Department for
Business, Energy
& Industrial Strategy

Evaluation of the reformed Renewable Heat Incentive (RHI)

Biomethane synthesis report

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Any enquiries regarding this publication should be sent to us at:
enquiries@beis.gov.uk

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Report summary

This report brings together findings from the Renewable Heat Incentive (RHI) evaluation relating to biomethane installations, with detailed evidence for applications made after December 2016.

Evidence sources include RHI administrative data, RHI applicant surveys and interviews, market analysis and cost-effectiveness analysis.

The evidence confirms that the RHI plays a significant role in the biomethane market, making up a substantial part of applicant's operational income. Recent reforms that provide financial certainty in advance of plant commissioning also support applicant access to investment. The way in which the RHI, and the reforms, have influenced applicants varies widely depending on the applicant type (e.g. developers vs farmers).

In comparison to other RHI technologies, biomethane offers strong value for money for both renewable heat generation and carbon abatement.

Glossary

Term	Definition
Theory-based evaluation	An approach to evaluation which involves systematically testing and refining the assumed connections (i.e. the theory) between an intervention and the anticipated impacts.
Realist evaluation	A type of theory-based evaluation which involves exploring 'what works, for whom and in what circumstances' (or 'contexts').
Additionality	The extent to which observed outcomes are attributable to the intervention and would not have occurred in its absence.
Anaerobic digestion (AD)	The breakdown of organic material by micro-organisms in the absence of oxygen. This the basic process behind biogas production, with additional processes applied to determine the end-use of the biogas, one of which is biomethane grid injection.
Biogas	An output from AD, which is typically used to fuel a Combined Heat & Power (CHP) engine, generating heat and electricity. It is also possible to create biogas through gasification or pyrolysis.
Biomethane	Biogas which is refined and subsequently injected into the natural gas grid.

Term	Definition
Feedstocks	In this context - the organic material which is used to produce biogas in AD plants. This includes crops, farm waste, food wastes, manufacturing waste and sewage waste.
Flow rate	Represents the estimated biomethane production capacity of an installation (measured in cubic metres per year)
Tariff degressions	The means of controlling the budget for the non-domestic RHI. The tariffs which can be paid to new applicants are lowered as more renewable heating systems are installed.
Tariff guarantees	Allows applicants to the Non-Domestic RHI for some technologies and capacities to secure a tariff rate before their installation is commissioned and fully accredited on the RHI.
2-stage commissioning	Prior to tariff guarantees, some applicants were able to inject some biomethane to the grid prior to the plant being fully commissioned in order to secure their tariff rate. This practice was no longer permitted after June 2018.
Virtual pipeline	A process in which biomethane is transported by vehicles away from the production facility to a specialist grid injection facility.
Renewable Transport Fuel Obligation (RTFO)	Under the RTFO Order, some transport fuel suppliers have an obligation to provide a volume of sustainable renewable fuel as a proportion of the overall volume of fuel they supply. Suppliers of sustainable biofuels, such as biomethane generators, can get certificates (RTFCs) issued which they can either use to meet their own obligation or sell on the market.
Feed-in-Tariffs (FiTs) scheme	A Government programme which requires electricity suppliers to make payments to smaller-scale generators of renewable and low carbon electricity. It closed to new applicants on 1 April 2019.
Renewables Obligation (RO)	A financial support mechanism for large-scale renewable electricity generation. It places an obligation on UK electricity suppliers to source an increasing proportion of the electricity they supply from renewable sources. RO Certificates (ROCs) are issued to operators of accredited renewable generating stations and can be traded with other parties. It closed to new generating capacity on 31 March 2017.

Context and introduction

This section provides an overview of:

- *The evaluation of the reformed RHI*
- *The core elements of a biomethane installation*
- *The reforms to the RHI biomethane tariffs*
- *The evaluation questions explored in this report*
- *The workstreams contributing to this report*

Renewable Heat Incentive aims to encourage deployment of renewable heating systems

The Renewable Heat Incentive (RHI) is a scheme to subsidise renewable heat installations amongst householders and businesses.

The subsidy is intended to help make up the cost differential between renewable and conventional heating systems, to incentivise deployment of renewable technologies.

Overall scheme objectives:

- Carbon abatement: contribute to carbon budgets
- Renewable heat generation: contribute to EU Renewable Energy Directive (RED) 2020 renewable energy targets
- Supply chain development: contribute to development of a market to support mass roll-out of renewable heating

Non-domestic scheme opened in 2011 with support for technologies including heat pumps, biomass, solar thermal, biogas and injection of biomethane into the grid.

The scheme has undergone a series of amendments since its launch to ensure the scheme effectively delivers against the objectives in a cost-effective manner.

A package of reforms announced in Dec 16 aimed to ensure that the RHI scheme as a whole:

- Focuses on long-term decarbonization
- Offers better value for money and protects consumers
- Supports supply chain growth and challenges the markets to deliver

For biogas and biomethane, the reforms aimed to:

- Vastly improve the carbon cost-effectiveness of further support through the implementation of the new feedstock requirements (a requirement that 50% of biogas generated to come from waste feedstocks)
- Support continued deployment through uplifts to the tariff
- Improve certainty for investors in larger projects like biomethane through the provision of tariff guarantees[1]

Evaluation overview

The evaluation will provide:

a) an assessment of the impact of the scheme
b) strategic learning to inform heat policy development.

The evaluation is structured around theory-based evaluation methods which will develop, test and refine realist theories about the reformed RHI as the scheme proceeds.

The evaluation is delivered by a consortium of CAG Consultants, Winning Moves, Hatch and EREDA/UCL Consultants.

Workstreams:

- Applicant data monitoring (Winning Moves)
- Qualitative research (CAG Consultants)
- Quasi-experimental impact assessment (EREDA/UCL)
- Sustainable markets assessment (Hatch)
- Cost-effectiveness assessment (Hatch)
- Competition & trade assessment (Hatch)
- Analysis & synthesis (CAG Consultants)

In 2018/19 one focus of the evaluation was on the impact of the reformed RHI on biomethane

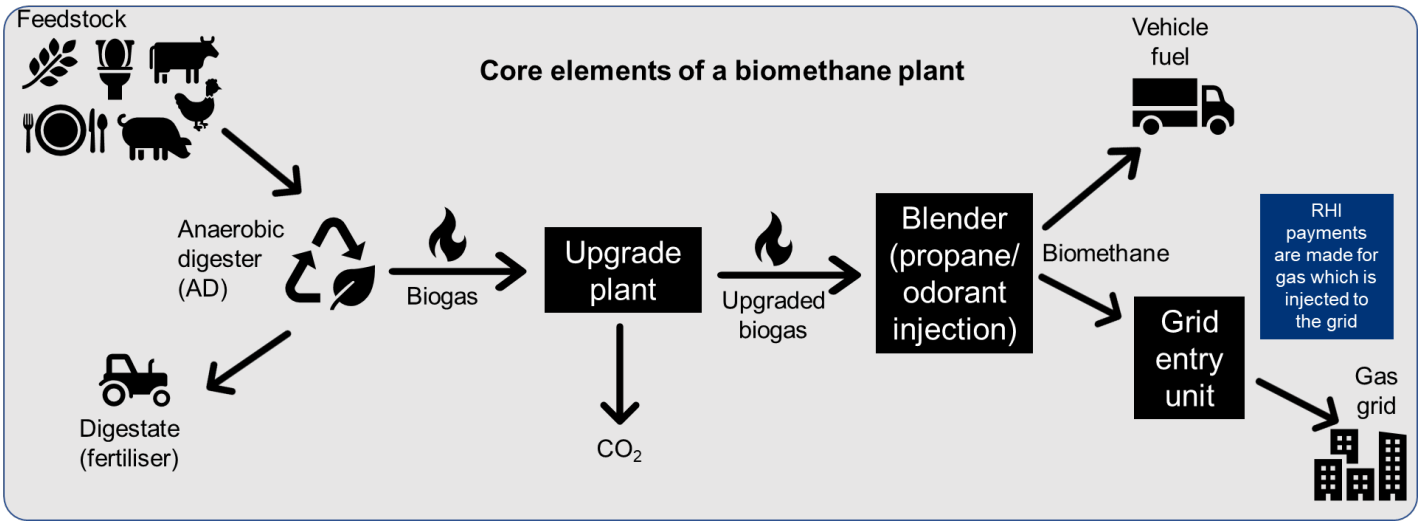
A flow chart is provided to illustrate the biomethane process, the steps of that process are as follows:

- Feedstock enters the anaerobic digester
- Outputs from the anaerobic digester include digestate and biogas
- The biogas enters an upgrade plant which outputs Carbon Dioxide and upgraded biogas
- The upgraded biogas enters a blender for propane and odorant injection) at which point the gas becomes biomethane

[1] The Renewable Heat Incentive: A reformed scheme. Government response to consultation https://www.gov.uk/government/consultations/the-renewable-heat-incentive-a-reformed-and-refocused-scheme, BEIS, 2016

- Biomethane is output from the blender to either use as vehicle fuel, or through a grid entry unit to the gas grid.

Figure 1: Flow chart showing biomethane plant processes



RHI reform implementation and tariff changes extended over several years

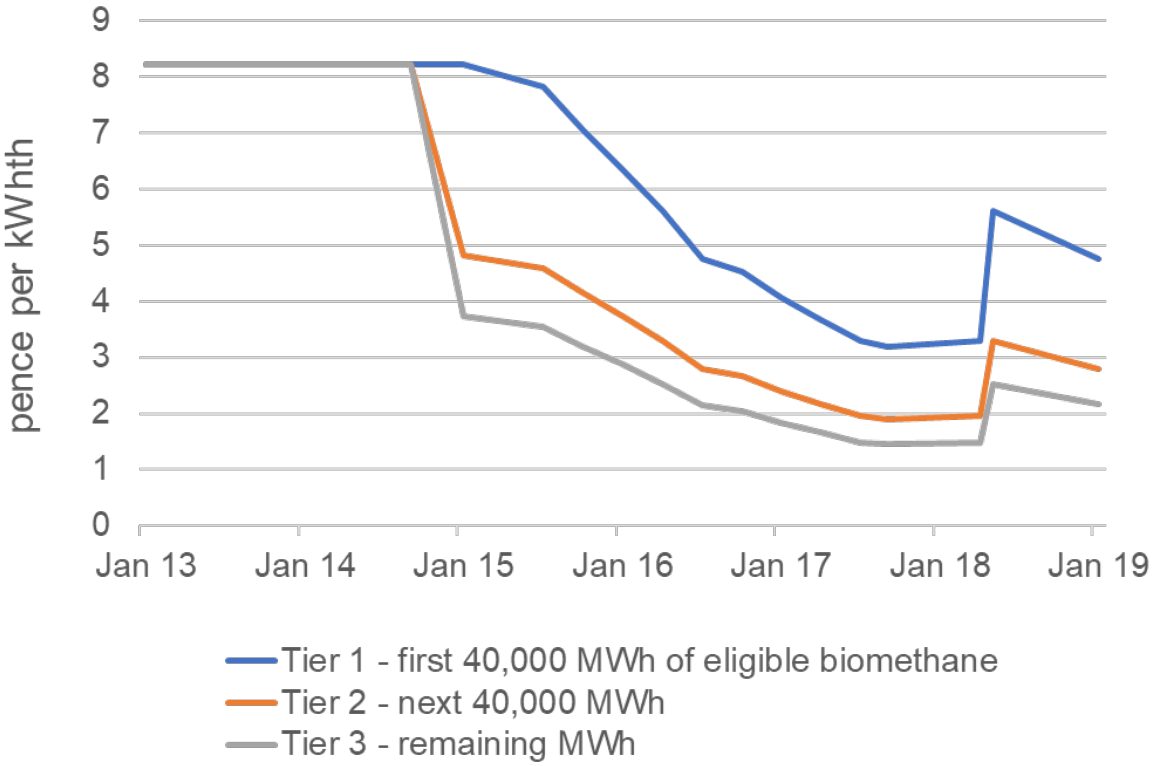
Timeline of key biomethane policy changes:

- Feb 15 – 3-tiered tariff introduced
- Oct 15 – feedstock sustainability requirements
- Dec 16 – package of reforms announced, including:
    - At least 50% production to be from waste feedstocks
    - Uplifted tariffs (available straight away for applications meeting new feedstock requirements)
    - Tariff guarantees
- May 18 – above reforms implemented in full
- May 19 – extended allocation of tariff guarantees, with new applicant commissioning deadline extended to 31/01/21

Full details of scheme changes available from Ofgem[2]

[2] Changes to the Non-Domestic RHI https://www.ofgem.gov.uk/environmental-programmes/non-domestic-rhi/about-non-domestic-rhi/changes-non-domestic-rhi, Ofgem, 2019

Figure 1: Timeline of Biomethane tariff rates



Evaluation questions which are being applied to biomethane

The evaluation of the reformed RHI seeks to answer the evaluation questions set out below. For the purpose of this report, these questions are applied to biomethane installations.

- How far have the reformed RHI outcomes been achieved, for whom and in what contexts, and how has the reformed RHI contributed to these outcomes?
- How has design and implementation of the reformed RHI influenced these outcomes, in what respects and for whom?
- To what extent is the reformed RHI offering value for money to taxpayers and to different beneficiaries?
- To what extent has the reformed RHI impacted competition and trade between EU member states, and has this been different across technologies and contexts? (Not covered in this report, see appendix for explanation)
- How has the reformed RHI contributed to the development of sustainable markets for renewable heat, and how does this differ across market segments or technologies?
- What lessons can be drawn from the evaluation of the RHI regarding future renewable heat policy?

Workstreams contributing to this report

Workstream name	Dates covered by data	Naming convention in this report
RHI administrative data	Using applicant data up to March 2019	Referred to as 'RHI admin' in this report
Qualitative research	With applicants from December 2016 to November 2018	Referred to as 'qual' in this report
Detailed applicant surveys	With applicants from January 2015 to February 2019	Referred to as 'quant SMA' in this report
Sustainable Markets Assessment	Most recent data from May 2019	Referred to as 'SMA' in this report
Cost-Effectiveness Assessment	Most recent data from March 2019	Referred to as 'CEA' in this report
Competition and Trade Assessment	Most recent data from February 2019	Referred to as 'CTA' in this report

- An overview of the methodology employed in each workstream is provided in Appendix A
- Note that there is limited scope for analysis and reporting of statistics from the quant workstream due to the relatively small number of biomethane applications and, therefore, responses. To make use of the evidence the quant and qual data have been combined as far as possible to increase sample size for the analysis but caution still needs to be applied in relation to 'quant' findings.
- Pre- and post-reform comparisons in the CEA have not yet been possible due to the limited number of commissioned post-reform biomethane projects

Questions

Q: How far have the reformed RHI outcomes been achieved, for whom and in what contexts, and how has the reformed RHI contributed to these outcomes?

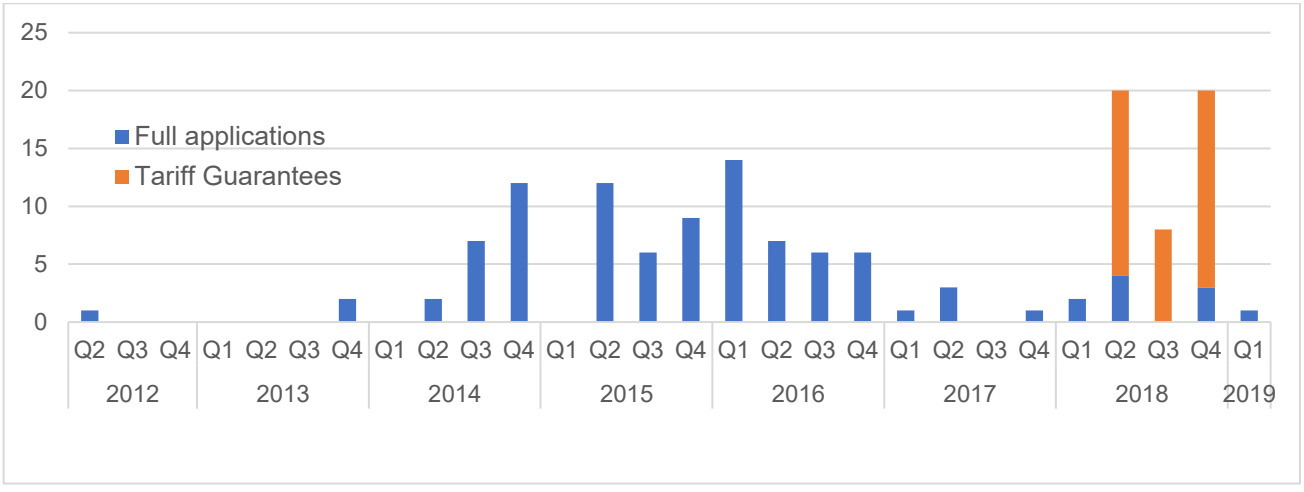
This section explores:

- How has the biomethane market developed since the December 2016 reforms announcement?
- What has been the overall significance of the RHI in that development?
- For whom and in what contexts has the reformed RHI been significant?
- To what extent have the achieved carbon savings been additional?

The reforms generated a short-term surge in applications in 2018

- There were a few applications after the reform announcements in Dec 16. There was then a surge of applications from May to Dec 18, once tariff guarantees became available, resulting in a tariff degression in January 2019.
- Qualitative evidence suggests that the low number of applications in Q1 2019 was due to the combined effect of the tariff degression and the approaching tariff guarantee deadline. The July 19 extension to the tariff guarantee deadline may yet stimulate further applications, despite the Jan 19 tariff degression.

Figure 2: Full and tariff guarantee biomethane applications by date of first submission (number of applications per quarter)

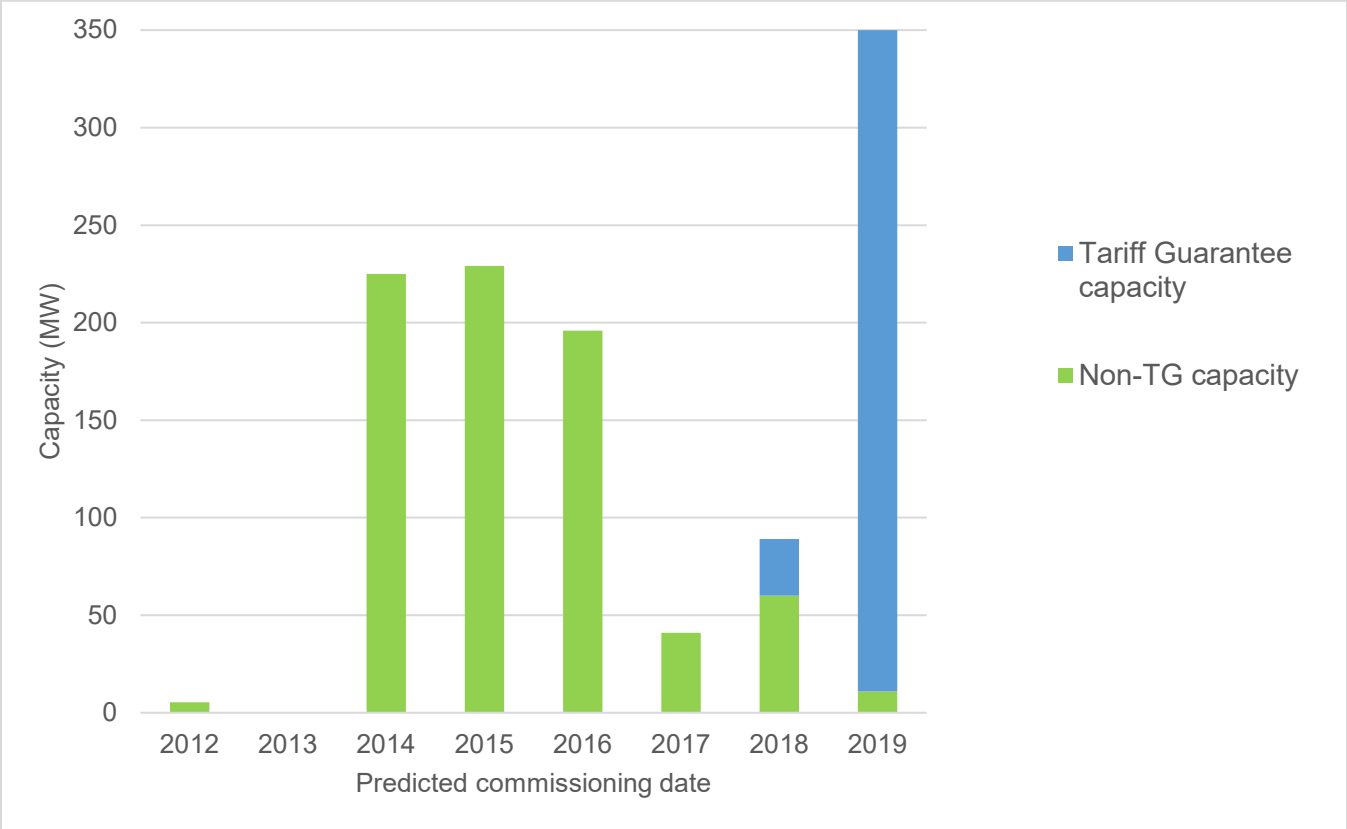


Source: RHI admin data. March 2019, excluding rejected, terminated, cancelled and withdrawn applications

Average annual deployment is above projected deployment but there have been significant fluctuations from year to year

- The capacity associated with the 140 live, pending or tariff guarantee biomethane applications to the RHI is higher than the anticipated annual deployment of 96-120 MW projected in the 2016 and 2018 Impact Assessments1,9 . Predicted deployment in 2019 is particularly high and is associated with a large number of tariff guarantee applications. The fluctuations since 2016 align with the uncertainty while reforms were implemented.
- Many of the 2019 applications have not yet been commissioned so uncertainties remain as to whether this capacity will be commissioned. At October 2018, only 62 biomethane plants had received RHI payments (compared to 140 applications shown in this chart).

Figure 3: New biomethane capacity accredited to the RHI scheme, by predicted commissioning date (MW)



Source: RHI admin data, March 2019 (1 MW capacity = 6,700,000 kWh expected annual gas generation, in line with RHI Impact Assessments).

* excludes rejected, terminated, cancelled and withdrawn applications.

Post-reform applications are larger on average

- Reasons for the increase in applicant plant size are uncertain but qual data indicates that tariff guarantees helped to de-risk external investment which may have enabled larger schemes to progress.

Average annual expected production of biomethane applicants by pre- or post-reform application date

Applicant timing	Average of annual expected production (m3 biomethane)
Pre-reform (78 applications)	5,794,574
Post-reform (62 applications)	6,583,429
Scheme Total	6,143,924

Source: RHI admin data, March 2019

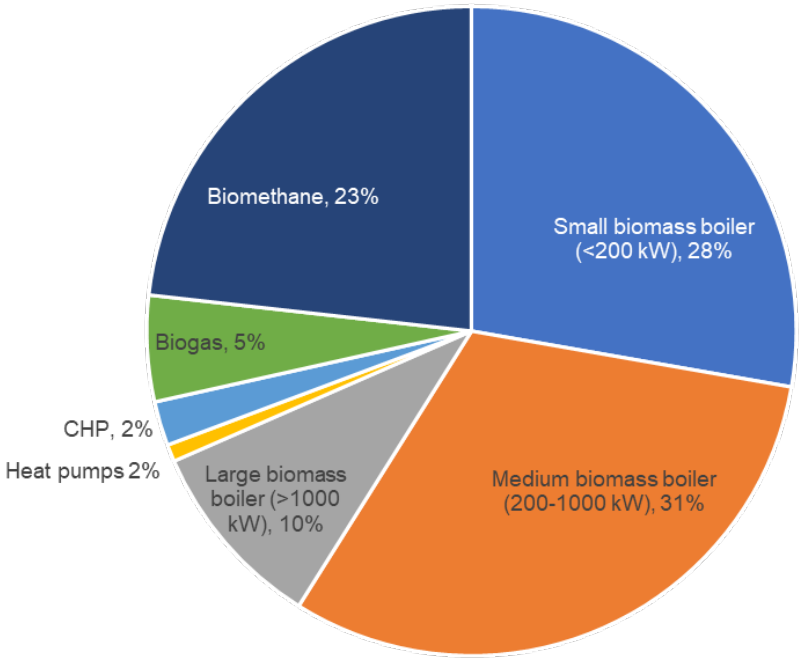
* Reform date set as consultation response of 14 December 2016 where reforms were confirmed

* Includes tariff guarantees and pending applications, excludes rejected, terminated, cancelled and withdrawn applications

Biomethane has become a very significant contributor to the renewable heat supported by RHI

- Up to end March 2019 biomethane injected into the grid under the RHI equals 7,405 GWth of heat equivalent5
- This represents 23% of the total heat generated and paid for under the non-domestic RHI5
- Only small biomass boilers (28%) and medium biomass boilers (31%) exceed biomethane in total heat generated. In contrast, large biomass boilers represent only 10% of heat generated up to end March 2019 and biogas represents only 5% of heat generated to date5.
- This contribution is expected to increase significantly as more of the post-reform applications are commissioned.

Heat generated and paid for under the non-domestic RHI scheme, by amount paid, 31 March 2019



Source: RHI admin data, March 2019

The RHI has underpinned biomethane outcomes

- Across the scheme 91% of biomethane installations are reported to be additional to what would have been installed in the absence of the RHI (CEA).
- In all observed cases in the qualitative research, the RHI was critical to the business case for development and typically reported by interview participants as comprising 70-80% of revenues (qual).
- Application numbers show a stall in the market was driven by the previous tariff degressions and anticipation of the reforms, leading to consolidation across the supply chain (SMA).
- Applications show an increase in the size of installations after the reforms were implemented, suggesting significant biomethane capacity has been unlocked.
- All applicants have to overcome a complex set of barriers including:
    - Cost-effective access to feedstock which meets the feedstock requirements
    - Cost-effective opportunity for grid injection at a site where planning permission can be gained (qual)

The reforms to the RHI were critical in most business cases

- Reforms were critical in most contexts for all those applying before and after tariff guarantees were available (qual). All survey respondents indicated awareness of reforms and some impact on timing or nature of application (quant).

- Uplifted tariff (available post Dec-2016) delivered the necessary return on investment in all but one set of observed contexts (qual)
- De-risking of investment offered by tariff guarantees important in some contexts, however, some were able to proceed :
    - with 2-stage commissioning (prior to this practice being made ineligible in June 2018); or
    - without any early securing of the tariff (qual).

Summary of post-reform additionality evidence (qual and quant)

Out of 15 post-reform biomethane applications who self-reported their additionality status:

- the majority stated that they would not have gone ahead at all in the absence of tariff guarantees
- only a very small minority would have gone ahead in the absence of tariff guarantees

Carbon savings and cost of carbon savings

- Biomethane plants accredited to the RHI up to the end of March 2019 represented expected lifetime carbon savings of 46.1 MtCO2e, of which 29.9 MtCO2e are upstream savings (RHI Admin).
- Up to the end of March 2019, RHI biomethane plants have generated 7,405 GWh of heat equivalent. No post-reform plants had generated any biomethane by this date, so pre- and post-reform comparisons are not possible.
- Biomethane contributed 50% of all non-domestic RHI carbon savings in the pre-reform period but represented only 32% of subsidy payments (CEA).

Figure 4: Biomethane carbon savings under the RHI scheme to end March 2019

Carbon abatement type	Total (MtCO2e)
Carbon abatement (Downstream only)	1.17m
Carbon abatement (Downstream and Upstream)	4.05m

Source: RHI admin data and RHI Impact Assessment Assumptions

Feedstock sources play a significant role in carbon savings

- The reforms implemented in 2018 sought to improve the carbon abatement resulting from biomethane, and biogas, through the introduction of a minimum requirement that 50% of gas generated should come from waste feedstocks.

- A higher % waste feedstocks and lower % of energy crops in the feedstock mix will have increased carbon abatement and reduced the cost per kgCO2e emissions (particularly from upstream savings)[3].
- There is currently limited evidence on feedstocks used by RHI applicants to support an assessment of the impact of the new feedstock requirements as no post-reform plants were operational at time of writing. Further evidence is being sought to support the final impact assessment under this evaluation. The figures presented on the previous slide rely on feedstock assumptions as set out in the 2016 RHI impact assessment.

The additionality of carbon benefits from biomethane plants is uncertain

Would applicants have pursued biogas CHP in the absence of a reformed biomethane tariff?

- Combined quant & qual data sets show that, without access to the RHI, a significant minority would have installed a different renewable heat technology, generally biogas CHP. Therefore the same feedstocks would have been used for renewable energy generation in the absence of the RHI.
- Qual data suggests that those with secure feedstock supply would have been more likely to pursue an alternative.
- The balance of biogas v biomethane applications has shifted significantly towards biomethane post-reform. The closure of FiTs (1 April 2019) and RO schemes (31 March 2017), also typically support the business case for biomethane over biogas CHP.

Summary of additionality evidence (qual and quant)

Of the 33 biomethane applicants who self-reported their additionality, responses were split broadly equally on whether they would have installed a different renewable heating system (generally biogas CHP), or would not have installed another system.

Only four applicants reported that they would have installed the same technology in the absence of the RHI.

Note: This evidence has been combined from the qualitative interviews and survey evidence. It provides insight into whether the applications were additional to what would have happened in the absence of the RHI but it is not robust enough to be representative of all biomethane applicants.

The additionality of carbon benefits from biomethane plants is uncertain

To what extent has biomethane utilised existing biogas production?

- Some biomethane installations are added to existing biogas AD facilities (qual & application data). In these cases the additionality of renewable gas production is uncertain. In the absence of the RHI the same anaerobic digestion process may still have gone ahead, with the same feedstocks, but with a different end-use.

[3] Impact Assessment No. 143 The Renewable Heat Incentive Scheme and Domestic Renewable Heat Incentive Scheme (Amendment) Regulations 2019 http://www.legislation.gov.uk/uksi/2019/1052/impacts, BEIS, 2019

- Applies to a small minority of applications (RHI admin) but not possible to robustly quantify this practice any further based on application data, for example due to restrictions regarding linking data to FiTs and ROCs schemes.

What carbon benefits have been generated by changes to feedstock rules?

- A higher % of waste feedstocks and lower % of energy crops in the feedstock mix mean that applications after May 2018 will achieve higher carbon abatement and reduced cost per kgCO2e emissions (particularly from upstream savings) (CEA).
- But there is uncertainty regarding the extent to which waste feedstocks, particularly food waste, have been diverted from other renewables. The evaluation will continue to seek evidence in advance of the final impact evaluation due in 2021.

Q: How has design and implementation of the reformed RHI influenced these outcomes, in what respects and for whom?

The qualitative workstream was the principal data source for question 2

- A realist evaluation approach was applied to understand not only whether the RHI contributed to biomethane outcomes but 'how, for whom and in what circumstances' it did so[4]. The realist structure is illustrated on this page.
- The qualitative workstream enabled the development and testing of theories of how the policy worked in different circumstances.
- Data from the other workstreams enabled further testing of these theories and some quantification of elements of those theories.

The realist evidence structure

Context

The circumstances which affect whether a policy 'works' and for whom. Consideration of 'context' forms an important part of realist approaches to evaluation.

Mechanism

A change in people's reasoning, brought about through the resources provided by a policy, which leads to a policy outcome. Identification of causal 'mechanisms', which operate in particular 'contexts', forms an important part of realist approaches to evaluation, e.g. tariff guarantees de-risking investment, or tariff uplifts improving profitability.

Outcome

A change in the state of the world, brought about as a result of a policy of other influences. Realist approaches to evaluation attempt to identify the 'contexts' and 'mechanisms' that lead to a particular 'outcome', e.g. went ahead with a biomethane plant after reforms that would not have gone ahead before.

The influence of the RHI and the scheme reforms varied significantly across different contexts

The realist structure is used to assess how aspects of the RHI, and reforms, had a differing effect on applicants depending on the contexts surrounding each applicant type.

Seven applicant types were identified in the qual research, Appendix B details those applicant types and the influence of the RHI reforms on them using the structure described on slide 25.

These applicant types are not exhaustive of all possible biomethane applicants to the RHI scheme. However, they do capture the applicants who took part in the research.

Applicant types identified (qual):

- Developers with external finance and insecure feedstock supply

[4] See reference 10.

- Design-Build-Operate developers
- Developers with internal finance and secure feedstock supply
- Developers with external finance and a secure feedstock supply
- Environmentally-driven farmers
- Water companies with existing biogas supply
- Manufacturers with wider business drivers

Key contexts identified	Role
Access to waste-based feedstocks	Evidence indicates that the feedstock restrictions led to some projects reliant on crop-based feedstocks being unable to proceed (qual), however, evidence is limited as potential applicants are difficult to identify and may have progressed no further than initial investigations.
Cost & source of development finance	Those reliant on higher cost external finance needed tariff guarantees and the uplifted tariffs to proceed whilst those with access to low-cost or internal finance had less need of the uplifted tariff and of early tariff confirmation (either through 2-stage commissioning or tariff guarantees) (qual)
Cost & security of supply of development feedstocks	Those purchasing feedstocks needed the uplifted tariffs but where applicants were able to charge gate fees, this reduced the need. Those with less secure feedstock supplies were more likely to need the de-risking of investment provided by tariff guarantees (qual)
Presence of wider business imperatives for biomethane production	The uplifted tariffs and tariff guarantees attracted more developers to the market whose primary interest was financial. Where applicants had wider business imperatives for biomethane production (e.g. a waste which needed to be dealt with or a wider interest in the biomethane market), this lessened the need for the uplifted tariffs and the need for early tariff confirmation (qual)

The role of these and other contexts is illustrated in the various types of applicants identified in the research. These are provided in detail in appendix B

The reforms have particularly benefited those with less secure feedstock supplies and more costly finance

- Speculative developers were most reliant on tariff guarantees and uplifted tariffs so have benefited most from the reforms (qual)

- Generally, reforms have most benefited those without a secure and low-cost feedstock supply and/or without access to low-cost finance (qual and quant)
- Notwithstanding the need for caution because of small sample sizes, there is some indication of this in terms of size of applicant organisations (assuming those with a secure feedstock supply and/or access to internal finance would typically be larger organisations such as manufacturers and water companies)… [5]
- …and in terms of funding sources.
- Sources of finance varied between biomethane applicants, both before and after the reforms.
- Prior to the reforms the most common source of finance reported by those interviewed (quant and qual data) was internal finance, this aligns with findings that pre-reform applicants were more likely to be larger organisations.[6]
- Following the reforms, the introduction of Tariff Guarantees was cited by applicants as being instrumental in allowing them to access external finance (qual). This aligns with post-reform applicants most commonly stating that their installation was funded using external private equity finance.

Feedstock restrictions may have enhanced sustainability but undermined viability in some cases

- Use of waste-based feedstocks increased following the reform announcements. This may, to some extent, have accelerated an ongoing trend, as reductions in tariff levels led applicants away from the more expensive crop-based feedstocks (qual)
- Increases in demand for waste-based feedstocks may have contributed to decline in gate fees for food waste (resulting in reduced income for AD operators) (qual), which were particularly notable in areas with substantial AD capacity (London/SE in particular)[7]
- Decreasing gate fee charges may hinder the viability of plants[8]. As noted above, some planned plants were unable to secure a cost-effective feedstock supply which met the restrictions (qual)
- This downward pressure on gate fees may be balanced by increased collection of food waste but this will take time and be dependent on waste policies (SMA)

[5] Within the survey, 26 applicants, provided information on their organisation size.
Pre-reform, the majority of applicants responding to the survey were organisations that had 10-49 employees
Post-reform, the majority of applicant organisations had under 10 employees.

[6] Among the 24 pre-reform applicants who were interviewed in the qual and quant, internal finance was the most common source of funding.
Of the 20 post-reforms applicants who were interviewed in the qual and quant, a minority reported that they used internal finance. External private equity was the most common funding source.

[7] See reference 4.
[8] See references 3 and 4.

Delays to the implementation of the reforms may reduce the number of projects completed and affect the quality of those which are completed

Reform	Effect
Full implementation of reforms announced in December 16 but delayed until May 2018	Stall in the biomethane market. Sector stakeholders reported limited market development across the equipment supply chain as a response to RHI policy delays (SMA).
Deadline for commissioning tariff guarantee projects set at January 2020	Coupled with reported lengthy approval processes, a significant number of projects were uncertain due to concerns (including among investors) about feasibility of meeting the commissioning deadline (qual). Concerns also expressed about operational effectiveness as a result of construction time pressures and other factors, with reports of 'distressed assets' being sold on by developers (qual).
June 2019 – extended allocation of tariff guarantees with a January 2021 deadline for commissioning	Applicants able to reapply to the scheme in order to access a longer time-frame for commissioning. Too early to assess the extent to which this has benefited the market.

Q: To what extent is the reformed RHI offering value-for-money to taxpayers and to different beneficiaries?

This section explores:

- the subsidy cost per kWh of renewable heat generated and how this compares with other technologies
- the subsidy cost per kWh per Tonne of CO2 abated and how this compares with other technologies
- whether there is any evidence of over- or under-compensation

Approach to value-for-money assessment

Definition of value for money

- This evaluation presents value for money as the direct subsidy cost of renewable heat generation and carbon abatement.
- It is not possible at this point in time to carry out full a social cost-effectiveness assessment. This would rely on evidence across the 20-year lifetime of the installations, which is not currently available.

Sensitivity analysis using evaluation evidence

- Central to the value for money of the RHI is understanding what action would have taken place in the absence of the RHI, aka additionality. A specific installation may not have been installed at all, a different technology may have been chosen or timing or sizing may have differed.
- Applicant surveys provide evidence of self-reported additionality – whether applicants report that the same installation would have taken place in the absence of the RHI. Sample sizes for biomethane are too small to provide robust evidence. However, this evidence is used for sensitivity analysis around the estimates provided in this report.
- The importance of feedstock usage is also central to carbon abatement from biomethane. This report relies on feedstock assumptions set out in RHI impact assessments; however, the sensitivity analysis around additionality also incorporates evaluation evidence regarding feedstock usage.

Subsidy costs for renewable heat generation from biomethane are competitive with the rest of the RHI scheme

	Subsidy cost per MWH of renewable heat generated to date (£//MWh)	
	Biomethane	All non-dom RHI
All accredited applicants – assuming 100% additionality	£75	£60

Source: CEA: Sample includes 67% of biomethane and 87% of all non-dom applications between scheme start and March 2019. Sample excludes tariff guarantees and any applications which have not generated any heat, or remain in the 12-month biomethane ramp up period.

- The subsidy cost per MWh of renewable energy is competitive when compared to the full non-domestic RHI scheme.
- The value of biomethane is strengthened when self-reported additionality is introduced to the sensitivity analysis, with biomethane subsidy costs (£82/MWh) falling below subsidy costs for all non-domestic RHI deployment (£91/MWh). As reported earlier, the RHI is central to biomethane business cases and 91% would not have gone ahead without the RHI, this can be compared to an average of 74% across the whole non-domestic scheme.
- At present biomethane figures are only available for the pre-reform period, as there is insufficient biomethane project data for the post-reform period to allow comparative analysis at present.

Subsidy costs for carbon abatement from biomethane are among the lowest within the RHI scheme

	Subsidy cost per tonne of CO2 emissions abated to date (£/TCO2e – all savings)	
	Biomethane	All non-dom RHI
All accredited applicants – assuming 100% additionality	£140	£167

Source: CEA: Sample includes 67% of biomethane and 87% of all non-dom applications between scheme start and March 2019. Sample excludes tariff guarantees and any applications which have not generated any heat, or remain in the 12-month biomethane ramp up period.

Carbon savings include upstream carbon savings (see note below).

- Subsidy costs per tonne of CO2 emissions abated are lower for biomethane than the non-domestic scheme as a whole. Only biogas and large biomass installations offer better value for money, but deliver substantially less carbon abatement overall.
- The inclusion of self-reported additionality in the sensitivity analysis further strengthens the value of biomethane (up to £150/TCo2e) when compared to the wider non-domestic scheme (up to £214/TCO2e) where additionality is lower.
- Since the start of the RHI, biomethane installations have contributed 50% of all carbon savings in the pre-reform period but represented only 32% of subsidy payments (RHI admin).
- Upstream carbon savings play a significant role on total biomethane carbon savings. There is uncertainty around the alternative uses of these feedstocks, particularly whether food waste feedstocks would otherwise go to landfill, therefore the figures here should be treated as an upper bound for the savings (resulting in a lower bound for cost effectiveness figures above)[9]. The evaluation will continue to collect evidence to inform this assumption.

Degressions and rising feedstock costs have mitigated the potential for over-compensation

BEIS assumptions 2016[10]:

- Capital = 30% lifetime costs
- Annual maintenance = 70%
- Feedstock costs = net zero

What we know (qual):

- Overall lifetime costs may be higher than assumed, due to split between capital & operational costs closer to 50/50.
- However, the assumption of net zero cost feedstocks is not evidenced in the research, with a net cost often incurred by many applicants.

Initial BEIS assumptions at the time of reform suggest a risk of over-compensation; however, this is mitigated by tariff degressions, which have reduced tariffs to 57% of original levels[11], and introduction of tiering for larger installations.

Risks of over-compensation are lowest for installations with higher feedstock costs and where the cost of finance is higher – to date the reforms have led to more applicants of this type (qual).

Biomethane constitutes 32% of spend on the non-domestic scheme, so any degree of over-compensation could have a significant impact on over-spending by the scheme.

[9] See reference 8.
[10] See reference 1.
[11] See reference 6.

Q: How has the reformed RHI contributed to the development of sustainable markets for renewable heat, and how does this differ across market segments or technologies?

Robust evaluation evidence was not available to address this question.

Insights from market intelligence have been collated and are presented in appendix C.

Q: What lessons can be drawn from the evaluation of the RHI regarding future renewable heat policy?

This section explores:

- What is the extent of biomethane potential in the absence of RHI?
- What is the extent of biomethane potential with a reduced RHI subsidy?
- What other policy or regulatory options exist?

Non RHI-supported biomethane potential is currently very limited

- The combined quant and qual dataset indicates that only a small percentage of applications would have proceeded in the absence of the RHI
- The removal of the biomethane tariff would dramatically reduce investment in biomethane in the UK if all other factors remained the same (qual)
- Key contexts in which there may still be non RHI-supported potential:
    - Where the potential developer has strong wider and longer-term interests in the UK biomethane market
    - Where the potential developer generates a waste suitable as a feedstock, e.g. from an industrial process or waste water treatment, and the current use or disposal of that feedstock is no longer viable (qual)

The feasibility of reducing tariffs will depend on wider market and policy changes…

- Lower biomethane tariffs are more feasible when the alternatives are less attractive. The expiration of ROCs and FiTs schemes has made the use of biogas for RHI-supported biomethane a more attractive option than electricity generation (qual)
- Any increases in gate fees may further enhance viability in a lower tariff regime, although such increases are only likely in the longer term and current trends are downward (SMA). Consideration could be given to addressing this time lag through higher tariffs for biomethane generated from more expensive food waste feedstocks.
- Increases in value of RTFCs and Green Gas Certificates could also enhance viability in a lower tariff regime, with plants operating to maximize income from various government support schemes

…but reducing tariffs could be aided by the way in which RHI is implemented

- Other features of support which may enhance opportunities in a lower tariff regime:
    - Increase certainty for investors, for example through continuation of tariff guarantees and/or less frequent tariff degressions (qual)
    - Support external financing, for example by aligning payment lifetimes with commercial funders looking for shorter-term returns on investment (e.g. reducing the 20-year tariff length, with proportionate increase in tariff levels) (qual) although this may reduce the longevity of plants
    - Enable development of the supply chain and investment in technologies, for example through stability of tariffs, eligibility and scheme rule (SMA and qual)

Reducing market reliance on the RHI would require wider policy and regulatory change

- The level of incentives for biogas-produced renewable electricity are critical, particularly in cases where potential applicants generate a waste which is suitable as a feedstock and have the choice between CHP and biomethane (quant and qual). Strategic decisions are needed about how UK biogas is best utilised.
- Enhancing the opportunities for and reducing costs associated with grid injection could play an important role, e.g. ‘virtual pipeline’ approaches or relaxing the requirements for propinisation (propane costs are reportedly significant). Could regulation or incentivisation of the Gas Network Operators be used to drive further efforts? (qual)
- Increases in food waste collection could enhance the gate fees available, highlighting the importance of government policy on waste (SMA and qual)
- Increased prices for RTFCs and the introduction of a floor price would enhance their role in investment decisions (SMA and qual)
- What opportunities are there to increase the availability of lower-cost finance? (qual)

References

No.	Authors	Date	Title
1	BEIS	2016	Consultation Stage Impact Assessment: The Renewable Heat Incentive: A reformed and refocused scheme
2	Renewable Energy Association	2018	REVIEW (Renewable Energy View)
3	ADBA (Anaerobic Digestion & Bioresources Association)	2018	ADBA Market Report
4	WRAP	2018	Gate Fees 2017/18 Final Report
5	BEIS	2019	Non-domestic RHI monthly deployment data: March 2019
6	Ofgem	2019	Non-domestic RHI tariff table (Q2 – 2019/20)
7	BEIS	2016	The Renewable Heat Incentive: A reformed scheme. Government response to consultation
8	BEIS	2019	Impact Assessment No. 143 The Renewable Heat Incentive Scheme and Domestic Renewable Heat Incentive Scheme (Amendment) Regulations 2019
9	BEIS	2018	Final Stage Impact Assessment: The Renewable Heat Incentive: A reformed and refocused scheme
10	R Pawson, R, and Tilley, N.	1997	Realistic Evaluation. London: SAGE Publications Ltd
11	BEIS	2019	Unpublished: RHI payment records
12	Ofgem	2019	Changes to the Non-Domestic RHI

Appendix A: Overview of workstreams

This appendix provides an overview of the purpose of and methodology employed in:

- The RHI administrative data
- The qualitative workstream
- The detailed applicant monitoring
- Combining the qualitative and quantitative data
- The sustainable markets assessment
- The cost-effectiveness assessment
- Competition and trade assessment
- The evidence synthesis process

Full technical annexes for each workstream are published alongside this report.

RHI Administrative data

Note: Data from this workstream is referred to as 'RHI Admin' in this report

Evidence use

This report uses the RHI administrative data in three ways:

- Re-presentation of published scheme statistics – for example application statistics on slide 15
- Presentation of unpublished data – for example the average annual expected production of biomethane applicants on slide 17
- Further analysis using scheme data as an input – for example the cost-effectiveness analysis on slides 35 and 36 which combines scheme data with survey data and evidence from scheme impact assessments

Evidence sources

Ofgem, the scheme administrator, collect data to support the delivery of the scheme, including:

Applicant and installation details, such a technology type and estimated energy generation. Statistics are published monthly at https://www.gov.uk/government/collections/renewable-heat-incentive-statistics

Unpublished applicant information including detailed installation information, details of payments made to applicants and records of actual energy generation.

Qualitative research

Note: Data from this workstream is referred to as ‘qual’ in this report

The qualitative research explored:

- What role did the RHI play in the business case for biomethane installations and how did this interact with the other factors in the marketplace?
- What role did the different elements of the RHI and scheme reforms play in the business case for biomethane plants?
- What would have happened without the RHI and without the reforms? How would this have altered the business case?

The methods used were:

- Scoping interviews with key stakeholders identified by BEIS to refine the interview topic guides
- 18 in-depth applicant interviews (covering 38% of post reform applications up to Feb 2018)
- 3 further in-depth interviews with other stakeholders involved in those applications
- 6 in-depth interviews with representatives from various aspects of the supply chain

Detailed applicant surveys

Note: Data from this workstream is referred to as ‘quant’ in this report

Online surveys are issued every 6 months to all applicants accredited to the RHI scheme in the preceding 6 months. Telephone boosts are conducted to address areas of low response.

Questions in the survey include:

- Influence of the RHI on decision to install, technology choice and timing
- Awareness of RHI reforms and influence on decision making
- Feedstock sources, costs and self-supply status
- Source of finance and payback period, installation costs and ongoing costs
- Methane losses and digestate storage
- Satisfaction with the installation, the RHI process and intention to apply for other installations in future
- Perceived additionality

All statistics are weighted to the population of applications to the RHI scheme, allowing for statistical reporting in relation to the RHI population.

There are three differences for biomethane applicants:

- Additional questions are included in the surveys which captures extra detail re feedstocks, costs, tariff guarantees.
- All pre-reform applicants were surveyed using a telephone method allowing for testing and refining of the questions prior to using the online method. Changes made to aid ease of completion but content remained unchanged.
- The overall method only issues surveys to accredited applicants, therefore tariff guarantee applicants are not surveyed until their installation is commissioned which can be up to a year after their first application. For biomethane this means that most of the post reforms applicants have not been surveyed, however, there is uncertainty as to if these installations will actually be built.

Table below shows the survey response rates for the biomethane survey (note: RHI reform date set as biomethane reforms coming into force in May 2028)

Survey response rates by reform status	Accredited applicants	Survey participants	Partial responses (included in total)
Pre-reform	72	16	0
Post reform	30	8	5
Total	102	24	5

Combining the qualitative and quantitative data

Note: Data from this workstream is referred to as ‘qual and quant’ in this report

To support the strength of conclusions that could be drawn from the analysis a decision was taken to seek to construct a mixed-methods dataset on some key topics based on data from the detailed applicant monitoring and qualitative research. The only data to which this process was applied was where the qualitative data provided direct responses from participants, free from the need for interpretation and where near-identical questions were asked.

The steps taken to combine the data were as follows:

- Unweighted survey responses for those who participated in the survey were extracted from the survey data – this covered 23 responses
- Partial responses from the survey were included within the 23 responses mentioned in the above bullet – the 23 responses therefore comprise 18 complete and 5 incomplete responses

- The coded data from the qualitative research were reviewed to identify where direct responses had been given to some of the key questions covered in the detailed applicant monitoring, e.g. on feedstock usage, source of finance etc.
- This process added 15 additional responses to some of the survey questions, once duplicates (i.e. five applicants took part in the qualitative interviews and quantitative applicant monitoring survey) had been removed.
- All of the responses collated through the steps above were used to construct data tables for those survey questions where the qualitative data could effectively be converted into the format used in the detailed applicant monitoring survey – see following section.

It is not appropriate to refer to the findings in a quantitative way by using them as estimates for the entire population as they are drawn from two different sources, are unweighted and because the qualitative sampling was purposive rather than random. Referring to the results quantitatively would imply a more robust sampling and data collection approach than is justified. The biomethane synthesis report presents these findings in a qualitative sense, relating to the sample of participants only. This approach acknowledges that these are true statements from applicants, without assuming they are representative of the population.

A full methodology is provided in the Annex C.

Sustainable Markets Assessment

Methodology

The Sustainable Markets Assessment conducts analysis regarding the extent to which the RHI is meeting its objective of contributing to the development of a sustainable market for renewable heat.

Across all RHI technologies a combination of quantitative and qualitative data sources are used to assess progress against demand, supply and cost for each renewable heat technology.

Quantitative evidence relating to biomethane is limited, however the analysis draws on the market reports and stakeholder consultations detailed on this page.

Due to lack of quantitative data for the biomethane market this report relies on the stakeholder consultations. This loss of robustness means this data has been referred to as Market Intelligence and detail is presented in the report appendix.

Evidence sources

Market reports consulted are shown in the table below

Organisation	Report provided
Renewable Energy Association	REview (2018)
Sector bodies and manufacturers	Consultation insights (undertaken Winter 2018/19)
Renewable Energy Finance Forum	Finance Forum member reflections (Winter 2018/19)
BEIS	Pellet Market Evidence and Industry Conversations (2018)
Anaerobic Digestion & Bioresources Association	Market and Policy Report (2018)
WRAP	Gate Fees Survey (2018)

Stakeholder groups consulted include: Anaerobic Digestion and Bioresources Association (ADBA), Eco-Fuels, Genius Energy Lab, Ground Source Heat Pump Association (GSHPA), Heat Pump Association (HPA), Home Insulation & Energy Systems Contractors Scheme (HIES), NNFCC, Re:heat, Renewable Energy Association (REA), Renewable Energy Association Finance Forum (REAFF), Renewable Energy Consumer Code (RECC), South East Wood Fuels (SEWF), Wood Heat Association (WHA)

The cost-effectiveness assessment

Note: This workstream is referred to as ‘CEA’ in this report

An assessment of progress against a range of factors that will affect overall cost-effectiveness, including:

- average annual subsidy cost per kW of installed capacity
- subsidy cost per kWh of renewable heat generated to date
- subsidy cost per tonne of CO2 emissions abated to date
- value of air quality damage costs saved to date per £ subsidy invested
- value for money from applicant returns on investment
- contribution to market development

An assessment of the cost-effectiveness of the reformed RHI compared to the pre-reform RHI.

A detailed methodology is included in the cost-effectiveness annex published alongside this report.

Analysis of the RHI administrative data was carried out for a sub-sample of biomethane applicants. Of the 91 accredited biomethane applicants in March 2019, 25 were removed due to being in their 'ramp up period'* and a further 6 were removed during data cleaning due to missing data or outlier values.

Additional information was included from the following workstreams:

- CTA workstream
- SMA workstream

The outputs reported in this document draw on calculations made using assumptions set out in existing RHI impact assessments (e.g. feedstock usage). The detailed dashboard published alongside this report includes a sensitivity analysis which replaces these assumptions with evidence from the evaluation surveys. The sample sizes are currently too small to be robust on their own, but do offer insight into potential sensitivity around the cost-effectiveness.

* 'Ramp up periods' are defined as the first 12 months of operation, where the plant is not operating a full capacity, making it inappropriate for cost-effectiveness calculations.

The competition & trade assessment

Note: This workstream is referred to as 'CTA' in this report

Findings from this workstream are not included in this report. Reasons for this are detailed for each method below.

To assess the impact of the RHI on competition between EU member states, the evaluation undertook two workstreams.

Workstream 1. Quantitative analysis to assess the risk that non-domestic applicants had been overcompensated by the RHI, to the extent that they would gain competitive advantage over other EU member states. This is delivered through assessing whether the assumptions used to set the RHI tariffs still hold true among applicant (for example if installation costs are lower than assumed there is a risk that applicants will be over-compensated)

Findings: This analysis was not possible for biomethane due to limited data from applicant surveys or lack of in-situ performance data.

Workstream 2: Competition and Markets Impact Assessment to assess the impact of the RHI on trade between EU member states.

Findings: An initial assessment in line with the UK's Competition and Markets Authority's (CMA) guidance on competition assessment has concluded that the RHI policy would be unlikely affect the markets for biomethane technologies or the other technologies eligible for the RHI. The key factors determining this conclusion were that biomethane, and other technologies, have a largely international supply chain for the core technologies. Limiting the RHI to UK installations would not prevent market actors from other EU member states from benefitting from the market growth. In the case of biomethane, the feedstocks (including

energy crops and wastes) have very localised supply chains and it is not economically feasible to transport them over long distances (i.e. they have low value and high transport costs)

The evidence synthesis process

As described on slide 13 the evidence presented in this report draws on multiple different sources. The process below describes how the evidence was synthesised.

Step 1. Evidence mapping. Relevant data from across the different workstreams was mapped against the evaluation questions, this highlighted where evidence provided insight into each question. At this stage gaps in the evidence were identified. The desk-based mapping was reviewed by workstream leads and a workshop was held to discuss the evidence, this ensured evidence was not missed and themes and commonalities could be identified.

Step 2. Additional analysis. The evidence mapping was used to identify additional analytical opportunities for generating a deeper understanding of the evaluation questions, as well as where additional analysis could fill evidence gaps. This involved additional analysis of the applicant survey data and qualitative data, resulting in the two sources being combined as described in slide 54 to maximise robustness of conclusions.

Step 3. Assessment of evidence. The evaluation evidence was assessed to establish the extent to which it supported conclusions against the evaluation questions.

Step 4. Refinement of theory. In line with the realist approach to the evaluation, the evidence was then fed into an overall theory mapping grid. This process ensures that evidence relating to biomethane contributes to the testing of the evaluation questions, and realist theory, at the higher level of the RHI scheme as a whole.

Appendix B: Biomethane applicant types

Context-Mechanism-Outcome (CMO) evidence structure

The slides in Annex B present the biomethane applicant types that were identified from the qualitative interviews with 18 applicants and 9 wider stakeholders. The realist evaluation approach results in findings which use a Context-Mechanism-Outcome (CMO) format, illustrated on this slide.

In addition to the contexts set out in each CMO, there were a general set of contexts which would normally need to be in place for any biomethane investment. These are set out on the next slide.

The table outlines the realist evidence structure

Realist evidence component	Meaning
Context	The circumstances which affect whether a policy 'works' and for whom. Consideration of 'context' forms an important part of realist approaches to evaluation. e.g. feedstock access and costs, source of finance, presence of wider business drivers
Mechanism	A change in people's reasoning, brought about through the resources provided by a policy, which leads to a policy outcome. Identification of causal 'mechanisms', which operate in particular 'contexts', forms an important part of realist approaches to evaluation. e.g. tariff guarantees de-risking investment, or tariff uplifts improving profitability
Outcome	A change in the state of the world, brought about as a result of a policy or other influences. Realist approaches to evaluation attempt to identify the 'contexts' and 'mechanisms' that lead to a particular 'outcome'. e.g. went ahead with a biomethane plant after reforms that would not have gone ahead before

General contexts for biomethane developments

The following set of contexts was observed in all applicant types, suggesting that they are core required contexts for any biomethane installation to be viable.

General contexts for biomethane

- Access to financially viable injection point (a function of distance, pipeline pressure, capacity, approval speed)
- Access to land (typically leased in the case of developer applications & owned in the case of others)
- Planning permission and relevant environmental permits secured
- Cost-effective access to appropriate technology
- Access to appropriate electrical supply (from grid and/or associated CHP)
- Access to cost-effective internal or external finance
- Cost-effective access to feedstock supply which meets post-reform requirements
- Cost-effective outlet for digestate (income from digestate sales is rare and never a significant income stream)
- For applications after 22 May 2018, a business case which was not reliant on digestate drying (note that this does not mean that no digestate drying is incorporated in plants)

Applicant Type 1: Developers with external finance and insecure feedstock supply

Realist evidence component	Evidence for Developers with external finance and insecure feedstock supply
Context	External high-cost finance – (not always yet secured) Reliance on re-financing or plant once operational Insecure feedstock supply & cost (some food waste can attract gate fees but not relied on in longer term)
Mechanism	The ROI brought by the uplifted tariffs and the reduced investment risk offered by the TGs made us sufficiently confident about securing external investment in the scheme for us to invest in seeking tariff guarantees for the scheme
Outcome	Viable business case for this proposed biomethane installation, that would not have been viable pre-reform

Summary:

- Developers seeking short-term profit from investment in biomethane
- Relatively insecure and sometimes costly feedstock supply (fully or partly food waste)

- External equity-based or high-cost debt finance
- Reliant on the uplifted tariffs and the reduced investment risk offered by tariff guarantees to achieve a fundable business case

Applicant Type 2: Design-Build-Operate developers

Realist evidence component	Evidence for Design-Build-Operate developers
Context	Internal finance Design-Build-Operate model EITHER access to existing, separately owned biogas supply with robust business case OR access to secure local feedstock (linked to manufacturing plant) Significant previous biomethane experience Long term, strategic interest in biomethane
Mechanism	The ROI brought by the uplifted tariffs available after December 2016 made our business case viable and our investment risk was sufficiently low for us to proceed without TGs or two-stage commissioning
Outcome	Viable business case for the proposed biomethane installation, that would not have been viable pre-reform

Summary:

- Developers linked to or part of companies with wider long-term business drivers for biomethane development
- Utilising either the proven biogas supply from existing AD plants or access to a secure local feedstock supply
- Needed the uplifted tariffs to achieve a viable business case.
- Access to internal finance and the wider business imperatives meant they had no need for the de-risking provided by two-stage commissioning or tariff guarantees.

Applicant Type 3: Developers with internal finance and secure feedstock supply

Realist evidence component	Evidence for Developers with internal finance and secure feedstock supply
Context	Internal finance at least for first stage of commissioning Secure feedstock supply (farm-based or linked to manufacturing plant) Previous biomethane experience
Mechanism	The ROI brought by the uplifted tariffs available after December 2016 made our business case sufficiently viable for us to proceed with a two-stage commissioning approach to manage our investment risk
Outcome	Viable business case for this proposed biomethane installation, that would not have been viable pre-reform

Summary:

- Developers with access to a secure feedstock supply
- Reliant on the uplifted tariffs to achieve a viable business case
- Needed to de-risk their investment through securing their tariff as early as possible
- Availability of internal finance meant they were able to do so using two-stage commissioning rather than tariff guarantees

Applicant Type 4: Developers with external finance and a secure feedstock supply

Realist evidence component	Evidence for Developers with external finance and a secure feedstock supply
Context	External equity finance – (not always yet secured) Previous biogas/biomethane experience Reliance on re-financing of plant once operational Secure feedstock supply (farm-based or linked to a manufacturing plant)

Realist evidence component	Evidence for Developers with external finance and a secure feedstock supply
Mechanism	The ROI brought by the uplifted tariffs available after December 2016 made our business case sufficiently viable for us to invest in seeking tariff guarantees for the scheme
Outcome	Viable business case for this proposed biomethane installation, that would not have been viable pre-reform

Summary:

- Developers with a secure feedstock supply
- Reliant on the uplifted tariffs to achieve a viable business case
- Using tariff guarantees to facilitate access to external finance although the security of feedstock supply meant that some such plants may have been able to proceed without these guarantees.

Applicant Type 5: Environmentally-driven farmers

Realist evidence component	Evidence for Environmentally-driven farmers
Context	Access to low-cost debt finance Wider business drivers (diversification, sustainability goals, good fit with local agricultural systems) Secure, on-site feedstock supply Project development at relatively late stage
Mechanism	The ROI brought by the uplifted tariffs available after 2016 made our business case sufficiently viable for us to invest in seeking tariff guarantees for the scheme, although we may have been able to proceed without these additional benefits
Outcome	Viable business case for this proposed biomethane installation, that may/would not have been viable pre-reform

Summary:

- Farmer applicants with a relatively secure feedstock supply

- Access to low-cost debt finance
- Wider environmental and business drivers for biomethane/AD
- Utilising the uplifted tariffs and reduced investment risk offered by tariff guarantee but the data is unclear as to whether the uplifted tariff and tariff guarantees were necessary to achieve a viable business case.

Applicant Type 6: Water companies with existing biogas supply

Realist evidence component	Evidence for Water companies with existing biogas supply – Option 1
Context	Internal finance with high IRR required Previous biomethane experience brought confidence in technology but concern about degressions Access to existing biogas supply supported by ROCs Wider business drivers (reduced disposal costs, sustainability goals) Secure supply of sewage sludge feedstock Internal or adviser team experience of 2-stage commissioning Concern about post-May 18 spike in applications
Mechanism	The ROI brought by the uplifted tariffs available after December 2018 made our business case sufficiently viable for us to proceed with a two-stage commissioning approach to manage our investment risk
Outcome	Viable business case for this proposed biomethane installation, that would not have been viable pre-reform

Realist evidence component	Evidence for Water companies with existing biogas supply – Option 2
Context	Internal finance with high IRR required Previous biomethane experience brought confidence in technology but concern about degressions Access to existing biogas supply supported by ROCs Wider business drivers (reduced disposal costs, sustainability goals)

Realist evidence component	Evidence for Water companies with existing biogas supply – Option 2
	Secure supply of sewage sludge feedstock Challenging gas connection Heightened investment risk
Mechanism	The ROI brought by the uplifted tariffs available after December 2016 made our business case sufficiently viable for us to invest in seeking tariff guarantees to the scheme
Outcome	Viable business case for this proposed biomethane installation, that would not have been viable pre-reform

Summary:

- Water companies with a secure feedstock supply and existing biogas generation
- Relying on the uplifted tariffs and utilising either tariff guarantees or two-stage commissioning to reduce investment risk and achieve a fundable business case which satisfies stringent internal funding requirements

Applicant Type 7: Manufacturers with wider business drivers

Realist evidence component	Evidence for Manufacturers with wider business drivers
Context	Internal finance Wider business imperatives (reduce waste disposal costs; replace out-dated equipment) On-site, secure feedstock supply
Mechanism	The RHI made our business plan viable and the uplifted tariffs and tariff guarantees helped us secure the internal finance needed, but we would have proceeded even in the absence of the reforms
Outcome	Viable business case for this proposed biomethane installation, if supported by either the pre-reform or post-reform RHI

Summary:

- Manufacturing companies with a secure feedstock supply
- Reliant on RHI and benefited from the reforms but had a viable business case irrespective of the reforms due to wider business imperatives and access to internal finance.

Appendix C – Sustainable Market Assessment

This appendix provides insights from the market intelligence collected as part of the sustainable markets assessment, up to February 2019.

This appendix provides an overview of how the biomethane market has developed and the role of the RHI in this, covering:

- Demand factors
- Supply factors
- Cost factors

There remains a strong market reliance on the RHI

Positive demand factors	Demand factor challenges
A recovery in the market was experienced post-reform (RHI admin), with latent projects coming forward2	The commissioning deadline for tariff guarantee projects may have resulted in some applications being abandoned (qual), although the extended allocation is expected to have mitigated this
The impact of the tariff guarantee commissioning deadline is expected to be mitigated by the recently announced extended allocation (qual)	Stakeholders, including investors, applicants and developers, are concerned about 'boom-bust' market dynamics caused by tariff guarantee deadlines, tariff degressions and the post-RHI policy landscape (qual, 2)
Sector stakeholders highlighted optimism around potential for growing demand in the food manufacturing industry and further sector development opportunities relating to the plants combining RHI tariffs with Renewable Transport Fuel Obligation (SMA)	

Longer-term market confidence is needed to build domestic supply chains

Positive supply factors	Supply factor challenges
Recognition within the sector of potential for investment in technology & supply chains as a result of increasing revenues3	Limited market development in equipment supply chains as a result of RHI delays3
Solid base of installers/distributors within the UK (SMA)	Manufacturing base remains largely internationalized with little evidence of on-shoring (SMA) – risks associated with currency fluctuations and the UK exiting the EU (qual)
	Post-reform surge in applications and commissioning deadlines have led to a skilled installer capacity issue (SMA)

Innovation is driving some cost-efficiencies but opportunities are seen to be relatively limited

Positive cost factors	Cost factor challenges
Access to finance improving as commercial opportunity is better understood (SMA)	Recent reductions mean that current gate fee levels may hinder the viability of plants3, 4
Innovation reported to be driving some cost-efficiencies (SMA)	Potential for capital cost reductions somewhat constrained by nature of construction, with limited scope for innovation and largely determined by cost of raw materials such as concrete and steel (qual)
Innovation and R&D (largely international) is focused on improving biomethane scrubbing, product & process efficiency and processing more complex wastes (SMA). All potentially contribute to a more cost-efficient process.	Overall costs negatively impacted by installer capacity constraints, grid connection complexities & exchange rate fluctuations (SMA)

This publication is available from: www.gov.uk/government/publications/rhi-evaluation-evidence-report-biomethane-installations

If you need a version of this document in a more accessible format, please email enquiries@beis.gov.uk. Please tell us what format you need. It will help us if you say what assistive technology you use.