RENEWABLE ENERGY ASSOCIATION

| BIOENERGY STRATEGY

PHASE 1:

Bioenergy in the UK – The state of play

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Finally, also thank you to all the industry stakeholders who continue to participate in the numerous working group discussions, across power, heat and transport, providing invaluable insight to inform the Strategy's development.

The REA Bioenergy Strategy Project

The REA is leading an industry wide strategy paper for bioenergy in the UK, which we believe is timely due to:

- The rapidly evolving UK and international perspective on bioenergy
- Its critical role in the UK renewable energy scene now and potentially in the future
- The absence of an up-to-date UK government strategy for bioenergy or plans to develop one.

Objective

The objective of this work is to provide an industry led perspective on:

- The current contribution of bioenergy to UK energy supply and demand, including looking at the benefits that this brings
- An appreciation of the strengths of the current UK bioenergy industry and its capabilities
- To identify the barriers, including those related to policy and regulation, which are holding back more rapid deployment
- To develop the vision of what the sector could provide (by 2032) and how this could help UK policy objectives relating to environment, energy security and to economic development
- The actions needed to deliver the vision, including what policy and regulatory framework would be needed to allow industry to deliver this future, along with the complementary actions by government, or other players, that would help deliver it. For example, investment in research, design and demonstration (R,D&D), removal of specific regulatory barriers and supporting finance, amongst further proposals.

The project will examine bioenergy as a whole, and will consider the current and potential contributions from bioenergy to electricity, heat and transport, and in the context of the development of a sustainable bioeconomy.

Consultation

In order to ensure that the strategy is based on the active engagement of key stakeholders the following groups have been constituted:

- An advisory group made up of senior REA officials and industrial decision makers who can represent the main sectoral interests, along with experts/influencers from academia/consulting backgrounds and including key government officials as observers

- A number of small working groups of industry players to provide more detailed information and views for each of the main sectors.

As the strategy develops the work will also be discussed more widely with industry representatives via consultative workshops. The REA have also launched a call for evidence via their website to enable a broad range of stakeholders to contribute their views.[1]

Work Plan

In order to meet the objectives and scope above, the work project is organised into three main phases which are:

- **Phase 1** – a review of the current status and trends in bioenergy in the UK, covering;

    - Trends in the deployment of bioenergy;
    - The benefits of current bioenergy deployment in the UK in terms of impact on the environment, energy security and the economy (including jobs) and in developing industry strengths and capabilities that will be needed in the future
    - A review of the current policy and regulatory framework and the extent to which this is holding back further deployment.

- **Phase 2** – will develop a vision of bioenergy for the future with a focus on the contribution that can be made by 2032 the end of the 5th carbon budget accounting period. This will:

    - Consider current perceived role of bioenergy in future UK low carbon energy mix as described in government scenarios and plans
    - Review these to look at the implications for sector development in the medium to long term (2032 to 2050)
    - Identify other opportunities for greater bioenergy contribution in the medium term which can lead to immediate benefits or provide insurance against the non-delivery of other technologies
    - Identify potential, costs and benefits of additional options

[1] See https://www.r-e-a.net/news/rea-launches-bioenergy-review-with-new-call-for-evidence

- **Phase 3** – will develop an industry view of the key actions by the main actors to allow the vision to be achieved. This will include recommendations for:
    - Policy and regulatory measures
    - R,D&D priorities
    - Other actions relating to industry and to the finance sector, if appropriate

The aim is to complete the necessary work in order to allow publication of the report later this year.

For each of the three phases, a working paper will be produced, summarising the information and analysis provided by stakeholders. A summary of each paper will also be published via the REA website. These papers will form the basis for the final report from the project – a strategic document aimed at decision makers in government and industry.

Key Messages

- Bioenergy is recognised as a key renewable energy technology, and an essential component of a low carbon energy economy, internationally and in the UK, playing an important role in providing electricity, heat and transport fuels. The Committee on Climate Change has concluded that bioenergy could provide up to 15% of UK energy demand in a low carbon economy by 2050, highlighting the important role bioenergy with carbon capture and storage (BECCS) could play in hard to decarbonise sectors such as aviation.

- In the last 10 years bioenergy's contribution to the UK has grown strongly, helped by a supportive policy framework. Bioenergy is the largest contributing renewable technology in the UK, providing 7.4% of primary energy supply and:
    - 11% of UK electricity
    - 4% of energy used to produce heat
    - 2% of energy needed in the transport sector

- This deployment has established a portfolio of technologies which are tried and tested and stimulated cost reductions so that bioenergy options provide some of the lowest-cost renewable solutions.

- The issues around the sustainability of bioenergy are better understood and industry has worked with government to put in place strict and comprehensive sustainability management systems which ensure that bioenergy leads to very substantial reductions in greenhouse gas (GHG) emissions while complying with wider sustainability objectives.

- These contributions provide significant benefits to the UK, including:
  - A 4% reduction in UK greenhouse gas emissions
  - Business worth £6.5bn to the UK economy and which sustains 46,000 jobs
  - Helping to meet policy objectives in other policy areas such as waste management and forestry.

- The expansion of the industry has helped build up industry expertise and the development of fuel supply chains (from within and outside the UK) that will be essential in underpinning the necessary expansion of the sector as part of a low carbon energy economy.

- The current policy and regulatory framework which has helped the recent progress is, however, time-limited with many of the key policy instruments, such as the Renewables Obligation (RO) and the Renewable Heat Incentive (RHI) now closed and due to close, respectively. The future regulatory context is unclear, and the associated uncertainty makes industry investment very difficult, if not impossible, for the scale required.

- The further expansion of bioenergy is being held back by other barriers such as the imposition of unnecessarily limiting sustainability regulations which constrain bioenergy developments and leave opportunities for continued fossil fuel use. For example, unrealistically tight GHG limits on bioenergy generation will prolong gas generation with emissions which are typically five times higher.

The lack of an ambitious and supportive policy framework as well as unnecessary existing constraints on bioenergy is already having a major impact, with notable lack of new large-scale projects entering the pipeline. This hiatus risks the loss of expertise and supply chains which have been built up over the last ten years and which will be essential to an expansion of bioenergy to meet the ambitious carbon reduction targets in the medium and long term.

- There is substantial potential for bioenergy to grow and provide environmental, economic and social benefits to the UK, helping to meet a broad range of policy targets in the short and medium term. This can be done using technologies which are available today and which in many cases are the lowest-cost renewable solutions.

- To realise these benefits the UK government needs to provide a supportive policy and regulatory environment. This should be complemented by an evidence-based sustainability governance framework base which prevents bad practice and incentivises better performance.

- Bioenergy will also be a key element in the portfolio of technologies, which will be needed in the long term. To facilitate this, there is a need for a clear roadmap, developed jointly by government, industry and academia, which shows how some of the key technologies can be readied for deployment, and identifies the appropriate policy and regulatory measures that will be needed. This is particularly important for biomass gasification and for BECCS/U options.

- The next stages of this project will identify the most significant bioenergy opportunities that can contribute to the UK's goals to 2032 and beyond, and will identify the key actions needed by government, industry and other stakeholders to deliver this vision.

Photo shot by Matt of 'Streatley' on Unsplash

CONTENTS

1. Introduction

The important role of bioenergy today and in future sustainable low carbon scenarios is well recognised. The International Energy Agency (IEA) notes that sustainable bioenergy currently makes the largest contribution to global final energy demand at 5% (more than five times that of wind and solar combined) (IEA 2018).[2] It is the only renewable technology so far making an important contribution in the heating and transport sectors. In the IEA's low carbon scenarios sustainable bioenergy expands four-fold by 2050 (IEA 2017). The International Renewable Energy Agency (IRENA) gives bioenergy a similar role in its global REmap scenario for 2030, with bioenergy providing 22% of total global energy needs for transport, 14% of energy for buildings, 19% of energy needs for industry, and 4% of electricity generation. (IRENA 2019)

[2] Excluding the "traditional use" of biomass for cooking and heating in development and emerging economies.

Bioenergy is playing a similarly important role today in the UK, underpinning the move to renewable sources for electricity generation, for heat and in the transport sector. It also features strongly in the UK's vision for a low carbon energy future. The UK Committee on Climate Change indicated that bioenergy could provide up to 15% of UK energy needs by 2050 and highlighted the important role of bioenergy associated with carbon capture and storage in hard to decarbonise sectors such as aviation (CCC 2018).

However, bioenergy is a complicated subject, with many possible combinations of feedstocks, conversion technologies and energy products. It involves many interactions with other parts of the bioeconomy – for example with agriculture, forestry and the waste management sectors. It can also be a controversial topic, particularly as far as ensuring the sustainability of the production and use of bioenergy. Over the last ten years the understanding of these issues has much improved, internationally and in the UK, and industry and government have worked together to develop comprehensive approaches to sustainability management.

Given the importance of bioenergy, now and in the future, it is important that there is a clear strategy for its future deployment. The last comprehensive UK bioenergy strategy was published in 2012 (DECC 2012).

Much has changed since then – bioenergy has been deployed more extensively, costs have reduced, and the issues around sustainability are better understood and managed. Increased deployment has been helped by a supportive policy and regulatory framework. However, many of the policy instruments, which have helped stimulate progress, are now coming to an end, and the future regulatory context is unclear.

There is the potential for bioenergy to grow further and to continue to deliver environmental and economic benefits, while at the same time laying the foundations for the important role that bioenergy will have to play in a low carbon UK in the longer term. Action is needed now to build on the successes of recent years and to maintain the expertise that has been developed. However, there is currently no clear roadmap for how the UK can build on the progress made and this makes it difficult for the industry to invest with confidence.

As such, to address this, The Renewable Energy Association (REA) has chosen to facilitate the development of an industry-led strategy for bioenergy.[3] This will be developed in three phases. The first phase takes stock of the current state of play. The next stage will look at how bioenergy could contribute to the UK's energy economy in the medium term (to 2032) and beyond. The final phase will look at what actions are needed by government, industry and other stakeholders to deliver this vision.

This document is a summary of the work carried out under the first of these three phases. It looks at how bioenergy is contributing to the UK's needs for energy today, and the benefits that this contribution provides. It then reviews the current policy and regulatory framework, and identifies the uncertainties and other issues likely to constrain progress in this sector.

2. UK Bioenergy Deployment Trends

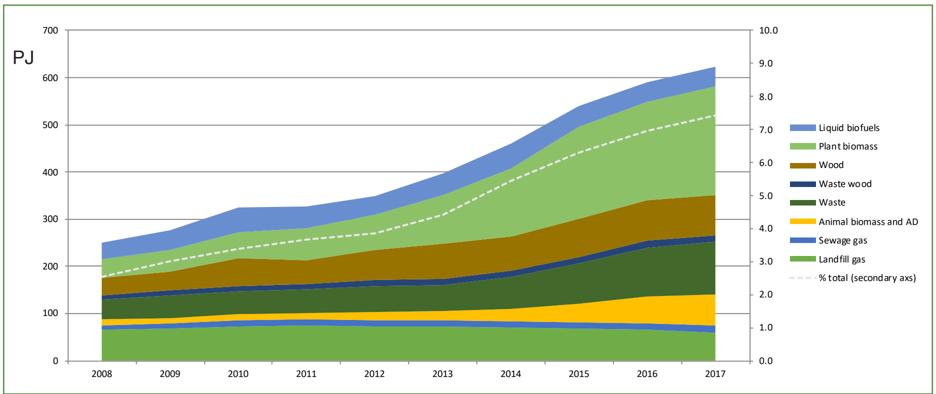
Based on the data in BEIS 'Digest of UK Energy Statistics' (DUKES) the contribution of bioenergy and wastes to UK energy supply has grown by a factor of more than 2.5 in the last ten years, from 250 to 623 Petajoules/year (Figure 1) (BEIS 2018a).[4] Biomass and wastes now supply around 7.4% of UK total primary energy supply compared to 2.6% in 2008.

[3] See https://www.bioenergy-strategy.com/ for a fuller description of the project.

[4] In this working paper, primary and final energy are expressed in metric units – e.g. giga-Joules (GJ) or multiples. Electricity generation is expressed in mega-watt-hours (MWh) or multiples. Conversion factors to other units are provided at the end of the document, but approximately one GJ = 0.024 tonnes of oil equivalent = 0.28 MWh.

The energy is provided by a diverse range of sources, with growth depending largely on the increased use of plant-based biomass and wastes.

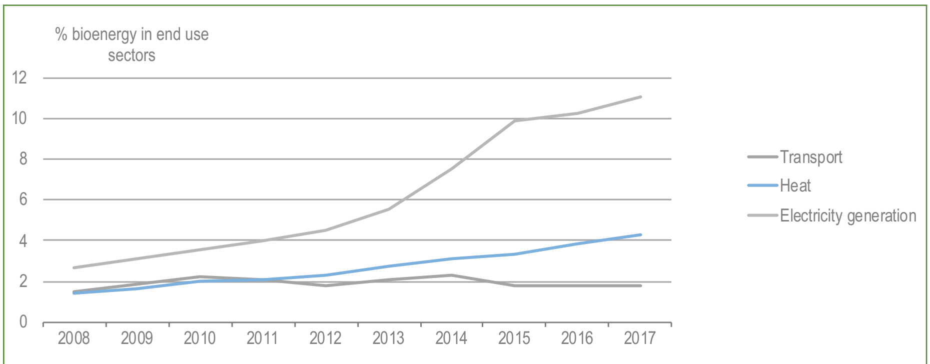
Figure 1 • Bioenergy and wastes in UK primary energy supply



Source: BEIS Digest of Energy Statistics (BEIS, 2018a)

Bioenergy plays a growing role in providing energy for electricity generation, heat and transport (Figure 2). Over the last 10 years, bio-electricity generation has grown the most, now providing 11% of UK electricity generation, along with 4% of heat used in homes, business and industry. Bioenergy in the transport sector has not grown significantly since 2008 and remains at around 2%.

Figure 2 • Bioenergy trends in end use sectors

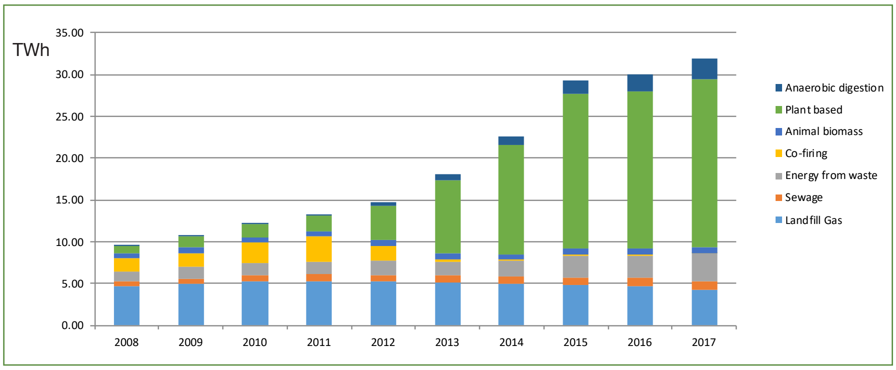


Source: BEIS Digest of Energy Statistics 2018 (BEIS, 2018a)

Electricity

Electricity generated from bioenergy sources has increased by a factor of 3.3 since 2008, stimulated by the Renewables Obligation and Feed-in Tariffs (Figure 3). In 2017, bioenergy was responsible for 32 TWh, over 11% of the UK's total electricity generation, and one third of all renewable electricity generation.

Figure 3 • UK Bioelectricity by source



Source: BEIS Digest of Energy Statistics (BEIS, 2018a)

This bioenergy generation is equivalent to the output of four nuclear plants such as Sizewell B, or around 1.5 times the anticipated output from the Hinkley Point nuclear plant, currently under construction.[5]

Figure 3 also shows how this generation has evolved, with a steady contribution from landfill gas being supplemented by a very strong growth in the use of plant biomass for power generation, based on a mixture of indigenous sources and imported wood. There has also been growth in other sources such as energy from waste and anaerobic digestion.

Bioenergy for Heating

Figure 4 shows the trends in bioenergy use for heating by sector, showing a 3-fold growth between 2008 and 2017, with bioenergy now providing around 4% of UK heat, up from 1.4% in 2008 (BEIS 2018a). Heat produced from biomass sources, using well-established technologies such as biomass boilers, provides the lowest cost renewable option.

[5] The capacity of the Sizewell B reactor is 1.22 GW. In 2017 it operated with an availability of 80%, so producing 8.5 TWh. Hinkley Point C's two reactors are planned to have a combined capacity of 3.26 GW. If operating at an 80% availability they would produce 22 TWh/year. (EDF Energy 2019)

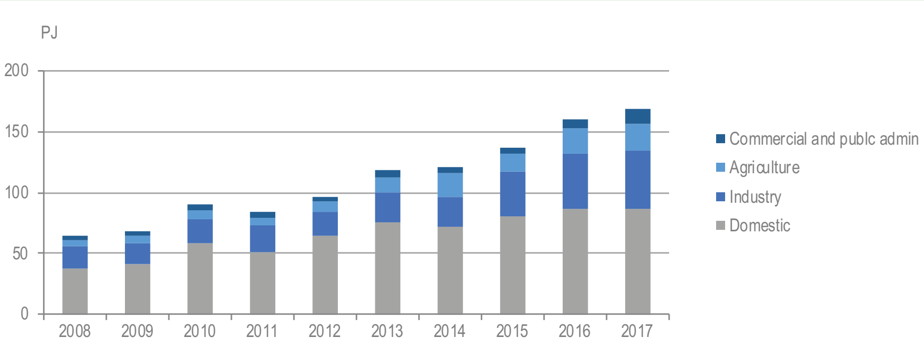
Domestic (residential) use makes the largest contribution (over 40% of the total) at 86 PJ in 2017 and the proportion of biomass in household energy supply has risen steadily from 2% to 5% since 2008. However, through our working groups it has become clear that industry questions this level of wood use and believes that the rate of growth in this sector has been significantly overestimated, and that the actual amount of energy provided by wood is closer to 45 PJ.[6]

Biomass use for heating has grown rapidly in the agricultural sector in the last ten years and biomass now makes up 35% of energy use (up from 15%). In industry more generally, bioenergy use now provides around 5% of heat needs (up from just over 1% in 2008), with use concentrated in the paper, printing and minerals sectors. Use in the commercial and public administration sectors has also risen by a factor of four since 2008. Biomethane production and injection into the gas network has grown rapidly between 2014 and 2018, stimulated by the Renewable Heat Incentive (RHI) (OFGEM 2018a).[7]

[6] Nearly 5 million tonnes of dry wood would be needed to provide 87 PJ. The total amount of fuel wood going into the residential heating market in the UK is estimated at only 2.5 million tonnes, giving energy content of around 45PJ.

[7] In 2018 8PJ of biomethane received payments under the RHI. UK capacity for biomethane is estimated at 16 PJ, which may rise to 25 PJ by 2020.

Figure 4 • UK Bioenergy for heating trends

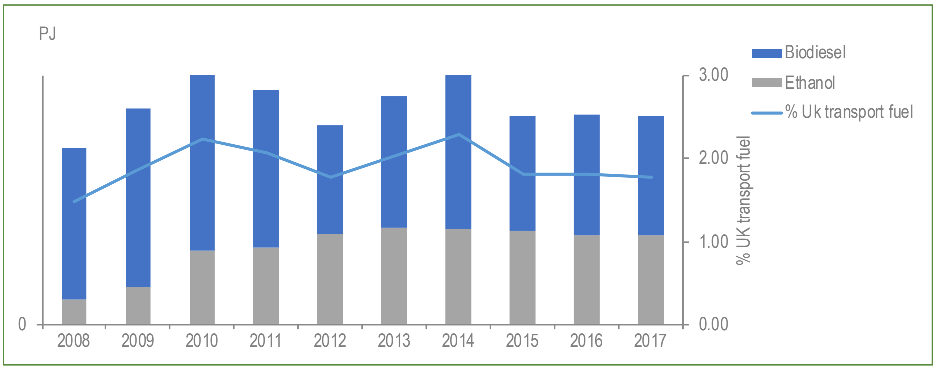


Source: DUKES Energy Balances 2018 (BEIS 2018a)

Biofuels in Transport

The use of biofuels in the transport sector has not significantly risen since 2008 and rests below 2% of total UK transport fuel requirements, despite the provisions of the Renewable Transport Fuel Obligation (RTFO) (Fig 5). The proportion of bioethanol in the biofuels mix increased to 2013 and in recent years made up 42% of the total.

Figure 5 • Biofuels in transport



Source: BEIS DUKES 2018 (BEIS 2018a)

However, the sources of biodiesel have changed significantly to the use of waste-based feedstocks, which provide higher GHG savings than crop-based biodiesel. Waste-based feedstocks are double-counted in the RTFO, which explains why the contribution made by renewables does not match the growing obligation level.

3. Benefits from UK Bioenergy

Greenhouse Gas Benefits

Bioenergy reduces Greenhouse Gas (GHG) emissions by replacing fossil-based fuels in the electricity, heat and transport sectors. Where possible, these savings have been estimated using the data and methodologies used by the government departments responsible for the support schemes that have been stimulating the deployment. In other cases, the GHG savings have been estimated using literature values for both the bioenergy and fossil fuel analogues.

Electricity

It is conservatively assumed that the production of electricity from biomass is replacing generation by gas and that each unit of gas generation would have been responsible for emissions of some 377 kg CO_2 equivalent (CO_2e)/MWh of electricity generated.[8]

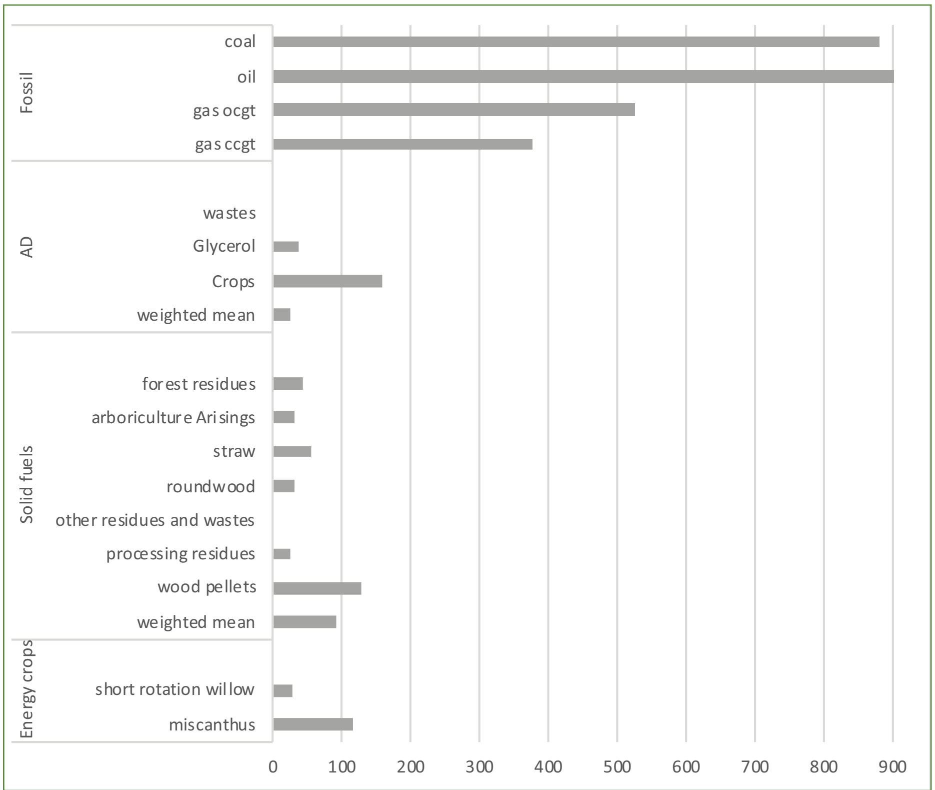
The upstream emissions associated with the use of bioenergy can be quantified using life-cycle assessment techniques.[9]

[8] Based on combined cycle gas turbine generation at average UK efficiency for 2017. It can be argued that in some cases the production of bio-electricity has stimulated a move away from coal, which would have a higher emissions factor (around 850 kg CO_2e/MWh).

[9] The methodologies for calculating GHG emissions from bioenergy use will be discussed in a separate working paper on bioenergy sustainability which is under preparation.

For generation, which falls under the UK regulatory frameworks associated with the Renewables Obligation and the Feed in Tariff schemes, generators have to report to OFGEM in detail on the GHG emissions associated with each batch of fuel they use (OFGEM 2018b). Analysis of the reported data allows the calculation of the average GHG emissions associated with each source, as shown in Figure 6, and comparison with the emissions from electricity generation from fossil fuel sources (based on average UK generating efficiencies for 2017).

Figure 6 • Greenhouse gas emissions from bioelectricity 2017 by source



Source: Analysis of Ofgem data (Ofgem 2018b)

Based on these factors and the pattern of generation in 2017, bio-electricity reduced GHG emissions by some 9.7 $MtCO_2e$ compared to equivalent generation from gas. This is equivalent to 13.4 % of the 72 $MtCO_2e$ produced by electricity generation in that year (BEIS 2018b).

Heat

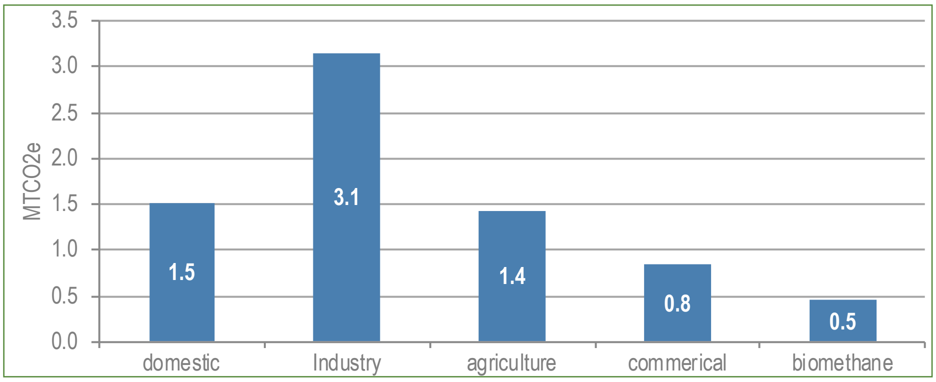
The energy statistics for the supply of heat are based on the energy content of the input fuel (rather than of the useful heat supplied after losses due to inefficiencies).

In the residential sector, most biomass fuels are used in open fires and stoves with low efficiency (BEIS 2016a). This means that each MJ of wood displaces much less than one MJ of gas or oil. On average one unit of wood fuel in the residential sector displaces only 0.5 energy units of oil or gas. Based on the DUKES data for 2017, domestic wood accounted for 86 PJ, giving net GHG savings of around 2.9 $MtCO_2e$. The estimate of savings has been reduced proportionately given the likely usage in the sector of closer to 45 PJ, to 1.5 $MtCO_2e$.

These GHG reductions along with those from the use of bioenergy from heat in the agriculture, industry and commercial sectors and for biomethane production are summarised in Figure 7. These are based on the assumptions used by OFGEM for the bioenergy fuels used under the Non-Domestic (ND) Renewable Heat Incentive (RHI) scheme (NAO 2018).

The total of 7.3 $MtCO_2e$ is equivalent to around 4.8% of the 153 $MtCO_2e$ emissions from these sectors in 2017.

Figure 7 • Emission savings from bioenergy heat by sector 2017, $MtCO_2e$

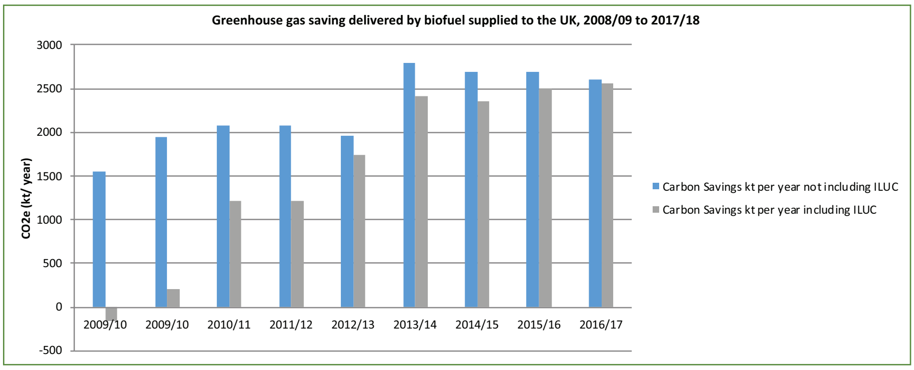


Source: (NAO 2018)

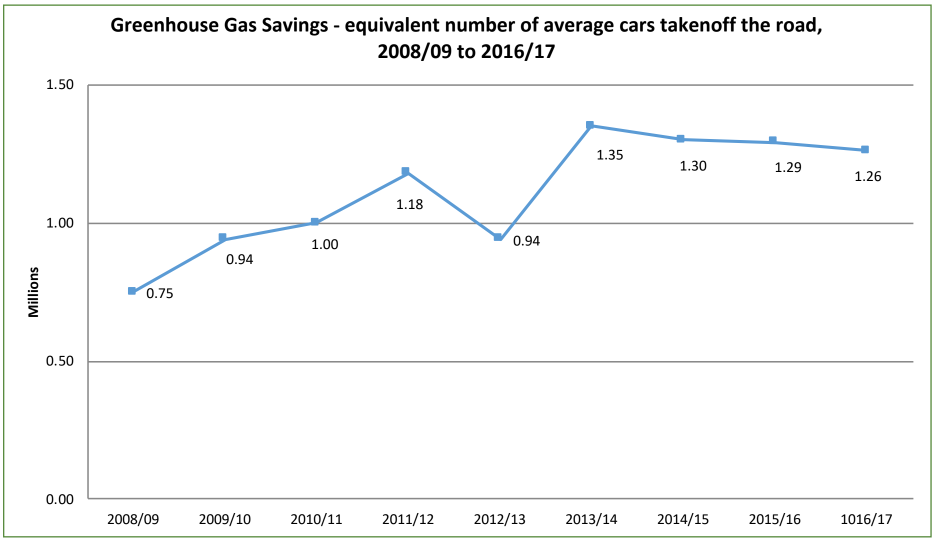
Transport

DfT publishes GHG savings achieved by biofuels in the transport sector through the RTFO. On average, using biofuels reduced emissions by 71% compared to the fossil fuels displaced (Figure 8). The savings have increased significantly with the move to waste-based sources of biodiesel and improvements in GHG savings from bioethanol. For 2016/17 the savings were estimated by DfT at 2.7 $MtCO_2e$ (DfT 2018a). These savings represent around 2% of total UK emissions from transport and are equivalent to taking 1.3 million cars off the road.

Figure 8 • Annual GHG savings from biofuels



Source: DfT RTFO Report 2018 (DfT 2018e)



Source: DfT RTFO Report 2018 (DfT 2018e)

Overall GHG savings

Consideration of all three major sectors – electricity, heat and transport indicate that in total bioenergy reduced GHG emissions by some 19.7 $MtCO_2e$ in 2017.

This corresponds to some 3.8% of total UK emissions for that year (513 $MtCO_2e$) (BEIS 2018c).

Energy Diversity and Security

The use of bioenergy reduces the UK's fossil fuel needs and so improves energy security and diversity.

It is estimated that in 2017 the use of bioenergy displaced some 406 PJ of fossil fuel in total replacing 314 PJ of gas in the electricity and heating sectors, and 92 PJ of oil for heating and transport.

The value of this fossil fuels reduction was around £21bn, assuming an average oil price of $60/barrel and a wholesale gas price of £4/GJ.

Economic Activity and Employment

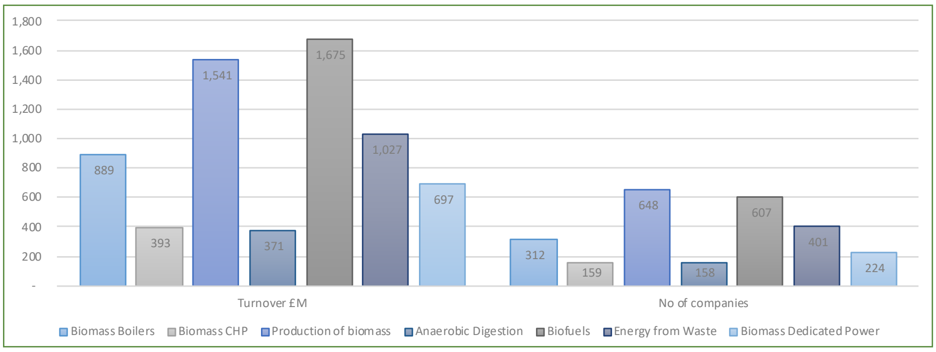
Companies and turnover

According to the REA's economic survey of renewable energy activities (REA 2018a), there are more than 2,500 companies involved in bioenergy related activities in the UK. Their bioenergy related activities generated a turnover which exceeded £6.5bn in 2017, as shown in Figure 9.

In the residential sector, most biomass fuels are used in open fires and stoves with low efficiency (BEIS 2016a). This means that each MJ of wood displaces much less than one MJ of gas or oil. On average one unit of wood fuel in the residential sector displaces only 0.5 energy units of oil or gas. Based on the DUKES data for 2017, domestic wood accounted for 86 PJ, giving net GHG savings of around 2.9 MtCO2e. The estimate of savings has been reduced proportionately given the likely usage in the sector of closer to 45 PJ, to 1.5 MTCO2e.

These GHG reductions along with those from the use of bioenergy from heat in the agriculture, industry and commercial sectors and for biomethane production are summarised in Figure 7. These are based on the assumptions used by OFGEM for the bioenergy fuels used under the Non-Domestic (ND) Renewable Heat Incentive

Figure 9 • Bioenergy related turnover in 2017

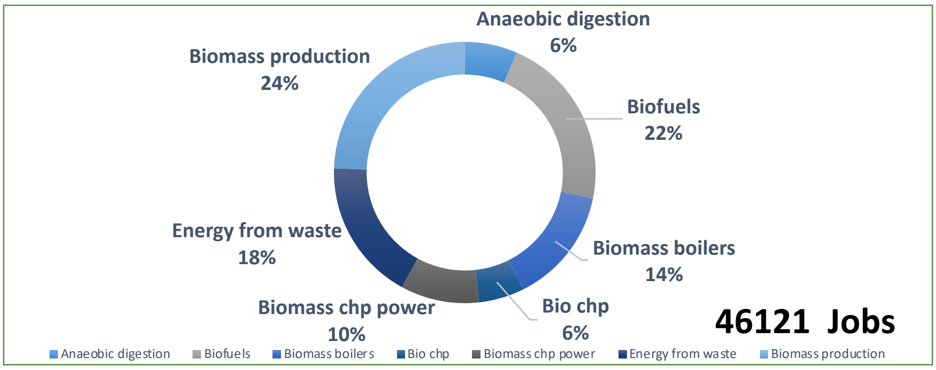


Source: REA REview 2018 (REA 2018a)

Jobs

The survey of economic activity and employment created by UK renewable energy shows that in 2017 there were over 46,000 bioenergy related jobs (36% of all renewable energy jobs). Figure 10 shows how these were distributed between the various bioenergy technologies and activities, with biomass production and biofuels providing most jobs.

Figure 10 • Jobs in bioenergy sector



Source: REA REview 2018 (REA 2018a)

Benefits to Other Policy Areas

Improved waste and resource management

The expanded production and use of bioenergy has also led to public benefits in a number of related policy areas, particularly in the development of improved waste management practice in the UK.

Benefits have included the extensive use of landfill gas as an energy source, providing an economic driver for the collection and management of the gas, leading to a significant reduction in methane emissions. Energy from Waste (EfW) has reduced the amount of waste sent for landfill - 7.3 million tonnes of waste were used for energy recovery in 2016, a four-fold increase since 2014 (DEFRA 2019). Anaerobic digestion plays an important role in reducing the amount of food waste sent to landfill, especially where separate collections are mandated, as in Scotland and Wales. On-farm AD also helps capture methane from slurries and manures, while AD sites connected to food and drink processing factories utilise production residues and liquid effluents on-site rather than seeing them sent to landfill.

Supply chain development

In addition to the quantifiable benefits listed above, the growth of bioenergy over the last ten years has led to the development of a number of features which will be indispensable if the sector is to grow and continue to contribute to UK carbon reduction in the medium- to long-term. In particular the UK has developed extensive supply chains, both for internal supply of materials and for imported materials.

The intra-UK supply chains now provide a number of materials for energy purposes including:

- 125,000 tonnes of energy crops
- 2 million dry tonnes of feedstocks for transport biofuels manufacture
- 6.5 Mt of crops, manures and residues processed by AD
- 1.0 Mt of straw for thermal power generation
- Over 3 Mt of wood fuel consumed in heating boilers

These developments have had a particularly beneficial impact on the rural economy, creating or securing employment and providing more diverse markets for agriculture and forestry products. The developing markets for wood fuels have contributed to the target for bringing a higher share of UK forest into management, part of the effort to improve forest biodiversity, and provide a stimulus for re-afforestation in some areas (Forestry Commission 2018).

The UK has also led internationally in the development of large-scale wood pellet supply alongside other products. UK companies have invested very significantly in fuel production and in the infrastructure needed to ship the materials to the UK from the southern US and Europe. Such infrastructure and supply chains will be essential if the UK wishes to move to the large-scale use of bioenergy with CCS in the future.

In addition, the UK is at the forefront in the development of sustainability governance systems needed to ensure that the supply of materials meet the highest sustainability standards. For example, UK companies played a leading role in establishing the Sustainable Bioenergy Programme (SBP), which is one of the leading certification systems for utility-scale use of biomass materials.[10]

[10] See further discussion in working paper on Sustainability of Bioenergy – in preparation.

4. Policy and Regulatory Framework

The UK has put in place a number of different policy mechanisms designed to stimulate a move to low carbon energy sources including the deployment of renewable energy. The policy objectives are to reduce GHG emissions from the energy sector, enhance energy security and provide opportunities for economic development and employment. In the bioenergy sector these include measures such as the Renewable Obligation (RO), the Renewable Heat Incentive (RHI) and the Renewable Transport Fuel Obligation (RTFO).

The rationale for these interventions was originally to stimulate some renewable deployment when the technologies were immature, and costs were high. The aim was to ensure market access for the technologies and to offset the higher costs of the energy produced. Policy priorities have shifted with current emphasis on managing and limiting policy costs, reducing the cost of energy production and, for bioenergy, imposing tighter sustainability constraints.

From an industry perspective the ability to deploy bioenergy technologies depends critically on the availability and cost of the finance needed to develop bioenergy projects. This depends on the perceived risk profile of the investment. For projects to be financeable:

- investors need to be assured of a well-defined income stream from the project over the period of debt repayment, backed up by a secure supply of feedstocks for the plant;
- the level of remuneration for energy production has to be sufficient to make projects attractive to investors;
- other elements of the regulatory framework, such as those relating to sustainability need to be clear and not subject to frequent changes.

These conditions are relevant even if the technologies are well proven technically, and when the costs are comparable to fossil fuel alternatives. If deployment is to proceed in as cost-effective manner as possible, then an enabling policy and regulatory framework that provides these characteristics needs to be in place (IRENA 2018). The development of mechanisms involving long-term, secure off-take contracts, such as Contracts for Difference (CfD) system or the RHI, is imperative.

Electricity

Generation of electricity from biomass has been supported by a number of schemes, notably the Renewables Obligation (RO), Feed-in Tariff (FiT) and the Contracts for Difference (CfD) schemes.

Renewable Obligation (RO)

The Renewables Obligation was initiated in 2002. The essential features of the RO include an obligation on UK electricity suppliers to source a proportion of their supply from renewables. Renewable generators are able to earn “Renewable Obligation Certificates” (ROCs) which they can sell (along with, or separate from, the power they generate) to suppliers who have to demonstrate that they have enough ROC’s at the end of the year to satisfy their obligation. If they have not purchased enough certificates at year end, they must pay a fine (the “buy-out fee”) for each certificate missing. The value of the buy-out fee rises each year according to inflation.

Support for biomass combustion under the RO has ranged between £55 and £80, whereas support for sewage gas and landfill gas has been much lower, below £50/MWh.

During this period, the cost of support for offshore wind under the RO rose to over £90/MWh (although this has subsequently reduced significantly). Support for on-shore wind was between £45 and £60/MWh (OFGEM 2018c).

Feed in Tariff (FIT)

The Feed in Tariff (FIT) scheme was introduced in April 2010 as a way of supporting small-scale, low carbon generation, specifically projects with a capacity of below 5MW. Amongst other technologies, the scheme provides support for generation from biogas produced through anaerobic digestion (AD). The essential element of the scheme is a generation tariff which is guaranteed for 15 years. The FIT scheme reduces the commercial risk associated with a project by providing a certain income for a long period of operation, making project planning and investment easier. The rate of deployment and the costs of support for each technology are managed by quarterly capacity caps which were introduced in 2016 (OFGEM 2018d). In particular, the introduction of a 5 MW quarterly capacity cap for AD greatly restricted the level of possible bioenergy deployment under the scheme in recent years.

By December 2018 the FIT schemes overall had stimulated a total of 6,400 MW of generation capacity, including 294 MW of anaerobic digestion capacity in 428 plants.

Tariffs have reduced significantly – for largest projects the tariffs have reduced from 11.51 to 1.57 p/kWh (a factor of 7.3), and for the smaller sizes by a factor of around 3.8. In 2018 BEIS announce the intention to close the scheme to new projects on 31 March 2019 (BEIS 2018f).

The Government has launched a consultation on the design of a replacement scheme - the Smart Export Guarantee (SEG) (BEIS 2019). The intention is that the SEG would be available to the same technologies that can participate in the FIT Scheme – i.e. including generation from anaerobic digestion (AD). Under the proposed scheme larger scale electricity suppliers would be obliged to offer a price to small scale generators exporting electricity to the grid. However, it would be up to suppliers to determine the tariff offered and the length of contract.

The proposed scheme lacks some of the key advantages of the FIT scheme – which offers a clearly defined tariff for a specified contract length. The attractiveness of the SEG to AD producers will depend on the terms and lengths of contract that are on offer from suppliers.

Contracts for Difference (CfD)

With the closure of the RO and the FIT scheme, the Contract for Difference Scheme (CfD) is the Government's main way of promoting low carbon electricity generation. CfDs aim to incentivise investment in renewable energy by providing developers with protection from volatile wholesale prices, while protecting consumers from paying high support costs when electricity prices are high (BEIS 2018d).

CfD contracts are awarded competitively and successful developers of renewables are paid a flat rate for the electricity they produce over a 15-year period. This is calculated as the difference between the 'strike price' (a price for electricity reflecting the cost of investing in a particular low carbon technology) and the 'reference price' (a measure of the average market price for electricity in the GB market).

There have been two auctions. In the first round, 27 contracts cleared the auction, this included three advanced conversion technology projects with a combined capacity of 62 MW, and two EfW Combined Heat and Power (CHP) projects (combined capacity 95 MW) were awarded contracts (BEIS 2018e). In the second round six advanced conversion technology projects with a combined capacity of 64 MW, and two dedicated biomass CHP projects were offered contracts – one large scale project (Grangemouth – 85 MW) and one much smaller project (Rebellion Biomass - 0.64 MW) (BEIS 2018f). There is some uncertainty about whether these projects are going to proceed.

A third allocation round is being launched by May 2019 (BEIS 2018g). Biomass projects with CHP will be included but the efficiency requirements have been tightened to require an overall efficiency of 70%, primary energy savings of 10% and 10% heat efficiency (BEIS 2018g). These new requirements place a limit of 29 kg CO_2e/MWh for new biomass CHP, which is significantly lower than the 180 CO_2e/MWh threshold that will apply from 2025-2030 for existing biomass generators under the RO.

This will severely constrain deployment of bioenergy projects under the scheme (REA 2018). Given these requirements, no bioenergy projects are likely to be brought forward under this round of the CfD. The Government have now committed to a CfD allocation round every two years, with a total support budget of £557 million. Further reforms to the scheme are also expected following its mandated 5 year review in 2019.

It is very difficult to identify opportunities for large-scale biomass CHP schemes in the UK, given the lack of district heating infrastructure, and the low prices of domestic and industry gas. This is made more difficult because support for heat under RHI is constrained to projects producing below 250 GWh/year – this is too low for the scale of plants likely to be cost-competitive within the CfD.

Photo shot by Sam Knight of 'West Sussex' on Unsplash

Other barriers to progress

In addition to the lack of a supportive policy framework there are a number of other barriers which hold back deployment of additional bio-electricity projects, outlined below.

- Some projects which rely on waste fuels – for example waste wood from demolition – find that they have to compete for limited waste supplies, both with other UK projects and with opportunities to export materials for energy use in other parts of Europe.

- Greater efforts to segregate such materials from waste streams would help to ensure waste management objectives are met, as well as ensuring that energy plants stay profitable and in operation.

- Unlike other renewable sources, such as wind and solar which are inherently variable, bioenergy can produce dispatchable power. It can therefore provide flexibility services to the grid, helping match demand and production. Bioenergy generation is also mostly bsed on turbine generation and so also provides inertia to the system – this will be an increasingly important element in maintaining grid stability as levels of wind and solar generation continue to rise. However, despite providing these services, bioenergy projects are not always able to access the appropiate markets which provide remuneration for such services when the projects are supported under the main generation support mechanisms.

Table 1 summarises the main policy and regulatory barriers embodied within the current framework which are impeding future deployment.

Table 1 • Current barriers to bio-electricity deployment

Policy uncertainty	Uncertainty about future support for RE power and budgets/timescales for CFD allocations
GHG emission limits	Extremely tight GHG limits on bio-electricity generation (under CfD) which will severely constrain generation opportunities
Lack of CHP opportunities/ infrastructure	Contraints to CHP operation limits potential in absence of significant heat network capacity and low gas prices. Support for heat under RHI constrained to 250 GWh/year which is too low for the scale of plants likely to be cost-competitive within the CfD
Access to remuneration for revenue for other grid services	Bioenergy provides dispatches power and can provide other system services, but these are not accessible when support for generation provided
Feedstock supply	Supply chains constraints have restricted availability of suitable feedstocks (e.g waste timber) and have undermined profitability of some existing projects

These constraints, especially the lack of a clear support mechanism which can support bio-electricity projects in the future, have severely restricted the development of new projects. The industry's perspective is very pessimistic – in their view, there are no significant further projects in the pipeline. Project developers cannot secure finance for projects due to these constraints, nor negotiate new biomass supply contracts at prices that allow the project to bid competitively under the CfD.

This lack of opportunity to develop further bio-electricity projects is blocking off one of the lowest cost sources of renewable power in the UK, prolonging fossil fuel generation with emissions which are around five times higher than those from bio-electricity generation.

Heat

Renewable Heat Incentive

The renewable heat incentive scheme (RHI) was introduced in November 2011, initially just for non-domestic applications. The scheme was extended to domestic applications from 2014 initially targeting particularly off-gas network homes. It was the first scheme internationally to provide incentives based on the amount of heat generated (similar in principle to FIT schemes for renewable electricity). The RHI was subjected to a major review which concluded in December 2016 (BEIS 2016b). The resultant reforms aimed to focus efforts on long-term decarbonisation, improve cost-effectiveness of the scheme and support supply chain growth. These reforms were implemented in May 2018.

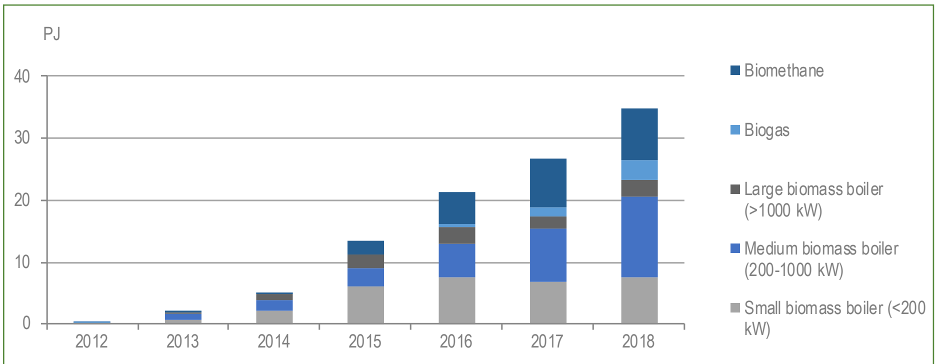
Expenditure is controlled through a complex system of budget caps and of reductions in tariffs once cost thresholds for parts of the scheme are reached. This makes it difficult for project developers to be certain what income they will receive while they are planning projects. For larger projects which take some time to develop, this uncertainty makes financing difficult. As part of the 2018 review, Tariff Guarantees (TG) were introduced which enable companies to have more certainty about project incomes. However, there are very tight time limits on obtaining financial closure and on commissioning a plant before the end of the scheme, while retaining a Tariff Guarantee which are difficult for developers to meet.

There is no commitment to fund new projects within the RHI beyond 2021 and no other measures are yet in place to support renewable heat. This lack of forward policy is now inhibiting the development of future projects, especially for larger scale biomass heat and biomethane projects.

Projects involving the use of biomass and biogas to produce heat directly or through a CHP system are eligible under the Non-domestic RHI (ND-RHI) along with other renewable alternatives. The scheme also supports the production of biomethane for injection into the gas network (OFGEM 2018h).

Between the scheme's inception and the end of 2018, bioenergy provided more than 96% of the total heat supplied under the ND RHI (OFGEM 2018e). Figure 12 shows the annual heat production from the various biomass sources which received payment under the ND RHI.

Figure 11 • Production of bioenergy heat under the ND RHI



Source: ND-RHI tariffs and payments (Ofgem 2018e)

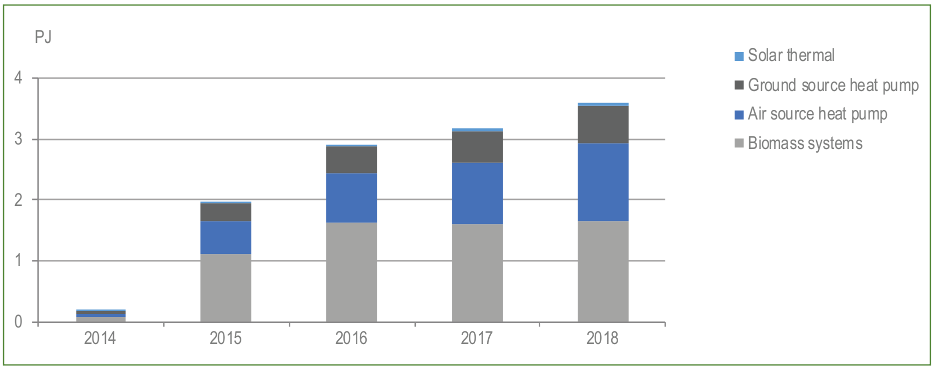
Direct bioenergy for heating, using biomass boilers, has provided the lowest cost heat supplied under the ND RHI, with RHI tariffs now set at 3.05p/kWh (and at 2.14p/kWh for higher heat loads). This compares to tariffs of 9.6p/kWh for ground source heat pumps and 10.75p/kWh for solar heating (OFGEM 218e).

The ND RHI has also effectively stimulated biomethane production in the UK. The tariffs paid for biomethane production under the RHI have been progressively reduced since the scheme's inception through tariff reviews and by automatic digression triggered when deployment thresholds were reached.

In order to encourage the use of waste and residues, rather than crops, the government allowed the tariffs to fall to unattractive levels while the feedstock regulations were put in place with an option to return to the June 2016 levels if they complied with the new feedstock rules. The May 2018 RHI reforms re-set the tariffs for biomethane to higher levels, and this has stimulated further deployment. As at end of December 2018 there were 50 biomethane plants that have applied for a Tariff Guarantee, although it remains to be seen how many of these will actually be commissioned given the tight window available for projects to complete under the RHI before the schemes closure.

The domestic RHI started operation in 2014 as successor to the Renewable Heat Premium Payment (RHPP) scheme, which in turn was based on an earlier capital grants scheme. Total heat generated under the domestic RHI is only around 10% of that in ND RHI. Bioenergy provides some 54% of the renewable heat, with air-source heat pumps rising rapidly in the last few years (Figure 13) (OFGEM 2018f). RHI tariffs are lowest for biomass heating –at 6.64 p/kWh, compared to 10.18 p/kWh and 19.86 p/kWh for air and ground source heat pumps, and 20.06p/kWh for solar heat (OFGEM 2019g).

Figure 12 • Heat generated under domestic RHI



Source: RHI Annual Reports (OFGEM, 2018f)

Barriers to extensive uptake of bioenergy for heating

Opportunities for use of biomass heat in the UK are constrained by a number of factors. These include:

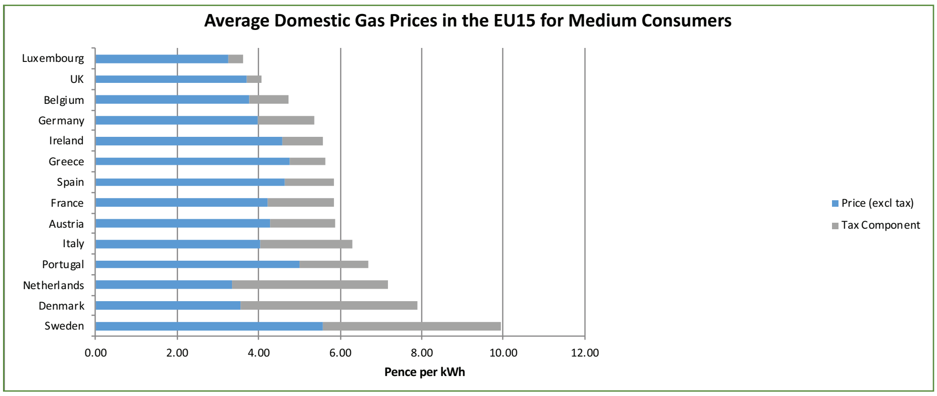
- The low level of fossil fuel prices in the sector and the absence of signals through taxes or duties

- A lack of district heating infrastructure
- Concerns about air pollution linked to use of biomass for heating, associated primarily with open fireplaces and inefficient stoves.
- Poor quality standards in project design and execution.
- A lack of established fuel supply chains able to provide good quality wood fuels.

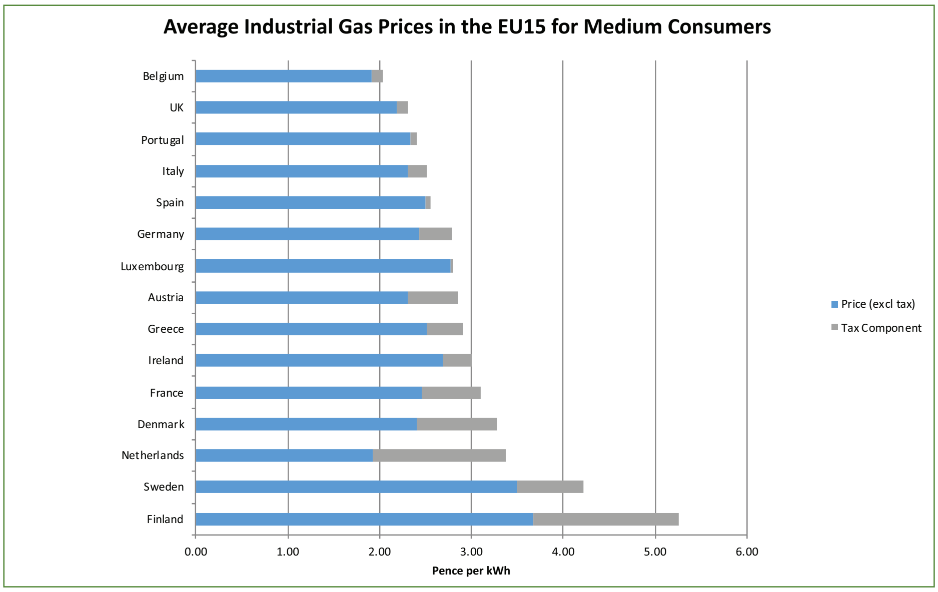
UK heating fuel prices

UK domestic gas prices are amongst the lowest in Europe – around 30% lower than the average, and a factor of more than two lower than in Sweden (Figure 14) (BEIS 2018l). This is because VAT is applied at the lower rate and there is no environmental tax on the carbon or energy content. Industrial gas prices are also low by European standards.

Figure 13 • Gas prices in UK and Europe



Domestic Gas – Source: DfT Quarterly Energy Prices, September 2018 (BEIS 2018l)



Industrial gas – Source: DfT Quarterly Energy Prices, September 2018 (BEIS 2018l)

These low prices make completion difficult for renewables alternatives and make the policy costs of promoting renewables options, including bioenergy, seem high.

Heat networks

The UK has low levels of district heating compared with many other European countries (notably those in Scandinavia). The availability of widespread heating networks is a strong enabling factor for renewables penetration into the heating sector and for the development of CHP rather than stand-alone power generation projects. It allows larger scale operation of biomass heating systems, which can meet the most stringent emissions regulations.

It is estimated by the Commitee on Climate Change (CCC) that around 18% of UK heat will need to come from heat networks by 2050 if the UK is to meet its carbon targets cost effectively (CCC 2016).

BEIS has some initiatives to encourage the development of heat networks in England and Wales. The Heat Networks Delivery Unit (HNDU) and the Heat Networks Investment Project (HNIP) have been established to provide support for project development and to support capital investment in heat networks (BEIS 2017,2018h). However, most of the projects supported under these schemes are based on gas rather than bioenergy or other renewable sources (BEIS 2018j, 2018k). In Scotland heat networks are promoted by the Heat Network Partnership (Scottish Government 2018). This supports a Scottish target of 1.5 TWh of heat a year to be delivered to homes, businesses and public sector buildings by 2020.

Despite the need for heat schemes under the RHI to be certified by the Microgeneration Certification Schemes (MCS) standards, early loop holes in the scheme has meant that some badly designed and installed systems have been deployed under the RHI, with systems often oversized or installed by poorly qualified companies. Such installations have given the sector a poor reputation and wasted support funds. Industry and Government have taken some steps to address these issues in the current scheme. However, lessons need to be learnt so that tougher design and installation standards, developed by industry in conjunction with regulators, are imposed as part for any future support arrangements.

Emissions

Most biomass used for heating in the UK is in the domestic sector and in open fires and stoves. These mostly operate at low efficiency and have poor emission performance, especially when low quality or wet wood is used as fuel. Modern, well-designed devices, using well-specified fuels such as wood pellets are much more efficient and can meet stringent emission performance standards even at small scale. At larger scale (such as boilers used for industry or heat network applications) can also meet stringent standards. The use of gaseous biomass fuels also avoids emission problems. Proposals to limit the use of biomass fuels in urban areas would close off some of the most cost effective low GHG heating options unnecessarily. Biomass systems (like all others) should have to meet stringent but technology neutral emissions regulations.

Barriers to biomethane deployment

There are constrained supplies of waste materials suitable for digestion in some areas, leading to competition for the feedstocks and increased prices, and threatening the profitability of some projects. The introduction of compulsory separate collection of biowastes in Scotland and Wales has improved the supply situation in these countries, and its potential introduction in England (as proposed under the recent Resources and Waste Strategy) should be helpful (DEFRA 2018).

The feasibility, costs and value of biomethane injection in the gas network depends on the location. At times there is insufficient capacity in the low-pressure gas network, which constrains injection. This could be avoided if there was additional capacity to pump gas from the low to high pressure networks, and it is beneficial for both the producers and gas network operators to optimise location. At present, there is limited information available to allow optimum siting. Access to more detailed gas network information would be useful in helping to site projects optimally. The standards for connecting to the gas network are complex and demanding and vary significantly from region to region. Connection costs are high and also vary considerably. A review of the connection standards and their uniform application would simplify and reduce connection costs. There are severe constraints to the quality of the gas injected into the network, including the need to add propane to the gas mix to mimic natural (fossil) gas composition – these push up production costs significantly. These requirements could be reviewed in order to introduce other ways of ensuring that customers receive good quality gas and pay for it according to its energy content (e.g. via “Smart” gas meters). AD projects depend on finding markets for digestate, which is a valuable nutrient rich biofertiliser able to displace expensive and carbon intensive synthetic fertilisers, helping to preserve soil fertility and the organic content of agricultural soils. While meeting quality conditions for these materials is important, uncertainty over future regulations are compromising the development of stable markets for digestate.

Table 2 • Summary of barriers to bio-heat and biomethane

Bio-heat

Low fossil fuel prices and duties for heat	Relatively low fossil fuel prices for heat discourage investment in low-carbon alternatives, including bio-heat, and make costs of specific support appear high.
Policy gap	Uncertainty about future support for RHI and budget allocations.
Uncertainty about income levels	The complex rules for tariff changes make it extremely difficult for developers to predict what the tariff is going to be by the time the plant is commissioned at the time when finance for projects is being secured.
Stringent time limits on RHI tariff guarantees	There are very tight limits on obtaining financial closure and on commissioning the plant while retaining a tariff guarantee before the RHI closure.
Lack of CHP opportunities/infrastructure	Constraint to CHP operation limits potential in absence of significant heat network capacity and low gas prices.
Proposed contraints on urban use	Proposed constraints on urban use will constrain biomass use for heat/CHP in main population centres even when most stringent emissions limits are met.
Quality standards under RHI	Badly designed systems (capacity too high) and poor quality of installation operation give poor reputation and waste support funds.

Biomethane

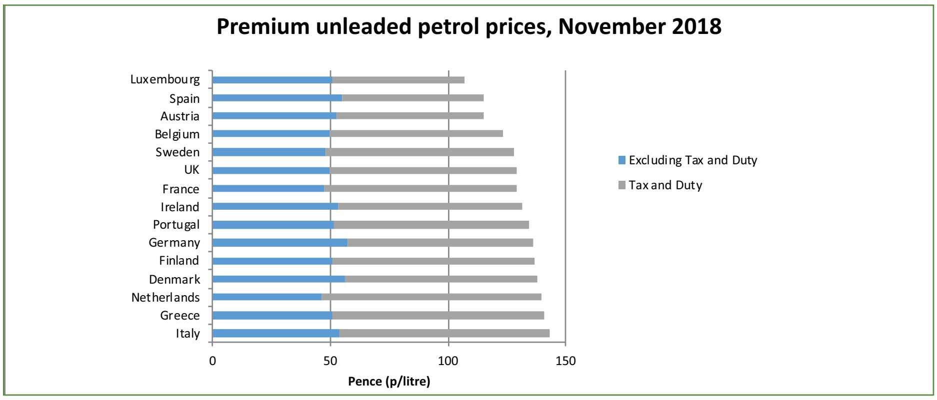
Gas network capacity	Constraints on low pressure gas network capacity and little information available on best opportunities for gas producers to inject gas into the network.
Costs and standard for network access	Varying and complex standards for achieving gas network access and varying high connection costs.
Tight gas quality constraints	Unnecessarily tight quality constraints on gas quality and need for propane blending.
Feedstock supply	Constraints on availability of suitable feedstocks (e.g. food wastes).
Uncertainties about management and use of digestate	Increased regulatory scrutiny on the management of its use and uncertainty over future regulations compromise the development of stable markets for digestate.

Transport

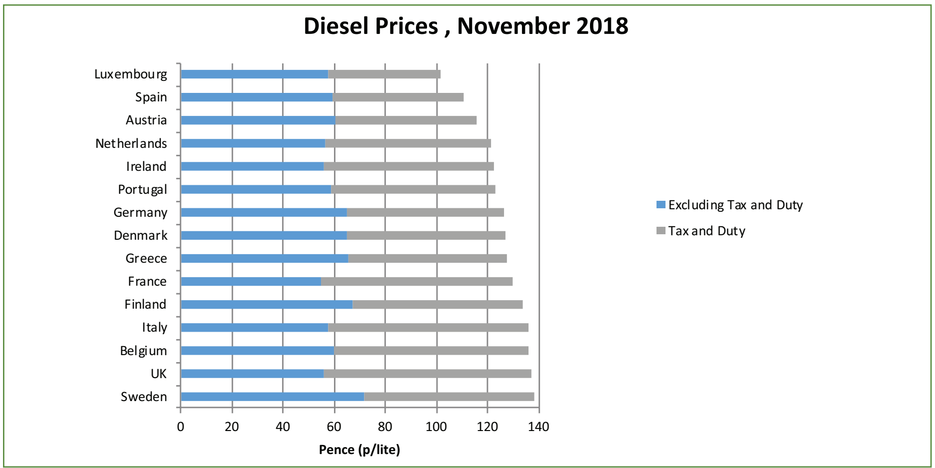
Duties and taxes

The UK has high taxes on transport fuels (BEIS 2018l). The average price of unleaded petrol at the end of 2018 was close to 129 p/litre, of which the fuel cost was 49 p/litre. Equivalent diesel costs were 13 and 56 p/litre respectively. Compared to other countries petrol is relatively cheap (the sixth lowest in the EU 15), while diesel is relatively expensive (the second most expensive behind Sweden) (Figure 15).

Figure 14 • Comparison of petrol and diesel prices within EU 15



Source: RHI Annual Reports (OFGEM, 2018f)



Source: RHI Annual Reports (OFGEM, 2018f)

There is no distinction between fossil and biofuels or other low-carbon fuels in duties and taxes in the UK with each paying the same duty on a pence/litre basis. This means that in fact the duties on biofuels are at a higher level on an energy basis.

Renewable Transport Fuel Obligation (RTFO)

The principal direct measure used to promote the use of biofuels in the transport sector in the UK is the Renewable Transport Fuel Obligation (RTFO). It was designed as a tool to promote the uptake of renewable fuels to meet the mandatory requirement within the EU's Renewable Energy Directive that 10% of transport energy needs should come from renewable sources. The RTFO was introduced in 2008, and amended in 2011 to include mandatory sustainability requirements, and then reviewed and changed again in 2017 (DfT 2012,2018b). The RTFO operates with Renewable Transport Fuel Certificates (RTFCs) which are awarded to suppliers of sustainable biofuels. In order to receive the certificates, the supplier must provide information, which demonstrates that their fuel meets the sustainability requirements. They must also have this data and the evidence supporting it independently verified.

Each supplier of fuel to the UK road transport fuel market must demonstrate that biofuel has been supplied to cover a set proportion of their overall fuel supply. For the 2016-17 year, this proportion was 4.75%. Suppliers can meet this obligation by redeeming certificates that they have received for their own biofuel supply, or by redeeming certificates that they have bought from other suppliers of biofuel.

Suppliers also have the option to buy out of their obligation, paying 30 pence per litre of biofuel for which they have not redeemed an RTFC.

Biofuel suppliers must demonstrate that they meet the requirements on carbon intensity and sustainability of the fuels under the EU's Renewable Energy Directive and Fuel Quality Directives to be awarded certificates under the RTFO. Fuel must meet a requirement of 50% GHG savings when produced in plants operating before October 2015, and 60% for plants which began operation after that.They must also show that the fuels were not produced from material grown on land with high biodiversity value nor from land which has high carbon stocks (such as forestry or peatland) (DfT 2018c). Evidence also needs to be provided to show under which band of fuels they qualify.

Following a consultation in 2017, the RTFO has been revised in line with the strategies to reduce GHG emissions from transport fuels and to deliver the goals of the Climate Change Act 2008. This includes extending the RTFO time horizon to 2032 to align with the end of the fifth UK carbon budget. (DfT 2017)

The main changes are:

- Increase the targets for renewable fuels to 9.75% of fuel supplied in 2020 with further incremental increases to 12.4% by 2032;
- Set sub-targets for the supply of renewable fuels classified as 'development fuels' - starting in 2019 at 0.1% and rising to 2.8% in 2032, this will increase the incentives to supply the new types of advanced fuels which are of strategic future importance to the UK, including renewable aviation fuels;
- Place a limit on the contribution that the use of food crops can make in meeting targets to supply renewable fuels, setting that limit at 4% in 2018, 3% in 2026 and 2% in 2032;
- Ensure that wastes which would be disposed of are eligible for greater incentives than those which have other productive uses.

The cost of an RTFC is modelled by DfT at between 18 – 24 p/RTFC, with a mean of 21 p/RTFC (DfT 2018d). In 2017 all suppliers complied with their obligation, with no buy out fees paid, implying that the costs of biodiesel, the marginal priced fuel, was lower than the 30p buy-out fee. Prompted by the provisions of the RTFO, which provides two RTFC's for waste-based fuels, there has been strong move away from crop-based biofuels (notably for biodiesel) towards waste-based feedstocks.

Barriers to progress

Unlike the support mechanisms in the electricity and heat sectors, the RTFO has not led to a significant increase in the level of biofuels used in transport in the UK which remains at roughly the same level as in 2008, below 2%. The RTFO has, however, increased the focus on biofuels with better greenhouse gas performance, notably through the incentives for fuels produced from waste materials.

The future plans for the RTFO include enhanced levels of the obligation. However, these paint an overly optimistic picture since they are not based on the physical volumes or energy content of the fuel to be used but on the number of RTFCs that will need to be generated. In volume or energy terms the proposed limits are well below the technical limits for blending bioethanol or biodiesel and do nothing to promote the move to higher blends. There is no noticeable progress towards the implementation of an E10 blend. There is therefore a significant lack of ambition which will significantly constrain the GHG benefits which can be achieved from biofuels in the short, medium and long term.

The income streams for a biofuel producer are variable – subject to global fluctuations in oil prices and in the prices of internationally traded biofuels, which are themselves dependent on policy factors including import and export tariffs. The value of RTFCs are also variable, with no floor price. This discourages investment in biofuel production and in efforts to establish supply chains and markets (for example for biomethane in the HGV sector). Introduction of a RTFC floor price would provide a higher degree of stability which would assist in securing investment in the sector.

The constraints on crop-based biofuels are motivated by concerns about increased emissions related to indirect land-use change, and about competition between fuel and food. Up to date evidence indicates that indirect land-use change (ILUC) effects for crops which are not likely to impact on high carbon soils or intensely forested areas (such as cereals) are very limited. There is also little evidence that energy production is compromising food production, with the Food and Agriculture Organisation (FAO) supporting the carefully planned integration of food and fuel production.[11] The limits on crop-based biofuels will severely constrain the deployment of biofuels and the resultant, very significant, carbon savings.

11 These issues will be further discussed in the working paper on bioenergy sustainability which is being produced as part of this project.

Some flexibility in the regulations is therefore needed, to take account of real experience, and of the possibilities of developing and using crop materials which have little or no ILUC impacts. These may include feedstocks produced as catch-crops, by increasing biomass yields while preserving food production levels or grown on un- or under productive land. The RTFO has, however, increased the focus on biofuels with better greenhouse gas performance, notably through the incentives for fuels produced from waste materials.

Table 3 • Summary of barriers to progress – biofuels in transport

Lack of policy ambition	Short- and long-term levels within the RTFO are very conservative.
No tax/ excise differential for biofuels	Constraint to CHP operation limits potential in absence of significant heat network capacity and low gas prices.
Conservative blending regulations	Lack of E10 and other higher biofuels blends restrict biofuels penetration.
Lack of RTFC floor price	The lack of a floor-price for RTFC's exacerbates uncertainties in the income streams for biofuel production plants and makes finance for new plants difficult
Tight constraints on biofuels from energy crops	Restrictions on "crop based" biofuels are over-restrictive and discourage production of "low-ILUC" biofuels.

Overall Assessment of Policy and Regulatory Framework

The range of policies deployed in the UK has been successful in stimulating deployment (as discussed above). They have helped establish supply chains and stimulated cost reductions, leading to the environmental and economic benefits summarised above. Industry has responded to the challenges posed by an increased focus on the sustainability of bioenergy in the regulations.

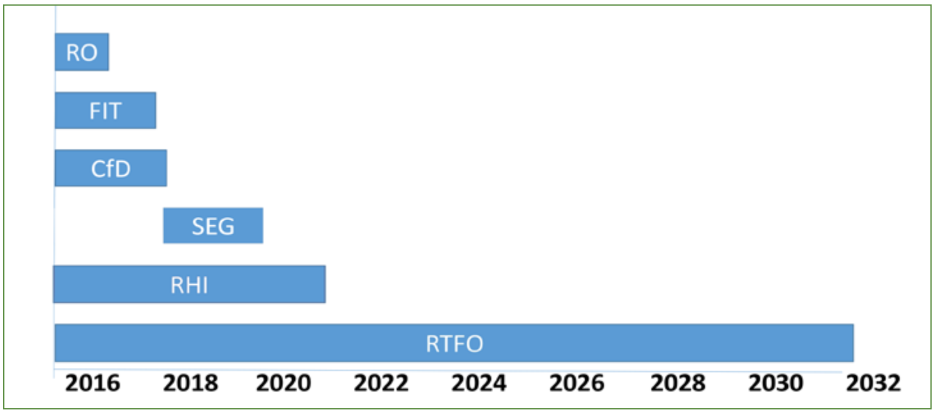
Bioenergy provides some of the lowest cost renewable solutions in the electricity, heat and transport sectors. Bioenergy will need to feature strongly in a low carbon energy future for the UK, and there is significant potential to build on the progress made so far in the short, medium and long term.

However, as discussed, the current policy framework is now failing to provide an enabling environment which can allow further deployment of bioenergy to progress.

There are gaps appearing in the policy and regulatory framework (Figure 15).

- In the electricity sector the RO and FIT schemes have closed, and opportunities for bioenergy are constrained under the CfD scheme;
- The RHI budget closes in 2021 with no signs of a successor programme in sight
- The RTFO runs until 2032, but the projected level of the obligation is very conservative.

Figure 15 • Policy and regulatory gap



Energy Insights Ltd – Enabling policy framework ending

This lack of policy frameworks is exacerbated by a number of sustainability requirements which are excessively strict and which, in inhibiting future bioenergy developments, effectively prolong the use of fossil fuels.

For example:

- The imposition of extremely tight emissions limits will inhibit further bio-electricity generation, which would replace gas generation with emissions of around 400kgCO_2e/MWh, 5 times higher than the emissions from the average solid biomass plant today.

- The proposals to restrict biomass heat plants in urban areas will restrict the important potential contribution of biomass as a low carbon fuel, for example in heat networks, when well-engineered plants can meet even the most stringent emission performance standards.

- Overly strict greenhouse gas criteria on the use of crop feedstocks for biofuels constrain supply unnecessarily when crops with excellent greenhouse gas performance are produced in ways which avoid ILUC GHG emissions and impacts on food security.

The lack of an ambitious and supportive policy framework and other policy and regulatory constraints to bioenergy has already had a major impact on new bio-electricity projects, with no new large-scale projects in the pipeline. The same is now happening in the heat and biomethane sectors as the end of the periods when new projects can qualify for the RHI draws near. This risks the loss of the expertise and supply chains which have been built up over the last ten years and which will be essential to an expansion of bioenergy to meet the ambitious carbon reduction targets in the medium and long term.

- There is substantial potential for bioenergy to grow and provide environmental, economic and social benefits to the UK, helping to meet a broad range of policy targets in the short and medium term. This can be done using technologies which are available today and which in many cases are the lowest-cost renewable solutions.

- To realise these benefits for the UK government needs to provide a supportive policy and regulatory environment. This should be complemented by an evidence-based sustainability governance framework which prevents bad practice and incentivises better performance.

- Bioenergy will also be a key element in the portfolio of technologies, which will be needed in the long term. To facilitate this, there is a need for a clear roadmap, developed jointly by government, industry and academia, which shows how some of the key technologies can be readied for deployment, and identifies the appropriate policy and regulatory measures that will be needed. This is particularly important for biomass gasification and for BECCS/U options.

5. Bioenergy Strategy – Next Steps

The next stage of this project will involve the development of a vision of the role that bioenergy could play in the future UK energy economy. This will look at the potential role of sustainable bioenergy in the long term (to 2050 and beyond). Importantly, the project will also focus on what contribution bioenergy can make to UK energy economy in the short term and specifically to the end of the fifth carbon accounting period in 2032. This approach recognises the inevitable uncertainties in the long term, the benefits of making early reductions in greenhouse gas emissions, and the need to maintain momentum so that technology solutions, expertise, supply chains and infrastructure needed later on can be preserved and progressively developed. It will estimate the environmental and economic benefits that realising such a vision could provide, along with the costs.

Phase 3 of the project will build on this vision and look at what government, industry and other players will need to do to enable it to be realised.

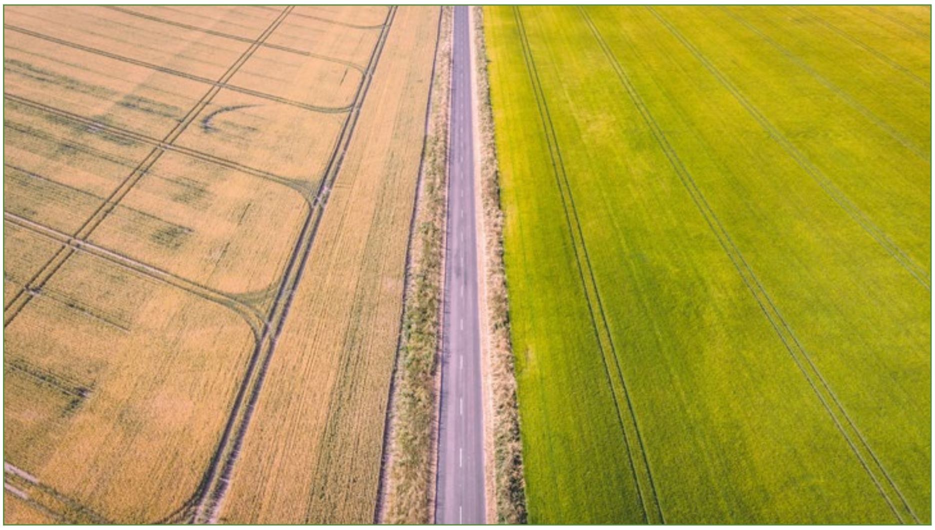


Photo shot by Matt on Unsplash

Units of measure

kilo (k)	10^3
mega (M)	10^6
giga (G)	10^9
tera (T)	10^{12}
peta (P)	10^{15}
exa (E)	10^{18}

EJ	exajoule
GJ	gigajoule
ktoe	kilotonnes of oil-equivalent
kWh	kilowatt-hour
Mtoe	megatonnes of oil-equivalent
MJ	megajoule
GW	gigawatt
GWh	gigawatt-hour
TWh	terawatt-hour

Conversion factors

1PJ = 277.8 GWh = 23.9 ktoe

1ktoe = 41.868 TJ = 11.63 GWh

1 MWh = 3.6 TJ = 85.98 toe

1 billion litres = 264 million US Gallons = 220 million Imperial Gallons

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