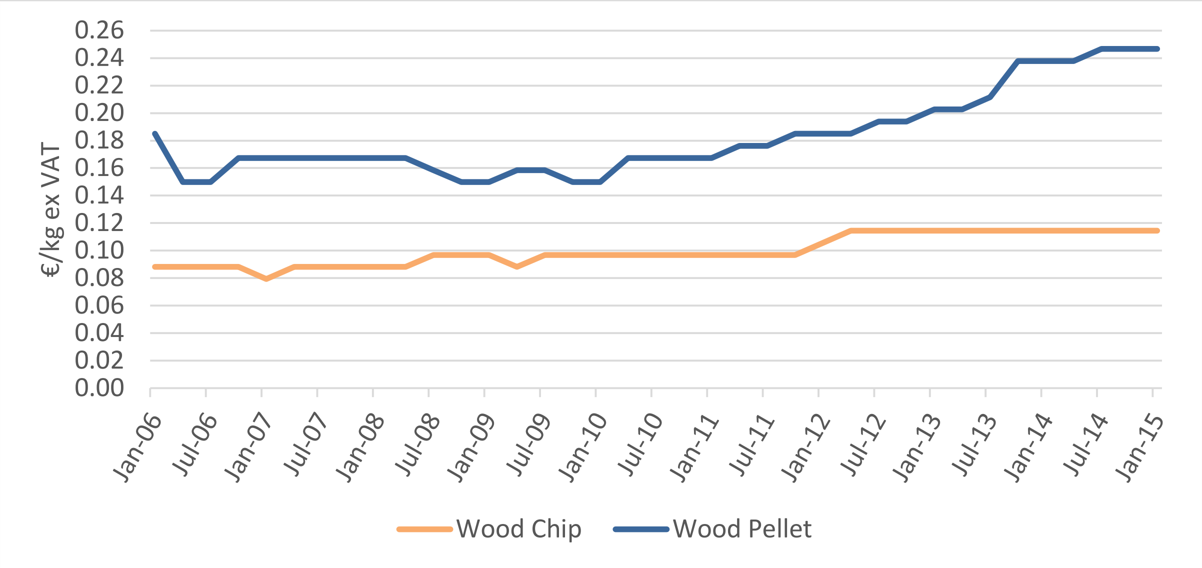

Figure 8: SEAI Commercial Wood Fuel Quarterly Cost Survey

It is important also to consider that oil and LPG are at their lowest price level in five years – which is a very challenging environment in which to develop renewable heating solutions.

Natural gas prices (at customer level) have displayed much less price volatility, but steady regulated increases that outstrip inflation. Prices in January 2015 for industrial customers were 40% above 2010 prices.

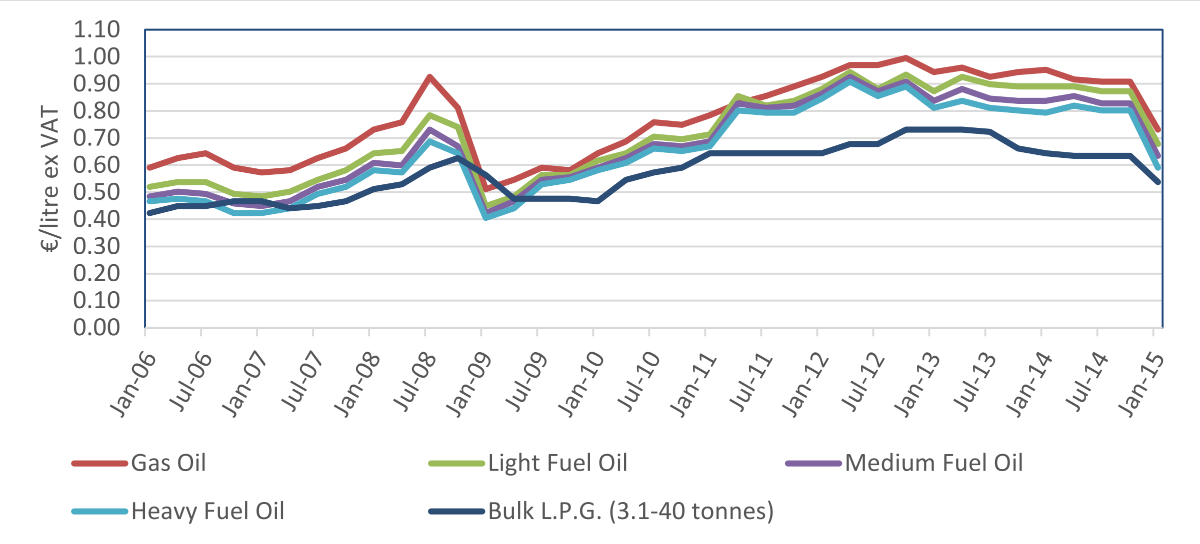

Figure 9: SEAI Commercial Oil/LPG Quarterly Cost Survey

6.1.6 Load Factor

Load factor (or % of annual hours at full load equivalent) is a critical variable in the viability of any heating system investment. Simply put, the more heat energy required, the higher the load factor, and the more scope there is for return on capital investment through operational and fuel savings.

The below assumptions have been made for model input, with regard to the reference sizes selected. The minimum load factor that could be considered is 15%, which would represent a typical heating season for a low occupancy non-residential end user, such as a school.

For a building with high level residential occupancy, such as a nursing home, hotel or hospital, a load factor in the range of 20% to 30% could be expected. This would vary greatly with site-specific factors, such as insulation levels, presence of a swimming pool or other unknown local factors.

At an industrial site with a year-round requirement for steam or hot water, a load factor of 50% is possible. The actual load factor would vary substantially depending on the nature of the process, the shifts worked (if more than one) and many other factors.

A modest sample of feasibility data from IrBEA members was used to inform the 50% used for the model in this instance.

Table 8: Modelled Load Factors at Reference Sizes

Reference Installation Size (kW)	Load Factor (%)
100	20
400	20
1,000	20
3,000	50
8,000	50

6.1.7 Discounting Capital

All government subsidies with the European Union must comply with state aid guidelines, and must be submitted for approval the EU Competition Commission for state aid approval.

State aid guidelines were substantially revised during 2014[22]. This is a complex legal area requiring careful legislative drafting and advice in the formation of new policies which involve state aid.

Where a capital investment is subsidised, this must be done with reference to a normal commercial market context. State aid legislation allows for a discount rate on upfront capital investment.

There is some precedent in this area, and for the purposes of this high level cost analysis the precedent under REFIT 2 and REFIT 3 will be used (both of which predate revision to state aid guidelines). These are policies implemented by DCENR and previously approved via state aid procedures to support renewable electricity generation. The concept of state aid for an RHI has already been well established in other Member States, such as the UK and France.

The precedent used for modelling is a 12% discount factor, over a term of 15 years.

A straightforward example is an investment of €1million. If this is annuitized over 15 years at a discount rate of 12%, it equates to a payment of €131,093 per annum. The "PPMT" function in Microsoft Excel is used to automate this calculation. This assumes the investment has no residual value after 15 years, and that payment is made annually in arrears.

A quarterly payment (as in the UK scheme) or any other variation in the timing of payments would alter the benefit and state-aid calculations necessary for discounting capital.

6.1.8 Boiler Efficiency

A simple assumption has been made for biomass and fossil fuel boiler seasonal efficiency. Gas boilers benefit from high efficiency at part-load, and a greater ability to modulate to demand. 90% is selected as representative of a reasonably efficient new gas boiler seasonal efficiency.

To attain these seasonal efficiencies assumes the use of modern, automated high efficiency boiler equipment. Biomass boilers with low load factors could expect a lower seasonal efficiency. SEAI use a range of 65-75% in fuel cost calculations[21] for solid fuel boilers. The upper limit of this range, 75%

[22] http://ec.europa.eu/competition/state_aid/legislation/compilation/index_en.html

has been selected as representative of a reasonably efficient newly installed boiler operating at a load factor of 20%.

Table 9: Assumed Seasonal Efficiencies

Boiler (by fuel)	Seasonal Efficiency estimate
Solid biomass	75%
Natural gas	90%

6.2 Model Results

A series of iterations were run of an RHI cost model, based on methodology and inputs outlined above. More detail is given for the 400kW reference system and an example of the base case modelling in Appendix 1.

For the 100 kW system, the recommended baseline support required is €12,949 per year (or 7.4 c/kWh), based on wood pellet being the biomass fuel of choice, and natural gas being the counter-factual.

The recommend baseline support required for the 400 kW reference system is €53,346 per year (or 7.6 c/kWh), based on wood pellet being the biomass fuel of choice, and natural gas being the counterfactual.

Once systems increase in size then wood chip becomes a more logistically viable option, so the recommended baseline support required for the 1,000 kW reference system is €88,511 per year (or 5.1 c/kWh), based on wood chip being the biomass fuel of choice, and natural gas being the counterfactual.

The recommended baseline support required for the 3,000 kW reference system is €308,788 per year (or 2.3 c/kWh), based on wood chip being the biomass fuel of choice, and natural gas being the counterfactual, and a 50% load factor.

Table 10: Heat Cost Differential for 100 kW Reference System

Fuel comparison choice	Cost Differential c/kWh	€/year RHI Estimate	
Wood chip vs Kerosene	4.5	7,910	
Wood chip vs Natural Gas	5.3	9,327	
Wood pellet v Kerosene	6.6	11,532	
Wood pellet v Natural Gas	7.4	12,949	Baseline

Table 11: Heat Cost Differential for 400 kW Reference System

Fuel comparison choice	Cost Differential c/kWh	€/year RHI Estimate	
Wood chip vs Kerosene	3.8	26,417	
Wood chip vs Natural Gas	5.5	38,857	
Wood pellet v Kerosene	5.8	40,906	
Wood pellet v Natural Gas	7.6	53,346	Baseline

Table 12: Heat Cost Differential for 1,000 kW Reference System

Fuel comparison choice	Cost Differential c/kWh	€/year RHI Estimate	
Wood chip vs Kerosene	3.3	57,411	
Wood chip vs Natural Gas	5.1	88,511	Baseline
Wood pellet v Kerosene	5.3	93,634	
Wood pellet v Natural Gas	7.1	124,735	

Table 13: Heat Cost Differential for 3,000 kW Reference System

Fuel comparison choice	Cost Differential c/kWh	€/year RHI Estimate	
Wood chip vs Heavy Fuel Oil	1.1	138,644	
Wood chip vs Natural Gas	2.3	308,788	Baseline
Wood pellet v Heavy Fuel Oil	3.1	410,319	
Wood pellet v Natural Gas	4.4	580,464	

Table 14: Heat Cost Differential for 8,000 kW Reference System

Fuel comparison choice	Cost Differential c/kWh	€/year RHI Estimate	
Wood chip vs Heavy Fuel Oil	-0.1	0	
Wood chip vs Natural Gas	2.2	761,184	Baseline
Wood pellet v Heavy Fuel Oil	1.6	544,427	
Wood pellet v Natural Gas	3.8	1,340,759	

6.2.1 Sensitivity Analysis

Sensitivity analysis is shown here for the example of the 400 kW reference system for the following variables: load factor, investment term and discount rate. There are multiple other variables that can be modelled for sensitivity, including biomass and counterfactual fuel costs, and all other inputs as outlined in the methodology. However, this would lead to many multiple scenarios and not necessarily provide any useful insights over and above using the present-day cost estimates.

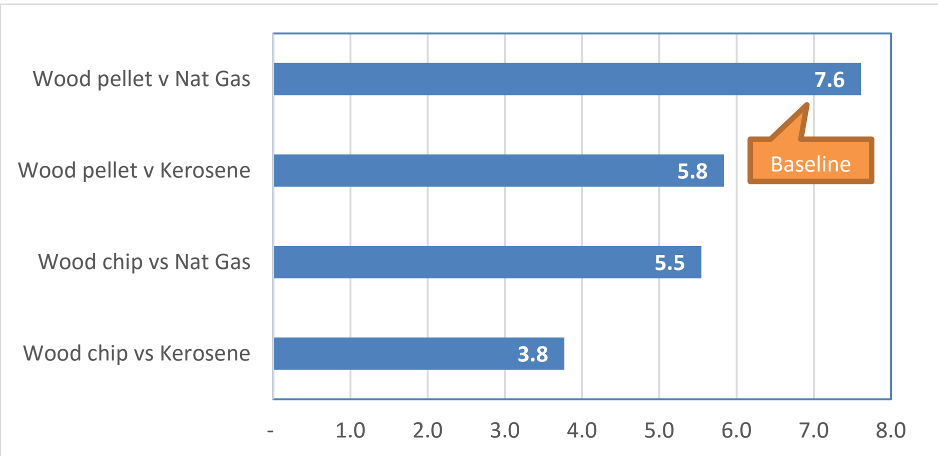

Figure 10: Cost Differential by Fuel Choice for 400 kW Reference Size

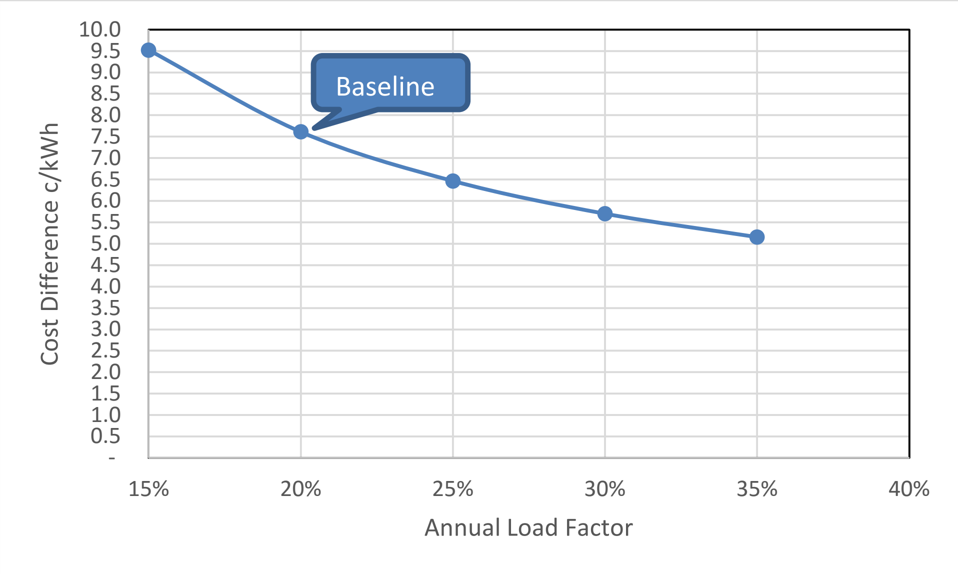

Figure 11: Sensitivity Analysis to Load Factor at 400 kW Reference Size

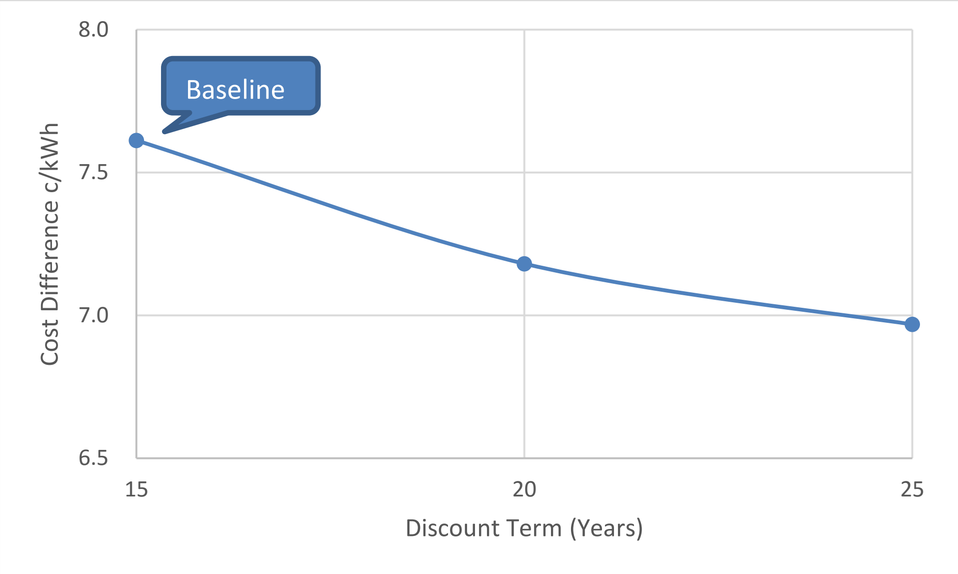

Figure 12: Sensitivity Analysis to Discount Term at 400 kW Reference Size

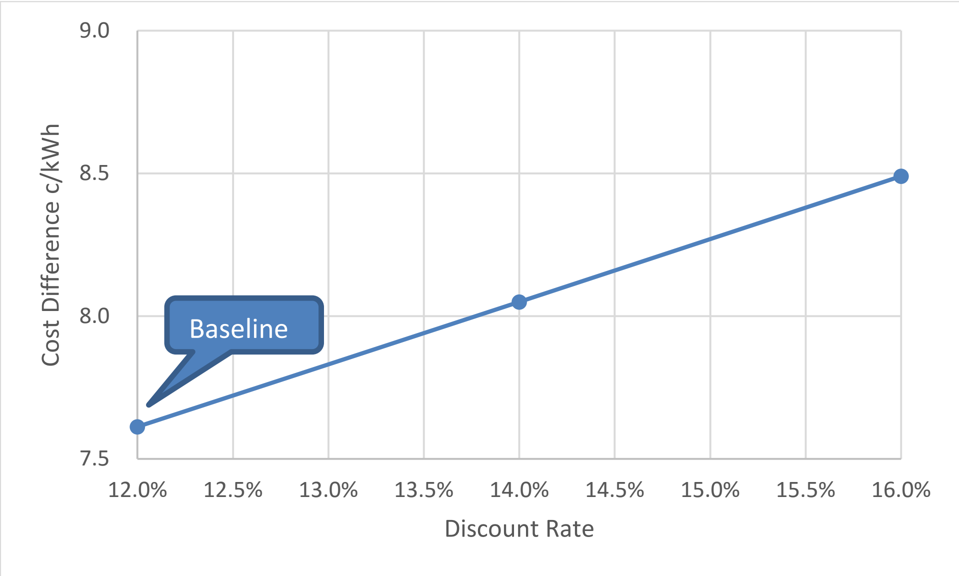

Figure 13: Sensitivity Analysis to Discount Rate at 400 kW Reference Size

7 Recommendations

The Irish Bioenergy Association, having completed a detailed body of research, is pleased to make some initial recommendations relating to the formation of an RHI based on learnings to-date.

To the extent possible, the scheme needs to be broadly inclusive across renewable heating technologies and renewable fuels.

The importance of stimulating the market early is paramount. A scheme with imperfections is better than the “do-nothing” option.

Any RHI tariff must be pitched at an attractive level to surmount the barriers to choosing a renewable heating system. Setting up a scheme with marginal benefit for participants will lead to low uptake. This will inevitably result in a scheme revision requiring more aggressive supports at a later date.

It must be kept in mind that an RHI policy alone will not deliver a significant level of market development – the policy and economic environment for biomass heating projects has been poor with virtually no market activity over the last 5 years. Support and commitment of government and its agencies to develop all aspects of the bioenergy supply chain is required.

The key attributes of a successful scheme are:

- Robust eligibility criteria
- Simple application and approval process
- Positive uptake
- Low ongoing administration burden (on applicants and administrators)

Further recommendations are set out under relevant sub-headings below.

7.1 Overall Scheme Design

The primary motive behind the proposal to introduce an RHI is to meet 2020 Renewable Energy targets, as legislated for in adopting binding EU agreements to meet 16% RES by 2020. While this is a useful short-term focus and trigger for action, RES-H policy should be designed with growth and delivery beyond 2020 in mind.

- The significant socio-economic benefits of biomass heating should be considered and included in any assessment of the impact of an RHI policy
- In considering a scheme design, IrBEA has looked principally to the NI and UK experience, and a similar French scheme, and is unaware of other appropriate international examples of unit-based heat incentives
- An early market signal is required, due to the learning curve and time lag in delivering a scheme. Lead times for some larger biomass heating projects can count in years, rather than months, especially if planning or environmental permits are required. IrBEA has welcomed the Government announcement of a “grandfathering” date for eligibility to a RHI scheme to allow projects to progress through the design and planning phases as scheme details are finalised.

However further clarity on scheme tariffs and eligibility criteria is required at the earliest possible date.

- Degression has worked well in the UK, and with appropriate market signals can work effectively in Ireland also
- Source of funds – IrBEA considers it would be a good principle to fund an RHI directly from carbon taxation
- It is recognised that energy efficiency measures are the cheapest form of energy, and that consideration should be given to implementation of minimum energy efficiency measures prior to investing in renewable heat solutions

7.2 Scale of Biomass Application

- ETS-registered sites would appear to be excluded from consideration, but the ETS mechanism (and very poor price of carbon credits) has proved insufficient to encourage investment in biomass boilers at this scale. Exclusion of ETS removes a number of opportunities of scale, which could make a meaningful contribution towards Ireland's RES-H target. These opportunities should be included within an RHI design, as is the case in the UK and Northern Ireland schemes
- The rationale for splitting the market into segments (either by boiler capacity or heat consumption) is clear – based on the UK experience it has proved more cost effective for the exchequer to subsidise specific sub-segments than a blanket tariff for the entire sector. Safeguards need to be put in place to minimise the opportunity to manipulate the scheme by over or under installing in relation to the actual site heat load
- The majority of opportunities seem likely to be in the lower end of boiler size expectations. There is no hard evidence for this available, but indicators and supporting market research point in this direction. Notwithstanding, there are good opportunities to deliver renewable heat at industrial scale
- The majority of commercial boiler sales are for modular gas boilers of between 44kW and 100kW capacity. For larger capacities these are often cascaded
- It is of note that the median size installation under Reheat was 165 kW
- Market research for the public sector indicates that a lower limit of 356kW would exclude a majority of public sector buildings
- Due to the banding of the NI RHI scheme, it has led to a large number of 99 kW pellet boilers. Similar rules in the UK have led to a disproportionate number of 199kW boilers. This is not a desirable policy outcome, and careful definition of site rules and eligibility will help avoid illogical designs using multiple biomass boilers to fall into a particular band

7.3 Scheme Design

A clear finding of IrBEA market research is that gas is the dominant heating fuel across the commercial, public and industrial sectors. Tariffs must be set at a level that is competitive with natural gas. It is extremely unlikely that all gas users would suddenly switch to renewable heating, as gas boilers are generally simpler to plan, quicker to install and involve less capital than renewable heating solutions

IrBEA heat market research outlines a scenario where 1 in 4 existing heat consumers may consider a switch to renewable heat. Based on this assumption, the maximum market response to an RHI signal would deliver 278 ktoe of renewable heat (excluding ETS sites). If natural gas users are excluded the potential is restricted to 109 ktoe of renewable heat, which is well short of the 200 ktoe required to meet 2020 targets.

- IrBEA proposes that a 15-year tariff with quarterly payments would be appropriate
- Tariffs should be revised annually in line with the consumer price index (CPI)

IrBEA presents the modelled price differential between biomass and natural gas as counterfactual fuel across a range of reference sizes for consideration in the formation of an RHI below.

Table 15: Recommended annualised incentive required for biomass heating at modelled reference system sizes

Reference system size kW	Modelled cost differential c/kWh	Biomass fuel modelled	Counterfactual fossil fuel	Annual payment at reference size
100	7.4	Wood pellet	Natural gas	€12,949
400	7.6	Wood pellet	Natural gas	€53,346
1,000	5.1	Wood chip	Natural gas	€88,511
3,000	2.3	Wood chip	Natural gas	€308,788
8,000	2.2	Wood chip	Natural gas	€761,184

The unit cost modelling reveals that a 400kW boiler would require a higher level of support than a 100kW system using identical fuels. The reason for this is that natural gas becomes more competitive with increasing usage. A consumer with a 400kW boiler would pay 16% less than the 100kW user (see Table 7).

At the 8,000 kW scale, customers are available to avail of further economies of scale in fossil fuel procurement, however a discount of 20% has been applied also to biomass costs in the modelling to reflect greater purchasing power for consumers requiring more than 10,000 t/year.

There is no ideal solution to subdivide the biomass heating market. IrBEA considered two approaches using banding or tiering mechanisms.

7.3.1 Banding Approach

A pragmatic range of bands was developed for consideration, and a tariff proposed for all boilers falling within this band range. After considering the pitfalls and limitations of the banding approach in the UK, it was decided not to recommend this approach but to propose an alternate tiering approach.

7.3.2 Tiering Approach

An alternate way to deliver the required support level is based around tiering, and a tier payment scheme is presented for consideration. The proposed tariffs are based around delivering the same annual support at the reference installation size modelled.

The key difference with the banding approach is that each installation above the minimum tier selected would receive a decreasing rate across a further number of output tiers. Such a design remains independent of the boiler rated capacity. After a number of iterations with different tiering levels, the optimum system to deliver the modelled support required at the reference size involves a 2-tier system, with different payments above and below annual output of 1,000,000 kWh.

Table 16: Recommended Tariff Tiers for RHI Implementation

Tier	Tariff tiers	Proposed Rate	Maximum tier payment
	kWh/year	**c/kWh**	**€/year**
Tier A	<= 1,000,000	7.6	76,000
Tier B	> 1,000,000	2.0	N/A

Applied examples at the reference installation sizes are presented below.

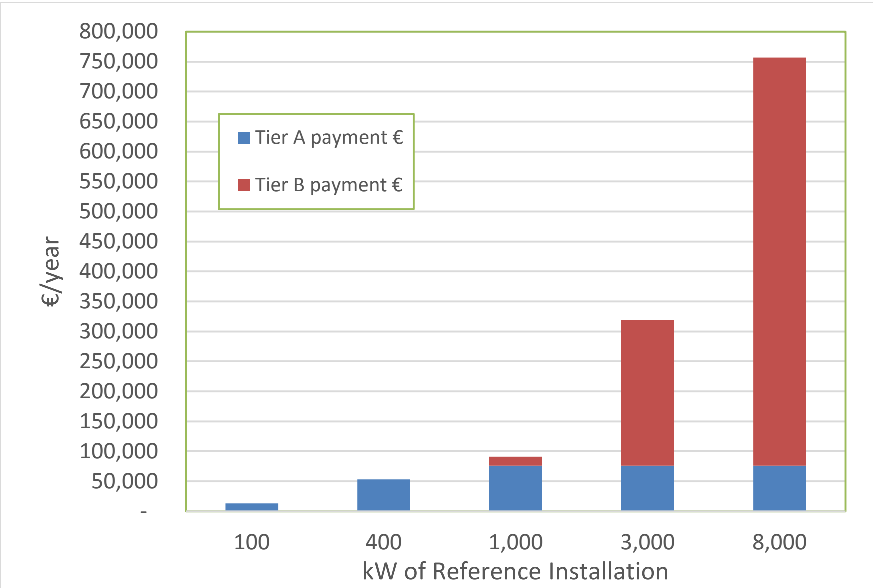

Figure 14: Example of payments by tier for reference boiler sizes

7.4 Biomass Fuel Supply

Members of IrBEA supply quality assured woody biomass products, as well as a range of other renewable fuels, such as:

- Wood chip
- Wood pellet
- Wood logs
- Torrefied fuels
- Straw, chicken litter and other agricultural residues
- Biogas
- Liquid biofuels (and tallow)
- And others

A number of IrBEA members supply fuel certified through a national Wood Fuel Quality Assurance (WFQA) scheme[23]. This scheme has an independent oversight committee and chairperson, but is

[23] www.wfqa.org

owned and administered by IrBEA. IrBEA suggests that participation in an externally audited certification scheme, such as the WFQA scheme, be a mandatory condition of wood fuel supplied to an RHI-supported system. This will ensure greater accountability for fuel supply, particularly in regard to moisture content.

- There are gaps in the fuel supply chain. Mobilisation of the private sector forest resource is critical to delivering new fuel resources. There is a great opportunity to develop the market for thinnings from private forestry, a resource that has proved difficult to mobilise without local demand. In 2015, COFORD published a report entitled 'Mobilising Ireland's forest resource'[24]. The report set out 40 recommendations to mobilise forestry resources to meet Ireland's projected future demand for fibre. These recommendations are aimed at various government departments, agencies, stakeholder groups or a combination thereof. IrBEA strongly encourages the implementation of the COFORD recommendations. It is important that parallel policy focus is maintained on facilitating investment by growers and processors of biomass
- Sustainability criteria, or certification of origin of material, should be proportionate but also allay any concerns about non-sustainable sources of material. Sustainability criteria should be fully harmonised with EU legislation
- In 2014, the European Commission published a report[25] on the sustainability of solid and gaseous biomass for heat and electricity generation. Non-binding recommendations are proposed on sustainability criteria for biomass. These recommendations are meant to apply initially to energy installations of at least 5MW thermal by 2025, and IrBEA recommends they are adopted for Ireland, including for fuel criteria under the RHI
- IrBEA does not recommend a prescriptive approach on fuel types. There are a wide variety of sustainable fuels and technologies available which should not be excluded from RHI market supports
- There are no restrictions on fuel crossing borders, and restrictions in free trade are neither possible nor recommended. However it is necessary during policy formation to consider the impact of imports and cross-border trade on the island of Ireland

7.5 Heating Technology

- Provision should be made not just for LPHW (low pressure hot water) systems, but also steam, hot air or other means of supplying heat to end users.
- There is a need to facilitate enabling technology, especially district heating and thermal energy storage. District heating is an expensive long-term infrastructure investment in comparison to a standalone biomass boiler and is likely to need separate policy support.
- SEAI operates an "EEE" or triple E register[26] for sustainable energy equipment qualifying for accelerated capital allowances (ACA). IrBEA recommends using the EEE criteria for demonstration of minimum equipment quality standards. Also compliance with relevant EN, IS or BS standards should be enforced.

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24 http://www.coford.ie/media/coford/content/publications/projectreports/Mobilising%20Irelands%20forest%20resources%20-%20Digital%20March2015.pdf

25 https://ec.europa.eu/energy/sites/ener/files/2014_biomass_state_of_play_.pdf Commission working document

26 http://www.seai.ie/Your_Business/Accelerated_Capital_Allowance/

- Proposed EU legislation suggests minimum emissions standards for plant greater than 5 MW by 2025 and 1-5MW by 2030 via the Medium Combustion Plant (MCP) Directive[27].
- Recently approved Ecodesign legislation[28] sets labelling and performance requirements for water heating devices below 500 kW capacity.
- Biomass CHP has historically been incentivised via REFIT3, but this is coming to an end and there is no further scheme at present proposed to incentivise biomass capital investment in this area. The interaction between supports for electricity and for heat needs to be considered. It is noted that REFIT3 has not led to timely delivery of biomass CHP projects, due to the limited incentive in place.

7.6 Administration

- During this critical scheme design stage, it would be very appropriate for DCENR to commit additional time or resources to the development of an RHI policy.
- Due to the expected additional administration requirements of a scheme, IrBEA recommends that the CER or other government agency be tasked with operation of the scheme.

7.7 Industry Role

IrBEA recognises that the industry has a key role and responsibility in delivering best-practice in renewable heat and fuel supply. There is a need for excellence right across the supply chain, including fuel quality, fuel sustainability, system design, installation quality, maintenance and post-installation support. IrBEA has a good track record in delivering industry initiatives and is committed to showing leadership in the bioenergy sector as shown through the activities outlined below:

- IrBEA operates a Wood Fuel Quality Assurance (WFQA) Scheme and is committed to further development, promotion and upholding the value and credibility of this scheme.
- Quality control of boiler and fuel store installations needs to be monitored on an ongoing basis. Some boilers installed over the previous decade are no longer operational due to either technical problems or commercial circumstance. The pay-per-use concept of an RHI will ensure boilers remain operational. However concerns remain over the professional standard of installations, with health and safety concerns, potential emissions and design flaws leading to poor performance. IrBEA has previously run boiler training programmes for engineers and installers and is committed to increasing delivery of industry events and more diverse training to address any skills gaps as the RHI is rolled out.

[27] http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52013PC0919&from=EN

[28] http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52013PC0919&from=EN Reference C(2015) 2623

Appendix 1: RHI Model Example – 400 kW

400	**kW**							
Commercial/Public Space heating					**Biomass fuel**		Wood pellet	
					Fossil fuel		Natural Gas	
	Capex	**Opex**	**Efficiency**	**Load factor**	**Size**	**Lifetime**	**Fuel cost**	**Barrier Costs**
	(€/kW)	(€/kW /yr)	(%)	(%)	kW	(years)	(c/kWh)	€
Biomass	634	20.15	75%	20%	400	15	5.09	8,000
Fossil fuel	0	5.42	90%	20%	400	15	4.42	-

	Delivered Heat	**Fuel input**	**Fuel conversion**	**Price equivalent**
	kWh/yr	GJ/yr	dry t/yr	€/t dry basis
Biomass	700,800	3,364	177	269
Fossil fuel	700,800	2,803		

Calorific values	**GJ/t**
Dry biomass	19.0

€ per year	**Annuitised capital cost**	**Annual operating costs**	**Annual Fuel Costs**	**Barriers annuitized**
Biomass	33,240	8,060	47,584	1,049
Fossil fuel	0	2,169	34,417	0
Difference	33,240	5,891	13,167	1,049
Sum of difference	53,346			
Discount rate used	**12%**			

Cost difference with Biomass – 400 kW:	**Amount (c/kWh)**
Annualised capital and barriers	4.89
Operating costs	0.84
Fuel costs	1.88
Total	7.61

Appendix 2: International Schemes

There are relatively few examples internationally of pure unit-based heat incentives. The IrBEA view remains that in the long term, progressive carbon taxation has been demonstrated as the most effective tool in incentivising investment in biomass heating. Carbon taxation has been particularly successful in Denmark and Sweden in encouraging widespread substitution of fossil fuel with biomass. Notwithstanding this longer term aim, a renewable heat incentive will certainly help kick-start the market and move towards 2020 and 2030 climate change action goals. It is recognised that an appropriately focussed RHI is the policy option with the lowest likely cost, as compared to broad-based taxation policies.

The UK regions, including Northern Ireland have introduced an RHI. The RHI in the UK regions has had a successful first few years. The overall scheme has been responsible for delivering over 1.5 GW of installed biomass heating capacity. The schemes differ quite substantially by region and incentive level.

The mainland UK scheme was legislated in 2011, but was open to installations commissioned after July 2009. It has undergone a number of revisions since.

In Northern Ireland, a non-domestic scheme was first introduced in 2012, but a further expansion of it is currently under consideration (Phase 2). In October 2014, an additional domestic scheme was launched.

Some information is also included below about the French Renewable Heat Fund.

Northern Ireland Non-Domestic Scheme

The primary objective for the RHI in Northern Ireland is to increase the uptake of renewable heat to 10% by 2020. It was at 2.4%, when the scheme was introduced, in 2014. The 10% target for renewable heat equates to 1.6TWh (or an additional 1.3TWh, when considering existing levels). It is equivalent to approximately 250MW of installed capacity.

Some key features of the initial non-domestic Northern Ireland scheme, which was introduced to help meet a 10% regional RES-H target for 2020:

- It was launched in November 2012, but with retroactive effect from September 2010
- It provides for 20 Years metered payments, with quarterly settlement
- Due to the banding of the scheme, it has led to a large number of 99 kW pellet boilers
- An RHI register has been setup and regulated by a department of OFGEM
- The payments are index-linked
- There are no tiers for production hours within the kW bands for the NI scheme
- There is no automatic degression of tariffs, but a commitment to review rates every 2 to 3 years

Table 17: Rates and Banding for NI Non-domestic RHI Phase 1 (DETI 2014)

Biomass Boiler Range	Annual Payment p/kWh	Euro equiv c/kWh[29]
Up to 19 kW	6.6	9.0
20 to 99 kW	6.3	8.6
100 to 999 kW	1.5	2.1

Data from Action Renewables shows that up to the end of 2014 there have been approximately 400 biomass applications in NI. This has resulted in about 50MW of boilers being installed. 92% of the applications so far were for boilers with a capacity of 99kW.

Setting of Rates and Bands

The economic analysis supporting Phase 1 of NI RHI[30] was carried out by Cambridge Economic Policy Associates Ltd and AEA Technology in 2011. This in turn was informed by a renewable heat market assessment[31] undertaken jointly by AECOM and Poyry in 2010. This clearly showed oil to be the de facto heating choice in Northern Ireland (Figure 15).

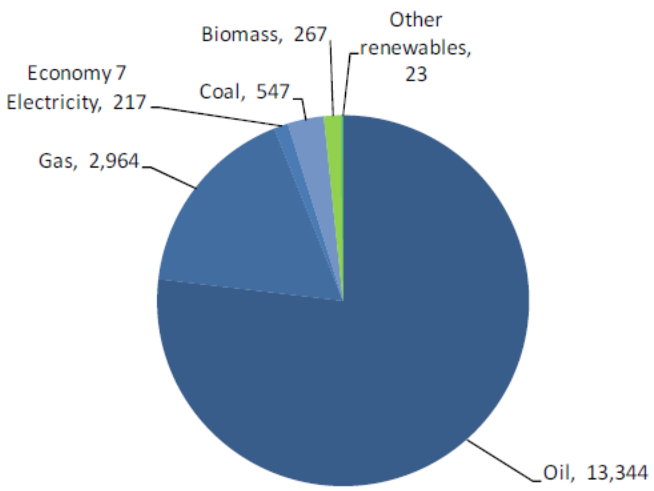

Figure 15: Composition of NI heating market 2010 in MWh (AECOM/Poyry)

The rates and banding recommended at the time are shown below (Table 18). They are based on a counterfactual fuel use of oil. As in the GB scheme, a target 12% return on investment was assessed for reference installations. There was a detailed modelling exercise undertaken, with inputs for both “conventional” or fossil fuel installations, versus the added capital and operational costs for an array of renewable heating technologies.

29 Currency conversions in this document use the rate of 0.73£/€ checked on 25/2/15
30 http://www.detini.gov.uk/economic_appraisal_into_the_northern_ireland_rhi_-_june_2011.pdf
31 http://www.detini.gov.uk/executive_summary_-_renewable_heat_study

A consultation process and series of workshops were run by DETI in 2011. CEPA/AEA were commissioned by DETI to carry out economic analysis[32] with a revised set of bands and cost assumptions. This was published in February 2012. This revised analysis was used as the basis for rates finally proposed by DETI (See

[32] A Renewable Heat Incentive for Northern Ireland Addendum, Cambridge Economic Policy Associates Ltd and AEA Technology Limited, February 2012; DETI

Table 17). DETI received notification[33] of state aid clearance from DG Competition in June 2012, with the proposed scheme being accepted without changes.

Table 18: Recommendations of CEPA/AEA for NI Biomass RHI bands and Rates 2011

Biomass Boiler Range	Annual Payment p/kWh
Up to 45 kW	4.5
Above 45 kW	1.3

There are several critical variables in the input modelling, including:

- Biomass installation capital costs (at a range of reference sizes)
- Counterfactual fuel choice – heating oil or heavy fuel oil (HFO) were used in NI
- Counterfactual fuel capital costs
- Operating costs for each system
- Efficiency for each system at reference sizes
- Load factor for each system at reference sizes
- Discount rate (12% used for all commercial cases)
- Method of calculating annuitized capital costs
- Biomass fuel choice – wood pellets has been used as default fuel
- Fuel cost assumptions
- Assumed upfront and ongoing barrier costs associated with biomass

The application of this model is revisited below, where worked examples are extracted for different reference scenarios.

Northern Ireland Non-Domestic Phase 2

The economic analysis supporting Phase 1 of NI RHI did not recommend a subsidy at that point for installations >= 1 MW. This was primarily based on the economic analysis at the time that biomass supply was cost effective at this scale without subsidy. It was also a lower priority due to the relatively small number of industrial sites with potential for introduction of biomass. These findings have been revisited with the proposed introduction of Phase 2.

Table 19: Proposed Rates for NI RHI Phase 2

Biomass Boiler Range	Proposed Annual Payment p/kWh	Euro equiv c/kWh[29]
1 MW +	0.6	0.8
District Heat uplift	7	9.6
New CHP	3.5	4.8
CHP conversions	1.7	2.3

Mainland UK Non-domestic RHI

An RHI scheme was launched in 2011, to deploy technologies that would help meet the 12% RES-H target in the UK. The scheme covers a wide range of renewable heating technologies, but over 98% of installations under the scheme to date have been biomass heating.

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[33] http://ec.europa.eu/competition/state_aid/cases/244651/244651_1375577_58_1.pdf

Key features of the scheme:

- Twenty year payments for renewable heat
- Three bands for biomass combustion (small, medium and large)
- Tiers within the bands for production hours (applies to small, medium biomass)
- Degression of tariffs in function of budget triggers

The scheme has seen a large uptake, with over 1GW of renewable heating installed by September 2014. Some lessons from the scheme include:

- An undesirable consequence of the banding has been the prevalence of 199kW biomass boilers.
- The complexity of the scheme, not least the range of technologies, bands and tiers has created a large administrative function within the regulator (OFGEM)
- Metering has proved a major complexity (and industry knowledge of metering)
- Accreditation is taking 14 hours per installation, according to OFGEM

Grandfathering

The scheme commenced in 2011, but was "grandfathered" to July 2009, meaning that installations commissioned after 2009 were eligible for the new heat payment (but only from 2011). This step did uphold market confidence and allow installations to proceed while the scheme was essentially still under development. Applicants did continue to make investments with a good deal of uncertainty over final outcome of the RHI. From a regulatory point of view, some compliance issues needed to be addressed once the scheme was eventually legislated for.

Evolution of Rates and Banding

AEA (technical consultants) and Nera (economic consultants) prepared a series of technical studies in 2009[34] and 2010[35] which were used to inform the baseline rate setting by DECC in 2011.

The original methodology was (broadly) to set a level of support that would stimulate 50% of the market potential for a given technology, and offering a rate of return of 12% for the reference technology. The Nera/AEA 2010 report[35] suggested the following banding levels and proposed support level for biomass heating:

Table 20: Original Tariff and Banding proposals UK 2010

Proposed band	Proposed RHI level p/kWh (2008 prices)
Small 0-45 kW	8.7
Medium 45-500 kW	6.2
Large > 500 kW	2.5

[34] http://www.rhincentive.co.uk/library/regulation/0907Heat_Supply_Curve.pdf
[35] http://www.rhincentive.co.uk/library/regulation/100201RHI_design.pdf

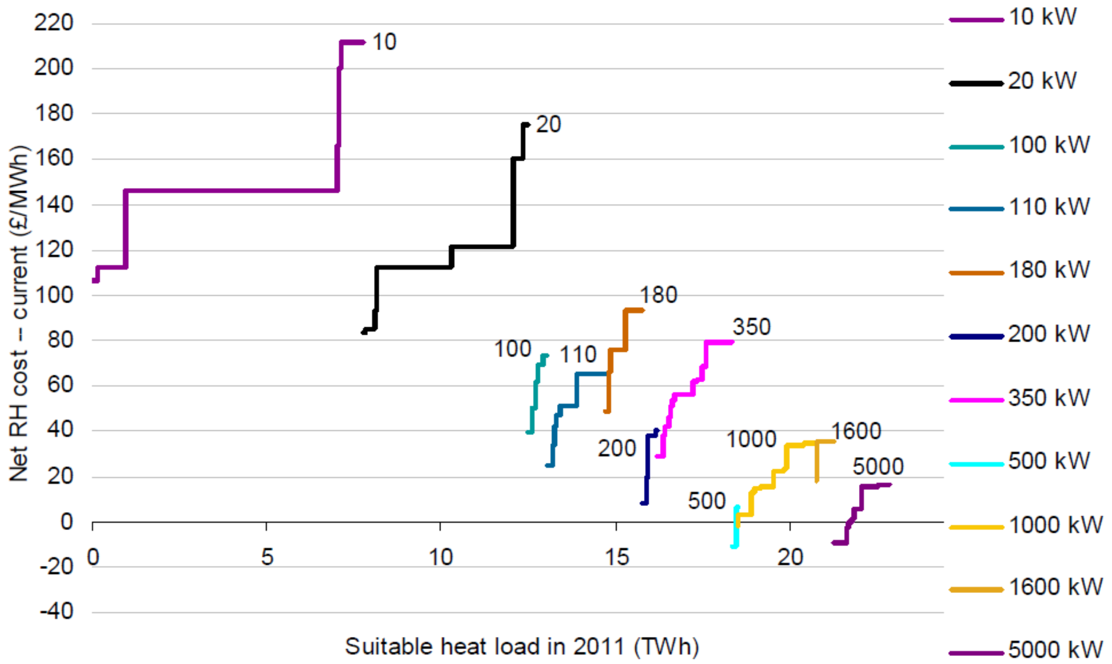

Figure 16: NERA/AEA UK Biomass heat Market Potential and Supply Curves 2010

The NERA/AEA analysis showed that different levels of support at different bands would enable increasing amounts of renewable biomass heat. The curves in the figure above are informative (but out of date and only appropriate to the UK market). Some high level findings include:

- At the larger end of the scale (>5MW) economic modelling indicates that a large part of the potential should be going ahead without an RHI.
- The unit subsidy required falls very significantly when going from 20 kW (Domestic scale) up to 100 kW (Commercial scale).
- It is easy to see why a commercial scheme was targeted – higher market potential at lower cost and complexity.

During the course of 2010 and 2011, DECC undertook industry consultations and commissioned further studies from AEA[36].

A new banding scheme and economic inputs for biomass RHI were announced by DECC in March 2011[37], based on industry consultations and updated studies and models. The rates proposed and bands proposed at the time are shown in Table 21.

A somewhat arbitrary new band was introduced at 200 kW, based on the advice from AEA that units would be predominantly wood-pellet fired below this threshold and wood chip above the 200kW threshold.

A 1MW threshold was introduced, acknowledging also that this was a "pragmatic compromise". Sustainability reporting was made mandatory for all units above 1MW.

[36] http://www.rhincentive.co.uk/library/regulation/1103AEA_Update.pdf
[37] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/48041/1387-renewable-heat-incentive.pdf

The concept of a "Tier Break" was introduced, which broadly reflects full load hours for the space heating season. This was introduced to discourage over-generation or wastage of heat.

Table 21: RHI Biomass Support Levels announced by DECC March 2011

Levels of support

Tariff name	Eligible technology	Eligible sizes	Tariff rate (pence/ kWh)	Tariff duration (Years)	Support calculation
Small biomass	Solid biomass; Municipal Solid Waste (incl. CHP)	Less than 200 kWth	Tier 1: **7.6**	20	Metering Tier 1 applies annually up to the Tier Break, Tier 2 above the Tier Break. The Tier Break is: installed capacity x 1,314 peak load hours, i.e.: **kWth x 1,314**
			Tier 2: **1.9**		
Medium biomass		200 kWth and above; less than 1,000 kWth	Tier 1: **4.7**		
			Tier 2: **1.9**		
Large biomass		1,000 kWth and above	**2.6**		Metering

DECC decided also to put in place a value for money cap of 10 p/kWh (index-linked). This was derived based on the cost of the alternative to fulfil 2020 targets, which in the UK was deemed to be the cost of offshore wind.

Box 1: RHI tariff setting methodology used in 2011:

1. Estimate the additional cost of installing and running a renewable heating system. This is used to calculate the cost per unit of heat produced for renewable technologies less the cost of the conventional technology alternative. Added to this cost are the additional barrier costs. Calculations are made using costs, use and performance data for each technology in each category of building (broken down by commercial, industrial, counterfactual fuel and location).
2. Estimate the heat demand of each building category, the number of such buildings and the proportion of them suitable for each renewable technology.
3. From these figures, a "supply curve" is produced for each technology which estimates the amount of renewable heat potentially fundable at each tariff level.
4. From these curves we are able to identify the tariff required to potentially incentivise the targeted percentage of the potential installations. This targeted percentage is the 50% point on the supply curve (unless the tariff is capped for value for money reasons).

Figure 17: Extract from RHI tariff review technical annex; DECC, May 2013

The finalised tariffs available to units installed prior to 2013 are published by Ofgem[38] and outlined below (Table 22). The most substantial changes from the original DECC announcement[37] in 2011 (Rates in Table 21) were:

- The original tariffs were based on 2010 prices, so an uplift based on the Retail Price Index has increased the levels substantially for small/medium installations
- The proposed 2.6p for units >1MW was deemed to be over-incentivising the market during the State Aid clearance process. A rate of 1p/kWh was assessed as an acceptable market support.

Table 22: Ofgem RHI Tariffs Prior to January 2013 (with RPI uplift)

Tariff as of January 2013	Eligible sizes	Annual payment (p/kWh)	Euro Equivalent[29] (c/kWh)
Small commercial biomass	< 200 kWth		
	Tier 1	8.8	12.1
	Tier 2	2.3	3.2
Medium commercial biomass	>= 200 kWth & < 1MWth		
	Tier 1	5.4	7.4
	Tier 2	2.3	3.2
Large commercial biomass	> 1MWth	1	1.4

Tariff review/Degression

In 2012, a year after the legislation was introduced, a consultation was launched on pricing and budget scoping for the RHI. Tariff reviews were implemented during 2013. An overall review of tariffs ran on a parallel timeline to the proposals on budgeting and degression.

The 2013 tariff review relied on further strands of information and the benefit of experience, including:

- Original AEA supply curves and studies (2009/2010)
- Stakeholder consultations
- Operational data from the scheme
- Sweett consultancy study (2013)[39]

[38] https://www.ofgem.gov.uk/environmental-programmes/non-domestic-renewable-heat-incentive-rhi
[39] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/204275/Research_on_the_costs_and_performance_of_heating_and_cooling_technologies__Sweett_Group_.pdf

External experts (Sweett) were used by DECC to review technology costs, during 2013.

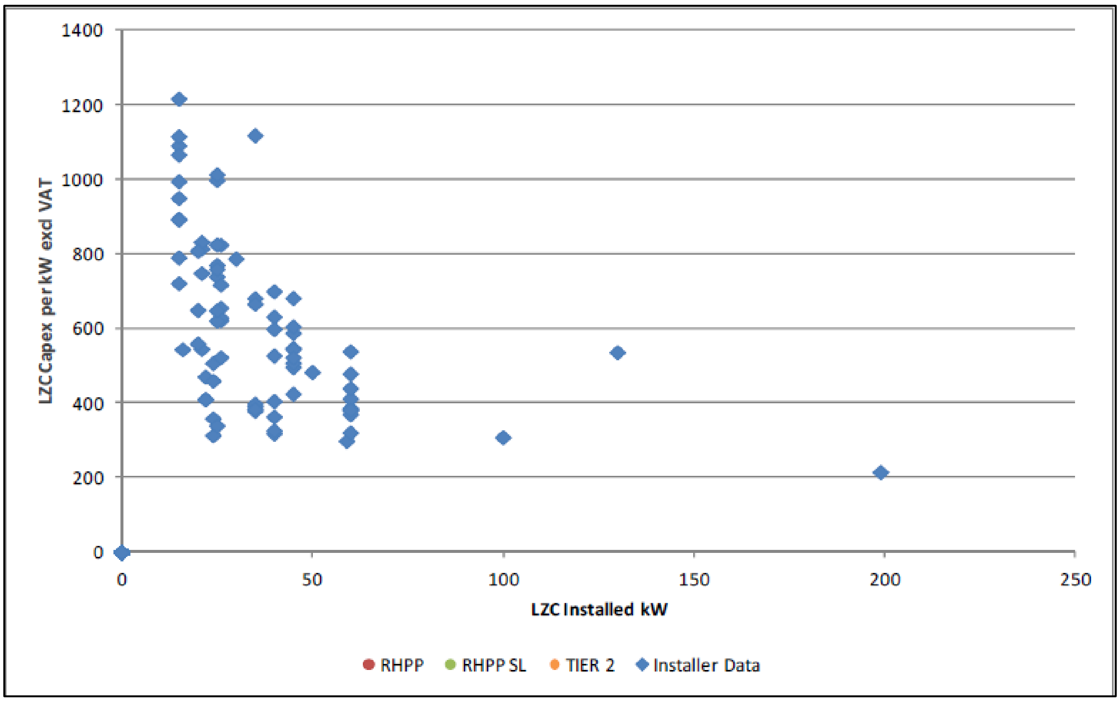

Figure 18: Range of specific costs for biomass installations in UK (Sweett surveys 2013)

Notes on Figure 18: LZC = Low to zero carbon technologies; Capex in £; Survey size was 93 installations

The scheme as a whole had been below projected spending, but had seen large uptake in biomass, and low uptake in almost all other categories.

A detailed budgetary mechanism was devised for triggering tariff reviews on a quarterly basis, with one month's public notice. The initial price signal would be capped at a 5% reduction, but further cuts of up to 20% can be implemented if particular technology categories do not trend back towards projected levels.

Low uptake in the 1MW+ category saw the tariff for this being increased from 1p to 2p/kWh in 2013.

High levels of uptake in the sub 200kW category have seen a series of tariff reductions over 2014/2015. This tariff has reduced from 8.8p to 6.8p/kWh during the course of 2014, a 23% cumulative reduction.

A summary of the key biomass tariff degressions implemented to-date can be seen below (Figure 19). Note that the tariffs are subject to indexation as well as degression. The Tier 2 tariffs were modified in the same proportion as the Tier 1 tariffs. The biomass heating tariffs presently available (February 2015) are also included for information (Table 23).

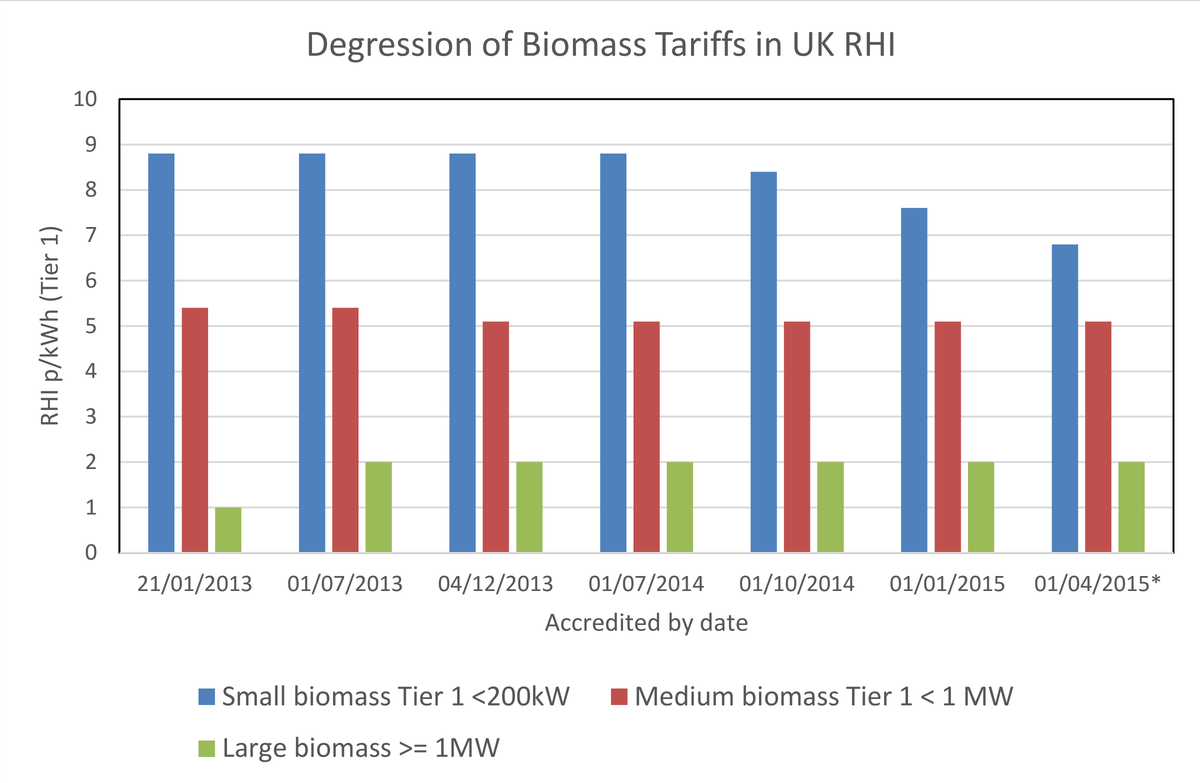

Figure 19: Degressions (Tier 1) of biomass RHI tariffs in UK

Table 23: Ofgem RHI tariffs in place as of February 2015

Tariffs as of February 2015	Eligible sizes	Annual payment (p/kWh)	Euro Equivalent[29] (c/kWh)
Small commercial biomass	< 200 kWth		
	Tier 1	6.8	9.3
	Tier 2	1.8	2.5
Medium commercial biomass	>= 200 kWth & < 1MWth		
	Tier 1	5.1	7.0
	Tier 2	2.2	3.0
Large commercial biomass	> 1MWth	2	2.7

France – Heat Fund

The heat fund was introduced in 2009, and is managed by ADEME[40] (Energy and Environment Agency). During the period 2009-2013, the heat fund spent € 1.12 billion to support approximately 3,000 installations and a total production of 1.4 million toe (tonnes oil equivalent). The fund supports solar, geothermal, waste heat, district heat, biogas and biomass heating applications.

It is not strictly a unit-based scheme, although the banding and quantum of payments are based around unit output. The scheme does provide useful benchmarks for heat payments in another Eurozone country.

[40] www.ademe.fr

A summary of the biomass part of the scheme is given here for info.

- Applies only to community heating, or applications in services, industrial or agricultural sectors
- Must have demand >= 100 toe, which is equivalent to 1,163 MWh/annum
- Units can be clustered to meet the 100 toe/annum minimum
- Minimum rated thermal efficiency 85%
- Various conditions around origin of material and certification
- Dust and NOx limits in place, where regional rules do not exist

Banding and Payments

In practice the payments are rolled up and paid out over the first 3 years of a project, but the concept and banding in France is informative. The minimum thresholds, usage categories and calculated annual equivalents are shown below (Table 24).

Table 24: Heat Fund Payment Bands for Biomass (Jan 2015)

Annual production (MWh/yr)	€/MWh (20 years) for community /services heating	€/MWh (20 years) for industrial heating	€/MWh (20 years) for industrial heating using own by-products
1,163 to 2,907	7.5	4.7	2.8
2,908 to 5,815	5.4		
5,819 to 11,630*	2.6	2.6	1.5
> 11,630*	1.3	Call for tenders	

**These higher bands are subject to not breaching value for money thresholds under cumulative bands*

The 20 years of payments are rolled up and paid out in 3 upfront instalments. These are paid at:

- Contract signing with ADEME (bond may be required)
- Commissioning of system
- Balance upon furnishing 12 months of metered heat data
- The aid can be completely reversed if less than 50% of proposed heat supply is met
- There are value for money caps in place for each category (for example maximum to an 800 toe/year (9,304 MWh/yr) industrial boiler is €730,000

An analysis of the bands using a range of run hours has been prepared and converted to the below kW banding for information (Table 25).

Table 25: Relationship between run hours and kW banding

MWh/yr	1,163	2,908	5,819	11,630
Run hrs/yr	*kW bands*			
1,500	775	1,939	*	*
3,000	388	969	1,940	3,877
4,500	258	646	1,293	2,584
6,000	*	485	970	1,938

** removed as highly unlikely combination of run hours and application*

Analysis of above (Table 24) leads to the following conclusions:

- The smallest likely boiler size in the scheme is 258 kW, though in practice service sector boilers will have lower than 4,500 run hours, and tend towards a larger size.
- The largest likely boiler size in the scheme is 3,877 kW. In practice an industrial boiler will tend towards a smaller size with higher run hours.

Appendix 3: Thermal Energy Balance

An analysis was carried out of the SEAI Energy Balance data and is presented below. This helps to analyse the overall RES-H market potential by fuel and by sector. The data is an extract from the SEAI 2013 Energy Statistics[41] for fuel type, with the following changes:

- Removal of all transport final consumption
- Removal of electricity as final consumption (including the part used for heating and the RES-H fraction thereof)
- Ignores non-renewable fraction of waste

Table 26: Interpretation of Thermal Only Data for 2013 TFC (ktoe)

kilo tonnes of oil equivalent (ktoe)	Oil	Coal	Peat	Natural Gas	RES-H	Totals
Total Final Energy Consumption (TFC)	1,972	355	218	1,633	255	4,433
Industry	546	82	-	620	153	1,401
Non-Energy Mining	34	-		10	-	44
Food, beverages and tobacco	137	21		90	28	276
Textiles and textile products	3	-		1	-	4
Wood and wood products	3	-		2	100	105
Pulp, paper, publishing and printing	3	-		3	-	6
Chemicals & man-made fibres	29	-		56	-	85
Rubber and plastic products	10	-		4	-	14
Other non-metallic mineral products	141	61		15	25	242
Basic metals and fab. metal prods	96	-		321	-	417
Machinery and equipment n.e.c.	6	-		5	-	11
Electrical and optical equipment	42	-		106	-	148
Transport equipment manufacture	5	-		2	-	7
Other manufacturing	39	-		6	-	45
Residential	918	273	218	606	64	2,079
Commercial/Public Services	307			407	38	752
Commercial Services	198			178	34	410
Public Services	109			229	4	342
Agricultural	177					177
Fisheries	24					24

[41] http://www.seai.ie/energy-data-portal/

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