National Audit Office

Report
by the Comptroller
and Auditor General

Department for Business, Energy & Industrial Strategy

Low-carbon heating of homes and businesses and the Renewable Heat Incentive

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National Audit Office

Department for Business, Energy & Industrial Strategy

Low-carbon heating of homes and businesses and the Renewable Heat Incentive

Report by the Comptroller and Auditor General

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Sir Amyas Morse KCB
Comptroller and Auditor General
National Audit Office

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This report examines the objectives of the Renewable Heat Incentive (RHI) and progress against them, its cost-effectiveness, monitoring and evaluation. We also look at whether the Department is learning lessons for the future and its approach to managing fraud, non-compliance and gaming.

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Contents

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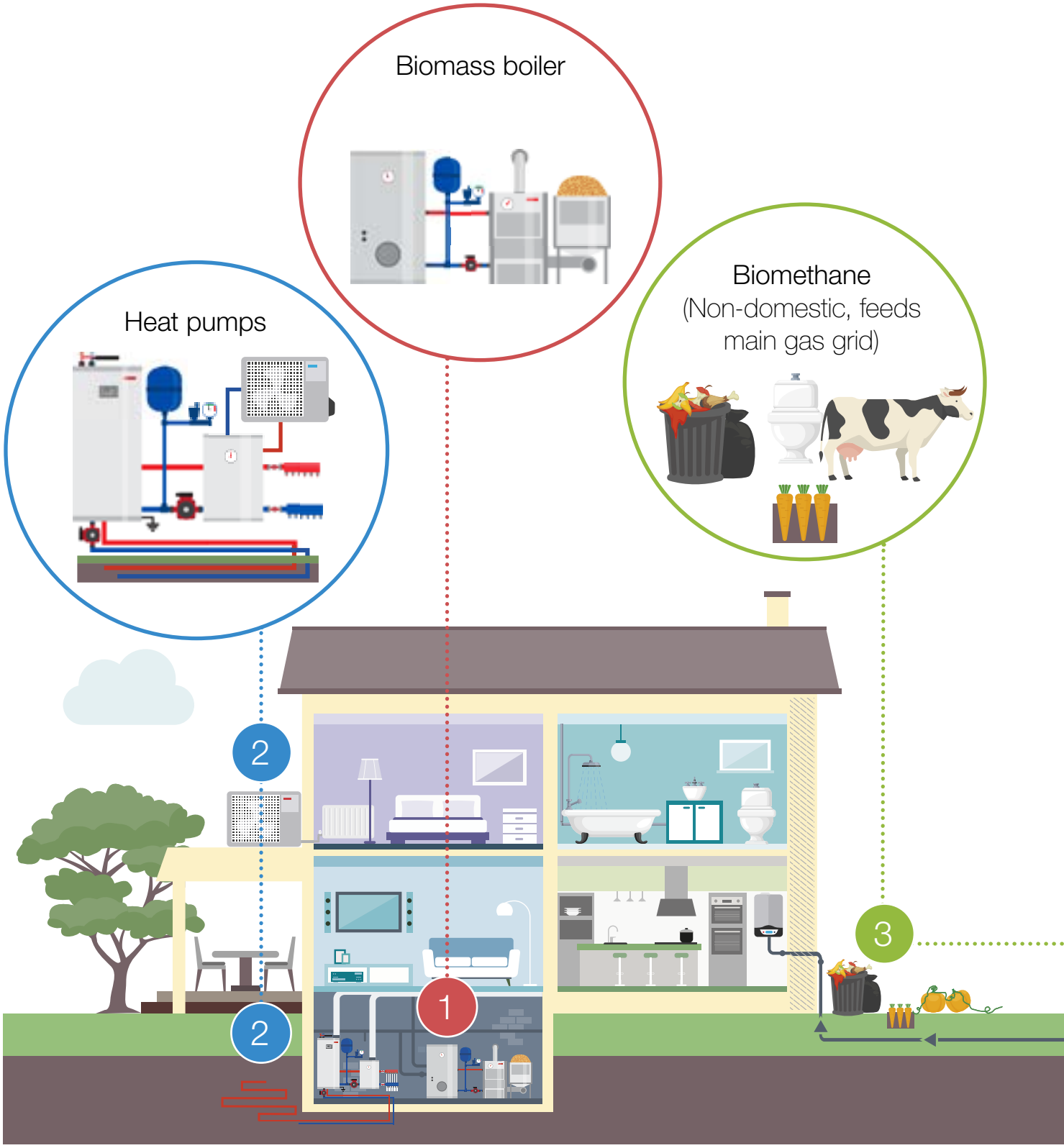
What is renewable heating?

Popular renewable heating technologies eligible for the Renewable Heat Incentive



1 Biomass

Biomass boilers are wood-fuelled heating systems that burn wood pellets, wood chips or logs to produce heat. This heat can then be used to heat radiators and underfloor heating systems and to provide hot water.

Source — **Wood** (logs/pellets/chips)

Use — Hot water; Central heating; Underfloor heating

2 Heat pumps

Heat pumps use electricity to absorb heat from either the air, ground or water. This heat can then be used to heat radiators and underfloor heating systems and to provide hot water.

Source — **Air**; **Ground**; **Water**

Use — Hot water; Central heating; Underfloor heating

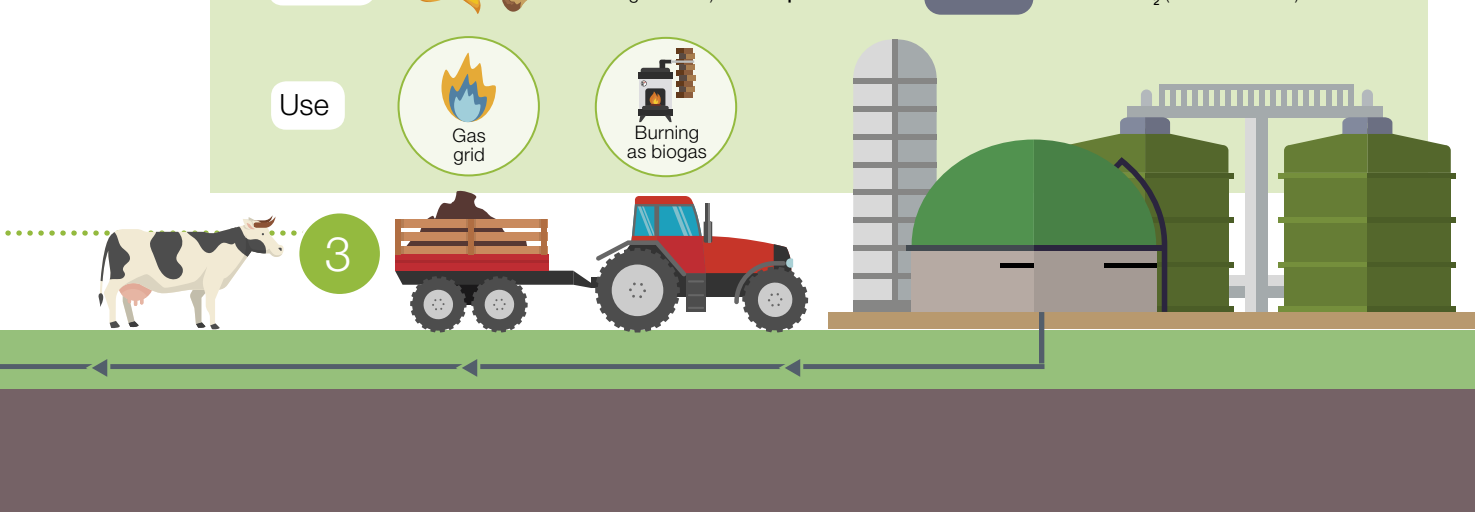
3 Anaerobic digestion

Anaerobic digestion is a biological process in which microorganisms break down biodegradable material in the absence of oxygen. Biogas is a product of this process. It consists of around 60% methane and 40% carbon dioxide. Biogas can be upgraded to biomethane by removing the carbon dioxide and other trace gases, and injected into the main gas grid.

Source — **Waste** (food, sewage and agricultural) **and crops**

60% CH_4 (Methane), **40% CO_2** (Carbon dioxide)

Use — Gas grid; Burning as biogas



Key facts

£23bn

estimated lifetime payments to participants on the Renewable Heat Incentive (RHI) scheme through to 2040-41 (in current year prices or cash terms)

£1.4bn

payments to date, as at August 2017

78,048

number of installations delivered by the RHI, as at December 2017

513,000	number of installations that the Department for Business, Energy & Industrial Strategy (the Department) originally planned that the RHI would deliver by 2020, in its 2012 business case
65% and 44%	reduction in planned renewable heat generated and carbon dioxide saved through the RHI scheme by 2020
4.5 million tonnes CO_2 equivalent	estimated carbon emissions saved in 2017-18, approximately 1% of total UK carbon emissions
4.4% and 2.5%	Ofgem's estimate in May 2017 of non-compliance (over-payment as a share of total payments) in the Non-domestic and Domestic RHI schemes during 2016-17
£3 million	estimated overpayments to RHI participants as a result of non-compliance with the regulations in 2016-17

Summary

1 The Renewable Heat Incentive (RHI) is a scheme to encourage a switch from fossil fuel heating systems to renewable and low-carbon alternatives in homes and business premises in Great Britain. It supports the government's approach towards meeting EU renewable energy obligations (by 2020) and UK statutory carbon reduction targets (out to 2050).

2 The RHI pays people and businesses money in the form of a tariff for each unit of heat produced from renewable sources. Technologies supported by the RHI include biomass boilers, heat pumps and anaerobic digestion plants, which produce biomethane injected into the gas grid. The scheme is funded directly by taxpayers, unlike subsidies for low-carbon electricity, which are funded through higher energy bills. Great Britain was the first country in the world to use this type of financial incentive to encourage the use of renewable and low-carbon heat.

3 The RHI is in two parts:

- Non-domestic RHI: launched in November 2011 for industry, businesses and public sector organisations, participants receive payments over 20 years; and
- Domestic RHI: launched in April 2014 for homeowners, self-builders, private and social landlords, participants receive payments over seven years.

4 The scheme's objectives are to:

- increase the amount of heat produced from renewable sources;
- reduce carbon emissions from heating homes and business premises; and
- help to grow supply chains which can support a national transition from fossil fuel to low-carbon heating technology from the 2020s.

5 Between November 2011 and August 2017, total payments under the RHI amounted to £1.4 billion. The scheme currently has a budget for new applicants until March 2021. Final payments to these applicants will run to at least 2040-41, by which time these payments are expected to have cost £23 billion.

6 The Department for Business, Energy & Industrial Strategy (the Department) is responsible for the design, performance and overall value for money of the RHI in Great Britain. Ofgem, a non-ministerial government department, is funded directly by the Department to administer the RHI on its behalf. Ofgem is responsible for approving applications, making payments to participants and ensuring that participants' heating systems comply with the scheme's requirements. Ofgem provides information on the RHI through its website. The Department mainly targets its marketing activity directly at trade associations who work in the heating supply chain through its Industry Advisory Group.

7 A similar scheme in Northern Ireland is now suspended to new applicants. The Department of Enterprise, Trade and Investment (DETI) was responsible for designing the devolved Northern Ireland RHI scheme, which is administered by Ofgem.

Our report

8 Our report assesses the value for money of the RHI for Great Britain only. The Northern Ireland RHI does not fall within the scope of this report.

- Part One sets the context, explains the rationale for the design of the RHI, the Department's approach to implementation, and take-up to date by homes and businesses.
- Part Two examines progress against the objectives of the RHI, the cost-effectiveness of the scheme, and how the Department and Ofgem monitor progress and learn lessons.
- Part Three assesses the Department and Ofgem's approach to controlling costs and managing the impact of fraud, non-compliance and gaming.

We outline our audit approach and evidence base in Appendices One and Two. We compare the Great Britain RHI to the Northern Ireland RHI and alternative policy approaches used by other countries in Appendices Three and Four respectively. We set out our more detailed analysis on cost-effectiveness in Appendix Five.

Key findings

Scheme take-up

9 Take-up of the scheme has been much lower than originally anticipated. The Department's original long-term strategy for reducing carbon emissions from the heating of the majority of homes and businesses was to replace oil and gas heating with heat pumps and biomass boilers. In its 2012 business case, the Department planned to deliver 513,000 new installations in Great Britain by 2020. It took a phased approach to launching the RHI, and showed appropriate flexibility in its decisions to delay the launch of the Domestic scheme by 18 months to prioritise its limited internal capacity on introducing cost control measures into the Non-domestic scheme. However, its initial assumptions about take-up were too optimistic and the Department could not deliver on its initial plans. As at December 2017, the RHI had delivered just 78,048 new installations in Great Britain. At current rates of take-up, we estimate the RHI will achieve around 111,000 new installations by March 2021, just 22% of its original expectations. (Paragraphs 1.14 to 1.17 and Figures 4, 5 and 6).

Progress against revised objectives

10 The Department has reduced its ambitions for the renewable energy produced by the RHI by 65% and carbon reductions by 44%. The Department has changed its strategy for reducing carbon emissions from heating. It now sees the role of the RHI to be more focused on a smaller number of homes and businesses which are not connected to the gas grid. In 2015, the Department agreed a Spending Review settlement with HM Treasury based on a refocused scheme. Taking this and other changes into account, the Department has lowered forecast lifetime spending from £47 billion to £23 billion (cash terms) and reduced ambitions for producing renewable energy and reducing carbon emissions. As of August 2017, it was on track to achieve these revised objectives. However, the Department has not fully replaced the reduced ambitions of the RHI for renewable heat with equivalent contributions from other sources. Through the implementation of its Clean Growth Strategy, it is exploring other measures which are anticipated to make-up for the reduced carbon savings from the RHI (Paragraphs 2.2 to 2.12 and Figures 7, 8, 9 and 10).

11 The Department has not set specific goals or clear milestones to measure progress on the objective of developing the supply chain for the future. It uses stakeholder engagement and management information to make judgements on progress and to adjust the scheme to support specific technology supply chains. However, the Department has not set specific goals, established a monitoring plan or defined clear criteria for making adjustments to the programme in support of this objective. We are therefore unable to determine whether or not the Department is on track. Measuring against the four areas it has identified as important for preparing the supply chain, we find mixed progress. The Department recognises this position and is undertaking reforms to the scheme (Paragraphs 2.13 to 2.17, and Figures 11 and 12).

12 The cost-effectiveness of the RHI in producing renewable heat and reducing carbon emissions is uncertain. Using the same key assumptions as the Department, our estimate of the cost to taxpayers of each megawatt hour of heat produced under the RHI scheme is £49 compared with the Department's latest target of £51. For carbon reductions, we estimate the cost to taxpayers for each tonne of carbon dioxide equivalent saved is £142. But our assessment found some of the Department's assumptions are optimistic. In particular, they do not take account of installations which may have occurred anyway, regardless of whether a RHI was launched, and assume large 'upstream' carbon savings from biomethane and biogas technologies. As a result, the actual cost-effectiveness of the RHI is uncertain, but likely to be worse than the Department's estimate (Paragraphs 2.18 to 2.22, Figure 13 and Appendix Five).

13 There are gaps in the Department's monitoring of progress. We found some examples of good practice. For example, the Department uses a benefit realisation tracker and budget reports to monitor progress on scheme objectives and spending. We also found gaps. The Department does not include measures on developing the supply chain in its benefit realisation tracker. The key performance indicators it has agreed with Ofgem focus on the number of applications and the speed at which they are processed rather than on their quality. There are also no targets for audit work to reduce levels of fraud and non-compliance (Paragraphs 2.23 and 2.24, and Figure 14).

Non-compliance and cost control

14 The Department cannot reliably estimate the amount it has overpaid to participants that have not complied with the scheme's regulations. Non-compliance includes generating heat for ineligible uses (such as heating domestic swimming pools), using unsustainable fuel sources and inaccurate metering. The Department needs to measure the impact of non-compliance to assess the costs and benefits of the RHI, as well as being able to assure Parliament of the regularity of expenditure. The Department relies on Ofgem to estimate the impact of non-compliance. Ofgem has conducted audits on a sample of scheme participants since 2015-16. In May 2017, Ofgem estimated that overpayments were worth 4.4% and 2.5% of Non-domestic and Domestic RHI expenditure respectively, equating to £3 million in 2016-17. But we found significant weaknesses in Ofgem's estimate. The financial impact of non-compliance could be higher, although it is not possible to say by how much. The Department did not review Ofgem's estimate and was unaware of its unreliability (Paragraphs 3.10 to 3.15 and Figure 16).

15 Ofgem could be more effective in how it is aiming to reduce the rates of non-compliance. In addition to its sample audits, Ofgem targets audit on participants it deems to be at highest risk of non-compliance. The Department and Ofgem have also changed regulations, issued new guidance and updated processes with the aim of reducing non-compliance. But there are ways of making these activities more effective. In particular, Ofgem could do more to pinpoint the root causes of non-compliance and target its activities accordingly. Furthermore, its activities have tended to focus more on the most commonly occurring types of non-compliance, rather than those that have the greatest financial impact. Ofgem's lack of a reliable estimate of non-compliance, means it cannot measure robustly how effective its actions have been in reducing non-compliance (Paragraph 3.16).

16 Ofgem could improve its management of the scheme by collaborating more effectively with other public bodies. The Environment Agency and local authorities have a remit to monitor and enforce civil and environmental regulations. These public bodies, which operate on the ground, could provide useful intelligence to Ofgem to assist with its audit and inspection programme. Data from Ofgem could also be used by other public bodies to support their wider environmental enforcement action. Ofgem has not been proactive in sharing its data. It is now developing a data-sharing agreement with the Environment Agency and it is exploring what more it can do with local authorities (Paragraphs 3.17 to 3.20).

17 The Department does not know the impact of 'gaming' by scheme participants. RHI regulations are complex and provide opportunities for gaming. This is where participants comply with the rules but act in a way that does not align with the scheme's objectives. For example, participants could be using heat in a way that is not energy-efficient, or installing multiple boilers to take advantage of the higher tariff rate for smaller units. The Department consults stakeholders and works with Ofgem to identify gaming risks, and it has changed the regulations of the scheme to close some known risks. However, the Department has not assessed the extent and potential financial impact of gaming. This means the Department does not know how much gaming reduces the scheme's value for money, nor whether it has addressed the risks that have the greatest impact (Paragraphs 3.21 to 3.26, and Figure 17).

18 At an aggregate level, the Department has controlled costs to remain within its revised budget. The Department designed cost control measures into the Great Britain scheme to manage the flow of new applicants and spending on existing participants. Key measures include switching participants' tariff from a higher to a lower rate as the amount of heat they produce increases over pre-defined limits; reducing tariffs for new applicants; and closing the scheme to new applicants if forecast spend exceeds a set amount. The RHI scheme in Northern Ireland did not include similar measures, and has suffered from budget overruns and accusations that participants were abusing the scheme (Paragraphs 3.3 to 3.6 and Appendix Three).

19 Controlling the cost of the scheme will be more challenging once the RHI closes to new applications. The RHI makes payments to participants for up to 20 years. The Department estimates total lifetime costs for the existing scheme of £23 billion, of which £18 billion could be spent between 2021-22 and 2041-42. The Department has fewer cost control measures available to manage its spending on existing participants. It is committed to making payments to participants based on the tariff offered at accreditation, which increases annually in line with inflation; and to Non-domestic participants on the basis of their meter readings. Long-term rates of inflation and the amount of heat produced under the Non-domestic scheme are uncertain. Where rates exceed the Department's expectations, the higher expenditure will have knock-on effects to the Department's expenditure and/or the taxpayer (Paragraphs 3.7 to 3.9, and Figure 15).

Conclusion on value for money

20 The Department needed to increase rates of renewable and low-carbon heating in order to meet the UK's legal obligations. The RHI is a novel approach to making progress against these obligations and identifying longer-term options for eliminating carbon emissions from heat production. The Department showed flexibility in rolling out the scheme, adjusting scheme objectives to respond to a changing strategy and over-optimistic initial planning assumptions and it is learning lessons for the future. Measures it introduced to control the scheme's costs have enabled it to avoid the budget control problems that occurred on a similar scheme in Northern Ireland. However, the Department has not achieved value for money. It does not have a reliable estimate of the amount it has overpaid to participants that have not complied with the regulations, nor the impact of participants gaming them, which could accumulate to reduce the scheme's value significantly.

Recommendations

21 The Department should:

a **Set clear goals and milestones for its objective of developing the supply chain** and develop indicators, in collaboration with stakeholders, which enable the Department to monitor progress.

b **Work with Ofgem to develop additional measures that provide further information on scheme delivery** beyond the accreditation process.

c **Work with Ofgem to improve management of the risk of fraud, non-compliance and gaming**, including:

- establishing a reliable estimate of non-compliance and factoring this into progress measures on renewable heat production, carbon savings and cost-effectiveness;
- introducing measures that enable the Department to monitor and evaluate the effectiveness of Ofgem's activity to reduce non-compliance;
- working more effectively with other public bodies to support its approach to preventing and detecting fraud and non-compliance; and
- developing new measures to estimate the extent to which existing and new participants may be gaming the scheme, assessing the consequences, identifying the highest-impact areas of gaming, and prioritising actions to address these, including via changes to regulation where appropriate.

d **Provide Parliament with assurance on how the costs and value for money of the RHI will be managed over the whole life of the scheme.**

Part One

The Renewable Heat Incentive

1.1 In this part, we:

- explain the context of how heating homes and business premises relates to climate change and EU targets;
- explain the design of the Renewable Heat Incentive (RHI) in Great Britain; and
- assess the approach taken by the Department for Business, Energy & Industrial Strategy (the Department) to implement the RHI and its take-up to date by homes and businesses.

Context

1.2 The UK has ambitious targets for reducing carbon (CO_2e) emissions. These targets are underpinned by the Climate Change Act 2008, which requires at least an 80% cut by 2050, compared to 1990 levels. In 2016, the UK had achieved a cut against 1990 levels of 42%, driven mainly from the power and industry sectors (see **Figure 1** overleaf). Total CO_2e emissions from the heating of homes and business premises made up 19% of all UK emissions in 2016.

1.3 The Committee on Climate Change advises that meeting the 2050 target may be impossible without a near complete elimination of emissions produced by heating people's homes and business premises. In its 2017 Clean Growth Strategy, the Department said the elimination of carbon emissions from heating is its most difficult policy challenge in this area.

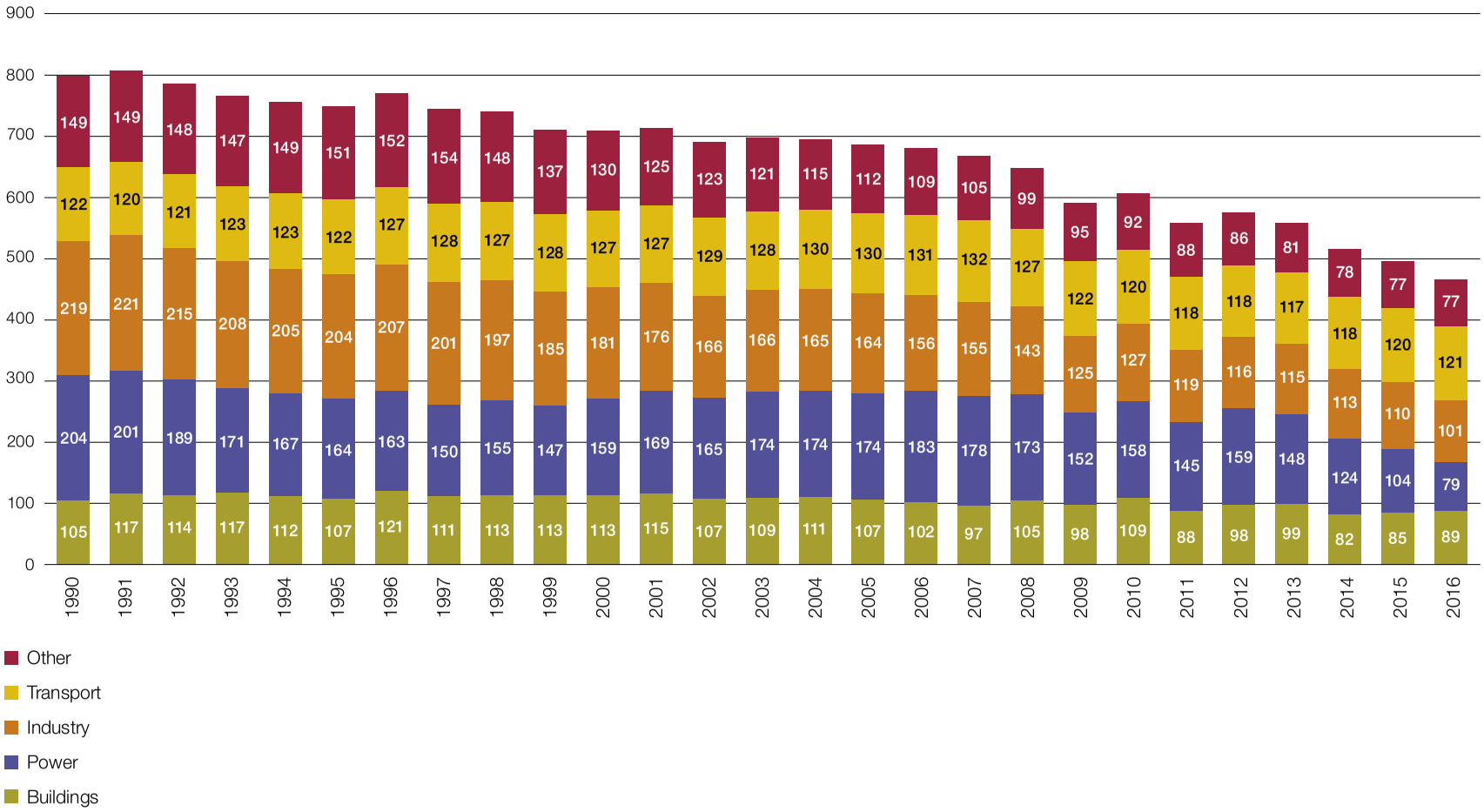
1.4 There are 26 million homes and 5.6 million businesses in Great Britain, the majority of which are connected to the gas grid. This is a national network of pipes suppling natural gas to buildings. When burnt, natural gas produces heat for industrial processes, gas boilers and cooking equipment as well as CO_2e, which is emitted to the atmosphere. The Department estimates around 60,000 non-domestic buildings in England and Wales use oil and liquefied petroleum gas as their main heating source[1] and approximately 850,000 households in England use oil heating.[2]

1 The Department's internal analysis of the Building Energy Efficiency Survey 2016. This estimate is not currently published and there is a high degree of uncertainty attached to the estimate.
2 Department for Business, Energy & Industrial Strategy, *Clean Growth Strategy*, October 2017. Available at: www.gov.uk/government/publications/clean-growth-strategy

Figure 1

UK carbon emissions by sector between 1990 and 2016

In 2016, the UK achieved a cut in carbon emissions of 42% against 1990 levels



Note

1 'Other' includes emissions from agriculture, waste and fluorinated gases.

Source: Committee on Climate Change, *2017 Progress Report*

1.5 In its 2013 document *The Future of Heating: Meeting the challenge*, the Department set out a high-level strategy for reducing carbon emissions from heating over the long term. It planned to expand the use of low-carbon heat networks in the 22% of households located in dense urban areas. For the remaining 78% of households in suburban and rural areas it planned to:

- promote the more efficient use of gas heating for all households connected to the gas grid, with gas use reducing to close to zero by 2050;
- support the uptake of renewable heating systems (including heat pumps and biomass boilers) in rural off-gas-grid areas; and
- over the longer term, replace oil and gas heating with the large-scale deployment of heat pumps alongside a greater role for heat networks.

1.6 While the UK remains within the EU, it has a legal obligation to meet a target of sourcing 15% of energy demand from renewables by 2020. In 2010, the Department's original plan was to achieve this by 30% of electricity demand, 12% of heat demand (compared with 1% in 2010) and 10% of transport demand coming from renewables.[3] There are no formal sub-targets for electricity and heat demand, this allows the Department some flexibility to adjust its plans.

RHI design and responsibilities

1.7 The RHI was originally designed to meet EU renewable energy requirements and support the Department's long-term strategy for reducing carbon emissions from heating. In the Department's 2012 RHI business case it set out plans to deliver 513,000 new renewable and low-carbon installations (with a range of 133,000 to 675,000) in Great Britain by 2020.

1.8 The RHI offers households, businesses and public sector organisations a financial incentive to switch their fossil fuel heating systems to renewable and low-carbon alternatives. The Department decided to link the financial incentive to the production of heat rather than to the upfront costs of installation.

1.9 The RHI is in two parts:

- Non-domestic RHI: launched in November 2011 for industry, businesses and public sector organisations; participants receive payments over 20 years.
- Domestic RHI: launched in April 2014 for homeowners, self-builders, private and social landlords; participants receive payments over seven years.

3 Department of Energy & Climate Change, *National Renewable Energy Action Plan for the United Kingdom*, 1 July 2010.

1.10 The two schemes support multiple systems including biomass boilers, heat pumps and anaerobic digestion plants, which produce biomethane to be injected into the natural gas grid.

1.11 The RHI is a taxpayer-funded programme, unlike most other subsidies for low-carbon electricity, which are funded through additions to energy bills. It works by paying a tariff for the production of renewable heat. The initial costs of designing and installing a new system must be financed by individual households and businesses.[4] Once the new system is installed, applicants can apply to Ofgem for accreditation on the RHI. Once accredited, applicants then receive quarterly payments (in arrears) based on the heat produced (see **Figure 2**).

Figure 2
The Non-domestic and Domestic RHI schemes

	Non-domestic RHI	Domestic RHI
Date launched and budget availability for new applications	November 2011 – March 2021.	April 2014 – March 2021.
Who can apply	Industry, businesses and public sector organisations.	Homeowners, self-builders, private and social landlords.
Technologies supported	Biomass boilers, air and ground source heat pumps, solar thermal, biogas, biomethane injection, water-source heat pumps, biomass combined heat and power and geothermal.	Biomass boilers, air and ground source heat pumps and solar thermal.
Financial incentive offered	Participants paid a tariff per unit of energy produced as recorded by an on-site meter over 20 years.	Participants paid a tariff per unit of energy produced, with most participants receiving payment based on an Energy Performance Certificate Assessment over seven years.

Source: National Audit Office analysis of Ofgem's Non-domestic and Domestic RHI guidance

4 The Department reported the average cost of a small solid biomass boiler on the Non-domestic scheme to be around £60,000 and an air source heat pump on the Domestic scheme to cost between £5,900 and £20,000.

1.12 Great Britain was the first country in the world to use this form of financial incentive for heating. It has been followed by Northern Ireland and the Netherlands. In Europe, countries which have achieved high rates of renewable heating typically started taking action in the 1970s and have used a mix of regulation, capital grants and carbon taxation. A comparison of approaches used in Europe is set out in Appendix Four.

1.13 The Department is responsible for the design, performance and overall value for money of the RHI in Great Britain. Ofgem, a non-ministerial government department, is funded directly by the Department to administer the RHI on its behalf. Ofgem is responsible for approving applications, administering the schemes and ensuring compliance with rules. It contracts out the audit and inspection of sites to Ricardo, a global engineering, environmental and strategic consultancy (**Figure 3** overleaf).

Scheme implementation and take-up

1.14 The Department implemented the RHI in phases. In November 2011, it launched the Non-domestic RHI, with the intention of launching the Domestic RHI in October 2012. The Department chose to delay the launch of the Domestic RHI by 18 months, in order to apply learning from its feed-in-tariff scheme for wind and solar energy, which highlighted the importance of cost control measures to manage the budget.[5] This flexibility allowed the Department to focus its limited internal resources on introducing changes to the Non-domestic RHI to ensure spend remained within budget. Due to the delay, the Department extended the length of the Renewable Heat Premium Payment (RHPP).[6] This was an interim measure to encourage the adoption of renewable and low-carbon heating equipment in homes. The Department used the lessons from RHPP and the Non-domestic RHI when designing and then implementing the Domestic RHI. This included incorporating measures to control costs from the launch of the Domestic RHI.

1.15 The Department has made other significant changes to the RHI. For example, it has introduced new technologies, revised tariffs and sustainability requirements on the Non-domestic scheme (see **Figure 4** on page 19 and Part Three for discussion of changes to cost controls).[7]

5 The feed-in tariff scheme is a government programme designed to promote the uptake of renewable and low-carbon electricity generation technologies.

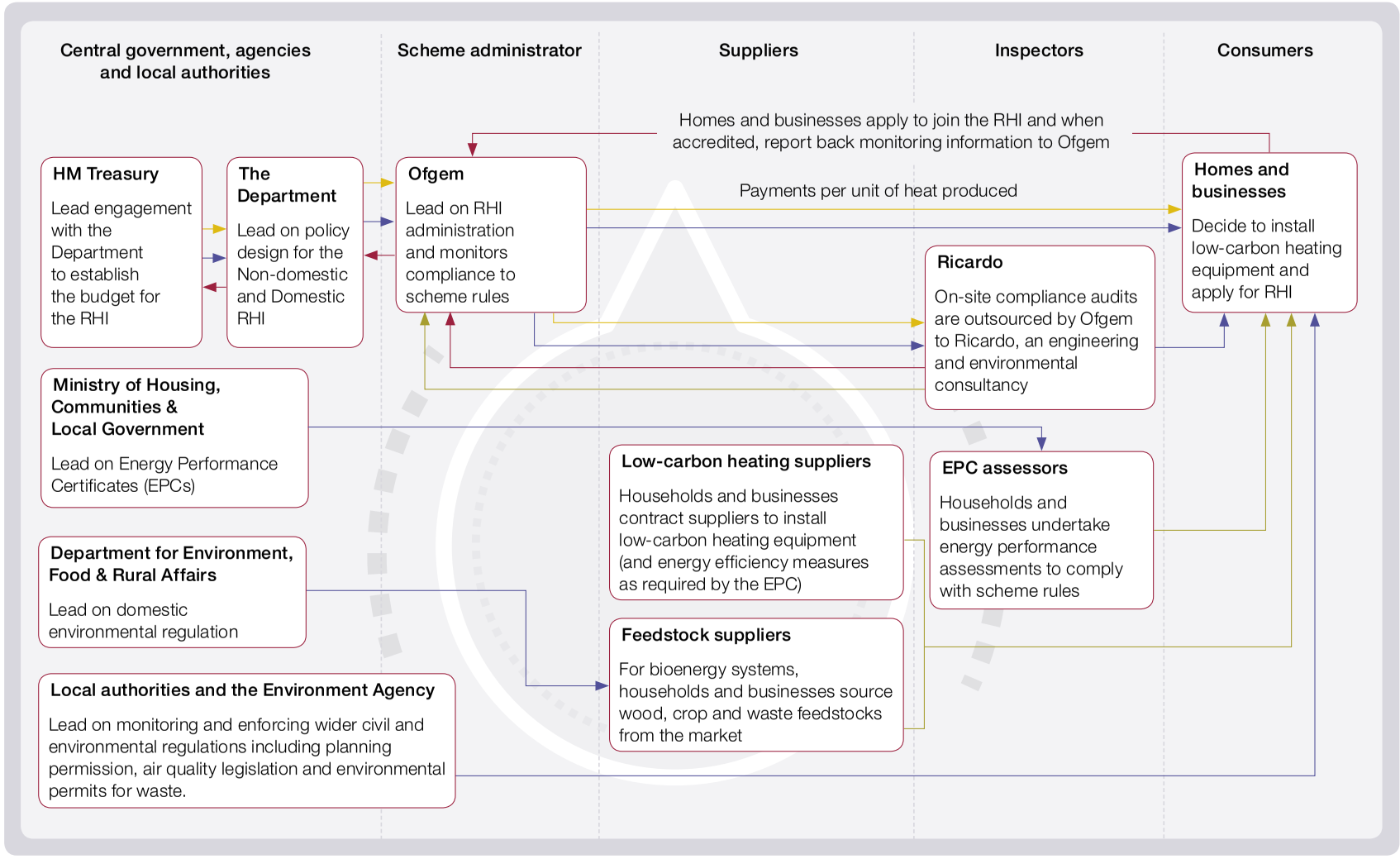
6 The RHPP was a government grant scheme available for installing domestic renewable heating systems prior to the introduction of the Domestic RHI. RHPP funding took the form of a one-off grant to help households with the cost of installing a renewable heating system. The RHPP is now closed.

7 For participants accredited to the Non-domestic RHI from 5 October 2015, fuel used for biomass, biogas or biomethane plants must meet greenhouse gas emission limits and land use criteria.

Figure 3

Roles and responsibilities for the Renewable Heat Incentive

The RHI is a demand-led scheme which is designed by the Department and implemented by Ofgem

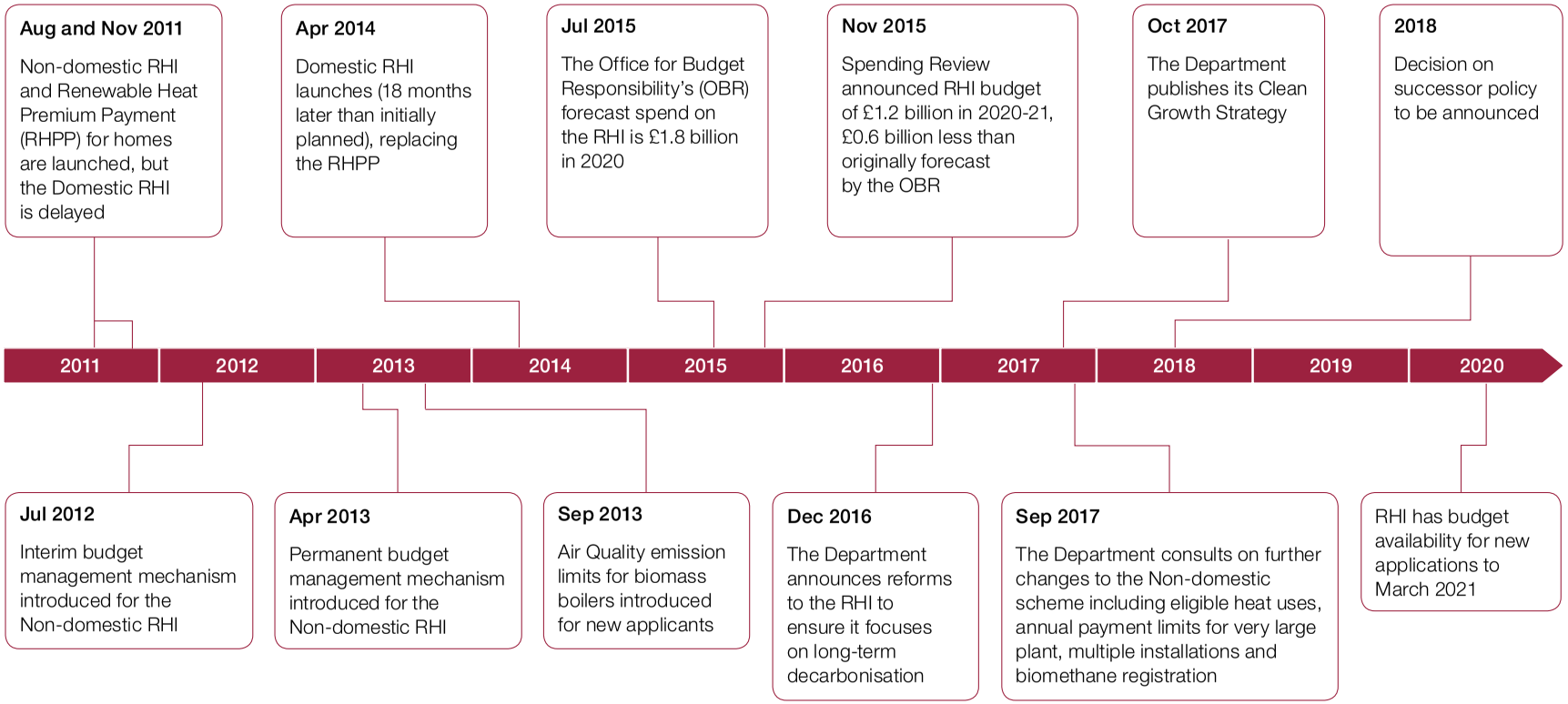


Source: National Audit Office analysis of Renewable Heat Incentive scheme design

Figure 4

Timeline of the Renewable Heat Incentive from its launch in 2011 to 2020-21

The Non-domestic RHI was launched in November 2011 with the Domestic RHI following in April 2014, 18 months later than initially planned



Source: National Audit Office analysis of Department for Business, Energy & Industrial Strategy announcements

1.16 The Department has identified multiple financial and non-financial barriers to uptake in the scheme, including high upfront costs, low public awareness and complex installation requirements. Measured against the original objectives of the RHI, the Department was unable to adapt the RHI's design to make it sufficiently attractive to consumers. It made and is now undertaking additional reforms to the scheme to address some of the barriers identified in **Figure 5**.

1.17 The delay in introducing the Domestic scheme, alongside barriers to uptake, meant the Department's initial assumptions of progress were too optimistic. As at December 2017, the RHI has delivered 78,048 new installations. Given the rate of take-up in August 2017, we estimate the RHI will achieve around 111,000 installations in Great Britain by March 2021.[8] This is just 22% of its original expectations of 513,000 installations and below its lowest estimate, which assumed the Domestic RHI scheme would not be launched (see **Figure 6** on page 22).

8 74,693 (accredited installations as at August 2017) divided by 14.8 TWh (estimated renewable energy produced by the RHI in 2017-18 as at August 2017) equals 5,034 installations for every 1 TWh. RHI funded renewable heat output in 2020-21 is estimated at 22 TWh. Based on current rates of deployment, this would lead to approximately 111,000 installations.

Figure 5

Barriers to uptake of the Renewable Heat Incentive the Department has identified

The Department has identified multiple barriers to uptake and has either taken or is planning to undertake additional action to overcome these

Barrier	Scale	Action the Department is planning or has undertaken
Public awareness and familiarity: People are aware of renewable heating technology but are unlikely to install it. The Department also acknowledges in its 2015 and 2016 surveys that awareness of the RHI is "low" and there is a "current lack of public knowledge and awareness in this area".	According to the Department's quarterly Energy and Climate Change Public Attitudes Survey which undertakes around 2,000 face-to-face interviews, between 63% and 78% of people said they were aware of renewable heating. Between 2015 and 2017 only 12% of homes (18% off the gas grid) and 21% of businesses were aware of the RHI. In 2017, only 6% to 12% of survey responders said they were likely to install a new biomass boiler or heat pump in their home.	Ofgem provides information on the Non-domestic and Domestic RHI through its website. The Department currently targets its marketing at trade associations who work in the heating supply chain through its Industry Advisory Group. It also ran RHI roadshows in 2014-15. The Department has told us it is confident it can remain on track to spend its budget and achieve its revised objectives for renewable heat and reducing carbon emissions based on current levels of awareness.
Competitiveness and upfront costs: Renewable and low-carbon heating has higher upfront costs and is less familiar to applicants than gas and oil heating. There are currently no upfront grant or financing options available to participants to cover these initial costs.	Approximately 60,000 non-domestic buildings in England and Wales use oil and liquefied petroleum gas and 850,000 households in England use oil heating. Upfront cost is a key concern for 42% of Non-domestic and 62% of Domestic applicants. Participants on the Domestic scheme are more likely to be from high-income households who can finance the initial capital costs.	The Department is consulting on the introduction of 'assignment of rights' on the Domestic scheme, where a third party pays for the installation costs of the technology in return for the RHI payments. In its Clean Growth Strategy, the Department announced plans to phase out the installation of high carbon fossil fuel heating systems in off-gas grid buildings during the 2020s, starting with new build.
Market uncertainty: Uncertainty for new applicants and the supply chain due to the risk of reduced tariffs mid-way through an application.	Uncertainty undermines investor confidence, particularly for large schemes.	The Department plans to introduce tariff guarantees that provide large Non-domestic projects certainty over the tariff that they will receive.
Complexity: Installation, maintenance and application process makes installing low-carbon heating equipment typically more challenging than for gas and oil boilers.	For existing properties, the installation of heat pumps is likely to require significant changes to households. Applicants in the Non-domestic scheme are required to complete a complex application process. For the Non-domestic scheme, only 1% of Non-domestic applications received were entirely correct the first time. For the Domestic scheme, despite an automated process, 56% of applications require manual intervention by Ofgem assessors.	The Department has removed the requirement for Green Deal Assessments and Ofgem is continuously working to improve application guidance.

Source: National Audit Office analysis of Department for Business, Energy & Industrial Strategy published documents

Figure 6

Expenditure and the number of installations through the Renewable Heat Incentive

The Department has made £1.4 billion in payments to participants on the RHI, which has 78,048 installations accredited

Technology	Total expenditure on the RHI as of August 2017 (£m)	Total installations to December 2017
Non-domestic RHI		
Biomass boilers	736	15,843
Biomethane	328	82
Biogas	72	506
Heat pumps[1]	21	1,205
Other[2]	18	319
Total payments made to participants on the Non-domestic RHI and the number of installations	**1,175**	**17,955**
Domestic RHI		
Biomass boilers	125	12,523
Heat pumps[3]	104	38,997
Solar thermal	6	8,573
Total payments made to participants on the Domestic RHI and the number of installations	**235**	**60,093**
Total payments made to participants on both the Non-domestic and Domestic RHI and the number of installations	**1,410**	**78,048**
Ofgem administration[4]	72	–
Total	**1,482**	**78,048**

Notes

1 Heat pumps in the Non-domestic scheme include air, ground and water source heat pumps.

2 Other technologies in the Non-domestic scheme include combined heat and power, solar thermal and geothermal.

3 Heat pumps in the Domestic scheme include air and ground source heat pumps.

4 Ofgem administration expenditure covers costs for the Non-domestic and Domestic RHI schemes. The Department has not supplied us with its administration costs.

5 Totals may not sum due to rounding.

Source: National Audit Office analysis of Department for Business, Energy & Industrial Strategy expenditure and installation data

Part Two

Performance of the RHI

2.1 In this part, we:

- describe how the Department for Business, Energy & Industrial Strategy (the Department) heat strategy and objectives for the Renewable Heat Incentive (RHI) in Great Britain have changed over time;
- report progress against those revised objectives including renewable energy production, carbon emissions savings and progress in preparing the supply chain for the future;
- evaluate the cost-effectiveness of the RHI; and
- assess how the Department and Ofgem monitor progress and their approach to learning lessons.

Changes to the Department's heat strategy and RHI ambitions

2.2 The Department's long-term strategy for reducing carbon emissions from heating has evolved. Our study has not audited this wider strategy which includes plans for heat networks and hydrogen injection into the gas grid. We have, however, found a clear change in the Department's direction, in the context of learning it took from the initial implementation of the RHI as outlined in Part One, and new evidence it has collected on alternative low-carbon heating technologies. For example, in November 2015, the then Secretary of State Amber Rudd said:

> "There are technologies which have great potential, such as district heating, biogas, hydrogen and heat pumps. But it is not yet clear which will work at scale. So different approaches need to be tested. We need a long-term plan that will work and keep costs down for consumers."

2.3 In its 2017 *Clean Growth Strategy,* the Department also highlighted that it was not clear which approach for reducing carbon emissions from heating will work best at scale and offer the most cost-effective, long-term answer. The Department is currently reviewing its evidence on the options for reducing carbon emissions from heat. It plans to publish this review later in 2018.

2.4 The National Audit Office's (NAO's) *Framework to review programmes*[9] highlights the importance of major programmes being sufficiently flexible to deal with setbacks and changes in the operating context. The Department responded appropriately to the changes described earlier by reducing its ambitions for the scheme. It is now focusing the RHI more narrowly on homes and businesses which are not connected to the gas grid and are often using oil for heating.[10] It is also using the scheme to encourage the production of biomethane, which can be injected into the existing gas grid.

2.5 The Department has reduced forecast lifetime spending for the RHI. In its 2012 business case the Department originally estimated the RHI would spend £47 billion between 2011-12 and 2040-41. As described in Part One, take-up of the RHI was lower than originally anticipated. By 2015, it had accordingly reduced forecast lifetime spending to approximately £37 billion. In November 2015, as part of its Spending Review settlement with HM Treasury, the Department agreed to lower forecast spending by an additional £14 billion to £23 billion. At the same time, ministers decided the Department should change the balance in RHI objectives towards reducing carbon emissions. Taking these changes into account, the Department has reduced its ambitions for renewable heat by 65% and for reducing carbon savings by 44% as measured against its original plans (see **Figure 7** and below for further discussion).

Progress against revised objectives

2.6 The RHI's revised objectives in Great Britain are set out in a 2016 business case:

- Deliver growth in renewable heating in the UK, to help the UK meet its legal obligations under the EU Renewable Energy Directive for sourcing 15% of energy demand from renewables by 2020.
- Contribute to the UK's statutory carbon emission reduction targets (also known as carbon budgets) between now and 2032, by supporting the deployment of low-carbon heating.
- Help grow supply chains to prepare Great Britain for a mass transition from fossil fuels to low-carbon heating from the 2020s, to support longer-term decarbonisation of heating.

2.7 As of August 2017, the Department reports it is on track to achieve these revised ambitions for producing renewable heat and reducing carbon emissions from heating. It reports 72% of all installations on the Domestic scheme are located in households not connected to the gas grid. No equivalent figure is available for the Non-domestic scheme (see **Figure 8** on page 26 and **Figure 9** on page 27).

9 Available at: www.nao.org.uk/report/framework-to-review-programmes/

10 Around 4 million households in Great Britain are not connected to the gas grid. The majority of these (2.2 million) use electricity. The remainder use heating oil, LPG, solid fuel and communal or district heating.

Figure 7

The Department's starting and current ambitions for renewable heating and carbon budgets

The Department has reduced its ambitions for the generation of renewable heat through the RHI by 65% and for reducing carbon emissions by 44%

	Starting ambition	Current ambition	Total percentage difference (%)
Renewable heating not eligible for the RHI by 2020[1]	10 TWh	37 TWh	+270
Renewable heating funded by the RHI by 2020[2]	61 TWh	21 TWh	-65
Total renewable heating by 2020	71 TWh	58 TWh	-18
Estimated renewable heating as a percentage of total heat demand by 2020[3]	12%	10%	-21
Lifetime carbon emission reductions funded by the RHI [4,5]	246 $MtCO_2e$ from 2018 onwards	137 $MtCO_2e$ from 2018 onwards	-44
Prepare the market for mass-roll out from the 2020s onward	Not defined	Not defined	–
Forecast lifetime spending[6]	£47 billion	£23 billion	-51
Net present value[5,7]	-£7 billion	£0 billion	–

Notes

1 Renewable heating not eligible for the RHI includes mainly wood-burning stoves, open fires and reversible air-to-air heat pumps.

2 The starting ambition for renewable heating is a composite measure combining a December 2011 estimate in the Non-domestic scheme of 57 TWh and a July 2013 estimate in the Domestic scheme of 3.5 TWh.

3 Total heat demand is based on the Department's forecast estimate in 2020 of 614 TWh.

4 The starting ambition for lifetime carbon emission reductions is a composite measure combining the Department's December 2011 Non-domestic RHI Impact Assessment and 2013 Domestic RHI Impact Assessment. Lifetime carbon emission reductions are measured from 2018. The Department's current ambition is measured using its 2018 Impact Assessment.

5 Lifetime carbon emission reductions have not reduced to the same extent as renewable heat. This is due to the Department including upstream emission reductions. This is where biomethane plants divert food waste from landfill where it would otherwise emit methane, a powerful greenhouse gas. Upstream emissions were not included in the Department's 2011 Impact Assessment.

6 Nominal and undiscounted.

7 Net present value estimates for the starting ambition of the RHI are estimated by combining the Department's 2011 estimate for the non-domestic scheme (measured over 30 years) and 2013 estimate for the domestic scheme (measured over 27 years). Estimates for the current scheme (£0.03 billion, rounded down to £0 billion) are based on the Department's 2018 Impact Assessment (measured over 25 years). All estimates are adjusted to 2018 prices, but are not adjusted to take account of the different time period measurements.

Source: National Audit Office analysis of Department for Business, Energy & Industrial Strategy 2011, 2013 and 2018 Impact Assessments; Delta Energy & Environment, The Contribution of Reversible Air-to-Air Heat Pumps to the UK's Obligation under the Renewable Energy Directive, February 2018.

Renewable energy obligation

2.8 The RHI's reduced ambition means its contribution to achieving European renewable energy obligations will be lower than initially intended. This is partly compensated for by an increased estimate of renewable heat produced from sources which are not eligible for the RHI. By 2018, the Department had almost quadrupled its initial estimate of this 'baseline' renewable heating from 10 TWh to 37 TWh per year. This mainly takes into account higher than expected use of household wood-burning stoves, open fires and reversible air-to-air heat pumps.

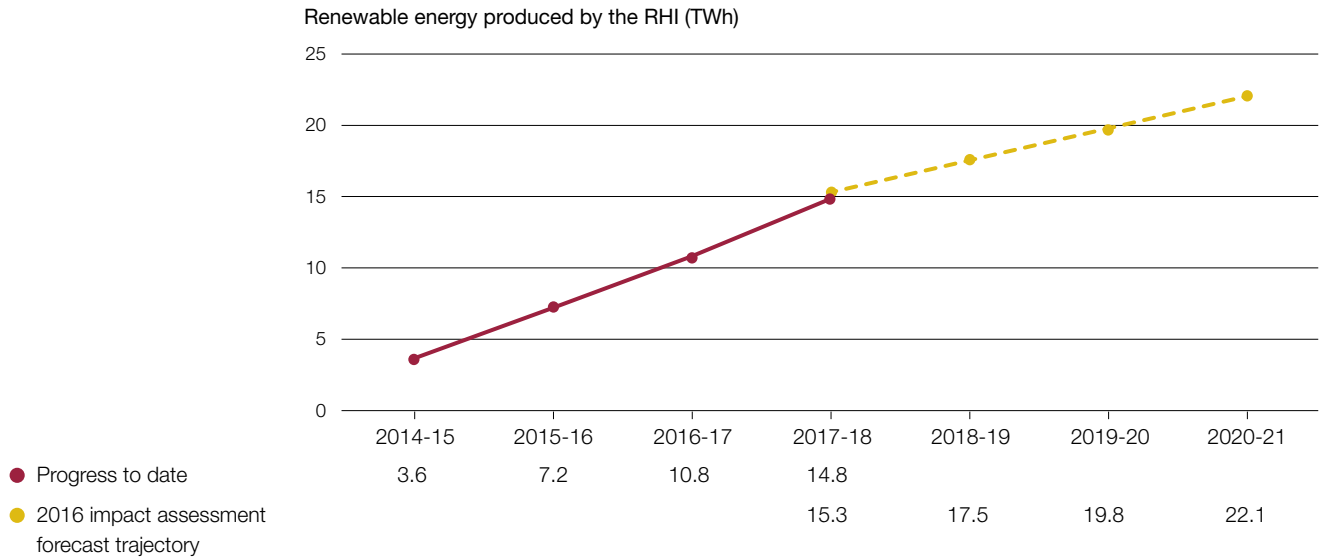
2.9 We estimate that the combination of these changes will enable the UK to increase its share of heat demand fuelled from renewable sources to 10% in 2020. This is two percentage points short of the Department's original plan of 12%.[11] If the government does not meet the renewable energy obligation it risks a fine. The options available to make up the shortfall are:

- increase renewable heat output, for example by increasing RHI funding;
- look to make additional progress on power and transport (see **Figure 10** on page 28); or
- buy surplus renewable production in the form of 'statistical credits' from other EU countries.

Figure 8

The Department's forecast to 2020 and outturns to date for renewable energy produced per year by the Renewable Heat Incentive

Progress on renewable heat is within 3% of its revised trajectory to 2020



Note

1 Data accurate as at August 2017.

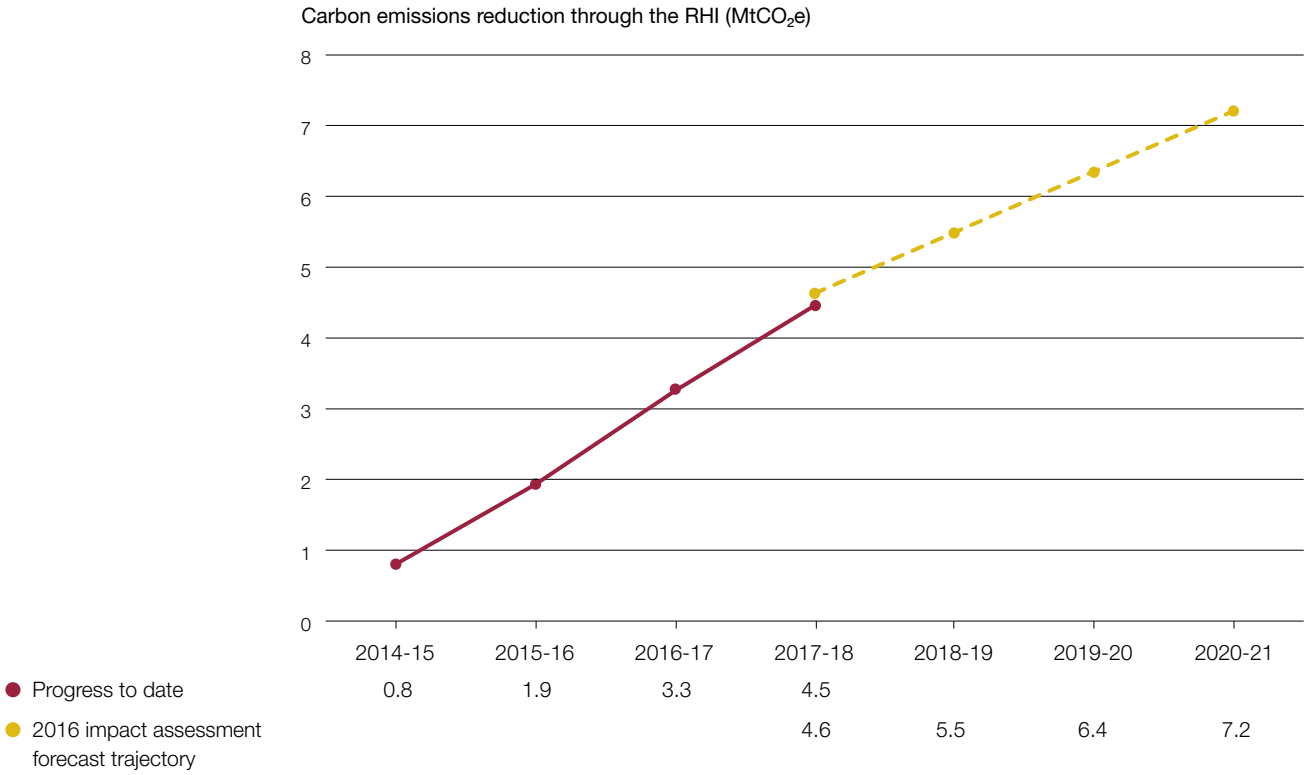
Source: Department for Business, Energy & Industrial Strategy benefits realisation report

11 There is no formal sub-target for heat. This allows the Department to flexibly adjust its plan between heat, electricity and transport.

Figure 9

The Department's forecast to 2020 and outturns to date for carbon emissions saved per year by the Renewable Heat Incentive

Progress on reducing carbon emissions is within 4% of its revised trajectory to 2020



Note

1 Data accurate as at August 2017.

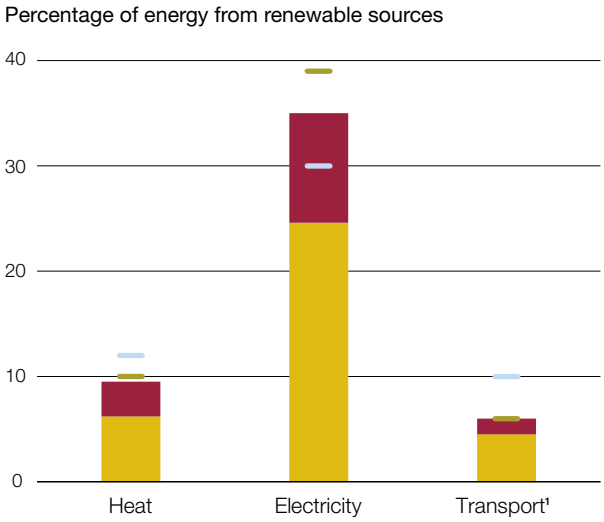
Source: Department for Business, Energy & Industrial Strategy benefits realisation report

2.10 Given the UK's intent to leave the EU in March 2019, it is not clear whether the UK is still required to meet the EU Renewable Energy Directive. The Prime Minister has proposed, in the context of the UK's overall negotiations with the EU, a transitional period of around two years where the UK would work within the existing structure of EU rules and regulations. The EU Renewable Energy Directive target falls in 2020 (within the proposed transitional period). Member states are not expected to report final progress against the EU Renewable Energy Directive target until December 2021.

Figure 10

The UK's progress in 2016 and expected progress in 2020 against the government's EU Renewable Energy Directive target

The Department's ambition for renewable heat is two percentage points lower than its original plan



	Heat	Electricity	Transport¹
Percentage of energy from renewable sources expected in 2020	10	35	6¹
Percentage of energy from renewable sources in 2016	6	25	5
The Department's original plan for meeting the EU Renewable Energy Directive in 2020	12	30	10
An indicative scenario to meet the EU Renewable Energy Directive in 2020²	10	39	6

Notes

1 There is a renewable transport sub-target of 10% which allows for 'multiple counting' of waste based biofuels and renewable electricity for rail and road transport. Multiple counting is not applicable for the wider Renewable Energy Directive target of 15% and is therefore not included in the chart.

2 In its written submission to the 2016 Energy and Climate Change Select Committee inquiry on 2020 renewable heat and transport targets, the Renewable Energy Association set out indicative scenarios for how the Renewable Energy Directive target may be met. The chart presents one of these indicative scenarios based on the assumption that 10% of heat demand and 6% of transport demand is met from renewable sources by 2020.

3 Labelled figures may not precisely match bars in the chart due to rounding.

Source: National Audit Office analysis of published documents from the Department for Business, Energy & Industrial Strategy, Department for Transport and Energy and Climate Change Select Committee inquiry into 2020 renewable heat and transport targets

Carbon budgets obligation

2.11 The UK's statutory carbon emission targets (also known as 'carbon budgets') are provisions of the Climate Change Act 2008.[12] Carbon budgets set emission reduction targets over five-year periods. The RHI is on track to reduce carbon emissions from heating by 7 $MtCO_2e$ per year from 2020-21 (approximately 1.5% of total UK carbon emissions) (see Figure 9). These savings have already been factored into the Department's projections for carbon budgets 4 (2023–2027) and 5 (2028–2032). The RHI is unable to produce additional carbon reductions over current plans due to budget constraints.

2.12 In its 2017 Clean Growth Strategy, the Department reported its forecast position against carbon budgets. It estimated surplus positions for the first three carbon budgets, but deficit positions for carbon budgets 4 and 5 (an average of 23 and 33 $MtCO_2e$ per year respectively). The Department is currently exploring other measures which it thinks can provide additional carbon savings.[13]

Growing the low-carbon heat supply chain

2.13 In December 2016, the Department revised its objective on preparing the market for the mass roll-out of low-carbon heating technology from the 2020s onwards.[14] In its response to a consultation on a reformed scheme, it said it wanted to support supply chain growth and challenge the market to deliver.

2.14 The Department monitors progress on this objective by collecting intelligence from equipment manufacturers, trade bodies and the wider supply chain. It combines this intelligence with data it collects on payments made to participants, new applications and accreditations to the RHI, and research it commissions. To make adjustments to the scheme, the Department uses its own judgement based on the range of evidence it collects, in the context of the budget it has available to spend. In Figure 4 we set out some of the adjustments the Department has made to the RHI using this system.

2.15 Our *Framework to review programmes* highlights the importance of clear, high-quality reporting on progress. It also highlights the importance of systematic reporting against clear criteria to reduce reliance on individual judgement. We found the Department has not set specific goals or clear milestones for this objective. It does not have a monitoring plan though it does use clear criteria for making adjustments to the tariff rates available to new applicants.

12 Carbon budgets are set to 2032 providing five-yearly limits on the amount of carbon dioxide the UK is allowed to emit from across the economy.

13 The Department's Energy and Emission Projections 2017 (published January 2018), include early stage policies and proposals from the Clean Growth Strategy. It shows an average, additional potential reduction, of up to 6$MtCO_2e$ and 16$MtCO_2e$ per year for carbon budgets 4 and 5. Forward projections for carbon budgets 4 and 5 have also been revised. The latest projections indicate smaller deficits at an average of 13 MtCO2e and 23 MtCO2e per year respectively.

14 Department for Business, Energy & Industrial Strategy, The Renewable Heat Incentive: A reformed scheme – Government response to consultation, December 2016.

2.16 In its 2013 business case, the Department considered four changes which were necessary to prepare the supply chain for the future. These were:

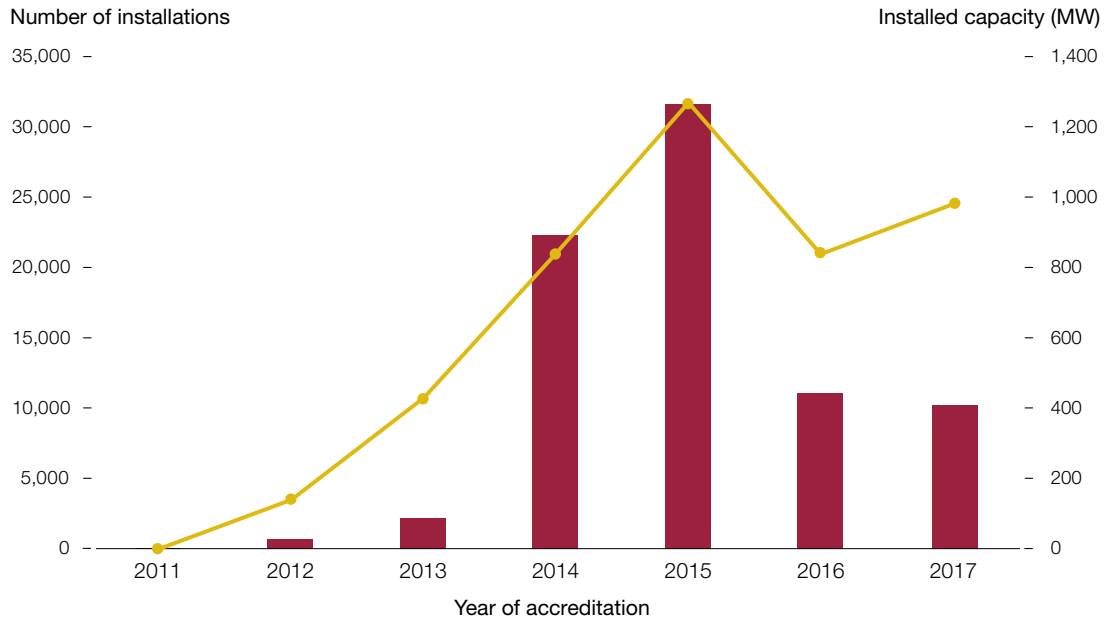
- building sustainable renewable heat supply chains;
- improving the performance of renewable heating technologies;
- reducing costs of installing renewable heating technologies, through deployment at greater scale; and
- reducing some of the non-financial barriers, especially the perceived risk and lack of awareness of renewable heat technologies in the general public.

2.17 We are unable to determine whether the Department's progress on this objective is on or off track as it has not set specific goals or milestones. Measuring against the four areas it identified as important for preparing the supply chain for the future, we found mixed progress (see **Figure 11** and **Figure 12**).

Figure 11

Accredited installations and installed capacity in each year of the Renewable Heat Incentive between 2011 and 2017

Between 2016 and 2017, the rate of new installations across the RHI fell 8% but installed capacity increased by 17%



	2011	2012	2013	2014	2015	2016	2017
Number of installations	2	705	2,135	22,283	31,642	11,087	10,194
Installed capacity (MW)	0	141	431	843	1,272	840	983

Notes

1 The Domestic RHI opened in April 2014 and includes both new and legacy installations (that is, installations installed prior to April 2014 but eligible for the domestic scheme).

2 The installed capacity of solar thermal installations is not included in the chart.

Source: Department for Business, Energy & Industrial Strategy Renewable Heat Incentive statistics

Figure 12

Our assessment of the Department's progress in preparing the supply chain for the future

Our analysis found mixed progress against the Department's four enablers for preparing the supply chain for the future

The Department's four enablers	Our assessment of progress
1 Building sustainable low-carbon heat supply chains	• Between 2014 and 2017 there has been a 65% reduction in accredited installers on the Microgeneration Certification Scheme (MCS)[1]. MCS certification is an essential part of the accreditation process for the Domestic RHI and is also required for heating systems rated 45kWth or less in the Non-domestic scheme.
2 Improving the performance of low-carbon heating technologies	• The Department has commissioned multiple research studies covering air and ground source heat pumps and biomass boilers. The evidence collected to date is inconclusive on whether the performance of heat pumps has improved over time. • For heat pumps, the research shows more than half but not all heat pumps investigated met minimum performance standards. Reported customer satisfaction on installed heat pumps was high. • For biomass boilers, one study found (using an unrepresentative sample of biomass boilers) those installations it investigated were under–performing industry standards by between 10% and 20%. This and another study also highlighted the risk of under-utilisation of biomass boilers, leading to reduced efficiency and increased emissions.
3 Reducing costs of installing low-carbon heating technologies, through deployment at greater scale	• Our analysis found the costs of installing Non-domestic biomass boilers, which have the largest number of installations through the RHI scheme, were 46% lower in 2016 compared with 2010.[2] • We found no significant cost decreases for biomass boilers or heat pumps in the Domestic RHI scheme. • Our analysis was not extended to several technologies on the Non-domestic scheme due to small sample sizes. Interviews with industry stakeholders provided anecdotal evidence of some cost reduction for biomethane plants.
4 Reducing some of the non-financial barriers, especially the perceived risk and lack of awareness of low-carbon heat technologies in the general public	• In Figure 5 we present analysis on non-financial barriers, the perceived risk and levels of awareness for the RHI.

Notes

1 The MCS is a quality assurance scheme. It certifies technologies and the installers of these technologies. MCS accreditation is part of the RHI and feed-in-tariff. People can receive MCS certification for more than one technology. Over the same time period, there has also been a reduction in the rate of installations of solar PV panels in the feed-in-tariff and the number of engineers certified on the MCS to install this type of technology.

2 Ofgem collects data on the costs of installing accredited installations. This data is self-reported by participants and not subjected to quality assurance checks. Our analysis found significant variation in self-reported capital costs with the most expensive comparable installations costing three times more than the cheapest.

Source: National Audit Office analysis of MCS accreditation statistics; Ofgem management information; and Department for Business, Energy & Industrial Strategy published research reports available at: www.gov.uk/government/collections/heat-pump-research

Cost-effectiveness of the RHI

2.18 Cost-effectiveness can be measured in various ways. One of the more straightforward measures is the amount of taxpayers' money spent to achieve each unit of desired output. In the case of the RHI, we use this measure of cost-effectiveness to calculate the money spent by the taxpayer (through payment of tariffs) to produce one megawatt hour (MWh) of renewable heat, and to reduce carbon emissions by one tonne (t/CO_2e).

2.19 A number of assumptions have to be made in these calculations, as we explain below. When we use comparable assumptions to the Department, we estimate that the Department will spend an average £49/MWh (2018 prices) in Great Britain to produce renewable heat over the lifetime of those installations accredited to the scheme by September 2017. This is in line with the Department's 2013 and 2016 estimates of £49/MWh and £51/MWh respectively (**Figure 13**).

Figure 13

Cost–effectiveness of the Renewable Heat Incentive in 2018 prices

Our analysis shows there is significant uncertainty in estimates of the actual cost-effectiveness of the RHI

	Renewable heat (£/MWh)	Reducing carbon (£/tCO_2e)
Department's 2013 impact assessment[1,2]	49	–
Department's 2016 impact assessment[1]	51	–
Our calculation – base case estimate using the Department's key assumptions[3]	49	142
Our sensitivity analysis using more pessimistic assumptions		
Reduced upstream carbon savings for biomethane and biogas plants	–	160
Taking into account survey evidence which implies installations would have happened without the RHI	65	189
Impact of Ofgem estimates of overpayments as a result of fraud and non-compliance	51	148

Notes

1 The Department's cost-effectiveness estimates have been uprated to 2018 prices.

2 The chart does not include the Department's estimates of carbon cost-effectiveness. These estimates use a different measure of cost-effectiveness which is not comparable to our estimates.

3 Our calculation uses accredited installations on the RHI scheme up to September 2017. It relies on a set of assumptions compiled by the Department. We have not tested the validity of these assumptions.

Source: Department for Business, Energy & Industrial Strategy 2013 and 2016 Impact Assessments and National Audit Office analysis of Ofgem data

2.20 However, this in part reflects the fact that the RHI has supported a different mix of technologies than the Department expected, in particular biomass rather than heat pumps. Biomass boilers receive the most payments under the RHI. They produce the most renewable energy in the scheme and are cheaper per unit of heat produced and carbon saved than some heat pumps (see Figure 22 in Appendix Five). Our analysis found significant cost reductions have been achieved in the installation of biomass boilers in the Non-domestic scheme. We found no equivalent trend for heat pumps (Figure 12). The Department recognises the long-term strategic importance of heat pumps to reduce carbon emissions from heating. They have consulted on changes to the RHI to increase tariff rates available for heat pumps to stimulate demand.

2.21 Regarding carbon emissions, using the Department's key assumptions we estimate it will cost the taxpayer £142 per tonne of carbon dioxide equivalent saved.[15] The Department uses a different measure of cost-effectiveness which is not comparable to our metric. It measures carbon cost-effectiveness as the net cost to the economy, a 'resource cost' measure.[16] Using this measure, in 2016 the Department estimated it will spend on average £56 per tonne of carbon dioxide equivalent saved.

2.22 In Appendix Five we set out our more detailed analysis of cost-effectiveness. Our 'base case' estimates of cost-effectiveness aim to match a number of the Department's assumptions. Our sensitivity analysis around those assumptions shows the actual cost-effectiveness of the RHI is uncertain, but likely to be worse than the Department's estimate.

- Our base case estimates assume significant upstream carbon savings for biomethane and biogas plants as a result of food waste being diverted from landfill sites. We have not audited this assumption and are unable to conclude on its validity. But our estimate of carbon cost-effectiveness is highly sensitive to changes in this assumption. A more pessimistic assumption about upstream carbon savings from biomethane and biogas plants would mean our carbon cost-effectiveness estimate for the RHI deteriorates from £142 to £160 per tonne of CO_2e saved.

15 In Appendix Five we estimate the cost-effectiveness of the Domestic RHI is £128 per tonne of CO_2e saved. In our 2016 report *Green Deal and Energy Company Obligation (ECO)* we reported ECO (an energy efficiency scheme installing measures such as loft insulation in people's homes) to cost the taxpayer £110 per tonne of CO_2e saved between January 2013 and March 2014 and £61 between April 2014 and March 2015, following policy changes to make easier-to-treat homes eligible for the scheme in 2014.

16 The approach is consistent with HM Treasury's Green Book, but is more complex to estimate than the cost to taxpayers per unit of desired output.

- Our base case estimates assume none of the accredited installations would have occurred had the RHI not been launched. The Department does not have a robust counterfactual it can use to measure the additional impact of the RHI. But surveys undertaken by the Department provide some evidence of the potential for 'deadweight costs' in the scheme.[17] These surveys found that 25% of participants in the Non-domestic scheme and 24% of participants in the Domestic scheme stated that they would have installed a renewable heating technology anyway, even if the RHI had not existed. Using this data to form a less optimistic assumption about the additionality of the scheme, our heat cost-effectiveness estimate deteriorates from £49 to £65 per MWh and carbon cost-effectiveness from £142 to £189 per tonne of CO_2e saved.

- Our base case estimates assume no financial loss as a result of fraud, non-compliance and gaming. As we explain in Part Three, Ofgem does not measure the financial impact of 'gaming' in the RHI. But it does measure rates of non-compliance. Taking Ofgem's estimate of non-compliance into account, our estimates of cost-effectiveness deteriorate slightly from £49 to £51 per MWh for heat and from £142 to £148 per tonne of CO_2e saved. In Part Three we discuss the validity of Ofgem's estimates of fraud and non-compliance.

Monitoring and learning lessons

2.23 To improve the RHI and support its efforts to learn lessons, the Department has invested in research, monitoring and evaluation. We found some examples of good practice, including:

- the tracking of progress – on renewable heat produced, carbon emissions saved and installations supported – through an internal 'benefits realisation tracker', used by the Department's RHI team to report to senior management in board meetings;

- improving its understanding of the user experience and the market through surveys, interviews with different scheme participants and industry stakeholders;

- reviewing the scheme following the problems experienced with the devolved Northern Ireland RHI scheme; and

- monitoring the uptake of individual technologies, which it uses to manage the budget and enable cost control measures as and when needed (see Part Three).

17 Evidence collected by the Department's surveys relies on the judgement of responders regarding how they would have acted in a hypothetical situation. Some care should be exercised in interpreting the results, since survey responders are not always able to accurately predict how they would act in hypothetical situations. More than a quarter of responders to the domestic survey, did not know how they would have acted without the RHI and are excluded from the analysis.

2.24 But there are gaps in the Department's approach:

- As explained earlier, the Department has not set specific goals or milestones to track progress against its objective to prepare the supply chain for the future. In 2016 it scaled back its measurement of the supply chain, citing challenges around the cost-effectiveness of collecting data and how representative it is of the entire market. The Department is now much more reliant on 'soft' market intelligence received from stakeholders and deployment data across the two schemes.
- The Department is commissioning a new evaluation programme running to 2020 but it will not be able to determine the additional impact of the RHI (that is, how many accredited installations would have happened anyway, if RHI had not been implemented).
- Key performance indicators (KPIs) agreed with Ofgem to monitor its delivery of the RHI focus on the process for accrediting new applications onto the scheme. There is only one KPI linked to the quality of outcomes achieved through the RHI – a measure of customer satisfaction (See **figure 14** overleaf).
- There are weaknesses in the design, implementation and use of scheme audit activity, as we discuss in Part Three.

Figure 14

The Department's KPIs used to monitor Ofgem's delivery of the scheme

The Department's nine KPIs measuring Ofgem's delivery of the scheme are mainly input or process related and concentrate on the accreditation process

Type of measure	Monitoring KPI	Non-domestic RHI April–September 2017	Domestic RHI April–September 2017
		Outturn (Target)	Outturn (Target)
Input	Business hours when IT system is available	98% (99%)	99% (99%)
Process	Time taken to make payments	96% within 30 working days (95%)	99% within 5 working days (95%)
Process	Enquiries responded to within 10 days	99% (90%)	95% (90%)
Process	Length of queue	1,503 (average below 1,000) 39% (less than or equal to 30% older than 6 months)	885 (Not above 500) 7% (less than or equal to 10% older than 6 months)
Process	Application receiving decision within 30 days	21% (30%)	83% (85%)
Process	Time taken to answer calls.	86% within 30 seconds (80%)	84% within 10 seconds (90%)
Process	Referrals logged and investigations / actions commenced within 7 days	94% (90%)	100% (90%)
Output	Number of applications processed per year	1,119 since April 2017 (3,200)	4,397 since April 2017 (11,000)
Outcome	Customer satisfaction score[1]	74% (60%)	87% (60%)

Note

1 Ofgem measures customer satisfaction using surveys completed each month. These surveys cover the initial application process and the customer's experience of the scheme's administration after they become a member.

Source: Ofgem's monitoring framework

Part Three

Controlling costs and the impact of fraud and non-compliance

3.1 In Part One we explained that the Department for Business, Energy & Industrial Strategy (the Department) is responsible for the design of the Renewable Heat Incentive (RHI). It is also responsible for ensuring the RHI provides good value for money, has controls in place to stay within budget, and to demonstrate to Parliament that payments under the scheme are regular and in line with Parliament's intentions.

3.2 In this part we:

- explain the Department's measures for controlling scheme costs, both now and in the future;
- assess the approach of the Department and Ofgem, to managing fraud and non-compliance and measuring its impact on the scheme's achievements; and
- assess how the Department is managing the risk that the scheme's regulations can be 'gamed'.

The Department's control of expenditure

3.3 The Department designed the RHI as a demand-led scheme, with funding for successful applicants guaranteed for a long period, to create confidence for investors, and the supply chain, leading to progress against the scheme's objectives.

3.4 Reflecting the demand-led nature of the scheme, HM Treasury agreed that RHI expenditure would be treated as Annually Managed Expenditure (AME) rather than as DEL spending, which has strict annual ceilings.[18] Classification as AME gives the Department some budget flexibility from year to year, and helps to manage potentially volatile categories of spending. HM Treasury incentivised the Department to control RHI spend by requiring any overspend in one year to be repaid through reductions in its RHI allocation in future years, and having to fund a proportion of this repayment from its wider DEL budget.

18 Departmental Expenditure Limit.

3.5 The Department introduced and maintains strong cost control measures for the scheme, by managing the flow of new applicants and spending on existing participants. These mechanisms have been effective in keeping the RHI within its budget to date (**Figure 15**). The main cost control measures are:

- tiered tariffs: included in the Non-domestic scheme when it launched, this involves switching participants' tariff under the Non-domestic scheme from a higher to a lower rate once their heat production reaches a pre-defined limit. This reduces the incentive for participants to produce excessive heat solely for the purposes of financial gain;
- deemed payments: included in the Domestic scheme when it launched, for most participants payments are based on the annual heat demand figure listed in the property's Energy Performance Certificate. This is known as 'deemed payments' and predetermines the amount of money participants will receive;
- tariff degression: introduced to the Non-domestic scheme in 2012 and the Domestic scheme when it launched in 2014. Degression enables the Department to reduce tariffs for new applicants when total forecast spending on a technology exceeds its pre-defined limit. This measure has led to significant reductions in the biomass boiler tariff since the scheme started; and
- budget cap: notwithstanding the intention to provide confidence to the supply chain, the Department introduced this control in 2016. It enables the Department to reserve the right to close the scheme to new applicants with little or no notice when forecast spend exceeds a pre-defined limit.

3.6 Scheme expenditure, take-up and risks to the budget are monitored by the Department and (since autumn 2015) reviewed regularly through a joint HM Treasury-Department governance arrangement consisting of a monthly cost control report and quarterly meetings of a cost control board.[19]

Future risks to cost control

3.7 There are risks to cost control for the remaining life of the scheme, which is expected to run until at least 2041. The Department is committed to making payments based on the tariff level offered at the point of accreditation, increasing annually by inflation.[20] Payments under the Domestic RHI will run until at least 2028, and under the Non-domestic scheme until at least 2041. Around £18 billion (nearly 80%) of the current scheme's expected lifetime spending of £23 billion will occur between April 2021 and March 2041 (Figure 15).

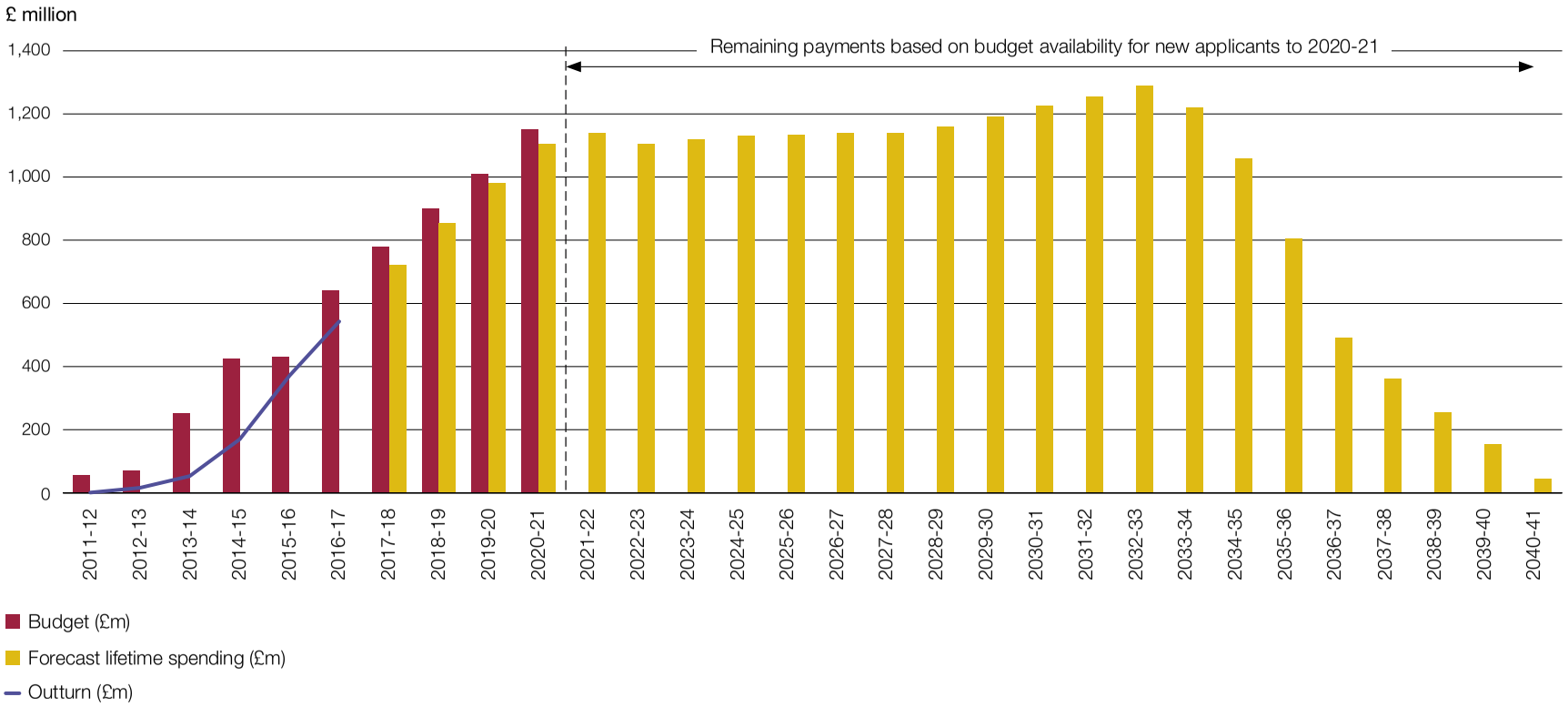
19 The Department's system to detect risks to increases in budget includes liaising closely with industry and forecasting future spend.

20 Participants who received accreditation before 1 April 2016 have their tariffs indexed by the Retail Price Index. All other participants have tariffs uprated by the Consumer Price Index.

Figure 15

Budget, outturns and forecast lifetime spending for the Renewable Heat Incentive between 2011-12 and 2040-41

The Department estimates lifetime RHI payments of £23 billion (nominal, undiscounted) to 2040-41, of which £18 billion is expected to be spent from April 2021



Notes

1 Only payments made in-year (including accruals to account for payments made in arrears) are reported in the Department's Annual Report and Accounts. The long-term future liabilities of the RHI are not included on the Department's balance sheet as all scheme participants are required to submit an annual declaration to Ofgem confirming their compliance with scheme rules.

2 Underspends against budgets are returned to HM Treasury. There is no impact on future year budgets.

3 Budget underspend prior to 2020-21 may not affect the lifetime cost of the programme should the cumulative uptake lead to spending of the full budget in 2020-21. Any underspend in 2020-21 will reduce the lifetime cost of the RHI.

Source: Department for Business, Energy & Industrial Strategy management information

3.8 The Department will have fewer levers to control expenditure when the RHI is closed to new applicants. Degression and budget caps will not apply to existing participants because the Department has made commitments to make index-linked payments to participants on the Non-domestic and Domestic schemes for 20 and seven years respectively. Tiering will be the main line of defence acting against the over-production of heat in the Non-domestic scheme. In addition, RHI regulations specify participants must not generate heat for the purposes of increasing financial income. For the Domestic scheme, deemed payments effectively pre-determine the income participants will receive.

3.9 The Department is exposed to a number of cost control risks, which it is currently reviewing:

- Budgets for the RHI and associated spending rules have been set to 2020-21. The Department is currently required to inform HM Treasury of any forecast overspend and may incur financial penalties if it exceeds agreed control totals.[21] The Department is committed to spending beyond 2020-21, with tariffs increasing in line with inflation. Unexpectedly high inflation could mean RHI expenditure is higher than forecast. Unless future spending review settlements with HM Treasury include a waiver for inflation, the Department may be required to offset this elsewhere in their DEL or AME budgets.[22]

- Payments made to Non-domestic RHI participants are based on meter readings. The Department has made assumptions about the expected heat usage when setting its future budget and spending expectations. Changes to a participant's behaviour could lead to higher than expected costs. In particular, there are a small number of biomethane and biomass installations which produce high amounts of renewable heat. Changes in the usage of these installations could have a significant impact on overall scheme spending.

- Over time, the cost of RHI fuel could diverge from the economy-wide inflation rate used to uprate the RHI tariffs, potentially increasing the incentive to burn fuel purely to maximise payments under the scheme. Tiering, which will reduce tariffs once fixed operation thresholds have been reached, will offer some protection. Burning unnecessary quantities of fuel is also against the regulations. The Department will nonetheless need to maintain an effective audit and inspection regime.[23]

- More generally, with a long-lived, complex and geographically dispersed scheme with a plan for more than 100,000 claimants, the Department will need to ensure it retains sufficient market intelligence and an adequate enforcement regime to identify and address fraud, non-compliance and gaming behaviour.

21 Current spending arrangements specify that where the actions or inactions of the Department increase spending beyond control totals, HM Treasury assumes the increase in spending will be funded by reductions in the Department's DEL budget, or by identifying firm savings in AME. HM Treasury may waive these financial penalties if overspends occur as a result of factors which are outside of the Department's control, for example as a result of unusually cold winters.

22 HM Treasury's Consolidated Budgeting Guidance set out rules applicable to different categories of expenditure. For AME spending, where expenditure is expected to come out higher than forecast, departments should be prepared to discuss what steps should be taken to offset these increases.

23 For the Renewable Obligation the Department partially reformed the scheme midway through implementation. It decided to stop grandfathering tariff rates for some biomass co-firing and small-scale solar projects and instead grandfather tariff rates based on a target rate of return. There is no equivalent framework in place for the RHI.

Fraud and non-compliance

3.10 As with any scheme, it is possible for participants to act fraudulently or not comply with the regulations, either deliberately or by mistake. On RHI, examples of non-compliance include:

- participants using the heat for an ineligible purpose, such as to heat domestic swimming pools;
- participants using an unsustainable fuel source, or not being able to demonstrate that they have used a sustainable fuel source;
- participants not providing the correct information about their installation to Ofgem, or not keeping Ofgem updated when they make changes to their installation; and
- errors in how participants meter the amount of heat they have used.

Non-compliance can reduce the value for money of RHI because the Department could be paying participants without achieving the commensurate benefits in terms of renewable heat generation and carbon reduction. Where non-compliance is detected, Ofgem has powers to stop payments, claim back any non-compliant payments made and adjust future payments to offset any overpayments once a site is compliant with scheme rules.

Measuring the impact of non-compliance

3.11 The Department relies on Ofgem to estimate the value of overpayments due to fraud and non-compliance. Since 2015-16, Ofgem has audited a randomly selected sample of scheme participants to estimate rates of non-compliance. This sits alongside its more targeted audits, which are directed at participants it considers high risk. In prior years, Ofgem only conducted targeted audits of high-risk participants, meaning it could not make a representative estimate of non-compliance. In 2016-17, Ofgem estimated that the financial impact of non-compliance was 4.4% in the Non-domestic scheme and 2.5% for the Domestic scheme. This equates to a total of £3 million in overpayments in 2016-17. If these rates of non-compliance were maintained for current accredited participants over the life of the scheme, this would lead to overpayments of around £150 million (**Figure 16** overleaf).

Figure 16

Ofgem's estimate of the financial impact of non-compliance, 2016-17

	Non-domestic RHI		Domestic RHI	
	2015-16	2016-17	2015-16	2016-17
Number of audits in sample[1]	124	86	361	268[2]
Percentage of participants found to be non-compliant through audit	53%	52%	23%	34%
Estimated financial impact of non-compliance	0.09%	4.4%	1.8%	2.5%
Equivalent overpayments in monetary terms in 2016-17[3,4,6]	–	£0.9m	–	£2.3m
Equivalent lifetime overpayments in monetary terms for accredited participants up to March 2017[3,5,6]		£132m		£18m

Notes

1 In addition to randomly selected site audits, Ofgem also undertakes a targeted site audit programme. In 2016-17 it undertook 110 and 456 targeted site audits in the Non-domestic and Domestic schemes respectively.

2 This is the number of audits completed at the time Ofgem made its estimate. Its total sample size was 436, with 168 audits still open at the time of Ofgem's estimate.

3 In paragraph 3.12 we explain the 2016-17 estimate of non-compliance in the Non-domestic scheme is not representative of all participants.

4 Equivalent overpayments in monetary terms: for participants accredited up to March 2016 in the Non-domestic scheme (0.09% x £356 million payments = £0.3 million); for participants accredited in 2016-17 in the Non-domestic scheme (4.4% x £13 million payments = £0.6 million); for all accredited participants in the Domestic scheme up to March 2017 (2.5% x £90 million payments = £2.3 million).

5 Equivalent overpayments in monetary terms: for participants accredited up to March 2016 in the Non-domestic scheme (0.09% x £9.8 billion estimated lifetime payments = £8.8 million); for participants accredited in 2016-17 in the Non-domestic scheme (4.4% x £2.8 billion estimated lifetime payments = £123.2 million); and for all accredited participants in the Domestic scheme up to March 2017 (2.5% x £0.7 billion estimated lifetime payments = £17.9 million).

6 Our overpayments analysis does not take into account accruals.

Source: National Audit Office analysis of Ofgem data

3.12 We have identified significant weaknesses in Ofgem's approach, which mean its estimates are unreliable.

- In 2016-17, Ofgem did not ensure its audit sample was representative of the overall scheme population. On the Non-domestic scheme, Ofgem only sampled participants that joined the scheme during the previous year. For its Domestic scheme estimate, Ofgem's sample excluded participants with payments above a certain threshold. On both schemes, it did not include participants that it had previously audited. Consequently, Ofgem's audit sample was not representative of the overall scheme population, meaning it cannot be used to estimate reliably the overall non-compliance rate.

- We found an error in the Domestic RHI calculation, and that Ofgem's calculation was based on an incomplete sample, with 39% of audits still open at the time it was made. We calculate that correcting for the error and including all the audits completed up to December 2017 would increase the central estimate of overpayments for the Domestic scheme from 2.5% to 4.5%.

- There are weaknesses in key assumptions underpinning Ofgem's estimate for overpayments under the Non-domestic scheme. Compliance investigations following an audit, which determine the amount that Ofgem has previously overpaid a participant, can take several months. Therefore, in order to provide the Department with a timely estimate of non-compliance, Ofgem estimated the potential financial impact of each occurrence of non-compliance detected through an audit. But these estimates, which the Ofgem audit team has set, are not robust. We found no evidence of routine review of their accuracy or independent validation.

- Ofgem reported its 2016-17 estimate of non-compliance to the Department as a single 'point estimate', which ignores the significant uncertainty inherent in the sampling methods used. All statistical sampling models have some uncertainty attached to the results, which is normally dealt with by showing a range of possible results. Decision-makers should consider the upper and lower estimates in combination with a central estimate as this could impact their interpretation of the results. Ofgem's own sampling tool indicated that the upper limit of its Non-domestic estimate was 1.9% in 2015-16 and 9.2% in 2016-17.

- Ofgem has not subjected its estimates to sufficient independent review to ensure their accuracy. The part of Ofgem that administers RHI, including accrediting the scheme, is also responsible for estimating rates of non-compliance. There is consequently a risk that it lacked independence and objectivity, particularly as the Department holds it to account on how effectively it administers the scheme, including minimising rates of non-compliance.

3.13 Ofgem is aware of the weaknesses in its approach and is implementing measures to address some of them. In 2017, the Department and Ofgem decided to include all participants in its sampled population for the Non-domestic RHI in 2017-18. It is also considering auditing participants if they are picked in the sample even if they have been audited previously. It is introducing a central assurance team, independent of Ofgem's RHI team, to provide an independent perspective on its audit and compliance work.

3.14 The Department's oversight of Ofgem's estimate of overpayments has been insufficient. As the Department accounts for RHI spending in its financial statements, it is responsible for ensuring scheme expenditure is in line with Parliament's intentions, with the amount wasted due to non-compliance at an acceptably low level. Given it holds this responsibility, and the risks of overpayment in a scheme which is novel, complex and large scale, the Department has not done enough to ensure Ofgem's estimate is reliable. It has not reviewed Ofgem's calculation and the underpinning assumptions, or the quality assurance arrangements Ofgem has put in place to ensure accuracy.

3.15 The weaknesses in Ofgem's approach mean it is not possible to estimate reliably the impact of non-compliance on RHI's value for money. The Department cannot adjust its assessment of the scheme's costs and benefits to take account of overpayments or non-renewable heat generated. Overall, we consider that there is a risk that the actual financial impact of non-compliance is higher than Ofgem has reported, although the weaknesses in its data mean it is not possible for us to say by how much. The rate is very likely to be higher than that which the Department has stipulated as its tolerable level of overpayment, namely 1% for Non-domestic RHI and 3% for Domestic RHI.

Ofgem's approach to reducing fraud and non-compliance

3.16 We have assessed Ofgem's approach to reducing fraud and non-compliance against good practice criteria we have identified through our audits of other government policies with similar features to the RHI, such as benefit and tax credit payments.[24] While we recognise that Ofgem has less experience with this type of operation than some other departments we have assessed, we have identified a number of areas where it could be more effective at reducing fraud and non-compliance:

- Ofgem does not know which types of non-compliance have the biggest financial impact, meaning it cannot know if it is targeting its activities effectively. Ofgem collates statistics on the most commonly occurring types of non-compliance found and reports these to the Department quarterly and annually. Previously, Ofgem has performed targeted audits on participants it considers to be at higher risk of non-compliance, but has prioritised the most commonly occurring types of non-compliance rather than those with the greatest impact. In 2017-18, it is beginning to target participants it considers to be at risk of the greatest financial losses if they are non-compliant, by performing additional targeted audits on high-value biomethane plants.

24 Comptroller and Auditor General, *Fraud and error stocktake*, Session 2015-16, HC 267, National Audit Office, July 2015.

- Ofgem could do more to use its audit and compliance work to pinpoint and address root causes of non-compliance. Where Ofgem has identified non-compliance with a large financial impact through audits, its subsequent actions to address the root cause are often incomplete, and sometimes not present at all. Performing more audits without addressing the root causes of non-compliance is unlikely to reduce non-compliance as the same errors will continue to occur.
- Ofgem is unable to measure the effectiveness of the actions it takes to reduce non-compliance, such as issuing new guidance or making changes to the application process. This is because it does not have a reliable estimate of the financial impact of non-compliance to provide a baseline.

Collaborating with other public bodies

3.17 Ofgem could improve its approach to non-compliance by collaborating more effectively with other public bodies. It has a range of tools to ensure participants comply with RHI regulations. These include checks at the accreditation stage, offering information and advice, targeting inspections and, in serious cases, suspending payments, issuing financial penalties or removing participants from the scheme. Local authorities and the Environment Agency have a wider remit and access to more information, which they use to monitor and enforce civil and environmental regulations.[25] This information could provide useful additional intelligence to Ofgem to support its audit and inspection programme. Likewise, data from Ofgem in relation to RHI sites could help other public bodies direct their environmental enforcement activities.

3.18 One example relates to the 28,000 biomass boilers accredited to the RHI spread across Great Britain. These installations mainly burn wood and emit smoke to the air. We found weaknesses in the monitoring of these emissions. We attended two site visits during our study and an environmental engineer from Ricardo (the firm to which Ofgem has contracted out site audit work) explained to us that the quality of emissions from biomass boilers is likely to deteriorate over time, particularly if equipment is not well maintained. RHI participants are required to comply with air quality rules to receive RHI payments. Ofgem's audit and inspection programme checks evidence of performance from an emission certificate, environmental permit, and/or the plant is operated in accordance with the manufacturer's requirements. It does not currently undertake any emission testing of pollutants which can damage local air quality, despite this being a condition to receive RHI payments.[26]

25 Regulations include planning permission, air quality, statutory nuisance and environmental permitting.

26 Air quality requirements are for biomass boilers accredited onto the RHI from September 2013. These requirements set maximum permitted emissions for particulate matter (30 grams per gigajoule (g/GJ) net heat input) and oxides of nitrogen (150 grams per gigajoule (g/GJ) net heat input). For sites accredited pre-September 2013, these requirements do not apply.

3.19 We are aware of instances of alleged serious smoke pollution from sites running biomass boilers that have received RHI payments. Local authorities are responsible for handling air quality complaints from citizens under statutory nuisance legislation.[27] We found Ofgem was not proactive in sharing its data to assist local authorities, data which these organisations could use to assist their monitoring and enforcement activity. We are aware of one local authority that had to formally request data from Ofgem using the provisions of the Data Protection Act.[28] The local authority now plans to use this data to prioritise its monitoring and enforcement activity.

3.20 Ofgem does not currently cross-check RHI applications with environmental permits which regulate waste management or planning permission applications. This is potentially valuable third-party data and information it could use to improve its approach to monitoring compliance and targeting its audit and inspection programme. Ofgem is now setting up a new data-sharing agreement with the Environment Agency to fill this gap. It is also exploring what more it can do with local authorities.

Gaming risks

3.21 RHI regulations are complex and provide opportunities for participants to game them. Gaming occurs where participants are generating and using heat eligibly according to the regulations, but in a way that does not meet the intentions of the scheme, such as by not being energy-efficient or environmentally friendly. Instances of gaming, while not against the rules, reduce the value for money of the scheme. The RHI could be vulnerable to gaming as its complexity and novelty present a challenge to drafting regulations that are clear on what is and is not compliant.

3.22 There are indications that some participants might be gaming the RHI regulations. For example, on the Non-domestic scheme there is a pronounced 'bunching' of boiler installations of precisely 199kWth (**Figure 17**). This reflects the more generous tariff rate that was available for boilers up to that size. A participant could install multiple boilers sized up to 199kWth, with a combined capacity above 200kWth, yet still receive the more generous tariff rate. We found more than 1,000 sites which have installed two or more biomass boilers, with 161 instances of five or more biomass boilers installed at a single site.

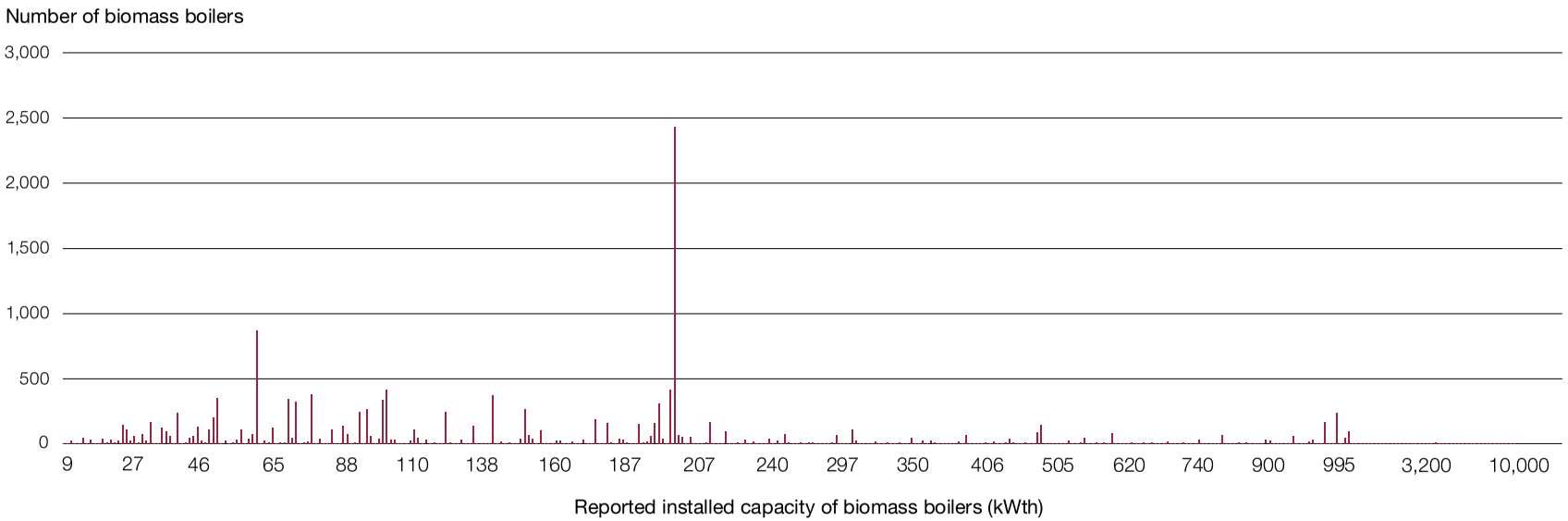
3.23 The use of multiple installations at a single site can be for legitimate purposes. For example, using more than one installation to serve multiple buildings or provide a back-up source of heating should the primary source fail. However, the Department has not assessed how many multiple installations could be purely to exploit the scheme's regulations.

27 Environmental Protection Act 1990.
28 Data Protection Act 1998, section 29-3.

Figure 17

Reported installed capacity of biomass boilers accredited to the Non-domestic Renewable Heat Incentive for accredited participants up to September 2017

16% of Non-domestic biomass boilers are reported to be sized at 199kWth



Source: Ofgem management information

The Department's management of gaming risks

3.24 The Department relies on Ofgem alongside its market intelligence and discussions with trade associations to flag up instances of gaming. The Department keeps a 'gaming register', which lists potential risks identified through Ofgem's audit programme, and the measures it is taking to mitigate them. An internal review in 2017 highlighted how the Department relies primarily on Ofgem to flag potential instances of gaming, but that Ofgem's audits focus on compliance with the regulations. There is less guidance from the Department on what Ofgem should report when "compliant but unforeseen activities" are observed.

3.25 The Department has used this system to identify and implement a number of changes over the course of the scheme to address gaming risks. For example, in 2017 it revised tariff rates available to new applicants for Non-domestic biomass boilers to a single band. The Department has also consulted on additional changes intended to tighten regulations on eligible and manufactured heat use, environmental permitting, incidental Non-domestic heat use and multiple installations. Based on its understanding of the scheme, the Department considers that the major remaining gaming risks will be addressed through these changes.

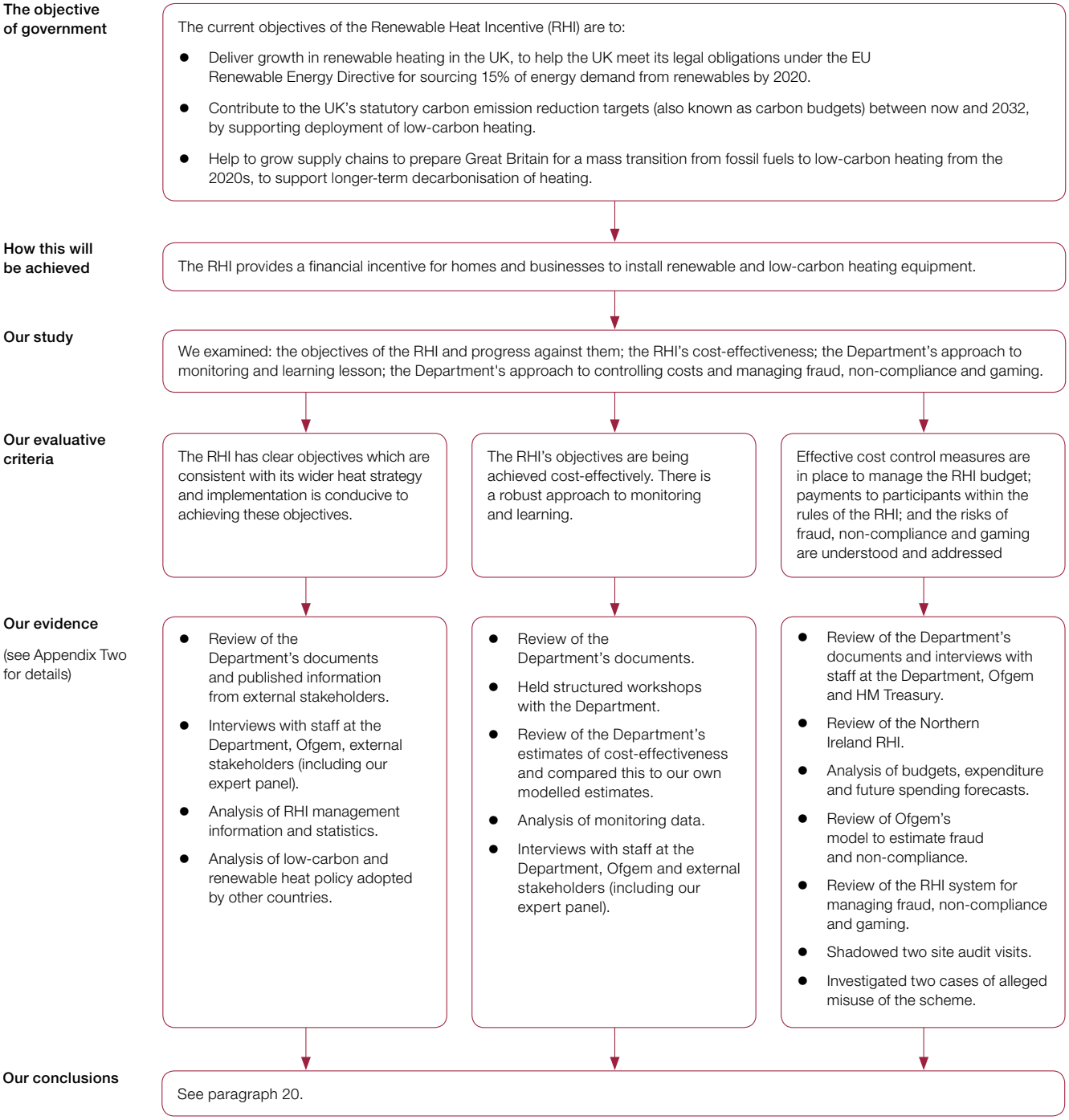
3.26 However, the Department does not know how prevalent gaming is across the RHI. It does not know the impact gaming has on the scheme's achievements to date, which types of gaming have had the most significant financial impact or whether the reforms it has introduced have been effective. Without knowing which types of gaming are most prevalent the Department cannot prioritise its future actions to address gaming effectively.

Appendix One

Our audit approach

1 See **Figure 18**, overleaf.

Figure 18
Our audit approach



Appendix Two

Our evidence base

1 We have reached our independent conclusions on the Department for Business, Energy & Industrial Strategy's (the Department's) implementation of the Renewable Heat Incentive (RHI) and whether the scheme has cost-effectively increased the generation of low-carbon heat in homes and businesses following our analysis of evidence collected between July 2016 and February 2018.

2 Our audit approach is outlined in Appendix One.

3 **We reviewed the context and design of the RHI programme (Part One).**

- We reviewed the Department's documents including business cases, impact assessments and consultations to understand the design of the RHI. We also reviewed published information from external stakeholders, including Committee on Climate Change progress reports.
- We interviewed staff at the Department and Ofgem, as well as external stakeholders, to understand roles and responsibilities, changes made to the RHI since its launch in 2011, the barriers to uptake and policy proposals developed by the Department to tackle these barriers.
- We analysed management information and statistics to measure payments and the number of participants accredited to the RHI.
- We compared the government's approach on low-carbon and renewable heat with other European countries (see Appendix Four).

4 We assessed the RHI's progress against objectives, cost-effectiveness and approach to monitoring and learning lessons (Part Two).

- We reviewed the Department's documents and management information to understand how objectives have changed; the progress made against the revised objectives; associated costs both incurred and expected; and the expected contribution of the RHI to wider obligations on renewable heat and carbon budgets.
- We used a market management toolkit and management information to assess progress in developing the supply chain for low-carbon and renewable heat.
- We held workshops with the Department to understand its own assessment of the cost-effectiveness of the RHI. We then used an anonymised dataset from Ofgem, to produce our own estimate of the renewable heat and carbon cost-effectiveness of the RHI (see Appendix Five).
- We conducted workshops with colleagues from the Department and Ofgem to understand their approach to mapping the customer journey and improving customer service. We analysed management information to determine progress against key performance indicators.
- We interviewed staff in the Department and Ofgem to assess how lessons are learned and whether those lessons influence planning and policy development.

5 We assessed the Department's approach to controlling costs and whether fraud, non-compliance and gaming are adequately prevented (Part Three).

- We reviewed the Department's and Ofgem's documents to understand how it manages the RHI budget, payments made to participants and compliance checks. We also interviewed staff at the Department, Ofgem and HM Treasury to further our understanding of the approach as well as how risks are identified, monitored and acted upon.
- We investigated the differences between the Great Britain and Northern Ireland RHI by reviewing Northern Ireland Audit Office reports and public inquiry documents on the Northern Ireland RHI (see Appendix Three).
- We analysed management information to measure RHI spending against the budget and expected forecast spending over the lifetime of the RHI.
- We reviewed the model used by Ofgem to estimate rates of fraud and non-compliance. We also analysed management information on site audit caseload and the outcomes of these site audits.

- We reviewed the management system for managing instances of fraud, non-compliance and gaming. We also visited Ofgem's two customer care centres where we conducted a process walk-through and interviewed staff to understand the accreditation, administrative and compliance-checking process.
- We shadowed on-site visits with scheme auditors to observe the site audit inspection process.
- We investigated cases of alleged misuse of the scheme brought to our attention by members of the public.

6 We received independent scrutiny and advice from an expert panel consisting of Jenny Hill (Committee on Climate Change), Zoe Guijarro (Citizens Advice), Keith MacLean (Chair of the UK Energy Research Centre and technical assessor to the Northern Ireland RHI Inquiry), Richard Lowes (University of Exeter), Robert Gross (Imperial College London) and Nick Eyre (University of Oxford).

Appendix Three

The Northern Ireland Non-domestic RHI scheme

1 The Department for Enterprise, Trade and Investment (DETI) was responsible for the Non-domestic Renewable Heat Incentive (RHI) scheme in Northern Ireland.[29] The scheme was launched in 2012 based on a similar design to the Great Britain RHI but with significant differences. DETI used different tariff rates to the Great Britain scheme. It also decided to use a single tariff band and not introduce tiered tariffs (which switch participants' tariff from a higher to lower rate once heat production reaches a pre-defined limit) to control spending for existing participants.

2 In Great Britain, tariff degression was introduced into the Non-domestic RHI from 2012. This cost control measure enabled the Department to reduce tariff rates for new applicants when the rate of applications exceeded pre-defined limits. As a result of degression, tariff rates for biomass boilers sized up to 200kWh in the Non-domestic scheme fell from 8.9p/kWh to 4.2p/kWh between 2013 and 2015.[30] Over the same time period, DETI increased tariff rates available for biomass boilers from 6.3p/kWh to 6.4p/kWh (see **Figure 19**).[31]

3 DETI did not implement cost control measures until 2015, following an increase in the number of applications as a result of the higher tariffs. It announced that it would introduce the tiering of tariffs, which led to a spike in applications before it was able to implement the cost control reform. This led to the scheme running out of money and being suspended to new applicants in February 2016.

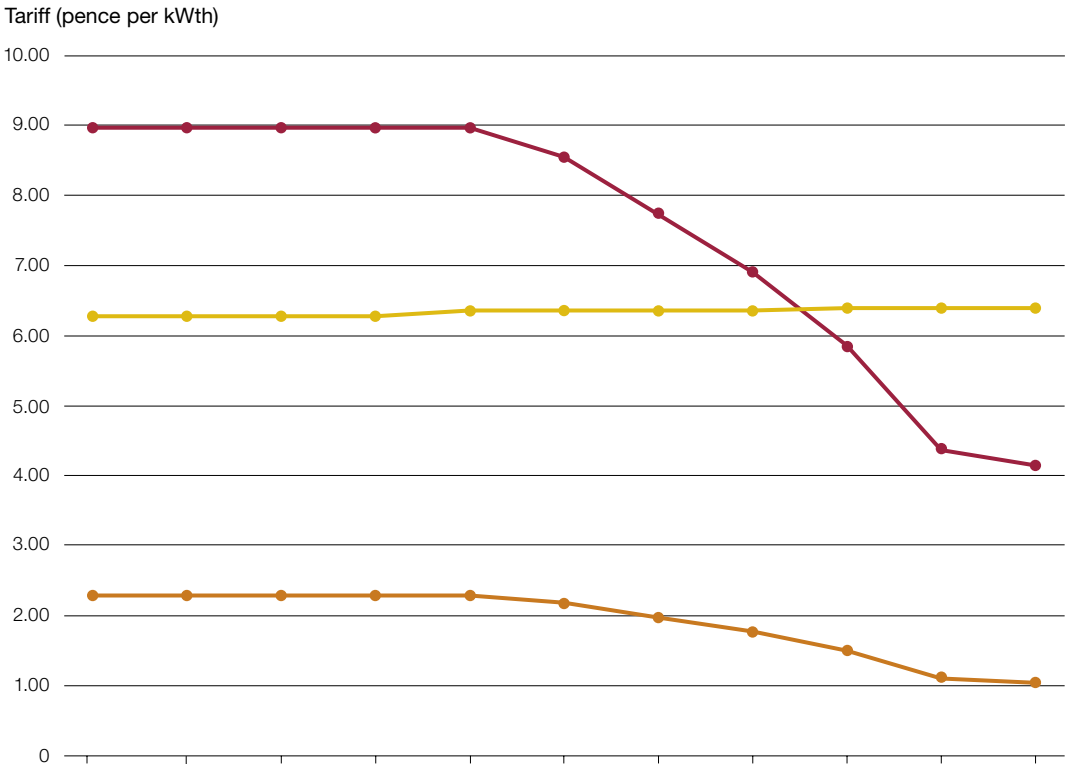
4 Since the suspension of the Non-domestic RHI in Northern Ireland there has been extensive parliamentary scrutiny and in 2017 a public inquiry was set up to investigate and report on the RHI scheme. Through this process, there have been accusations of participants abusing the scheme. As there was no tiering of tariff rates, degression of tariffs for new participants or an absolute cap on the amount of heat a participant could produce, participants were provided with a financial incentive to run their heating system 24 hours a day all year round, even if the heat generated was not used. The Northern Ireland inquiry is looking into these issues.

29 Renamed the Department for the Economy in 2016.
30 Tariffs in 2015-16 prices.
31 See footnote 30.

Figure 19

Tariff rates for biomass boilers in the Northern Ireland and Great Britain Non-domestic Renewable Heat Incentive

Tariff rates for biomass boilers in the Northern Ireland Non-domestic RHI increased between 2013 and 2015 whereas they fell in the Great Britain equivalent scheme as a result of degression



	Apr 13	Jul 13	Oct 13	Jan 13	Apr 14	Jul 14	Oct 14	Jan 15	Apr 15	Jul 15	Oct 15
GB Tier 1	8.94	8.94	8.94	8.94	8.94	8.53	7.72	6.91	5.87	4.40	4.18
Northern Ireland Tariff Rate	6.29	6.29	6.29	6.29	6.37	6.37	6.37	6.37	6.4	6.4	6.4
GB Tier 2	2.34	2.34	2.34	2.34	2.34	2.24	2.03	1.83	1.56	1.17	1.11

Notes

1 This figure compares the Great Britain small commercial biomass boiler tariff, which include boilers that are less than 200 kWth in size, to the Northern Ireland medium commercial biomass and municipal solid waste tariff, which include boilers between 20 kWth and 200 kWth in size.

2 The tariffs are in 2015-16 prices.

Source: Report by the Comptroller and Auditor General for Northern Ireland, Department of Enterprise, Trade and Investment, Resource Accounts 2015-16

Appendix Four

International comparisons

1 The UK has lower rates of renewable heating than other countries in the European Union. The Renewable Heat Incentive (RHI) was the first major programme in the EU to increase rates of renewable heating using a tariff-based financial incentive. Other European countries have focused on the use of regulation, capital grants and carbon taxes to incentivise renewable heating (see **Figure 20** and **Figure 21**).

2 Our analysis has found that across 22 countries in Europe in 2013, high rates of renewable heating were correlated with high rates of district heating. District heating or heat networks are distribution systems of insulted pipes that takes heat from a central source and delivers it to a number of domestic and/or non-domestic buildings. The heat source can be a facility that provides a dedicated supply to the heat network such as a biomass boiler or heat pump, or energy from waste plants (see **Figure 22** on page 58).

Figure 20

Policy approach to increase rates of renewable heating and cooling in five European countries

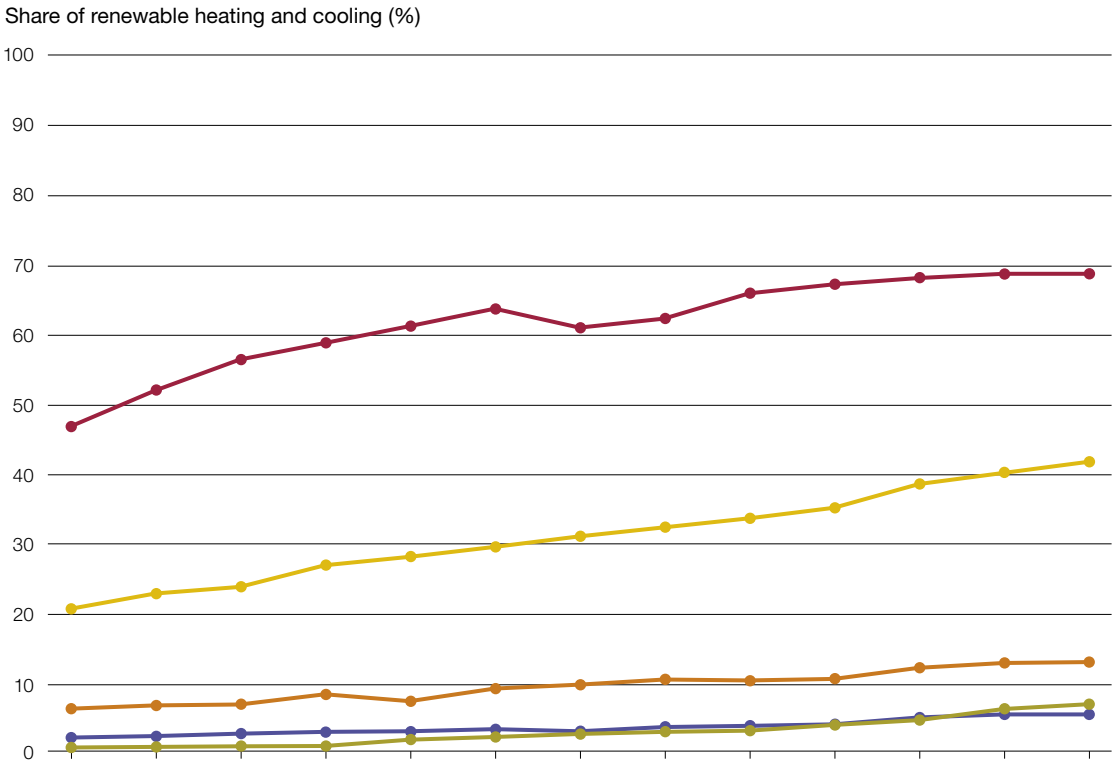
Country	Renewable heating and cooling rate in 2016 (%)	Approach to increasing rates of renewable heating
Sweden	69	Policy framework established in the 1970s, high carbon taxes on fossil fuels, focus on district heating and use of national biomass resources
Denmark	42	Policy framework established in the 1970s with a focus on district heating
Germany	13	Grant funding for renewable heating equipment launched in 2000
Netherlands	6	Tariff-based financial incentive launched in 2011, subsidies are auctioned to Non-domestic bidders twice a year
UK (including Northern Ireland)	7	Tariff-based financial incentive launched in 2011, Heat Network Investment Project piloted in 2017

Source: National Audit Office analysis of international evidence on heating policy

Figure 21

Renewable heating and cooling rates for Sweden, Denmark, Germany, Netherlands and the UK between 2004 and 2016

The UK is starting from a historically low level of renewable heating compared with other European countries



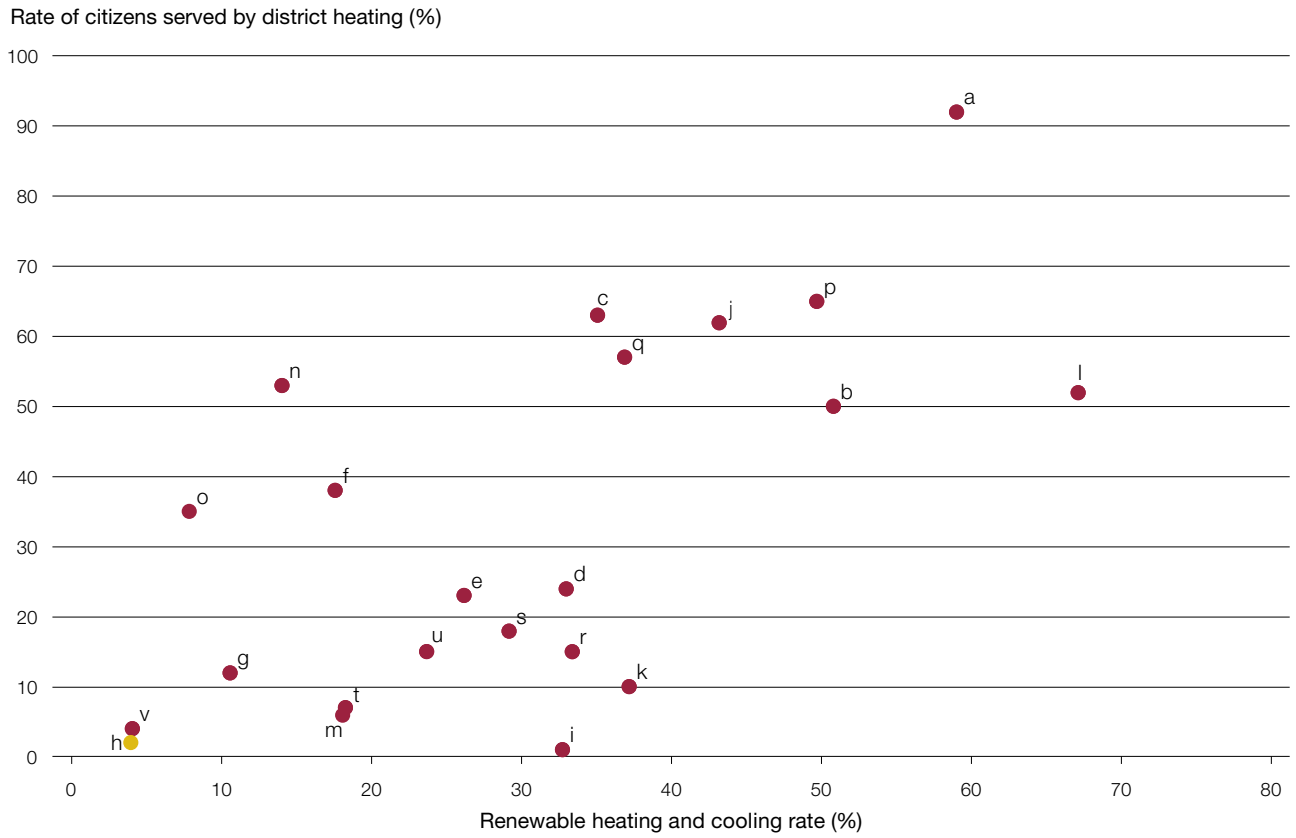
	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Sweden	47	52	56	59	61	64	61	62	66	67	68	69	69
Denmark	21	23	24	27	28	30	31	32	34	35	39	40	42
Germany	6	7	7	8	7	9	10	11	10	11	12	13	13
Netherlands	2	2	3	3	3	3	3	4	4	4	5	6	6
United Kingdom	1	1	1	1	2	2	3	3	3	4	5	6	7

Source: Eurostat

Figure 22

Renewable heating and cooling rates and the rate of citizens served by district heating across the European Union, Iceland and Norway in 2013

In Europe, high rates of renewable heating were correlated with high rates of district heating



a	Iceland	i	Norway	p	Latvia
b	Finland	j	Estonia	q	Lithuania
c	Denmark	k	Croatia	r	Slovenia
d	Austria	l	Sweden	s	Bulgaria
e	Romania	m	Italy	t	France
f	Czech Rep	n	Poland	u	Hungary
g	Germany	o	Slovakia	v	Netherlands
h	UK				

Source: National Audit Office analysis of Eurostat data (2013) and biennial Euroheat & Power publication (2013)

Appendix Five

Cost-effectiveness of the Renewable Heat Incentive

1 The cost-effectiveness of the Renewable Heat Incentive (RHI) can be measured in different ways. The Department for Business, Energy & Industrial Strategy (the Department) uses a method based on the net 'resource cost' to the economy. This compares the cost of installing and running the technology with an estimate of the monetary value (to society) of the carbon saved and renewable heat generated. This measure does not separately identify the amount of money spent by the taxpayer and relies on forecasting carbon prices (market price and non-traded carbon price) more than 20 years into the future.

Our methodology

2 We measure cost-effectiveness as the amount of taxpayers' money spent to achieve each unit of desired output: one megawatt hour (MWh) of renewable heat and one tonne of carbon emissions avoided (t/CO_2e). In our analysis, we estimate payments, heat generated and carbon saved over the lifetime of the heating systems installed up to September 2017.[32] As a 'base case' we have attempted to replicate the most relevant assumptions the Department has used in its impact assessments and monitoring tools. We then examine the implications of varying these key assumptions.

3 Our results also rely on other simplifications, which means they should be treated as indicative rather than definitive. For example, we extrapolate 20 years of generation and payments from the first five years of the schemes, so small changes in the base data could imply large changes in the results.

32 Our results are in real terms and do not take into account inflation. We have used a 2018 price base.

4 We used different approaches to estimate cost-effectiveness for the Non-domestic and Domestic schemes.

- Non-domestic scheme: payments to participants are based on the amount of renewable heat they produce. This is measured through meter readings participants submit to Ofgem in order to receive payments. We used Ofgem payment records to estimate the average amount of renewable heat each applicant has produced to date, extrapolating this over the 20 year expected lifespan of the technology. For participants with payment records covering less than one year, we used an average load factor (applies to 21% of applications).[33] We used a different approach for biomethane plants because they have long ramp-up periods: extrapolating from generation early in the life of the plant would underestimate lifetime generation. To avoid this, we used the Department's estimate.
- Domestic scheme: payments, over seven years, are based on a specified heat demand as set out in the applicant's Energy Performance Certificate. We used this to estimate lifetime payments, renewable heat produced and carbon emission savings. We have assumed the technology's lifespan to be 20 years, in line with the Department's expectations.

Data

5 Ofgem provided the data for our 'base case' analysis. It contains anonymised records of the technology installed, application status, tariff rates and payments made to date. The payment data does not take into account accruals.

Base case results

6 Using the Department's key assumptions, we estimate the Department will spend an average of:

- £49/MWh to produce renewable heat over the lifetime of the installations accredited to the scheme up to September 2017; and
- £142 per tonne of carbon dioxide equivalent saved over the lifetime of the installations accredited to the scheme up to September 2017.

7 **Figure 23** breaks down these estimates by scheme (Non-domestic and Domestic) and technology within each scheme. The Domestic scheme is more cost-effective both in terms of heat and carbon cost-effectiveness. However, the low amount of heat generated by domestic installations (7.7% of the total) means they have little influence on the overall cost-effectiveness of the RHI. Cost-effectiveness, in terms of renewable heat generated and carbon emissions avoided, is heavily influenced by biomass boilers installed under the Non-domestic scheme. This contributes to 52% of the renewable heat generated through the RHI.

33 BEIS, *Survey of Non-domestic RHI Applicants* (Wave 2), January 2016

Figure 23

Estimated 'base case' cost-effectiveness of the scheme for participants accredited to the RHI up to September 2017

Technology	Total estimated lifetime payments (£bn)	Total estimated lifetime renewable heat production (TWh)	Total estimated lifetime carbon emission reductions ($MtCO_2e$)	Renewable heat cost-effectiveness (£/MWh)	Carbon cost-effectiveness (£/tCO_2e)
Non-domestic RHI					
Biomass boiler	7.3	162.2	37.8	45	193
Biomethane[1]	4.2	64.3	38.5	65	109
Biogas[1]	1.2	21.9	12.7	54	92
Air source heat pump	0.0	0.4	0.1	26	137
Ground source heat pumps	0.2	3.0	0.6	78	411
Other[2]	1.4	33.3	10.8	43	134
Subtotal	**14.3**	**285.2**	**100.4**	**50**	**143**
Domestic RHI					
Biomass boiler	0.4	9.6	2.8	37	129
Air source heat pump	0.2	9.4	2.0	17	81
Ground source heat pump	0.2	4.6	1.1	48	204
Solar thermal	0.02	0.3	0.1	71	244
Subtotal	**0.8**	**23.9**	**5.9**	**32**	**128**
Total	**15.1**	**309.0**	**106.3**	**49**	**142**

Notes

1 Our base case assumes a feedstock mix of 65% food waste and sewage, 35% agricultural (crop). Carbon cost-effectiveness estimates for biomethane and biogas plants are highly sensitive to changes in feedstock mix. Where only crops are used in these plants, we estimate carbon cost-effectiveness worsens to more than £500 per tonne.

2 Includes combined heat and power, geothermal and solar thermal.

3 Cost-effectiveness estimates are in real terms, 2018 prices. Forecast estimates of payments and heat production are undiscounted, payments do take into account forecast inflation rates.

4 This analysis relies on a set of assumptions compiled by the Department for Business, Energy & Industrial Strategy. We have not validated these assumptions.

5 Totals may not sum due to rounding.

Source: National Audit Office analysis of the actual cost-effectiveness of the Renewable Heat Incentive

Sensitivity analysis

8 **Figure 24** on pages 63 and 64 sets out five of the most important assumptions underpinning our estimates of cost-effectiveness. **Figure 25** on page 64 and **Figure 26** on page 65 show the sensitivity of our estimates in terms of renewable heat and carbon cost-effectiveness. Our analysis indicates that there is significant uncertainty around our base case estimates, in particular carbon cost-effectiveness.

9 Changing the Department's assumptions on upstream emissions, additionality, fraud and non-compliance, lead to renewable heat and particularly carbon cost-effectiveness estimates worsening in all scenarios. This indicates that actual cost-effectiveness is likely to be worse than our base case results.

10 Note that the impacts estimated for each of the five key assumptions should not be combined.

Figure 24

The effect of five key assumptions on our cost-effectiveness estimates

The Department's central assumption	Implication of changing the assumption for estimated costs, outputs and cost-effectiveness
1 **Upstream emissions:** biomethane and biogas technologies are capable of saving large amounts of CO_2e per unit of heat generated. Where these technologies use feedstocks such as food waste - organic matter which would otherwise have been disposed in a landfill (where it would decompose and emit methane, a powerful greenhouse gas) - an anaerobic digestion process is used to produce biomethane which is injected into the gas grid or biogas to produce heat. This process offsets waste disposal to landfill (upstream) and natural gas use (downstream). The Department assume approximately 65% of feedstock for biomethane and biogas is from either food waste or sewage sources. The remaining 35% feedstock is from agricultural sources, typically crops, which do not provide the same upstream benefits.	Adjusting assumptions on upstream emissions does not influence renewable heat cost-effectiveness. But our estimate of carbon cost-effectiveness is highly sensitive to this assumption. Analysis of UK anaerobic digestion plants indicates around 40% to 60% of plants could be using mostly agricultural, crop based feedstocks. Our pessimistic scenario assumes 56% of feedstock is crop based (compared to 35% in the base case), with the remaining 44% using either food waste or sewage. In this scenario, carbon cost-effectiveness for the RHI worsens to £160 per tonne.
2 **Biomethane correction:** participants declare to Ofgem expected volumes of biomethane to be injected to the gas grid under the RHI. The Department assume a significantly lower volume will in fact be produced (around 45% lower).	If all participants injected 100% of the biomethane they declared to Ofgem, total lifetime payments for biomethane would be £3.6 billion higher than the Department currently expects (for participants up to September 2017). In this scenario, renewable heat cost-effectiveness would worsen by between £1-£2 per MWh. This is because biomethane is above the renewable heat cost-effectiveness average for the RHI. Carbon cost-effectiveness however would improve from £142 to £118 per tonne. This is because of the Department's assumption on upstream emissions.
3 **Converting renewable heat into carbon savings:** the Department uses a conversion table to translate renewable heat to carbon emission savings. We have not audited these conversion factors.	Varying carbon conversion factors has no influence on renewable heat cost-effectiveness. Our sensitivity analysis uses ranges provided by the Department to estimate how base case carbon cost-effectiveness would vary using different conversion factors. We find that carbon cost-effectiveness would range from £101 to £256 per tonne.
4 **Additionality:** the Department assumes that each installation accredited to the scheme would not have happened in the absence of the RHI. But a Department telephone survey of 501 non-domestic participants in February 2015 (adjusted to take account of a change in the mix of technologies on the scheme as at December 2017) found 25% would have installed the same or different renewable heat technology without the RHI.[1] The Department's survey of 5,513 domestic participants between 2014 and 2016 reports that 24% would have installed the same or different renewable technology without the RHI.[2]	Excluding renewable heat generated and carbon emissions saved from applicants, who the Department's surveys indicate, may have installed a renewable heating system anyway (that is, in the absence of the RHI), we estimate:[4] ● heat cost-effectiveness worsens to £65 per MWh of heat generated; and ● carbon cost-effectiveness worsens to £189 per tonne of CO_2e saved.

Figure 24 *continued*

The effect of five key assumptions on our cost-effectiveness estimates

5	**Fraud and non-compliance:** the Department assumes no fraud and non-compliance takes place in its cost-effectiveness analysis.	Using Ofgem's estimates of the level of fraud and non-compliance (4.4% for Non-domestic and 2.5% for Domestic), our sensitivity analysis assumes no impact on lifetime renewable heat produced and carbon emissions saved, but that participants on the scheme are effectively overpaid. In this scenario: • heat cost-effectiveness worsens to £51/MWh; • carbon emission savings cost-effectiveness worsens to £148/tCO_2e; and As explained in Part Three, we found significant weaknesses in Ofgem's estimates of overpayment and actual rates of fraud and non-compliance could be higher.

Notes

1 Department for Business, Energy & Industrial Strategy, *Survey of Non-domestic RHI Applicants (Wave 2)*, January 2016.

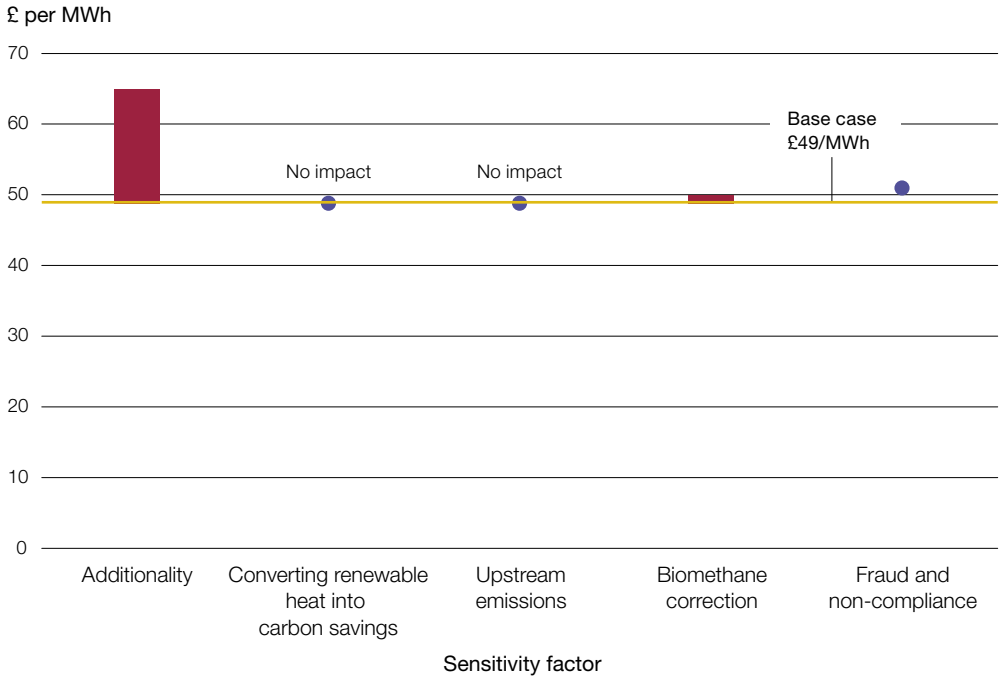
2 Department for Business, Energy & Industrial Strategy, *Report from waves 1-24 of the Domestic RHI census of accredited applicants, Annex: data tables domestic census waves 1-24*, September 2017.

Source: National Audit Office methodology for estimating the cost-effectiveness of the Renewable Heat Incentive

Figure 25

Renewable heat cost-effectiveness sensitivity analysis

The additionality assumption has the greatest impact on renewable heat cost-effectiveness

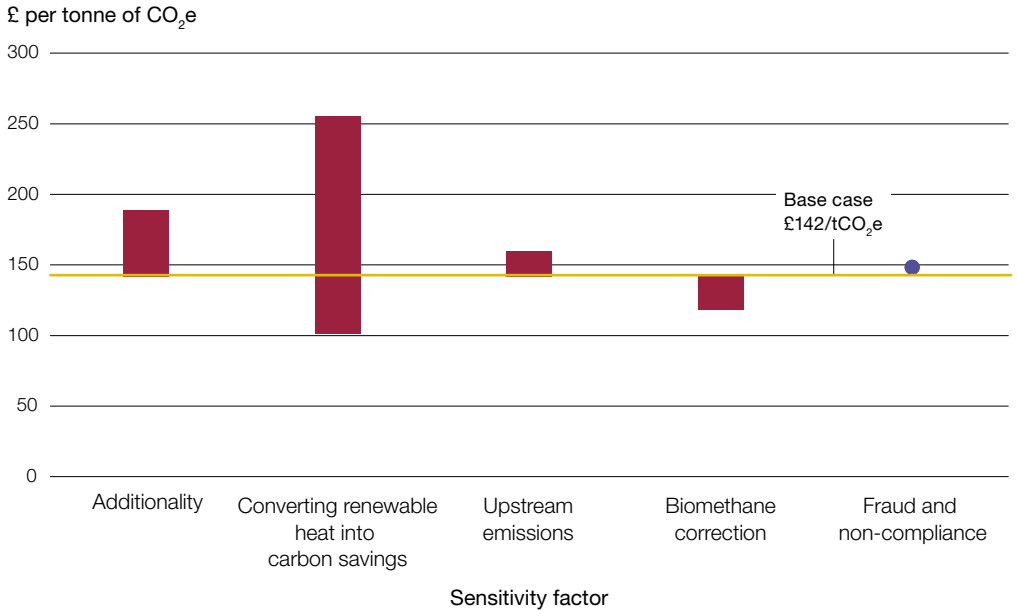


Source: National Audit Office sensitivity analysis around our cost-effectiveness estimates for the Renewable Heat Incentive

Figure 26

Carbon cost-effectiveness sensitivity analysis

Upstream emissions, converting renewable heat into carbon savings and additionality assumptions have the greatest impact on carbon cost-effectiveness



Source: National Audit Office sensitivity analysis around our cost-effectiveness estimates for the Renewable Heat Incentive

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