Department for
Business, Energy
& Industrial Strategy

The Role of Biomass in Achieving Net Zero

Call for Evidence

Closing date: 07 June 2021

April 2021

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

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General information

Why we are conducting a Call for Evidence

This Call for Evidence seeks early input from a wide range of stakeholders on a forthcoming Biomass Strategy. We are conducting a Call for Evidence to strengthen the Government's evidence base around biomass, including how it should be sourced and used across the economy to best contribute to meet our net zero target.

The information provided by stakeholders in this Call for Evidence will support a review of the amount of sustainable biomass available to the UK, and how this resource could be best utilised across the economy and in different end-uses, considering existing and future demand, to support the net zero target. The Call for Evidence will also inform an assessment of the UK's current biomass sustainability standards, already some of the world's most stringent, to see where and how we can improve them even further. This assessment will consider the risks and opportunities provided by biomass in delivering our wider environmental targets, including on biodiversity, air quality and water. This Call for Evidence will also inform our considerations on the role of Bioenergy with Carbon Capture and Storage in reducing greenhouse gas emissions across the economy, and if and how the technology could be deployed.

We welcome views from a range of stakeholders focused on biomass feedstock production via established and novel sources, and those focusing on using biomass as an alternative to fossil fuels to decarbonise sectors of the economy.

Consultation details

Issued: 12 April 2021

Respond by: 07 June 2021

Enquiries to: Biomass.strategy@beis.gov.uk

Consultation reference: Role of Biomass in achieving Net zero – Call for Evidence

Territorial extent:

This Call for Evidence seeks information for consideration by the UK government but does not contain policy proposals. Some matters covered by the Call for Evidence may be devolved to Scotland, Wales and Northern Ireland. The UK government will work with the devolved administrations to ensure that the development of future policy takes account of devolved responsibilities and policies across the UK.

How to respond

We are inviting responses to this Call for Evidence via the online e-consultation platform, Citizen Space. Your response will be most useful if it is framed in direct response to the questions posed, providing evidence in support wherever possible. You should not feel the need to respond to all the questions posed and may choose the questions you wish to respond to depending on your specific areas of interest and/or expertise. When responding, please state whether you are responding as an individual or representing the views of an organisation. We are particularly interested in collecting evidence, information, and data from primary research where possible. We encourage respondents to share links to papers or evidence they might have to support their responses.

Consultations and Call for Evidence receive a high-level of interest across many sectors. Using the online service greatly assists our analysis of the responses, enabling more efficient and effective consideration of the issues raised. Therefore, we strongly encourage responses via Citizen Space.

Respond online at: https://beisgovuk.citizenspace.com/clean-electricity/biomass-strategy-call-for-evidence

We advise that you do not send responses by post to the department at this time, as we may not be able to access them.

Confidentiality and data protection

Information you provide in response to this consultation, including personal information, may be disclosed in accordance with UK legislation (the Freedom of Information Act 2000, the Data Protection Act 2018 and the Environmental Information Regulations 2004).

If you want the information that you provide to be treated as confidential, please tell us but be aware that we cannot guarantee confidentiality in all circumstances. An automatic confidentiality disclaimer generated by your IT system will not be regarded by us as a confidentiality request.

We will process your personal data in accordance with all applicable data protection laws. See our privacy policy.

We will summarise all responses and publish this summary on GOV.UK. The summary will include a list of names or organisations that responded, but not people's personal names, addresses or other contact details.

Quality assurance

This consultation has been carried out in accordance with the government's consultation principles.

If you have any complaints about the way this consultation has been conducted, please email: beis.bru@beis.gov.uk.

Introduction

This Call for Evidence seeks evidence and views from stakeholders on the potential for biomass to support the UK's net zero target. This includes opportunities and risks of using different biomass feedstocks for a variety of end uses, as well as the potential benefits and trade-offs that should be considered in different applications. Sustainable biomass is a unique renewable organic material, in that there is a wide array of applications in which it can be used as a substitute for fossil-fuel based products and activities, from power generation to hydrogen production and even in new forms of plastics. Along with its ability to deliver negative emissions, this makes biomass a valuable tool for reaching net zero emissions. Since the 2012 Bioenergy Strategy was published, biomass has played a prominent role in our efforts to decarbonise the economy.

Biomass encapsulates a diverse range of materials. For the purposes of this Call for Evidence, we are defining biomass as any material of biological origin (including wastes) which is used as a fuel for bioenergy (conventional combustion, gasification, energy from waste and low-carbon fuels like biofuels or hydrogen) or in products (such as chemicals, bio-plastics and materials). It can be purposely grown for energy use, or arise as a co-product of other processes, or as a post-consumer waste, and each type will have different sustainability implications and barriers to deployment.

The use of biomass in energy generation in the UK's power sector has helped to dramatically reduce the use of coal. In 2019, the share of biomass for energy supply increased to 7.3%, overtaking nuclear and making it the largest component of primary energy consumption from low carbon sources. This contributed to helping to further reduce the share of primary energy consumption from fossil fuels to a record low of 78.3%. The share of electricity generation from coal fell to just 2.1% in 2019, while renewables' share of electricity generation, including from biomass reached a record high in 2019 at 37.1% up from 33.1% in 2018[1]. Electrical generation from plant-derived biomass increased by 9.2% (2.1 TWh) to 25TWh in 2019.

The use of biomass in heat generation has also increased in recent years. Renewable heat generation across all technologies (e.g., bioenergy technologies, active solar heating, heat pumps etc) has increased by 2.4% in 2019 to 5.2 Mtoe. Wood (59%), plant biomass (21%) and heat pumps (15%) are the top three renewable sources accounting for this increase, with other sources such as sewage gas accounting for the remainder[2].

Separately, low carbon fuels in transport, in particular biofuels, are contributing to a third of carbon savings in the transport sector under existing carbon budgets and in 2019 constituted 5.1% of total road and non-road mobile machinery fuel, providing an average GHG savings of 83% compared to fossil fuels[3].

[1] https://www.gov.uk/government/statistics/renewable-sources-of-energy-chapter-6-digest-of-united-kingdom-energy-statistics-dukes
[2] See Dukes table 6.6 in link above.
[3] https://www.gov.uk/government/collections/renewable-fuel-statistics

An innovative bio-based economy offers significant opportunities for the development of a more circular economy and the optimal use of resources to meet the needs of society and the environment, as outlined in the 2018 Bioeconomy Strategy[4] in response to the UK's Industrial Strategy. The bioeconomy is growing, with biomass increasingly used in products, processes, and services.

The context within which we use biomass has changed since the 2012 Bioenergy Strategy. Our net zero target means we must look system-wide at how and where biomass best contributes to decarbonisation targets. Technological changes mean that biomass usage can now go beyond carbon-neutral and deliver negative emissions. In order to realise these advances and maximise the use of sustainable biomass, we want to look at what innovation may be required and where we should focus our efforts to enable the wider deployment of currently less mature technologies which have a potential to support decarbonisation targets. We are also seeking evidence on the potential trade-offs we need to consider when making decisions on how to best utilise biomass to support our net zero target and how these could be overcome. These include evidence on the potential impact of biomass use on air quality in different applications.

The 25 Year Environment Plan[5], the future schemes to reward environmental land management, ambitious targets for tree planting, and peat and nature restoration mean that environmental improvements are at the heart of decisions on how we use our land. As a result, we need to improve our understanding of the availability of sustainable biomass to support the net zero target, and of the environmental and land use considerations associated with biomass feedstocks from different sources. Concern about how biomass is sourced means we need to be ever more assured that the criteria we place on sustainability are as robust as possible.

The 2018 Resource and Waste Strategy for England[6] sets out how we will preserve material resources by minimising waste, promoting resource efficiency, and moving towards a circular economy in England. It introduces targets to reduce the volume of waste produced, implement separate food and garden waste collections, and find opportunities to move waste further up the waste hierarchy, away from landfill and incineration.

This Call for Evidence seeks early input from a wide range of stakeholders on a forthcoming Biomass Strategy. The strategy will look at all aspects of biomass, including how it should be sourced and used across the economy to best contribute to meet our net zero target.

Details of the Call for Evidence

Purpose and objectives

The purpose of this Call for Evidence is to strengthen the Government's evidence base around biomass and its role in achieving net zero. This includes evidence on the availability of

[4] https://www.gov.uk/government/publications/bioeconomy-strategy-2018-to-2030
[5] https://www.gov.uk/government/publications/25-year-environment-plan
[6] https://www.gov.uk/government/publications/resources-and-waste-strategy-for-england

sustainable biomass from domestic and international sources, how biomass should be used to support our net zero target, on opportunities for innovation, on the sustainability of the supply chain, and on the accounting of GHG emissions from biomass use, including Bioenergy with Carbon Capture and Storage (BECCS).

The information and evidence we receive from stakeholders will be used to inform policy development in the growing area of biomass and will directly contribute to the development of the upcoming Biomass Strategy.

It is currently our intention that the information provided by stakeholders in this Call for Evidence will support:

- our review of the amount of sustainable biomass available to the UK, and how this resource could be best utilised across the economy and in different end-uses, considering existing and future demand, to support the net zero target;
- an assessment of the UK's current biomass sustainability standards, already some of the world's most stringent, to see where and how we can improve them even further. This will also consider the risks and opportunities provided by biomass in delivering our wider environmental targets, including on biodiversity, air quality and water;
- our considerations on the role of BECCS in reducing carbon emissions across the economy, and if and how the technology could be deployed.

We invite views from a range of stakeholders focused on biomass feedstocks from established and novel sources, and those focusing on using biomass as an alternative to fossil fuels to decarbonise sectors of the economy, including innovative solutions to supply chains and new and established uses of biomass. In particular, we welcome information from researchers, experts, investors, growers, industry, and local authorities with evidence in these areas they can share with us. We also invite views from researchers, industry, and experts on establishing robust sustainability criteria for biomass, including on monitoring, reporting and verification. In addition, we welcome views from experts on different applications of Bioenergy with Carbon Capture and Storage (BECCS) to deliver negative emissions, including on the accreditation and verification of carbon emissions. Further information is sought regarding biomass Life Cycle Assessments (LCA) and the interactions with key technologies such as BECCS.

Information submitted in response to this Call for Evidence may be shared with third party contractors for the purpose of helping us with the analysis of the responses. Please indicate in your submissions if you do not give permission for your evidence to be used in this way. We will not share any personal information (names, organisation, etc) with contractors that could identify individuals, and personal information will not be made public.

1. **Do you give permission for your evidence to be shared with third party contractors for the purpose of analysis?**

Scope

This Call for Evidence is primarily interested in gathering evidence on the availability of sustainable biomass from domestic and international sources, how biomass should be used to support our net zero target in the context of the availability of sustainable biomass feedstock, and on the sustainability of the supply chain and opportunities for strengthening existing criteria. It also aims to collect information about accounting of GHG emissions from biomass use, including BECCS, and the potential opportunities for innovation to support wider deployment of technologies with potential to support the net zero target. The information collected will directly support the development of the Biomass Strategy. We are also seeking to use the Call for Evidence to identify stakeholders and build relationships recognising that the biomass space has changed since we last formally engaged with stakeholders.

Structure of the document

The Call for Evidence consists of four main chapters:

- **Chapter 1** explores the variety of biomass feedstock types from domestic and international sources and seeks information on the potential size and makeup of domestic biomass resource from different sources as well as on the current and potential future costs of these biomass resources. In addition, it invites evidence on the environmental, climate, and land use considerations associated with the different feedstocks. It also asks for information on any opportunities, risks, benefits, and trade-offs of increasing domestic production. The questions in the chapter also welcomes views on imports of biomass and the risks and opportunities that might arise from increasing imports and any barriers that might apply.
- **Chapter 2** explores the various range of end-uses and applications that biomass can be used for. It invites evidence on the role and potential of different biomass feedstock types to support the decarbonisation of different areas, such as agriculture, chemicals and materials, transport, and power, and asks which areas are best suited for priority applications in the short and long term as well as the policy gaps and wider barriers that need to be overcome to realise their potential. In addition, it seeks information on how the deployment of BECCS could be supported, how biomass use could be prioritised to best deliver our net zero target, and whether and how the Government could target sustainable biomass use towards the highest priority applications.
- **Chapter 3** addresses the sustainability criteria around biomass supply and use, invites stakeholder views about our existing sustainability criteria as well as the potential for amending them to ensure we supports wider climate, environmental and other goals and how we could improve monitoring and verification against these criteria. It also welcomes evidence and views on approaches for accounting for full life cycle emissions from domestic and international sources and the implications of these for carbon budgets and reporting against sustainability criteria. It also invites evidence on options for reflecting life cycle emissions of biomass in the UK's Emission Trading System, carbon pricing and our reporting standards, as well as on the options for accounting and reporting of negative emissions delivered by BECCS.

- Finally, **Chapter 4** explores the role of innovation and seeks evidence on how innovation could bring down costs and reduce barriers to deploying technologies, or improving the way current, more mature technologies operate.

Glossary

BECCS: Bioenergy with Carbon Capture and Storage

Biomass refers to any material of biological origin (including wastes) which is used as a fuel for bioenergy (conventional combustion, gasification, energy from waste and low-carbon fuels like biofuels and hydrogen) or in products (such as chemicals, bio-plastics and timber for construction).

Biomass feedstock refers to any material of biological origin which is used to supply or fuel a machine or industrial process, including construction.

CCUS: Carbon Capture Usage and Storage

Energy crops refers to perennial energy crops that are grown for energy or material uses only and would not normally be used for consumption as food or feed.

GGR: Greenhouse Gas Removal

GHG: Greenhouse gas

ILUC: Indirect land use change

LCA: Life cycle assessment

SAF: Sustainable aviation fuel

Chapter 1: Supply

A fundamental question we must ask as part of a strategic look at the use of biomass across the economy is: how much sustainable biomass is available to us? Over the last ten years a range of different government incentive schemes have supported biomass use in a variety of sectors including power, heat, and road transport. There is also interest in the role that biomass could play in novel chemical or a bio-based products industry, or in more conventional roles (e.g., timber in construction) and harder to decarbonise sectors (e.g., sustainable aviation fuels). We recognise that sustainable biomass is a finite resource and there is significant uncertainty about the makeup of this resource in the near and longer-term future. In this chapter we aim to develop our understanding of what volumes and types of biomass the UK can expect to have access to internationally and domestically and the associated costs and impacts from accessing it and utilising it for energy or material use.

First and foremost, biomass must be sustainable to ensure its use delivers genuine GHG savings. We want to consider how biomass can be sourced, processed, and used in a way that delivers the highest possible carbon savings across the economy whilst also considering wider impacts including biodiversity, air quality, and other environmental, social, and economic impacts. Chapter 3 of this Call for Evidence looks at how we assess biomass sustainability in detail. However, when assessing the potential availability of biomass supply from different sources, we also wish to take these wider factors into account.

The current biomass resource supply is diverse. According to most recent statistics, a significant portion of the biomass supply is composed of wastes and residues, with some purpose-grown arable crops being used for renewable gas or transport fuel production[7]. Landfill gas, waste incineration and sewage gas have made significant contributions to the renewable electricity mix over the years, however, today this is dominated by wood pellets produced from forestry residues and lower grade pulpwood, much of which is imported. The heat sector utilises a combination of wood and animal-derived wastes (such as manures, poultry litter, animal processing residues), landfill gas, organic waste (wood, food waste), crops such as maize, and wood pellets in domestic heating. In 2019 the UK's renewable transport fuel supply was predominantly (54%) composed of used cooking oil, followed by crops such as corn, sugarcane and sugar beet[8].

Therefore, wastes and residues currently form the bulk of the UK's biomass supply for energy use, however there are some crops which are grown specifically for bioenergy purposes, including food and feed crops[7],[8]. There are government policies currently in place to limit the levels of arable (food and feed) crops for bioenergy use, including in conventional biofuel production (e.g., from wheat, sugar beet, oilseed rape), and in anaerobic digestion for the production of biomethane (from maize and forage grasses). These limits were established to prevent the use of these crops distorting existing markets and leading – directly or indirectly – to land use change which would impact on the final greenhouse gas savings this biomass can

[7] Digest of United Kingdom Energy Statistics (DUKES) 2020- Electricity fuel use, generation and supply
[8] https://www.gov.uk/government/collections/renewable-fuel-statistics

provide. Policies are set in place to incentivise the use of wastes and residues instead. However, provided their use leads to significant GHG savings and other environmental risks are addressed, crops (including energy crops) may continue to play a role in the bioenergy sector as growing them for bioenergy purposes can provide some reliability of supply and quality. There may be other demands for biomass materials (e.g., packaging) that should be taken into account when considering the production and use of biomass feedstocks.

The publication of the Climate Change Committee's Land Use: Policies for a net zero UK report and the 6th Carbon Budget report[9] has contributed to an increased interest in the role of energy crops to deliver GHG emission reductions in both the land use and energy sectors. Key examples of these are the energy grass Miscanthus, and short rotation coppice (SRC) willow and poplar[10], of which a small area (~10,000 hectares) is cultivated in the UK at present, used for various uses, including for energy production and as a material. There may be other novel, purpose-grown biomass feedstocks, such as algae, that could be considered for a variety of uses.

Post-consumer wastes, such as food waste, have additional benefits as their use for bioenergy or in the generation of bioproducts can align with wider Government strategies, such as the Resource and Waste Strategy[11] (RWS). The Resource and Waste Strategy sets a target to reduce the volume of waste produced, implement separate food and garden waste collections, and find opportunities to move waste further up the waste hierarchy, away from landfill and incineration. Therefore, it is likely that the nature of the waste supply may change over time, in terms of volume and composition. Although some segregated wastes may become more homogeneous, this may concentrate the more problematic and mixed residual waste portion that is challenging to segregate into organic and non-recyclable fossil fractions, such as in the form of contaminated packaging, sanitary waste, or composite products such as waste tyres or polycotton textiles. Some wastes may be less difficult to handle, for example co-products from other processes (e.g., crude glycerine or waste vegetable oil pressings), though as Government, we must be sure they have no alternative market (i.e., these materials cannot be reused or waste prevented, which would be higher up the waste hierarchy). Otherwise, there may be unintended consequences from incentivising their use in material or energy recovery.

Alongside wastes, agricultural and forestry residues are a key biomass resource used in the UK. These residues are different to wastes and co-products as there is an option to recover them or not. This does not imply that there are no sustainability issues with their removal and utilisation, and there are questions around what impact the relatively nascent market for biomass has had on the way forest and agricultural residues are recovered and used as biomass feedstocks.

The CCC's 6th Carbon Budget report outlined the potential role engineered GHG removals, in particular, Bioenergy with Carbon Capture and Storage (BECCS), could play in supporting the

[9] https://www.theccc.org.uk/wp-content/uploads/2020/01/Land-use-Policies-for-a-Net-Zero-UK.pdf and https://www.theccc.org.uk/publication/sixth-carbon-budget/

[10] The CCC considers short rotation forestry (SRF) species (e.g., Eucalyptus) as complimentary but separate to energy crops.

[11] https://www.gov.uk/government/publications/resources-and-waste-strategy-for-england

delivery of the UK's net zero target e.g. through a range of applications such as hydrogen production. The projected scale-up of such biomass applications mean that we need to explore what the future demand will be, and to what extent the UK can or should increase its domestic biomass supply. Also, in reverse, there are questions around how Government can give investors in end-use technologies the confidence that there will be an adequate biomass supply over the timescale of the life of that technology. We therefore welcome views specifically on what the barriers are to increasing the supply of domestic biomass for use in BECCS, and what policy interventions might be needed to overcome these, should they be an area we pursue.

Biomass production and the use of biomass in different technologies in the UK have the potential to provide significant support to the UK's economy. The Biomass and Bioenergy Energy Innovation Needs Assessment in 2019[12] identified, within the biomass and bioenergy sector, domestic business opportunities that could support up to 15,000 jobs by 2050, dependent on how large of a role biomass has within the UK.

An additional aspect to consider is the global availability of biomass and how much the UK must rely on imported biomass. In 2019, around one third of the biomass used for energy in the UK was imported. The majority (72%)[13] of this was in the form of wood pellets, predominantly for electricity generation. Also in 2019, 89% of our renewable transport fuels were sourced from feedstocks produced from over 70 countries. We therefore recognise the importance of imported biomass in the UK bioenergy and wider bioeconomy mix, however there is a need to consider how the availability of internationally sourced biomass may change in the coming decades as more countries look to biomass to help them decarbonise their economies. We must also consider how the UK may continue to be attractive for biomass imports, so where a key role for biomass is identified in meeting net zero, we have some security of supply, and an understanding of the sustainability of this supply.

Biomass Availability – How much biomass can we assume the UK will have access to?

We welcome evidence and views on:

2. **What is the potential size, location and makeup of the sustainable domestic biomass resource that could be derived from the a) waste, b) forestry, c) agricultural sectors, and d) from any other sources (including novel biomass feedstocks, such as algae) in the UK? How might this change as we reach 2050?**

3. **What are the current and potential future costs of supplying these different biomass feedstock types, and the key environmental and land-use impacts (positive or negative) associated with supplying and utilising these different types**

[12] https://www.gov.uk/government/publications/energy-innovation-needs-assessments
[13] https://www.gov.uk/government/collections/digest-of-uk-energy-statistics-dukes

of biomass, e.g. impacts on GHG emissions, air quality, water quality, soil health, biodiversity, food security, land availability, etc?

4. **How do we account for the other (non-GHG) benefits, impacts and issues of increasing our access to, or production of domestic biomass (e.g., air quality, water quality, soil health, flooding, biodiversity)?**

5. **How could the production of domestic biomass support rural employment, farm diversification, circular economy, industrial opportunities, and wider environmental benefits? This can include considerations around competition for land, development of infrastructure, skills, jobs, etc.**

6. **What are the main challenges and barriers to increasing our domestic supply of sustainable biomass from different sources?**

7. **What is the potential biomass resource from imports compared to the levels we currently receive? What are the current and potential risks, opportunities and barriers (e.g., sustainability, economic, etc) to increasing the volumes of imported biomass?**

Chapter 2: End use of Biomass

Sustainable biomass is one of the most versatile forms of low carbon and renewable energy, a feature which presents both an opportunity and challenge when we consider what role biomass will play in our wider decarbonisation goals. In Chapter 1, we considered the volumes, sources and characteristics of the biomass resource, and here we take into account the various range of end-uses and applications that it can be used for.

Currently, the UK Government provides incentives for the use of sustainable biomass for the generation of renewable power, heat, and transport fuels. As a result of these policies, according to most recent published statistics, bioenergy accounts for 7.3% of total energy consumption in the UK with the majority (62%) being used in power generation[14]. Bioenergy contributed 31% of the total renewable electricity generated in 2019, or 12.1% of all electricity generated. Biomass electricity generation has been incentivised under the Renewables Obligations, the Contracts for Difference (CfD) scheme and the Feed in Tariff, while the supplier-led Smart Export Guarantee also includes generation from biomass.

The Domestic[15] (from 2014, closes to new applicants on 31st March 2022) and Non-Domestic[16] Renewable Heat Incentive (since 2011, closed to new applicants on 31st March 2021) has supported the increased deployment of low carbon heating technologies, by incentivising the switch to systems that use renewable energy sources. It has stimulated the establishment of a range of heating applications at various scales, including domestic and non-domestic wood boilers, biomass with combined heat and power and anaerobic digestion.

A new Green Gas Support Scheme (GGSS) has been established to provide continued support for the generation of biomethane for injection into the gas grid via anaerobic digestion. The transition to low carbon heating is likely to see a mix of technologies used, including the electrification of heat for buildings not suitable for heat pumps, potentially switching the natural gas in the grid to low-carbon hydrogen and biomethane, and utilising heat networks. Beyond these technologies, we expect there to be a niche and limited role for other forms of biomass in some harder to treat off gas grid buildings, in line with advice from the Climate Change Committee.

The Renewable Transport Fuel Obligation[17] (RTFO) is one of the Government's main policies for reducing GHG emissions from transport, saving just under 5.4 million tonnes CO2e in 2019. The RTFO sets out increasing targets on fuel suppliers for the supply of renewable transport fuels, which include biofuels as well as renewable fuels of non-biological origin (the latter being outside the scope of the Biomass Strategy). Since 2018, the 'development fuel' target has been providing greater incentives for the production of strategically important fuels such as

[14] https://www.gov.uk/government/statistics/electricity-chapter-5-digest-of-united-kingdom-energy-statistics-dukes
[15] https://www.ofgem.gov.uk/environmental-programmes/domestic-rhi
[16] https://www.ofgem.gov.uk/environmental-programmes/non-domestic-rhi
[17] https://www.gov.uk/government/publications/renewable-transport-fuel-obligation-rtfo-guidance-2021

aviation fuels, hydrogen, drop-in fuels and synthetic natural gas. Development fuels can only be produced from qualifying wastes, or non-biological renewable sources.

The fuels supported under the RTFO have driven and will continue to drive significant carbon emissions savings in the road transport sector. However, in view of the electrification of cars and vans and the future decarbonisation of heavier road vehicles it is important we also consider how low carbon fuels could be best deployed in other transport modes, such as aviation[18]. Increased domestic production of these fuels could also support jobs and security of supply. Sustainable aviation fuels (SAF) from residues or waste (or renewable electricity and carbon, outside of scope of this Call for Evidence) are an attractive option as they can be blended into fossil fuel and used in existing aircraft, without any engine modifications, achieving significant carbon emission savings over their lifecycle (80% on average). The CCC's 6th Carbon Budget report[19] stressed the role of advanced fuels in decarbonising aviation, with potentially 17% of jet fuel consumed in 2050 in the UK coming from biofuels. The Government's Ten Point Plan included commitments to support the development of the emerging SAF market, including a consultation on a SAF blending mandate and a £15m "Green Fuels, Green Skies" competition to provide development funding for new SAF production plants in the UK. As we look to build a strong SAF industry in the UK, it is important we consider the availability of biomass, including waste, and facilitate the development of local supply chains to allow SAF plants to scale up and costs to go down, so that SAF can effectively contribute to the decarbonisation of the sector.

In addition, biomass has the potential to replace fossil resources in innovative products through the production of high-value chemicals and bio-based products. To date, there are no specific policies incentivising the production of biomaterials or chemicals, however this could be within the scope of the Biomass Strategy if there are specific priority uses that play a role in meeting the net zero target. The use of timber in the construction sector, for example, was highlighted in the CCC's 6th Carbon Budget report[18] as an important mechanism to deliver GHG emission savings through the long-term storage of carbon in buildings, offsetting emissions by lowering demand for other building materials such as steel and promoting the increased demand for forest products and other biomaterials.

Today, in the context of the Net Zero target, there is additional emphasis on the role for biomass to contribute towards achieving net negative greenhouse gas removals (GGRs), which are needed to offset GHG emissions from those harder to decarbonise sectors such as heavy industry, agriculture and aviation. Therefore, there may be questions about how biomass is best used to mitigate and offset emissions from some sectors, particularly aviation, where there may be trade-offs between in-sector emission reductions through the use of SAF and carbon removals in terms of net GHG reduction, biomass suitability and costs.

[18] Demand for low carbon fuels is also expected to rise in maritime sector. However, given the wider range of options available to this sector and limits to the availability of sustainable biomass, it is anticipated that the fuels deployed in this transport mode, including for example hydrogen and ammonia created by green electricity or equivalent, will be mainly outside the scope of this call for evidence.
[19] https://www.theccc.org.uk/publication/sixth-carbon-budget/

In its 'Balanced Net Zero Pathway', the CCC estimates that removals of 58 MtCO2/year could be required from engineered GGR methods, such as BECCS and Direct Air Carbon Capture and Storage (DACCS) in 2050, in addition to nature-based sinks of 39 MtCO2/year from UK land. There may be various routes through which removals on this scale could be achieved. The CCC specifically identifies afforestation and peatland restoration (alongside bioenergy crops) as potential routes for "land-based removals" alongside engineered removal technologies such as BECCS and DACCS. Therefore, biomass for energy or materials (e.g., timber mentioned previously) may play a role in both the land and engineered routes for removals, and biomass use could be combined with afforestation, changes to forest management and soil sequestration to achieve additional carbon reductions by increasing the land carbon stock. There is a further potential role of biomass in the production of 'biochar', which can enhance soil carbon storage while also has the potential to provide a range of fertility and soil quality co-benefits.

The CCC identified that bioenergy coupled with carbon capture and storage (BECCS) could deliver a significant reduction of up to 53 MtCO2e by 2050, the rationale being that we can both recover the energy and capture the carbon contained in biomass, delivering negative-carbon energy. There are opportunities for BECCS through retrofitting existing power generation, new power generation, hydrogen production, in anaerobic digestion and the production of renewable transport fuels, amongst others, and we are seeking views on what specific arrangements are needed to incentivise wider deployment of BECCS in these different applications and overcome the challenges and barriers specific to BECCS, compared to the support that may be needed for other GGR and carbon capture and utilisation technologies.

Government support for bioenergy has already successfully delivered GHG emission savings (as outlined in the Introduction) by stimulating the use of biomass, building supply chains and economies of scale, and gaining access to new biomass materials that would alternatively have been underutilised. The supply of sustainable biomass, however, is ultimately limited, and therefore it is suggested that its use within the economy should be targeted towards those areas that offer the greatest opportunity to decarbonise or are more difficult to decarbonise via alternative routes.

However, there may be various interdependencies that should be considered, and it is important to ensure that the use of biomass does not create indirect and unintended negative impacts on the environment. For example, it is vital that the UK's decarbonisation pathway also strives to improve air quality and minimises adverse impacts on human health, as set out in the Clean Air Strategy[20] (explored in Question 14). The impacts of biomass use will vary depending on the particular use, the fuels which are being replaced and the proximity of emissions to areas of population. Certain uses of biomass can have significant air quality impacts, for example ammonia emissions from anaerobic digestion can cause biodiversity loss and negative impacts on human health. The use of biomass for domestic burning is also a significant contributor to the UK's PM2.5 levels, and the Government intends to issue a Call for Evidence this year which will look at the health and environmental impacts of new waste-based

[20] https://www.gov.uk/government/publications/clean-air-strategy-2019

fuels such as coffee logs. We therefore welcome views on how the potential impacts on air quality should shape how and where biomass is used.

The 2012 Bioenergy Strategy[21] introduced a series of principles to act as a framework for future Government policy on bioenergy. These set the position that bioenergy should deliver genuine GHG reductions, should make a cost-effective contribution to UK GHG emission objectives, and to take into account the impacts of an increased deployment of biomass on other areas, such as food security and biodiversity. While these objectives remain important today, we now aim to build on those and are considering what principles, or framework, should be applied when determining how biomass could be best utilised across the economy to help achieve our net zero target while also supporting the delivery of our wider environmental targets.

It is therefore important to define what is meant by 'best', and whether a framework is needed to define this. For example, the most effective routes for biomass to contribute to decarbonisation targets may depend on various factors. Firstly, it may depend on the other technologies available to decarbonise a particular sector, for example electrification of transport. Otherwise, the most effective use of biomass may depend on technical limitations, including the characteristics of particular biomass feedstocks (composition, moisture content, contaminants), fuel quality and the technologies available, and associated costs, to convert different feedstocks into the needed outputs. This may well change over time as we see different biomass feedstocks become available, and as technology innovates to make use of that biomass (see Chapter 4). There may be limitations on where biomass can be used, based on the impacts on the local population, or the logistics of collecting material with a low geological density of supply. There may also be opportunities to encourage synergies between different environmental goals, which could be achieved through efficient use of by-products and co-products at each stage of the value chain.

Consequently, Government policies may need to be able to compensate for trade-offs between what may be the most cost-effective, deployable, or energy efficient route for biomass conversion, and the need to meet specific decarbonisation goals in specific sectors. Also, policies may need to help provide a balance between supplying biomass and the demands for biomass, as in some instances biomass feedstocks could have multiple uses, and there could be impacts on other markets due to an increase in biomass use. In some cases, the market itself might play an important role without regulatory intervention, and the impacts of this may also need to be considered.

To address these concerns our questions focus on how different biomass materials or feedstocks, (as identified in Chapter 1), could be used in different sectors, and what would be considered priority uses in order to meet the net zero target. We also ask about how we might assess what a 'priority use' might be, and how these uses can be supported through policy.

[21] https://www.gov.uk/government/publications/uk-bioenergy-strategy

Use of Biomass - How should we use biomass to reach net zero?

We welcome evidence and views on:

8. **Considering other potential non-biomass options for decarbonisation (e.g. energy efficiency improvements, electrification, heat pumps), what do you consider as the main role and potential for the biomass feedstock types identified in Question 2 to contribute towards the UK's decarbonisation targets, and specifically in the following sectors?**
    - **Heat**
    - **Electricity**
    - **Transport**
    - **Agriculture**
    - **Industry**
    - **Chemicals and materials**
    - **Other?**
9. **Out of the above sectors, considering that there is a limited supply of sustainable biomass, what do you see as the priority application of biomass feedstocks to contribute towards the net zero target and how this might change as we reach 2050? Please provide evidence to support your view.**
10. **What principles/framework should be applied when determining what the priority uses of biomass should be to contribute to net zero? How does this vary by biomass type and how might this change over time?**
11. **When thinking of BECCS deployment, what specific arrangements are needed to incentivise deployment, compared to what could be needed to support other GGR and CCUS technologies as well as incentivising wider decarbonisation using biomass in the priority sectors identified?**
12. **How can Government best incentivise the use of biomass, and target available biomass towards the highest priority applications? What should the balance be between supply incentives and demand incentives and how can we incentivise the right biomass use given one feedstock could have multiple uses or markets?**
13. **Are there any policy gaps, risks or barriers hindering the wider deployment of biomass in the sectors identified above?**
14. **How should potential impacts on air quality of some end-uses of biomass shape how and where biomass is used?**

Chapter 3: Sustainability and Accounting for Emissions

Biomass must be sustainable and deliver genuine GHG emission reductions. Sustainability standards are the main means through which we set the sustainability requirements that biomass must meet before its use is supported. These requirements are intended to ensure that any supported biomass delivers GHG emissions reductions and limit any negative impacts on the environment, including on land use and biodiversity.

In the 2012 Bioenergy Strategy we made clear that a pre-eminent concern of the UK Government in bioenergy policy is that bioenergy offers a genuine reduction in GHG emissions. The point was made that clear, enforceable, transparent sustainability criteria have a key role to play across the policy landscape. This may be regulated in various ways, either through the conditional support through grants or subsidies, or 'renewable certificates', or by mandating the use of approved supplier lists. While we will mainly focus on supported uses of biomass, there may be considerations around how unsupported biomass is used and how, in that case, the sustainability criteria can be enforced. There are also different ways compliance with these criteria can be monitored, for example through the use of voluntary certification schemes, and we welcome stakeholder views on how these could be best utilised to support biomass sustainability.

Since publishing the 2012 Bioenergy Strategy we have implemented mandatory sustainability criteria for solid and gaseous biomass used for heat and power generation. These criteria go beyond those set in the European Commission's Renewable Energy Directive[22], and the criteria set out what types of land the biomass must be sourced from and what GHG emissions savings must be achieved. For woody biomass, the land criteria include requirements to protect soil, water, biodiversity, and ecosystems, maintain the productivity of the area and have regard to traditional rights of tenure and land use. They also set out that the forest, or land, must be managed in a way that is consistent with the Forest Europe Sustainable Forest Management Criteria[23], or a set of similar international principles. For non-woody biomass and biofuels the criteria protect, among other things, primary forest, highly biodiverse grassland, wetland and peatland.

Similar standards exist for transport fuels supported under the RTFO. These were established in 2011 and include minimum GHG emission saving thresholds and land criteria which specify the habitats on which feedstocks for biofuels can and cannot be grown. Biofuel supply chains can be long and complex with both feedstocks and finished fuels traded globally. The existing UK sustainability criteria requirements for transport fuels are largely compatible with similar

[22] https://ec.europa.eu/energy/topics/renewable-energy/renewable-energy-directive/overview_en
[23] https://foresteurope.org/sfm-tools/

standards used by other European countries, and this compatibility is important for fuel suppliers who often do not know the destination market at the point of production.

The GHG emission savings of a particular biomass use are calculated based on a full supply chain life cycle assessment (LCA), ensuring that all stages of cultivation[24], collection processing, transport and conversion (where relevant) are accounted for. In the case of biofuels and bioliquids this is expressed as a percentage saving compared to a fossil fuel comparator; for solid and gaseous biomass absolute emissions limits are set. In the case of biofuels there are additional 'indirect land use change' (ILUC) factors that are added in order to monitor the supply of fuels made from feedstocks with a higher risk of causing indirect land use change.

There are different Government support schemes for bioenergy use in different sectors and to some extent the sustainability criteria vary from scheme to scheme. The key requirement across all schemes is that operators seeking Government support for the production, supply or use of bioenergy must demonstrate they meet the sustainability criteria on a consignment basis, or within a certain application time period, and provide independent audit reports. Operators are not supported where they cannot demonstrate they meet the sustainability criteria set out in the relevant support scheme.

The UK has led the development and contributed to a number of wider international bioenergy sustainability schemes (e.g., the Renewable Energy Directive), but in many cases has gone further and the UK's bioenergy sustainability criteria are considered to be among the most stringent in the world. There are, however, questions about whether updates are needed in light of new evidence and in the case of any Government support schemes, e.g., capital grants, to support bioenergy where there is not necessarily a clear mechanism for long term monitoring of sustainability. We must also consider how the UK can continue to be attractive to biomass imports and consider the impact any strengthened sustainability criteria have on the compatibility of standards affecting international suppliers, including those that use voluntary certification schemes to demonstrate compliance.

The CCC's view is that the evidence suggests existing criteria are helping to limit the sustainability risks[25]. However, they have identified three key areas where there are gaps:

- *"Risks are only partially managed and there is a focus on compliance with minimum standards, at the expense of best practice.*
- *The current rules are tied to subsidy-schemes and do not apply where use is not subsidy-dependent.*
- *There is a risk the UK select the most sustainable feedstocks pushing the less sustainable feedstocks into other markets."*

In addition to the CCC's observations, there have been a range of other suggested alternative sustainability approaches to ensure the use of bioenergy achieves reductions in GHG

[24] The LCA of wastes and residues begins at the stage of collection.
[25] Biomass in a low carbon economy

emissions, and other environmental impacts as mentioned above. We are interested in views on all potential options that take into account the latest evidence in this area.

In this Call for Evidence we are interested in views and evidence on what changes we might make to better monitor the wider impacts of bioenergy policy, such as indirect land use change, air quality implications and wider impacts on ecosystem services, and maximise the potential benefits of biomass. While the LCA methodology results in a total GHG emissions figure for the supply chain associated with a particular consignment of biomass, (which ensures the bioenergy results in reductions in GHG emissions below a particular threshold), such quantitative analyses may not be applicable for monitoring impacts on land, soil, water, and biodiversity, which are to some extent regulated using qualitative sustainability criteria. There may be some scope to improve how quantitative methods are adopted, for example in the case of air quality, as there are air pollutant emission factors that could be applied to most economic activities.

Carbon accounting improvements for BECCS and other GGR technologies (not covered in this call for evidence) will be crucial to ensure that carbon removals can be robustly and transparently included in the UK's GHG emissions inventory, as well as enabling policy mechanisms to be linked to performance and outcomes. However, there are a range of uncertainties around the amount of CO2 removed, life-cycle emissions, and difficulties around monitoring, reporting and verification are all barriers to large-scale deployment of BECCS and other technologies.

Guidelines by the Intergovernmental Panel on Climate Change are already in place for reporting GHG emissions and removals for BECCS[26] for national and international reporting on the UK's GHG emissions, although these provide default methods and emission factors, which are not country specific and require land use change emissions and stored CO2 to be accounted for in different countries when biomass is imported. Accreditation of negative emissions will be important to increase confidence in voluntary offset markets and enable companies who are looking to offset their emissions and combat climate change.

Therefore, this Call for Evidence is also seeking views on how life cycle accounting methodologies could be more transparent and how this information is used in national reporting of GHG emissions or in carbon budgets. For example, we are looking for views and evidence on how and in which sectors (existing or new) supply chain emissions are accounted for, or in which sectors sources and sinks of carbon through growing and harvesting biomass are recorded, and how and whether these could be amended to best deliver negative emissions and play a part in the UK's Emissions Trading Scheme (UK ETS) in the future. The UK ETS replaced the EU ETS on 1st January 2021, providing continuity of emissions trading for UK businesses. GGRs, including BECCS, are not permitted in the UK ETS currently, however, the UK government and devolved administrations' response to 'The future of UK carbon pricing' noted that the government will continue to monitor the maturity of GGR technology and look to review its potential for inclusion in the UK ETS as the scheme

[26] IPCC (2006), 2006 IPCC Guidelines for National Greenhouse Gas Inventories; IPCC (2019) 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories

evolves[27]. Therefore, we are seeking views on how negative emissions, such as from BECCS, can be incorporated into UK ETS, national reporting, and how this may be considered in domestic and international biomass supply chains.

Supply Chain sustainability – How can we strengthen our sustainability criteria?

We welcome evidence and views on:

15. **Are our existing sustainability criteria sufficient in ensuring that biomass can deliver the GHG emission savings needed to meet net zero without wider adverse impacts including on land use and biodiversity? How could they be amended to ensure biomass from all sources supports wider climate, environmental and societal goals?**

16. **How could we improve monitoring and reporting against sustainability requirements?**

17. **What alternative mechanisms would ensure sustainability independent of current incentive schemes (e.g., x-sector legislation, voluntary schemes)?**

18. **What additional evidence could suppliers of biomass-derived energy (for heat, fuels, electricity) provide to regulators to demonstrate they meet the sustainability criteria?**

19. **How do we improve global Governance to ensure biomass sustainability and what role does the UK play in achieving this?**

Accounting for Emissions – How can we improve the way we account for biomass emissions?

We welcome evidence and views on:

20. **How should the full life cycle emissions of biomass be reflected in carbon pricing, UKETS, and within our reporting standards?**

21. **How should BECCS be treated for domestic and international GHG emissions accounting and reporting? What are the implications of existing reporting rules on our ability to deliver negative emissions, when for instance, land use change emissions and stored CO2 are being accounted for in different countries?**

[27] The future of UK carbon pricing - UK government and devolved administrations' response

Chapter 4: Innovation

Chapter 1 examined the potential future biomass supply, and Chapter 2 questioned what role biomass would have in meeting the net zero target. Here we ask what innovation is needed to maximise the use of the sustainable biomass supply and meet our decarbonisation targets without needing substantial amounts of productive land or have wider negative impacts. The focus of this section is on how innovation could minimise the barriers to deployment and improve the way both current and mature technologies operate.

Biomass has been used in a wide array of applications in recent years to displace fossil fuels, including replacing coal in conventional electricity generation and replacing coal, oil, and gas in some heating settings. There is also a growing volume of renewable fuels produced from biomass, built upon conventional fermentation or transesterification technologies, which can replace fossil fuel usage in road transport. Some of these applications are considered technically mature and are on a trajectory to becoming cost-competitive with their fossil counterparts. However, whole systems modelling from the CCC, Energy Systems Catapult, and other institutions see a crucial role for less mature applications of biomass. This requires effective innovation in both the production of biomass and the technologies that can use biomass to meet our decarbonisation goals. There are also opportunities to drive innovation to scale up and commercialise the production of materials that can be used in non-energy sectors, such as textiles, construction, pharmaceuticals and other high value chemicals.

In the energy sector there is increasing interest for technology innovation, as shown by the uptake of Government support for the development of advanced conversion technologies to produce electricity and renewable fuels, which present opportunities to move away from conventional combustion technologies and increase the efficiency standard of conversion from feedstock to end-product. Advanced conversion technologies, such as gasification, pyrolysis, hydrothermal liquefaction or alcohol to jet fuel, have been identified as key enabling technologies by the CCC to meet our net zero ambitions. One of the benefits of advanced technologies is that they offer an opportunity to upgrade low quality and heterogeneous biomass feedstocks into high quality products that could be used in the harder to decarbonise sectors, including transport. These products include synthetic natural gas or hydrogen, or the products that can be further upgraded (e.g., via Fischer–Tropsch) into aviation or drop in fuels. Some of these routes are currently incentivised under DfT's RTFO Development Fuel target, providing that eligible waste feedstocks are used and minimum GHG emissions can be achieved and are likely to play an important role in the development of a strong sustainable aviation fuels industry. We are keen to hear views on how, given the complexity of the technologies, innovation could and should be further supported or incentivised.

The CCC also identified that BECCS - combining bioenergy use with carbon capture and storage - could play an integral role in meeting our carbon budgets out to 2050. As an 'engineered' GGR, BECCS is reliant on a Transport and Storage network for captured CO2. This is not covered under the scope of the Biomass Strategy, however, there is an

interdependency with the overall infrastructure capability that may affect where and how BECCS is deployed.

Innovation may therefore be required to enable the less mature of these technologies to come down the cost curve to fulfil their potential to support achieving the net zero target. For example, a variety of whole systems models expect BECCs hydrogen to play a significant role in meeting the net zero target by 2050, but so far has seen limited progress in deployment due to high start-up costs associated with the need to prove the technology and lower investment risk. However, for more developed technologies, such as conventional biomass generation combined with post-combustion capture, further innovation is linked to creating a stable commercial landscape to extend investment. We are keen to hear from technology providers how Government can target different types of innovation support in this area and the expected benefits.

Additionally, within the scope of the Biomass Strategy, there are innovation needs in the more conventional and mature technologies, and these needs may differ depending on the scale adopted. It is possible that innovation could help technologies to realise their full potential and maximise GHG savings while reducing other unwanted impacts such as poor soil or air quality. This could be done through innovation in monitoring or abating of non-GHG emissions from biomass technologies, for example biomass boilers. Innovation in biomass pre-processing could help improve conversion efficiencies, reduce contamination or conserve against biomass dry matter losses. Also, innovation in post-processing or handling of products, such as digestate in anaerobic digestion could mitigate emissions of ammonia, which can help with meeting the air quality targets set out in the Clean Air Strategy, while also minimising impacts on soil and water. There may also be innovative co-processing routes with conventional refineries that can increase the penetration of biomass into conventional transport fuel routes or plastic manufacturing, that could play a role in intermediate decarbonisation pathways.

The feedstocks we use may also benefit from targeted innovation support. A challenge facing the UK will be bringing together a range of different priorities for domestically grown feedstocks, including determining the right feedstock for different bioenergy applications, where they grow best in relation to other uses of land, and how to drive down the carbon intensity of their supply chains. Another challenge is developing the skills and training we need to see future bioenergy markets established. We are keen to hear from the feedstock supply sector where innovation can effectively help bring together these priorities.

Innovation – What technological or systems developments do we need to see?

We welcome evidence and views on:

22. **Given the nature and diversity of the biomass feedstock supply (as referenced in Chapter 1), what specific technologies are best positioned to deliver the priority end uses (as referenced in question 9), and how might these change as we reach 2050?**

23. **What are the barriers and risks to increasing the deployment of advanced technologies (e.g., gasification, pyrolysis, biocatalysis) and what end use sectors do you see these being applied to?**

24. **In what regions of the UK are we best placed to focus on technological innovation and scale up of feedstock supply chains that utilise UK-based biomass resources?**

25. **Post-combustion capture on biomass electricity generation is one method in which BECCS can be deployed to deliver net-zero. Specifically, how could innovation support be targeted to develop the maturity of other BECCS applications, such as biomass gasification?**

26. **What other innovation needs to take place in order to reduce life cycle GHG emissions and impacts on air quality in biomass supply chains? Are all of these easily achievable, and if not, what are the barriers?**

Next steps

This Call for Evidence will close on xx 2021. We are committed to ongoing dialogue with stakeholders as we review responses to this Call for Evidence and develop the Biomass Strategy.

Our intention is for the formal government response to this Call for Evidence to be as part of the Biomass Strategy, to be published in 2022.

This consultation is available from: https://www.gov.uk/government/consultations/role-of-biomass-in-achieving-net-zero-call-for-evidence

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