Draft Bioenergy Policy Statement

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Scottish Government
Riaghaltas na h-Alba

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Ministerial Foreword

With the impacts of climate change becoming ever more acute, it is essential that we meet our ambitious target to reduce greenhouse gas emissions to net zero by 2045. This draft Bioenergy Policy Statement sets out the role we see bioenergy playing in Scotland's journey to net zero.

Bioenergy is already a key component of our energy system and contributes to a more circular economy, by turning wastes into valuable resources which can be used for electricity and heat production or to displace fossil fuels in our gas network and transport systems.

Bioenergy has huge potential to reduce emissions across our economy when used with carbon capture and storage technology, which can permanently remove carbon dioxide from the atmosphere. Realising this potential can help to deliver a just transition for our energy sector, and through developing a thriving and homegrown market for domestic production of bioenergy feedstock, can provide opportunities for rural communities.

Sustainability of this supply chain and protection of our natural environment are of critical importance. We must ensure that stringent controls are in place as we seek solutions to the twin nature and climate crises.

This draft policy statement was developed though a cross-sectoral approach. It has been driven forward by a Bioenergy Policy Working Group which brings together officials from across government. We have carefully taken on board advice and contributions received from the Climate Change Committee and wider stakeholders, and this policy statement builds on our previous Bioenergy Update published in March 2021.

The Scottish Government is committed to reducing emissions, reducing inequalities and protecting our environment whilst developing a competitive and innovative wellbeing economy. We are now seeking your views on the policy direction, priorities and opportunities which would help the bioenergy sector in Scotland deliver on these objectives.

It is our ambition that this Bioenergy Policy Statement will support the realisation of economic opportunities in pursuit of a just transition, reduce our reliance on global imports, help provide security of energy supply, and further develop a stable and sustainable part of Scotland's green economy.

Gillian Martin MSP, Minister for Energy, Just Transition and Fair Work

Executive Summary

Bioenergy is a diverse sector with applications which can displace fossil fuels across heat, power, industry and transport. This flexibility has led to a steady increase in the use of bioenergy across the globe, with many forecasts assuming even greater demands in the coming years. The emergence of Bioenergy with Carbon Capture and Storage (BECCS) is also expected to play a valuable role in our pathway to net zero.

These demands require a sustainable supply chain of biogenic materials. At any one time there is a finite amount of sustainable bioresource available and we should ensure that any feedstock has no wider residual value within society before being utilised for energy.

We want to see the resources which are available to the bioenergy sector being used where they can best support Scotland's journey towards net zero. This means that use of bioresources need to be prioritised to where they can be most effective in reducing emissions and where there is greatest need for alternatives to fossil fuels. In the longer term, the finite bioresources which are available should be prioritised towards applications with carbon capture, wherever that becomes feasible. We are seeking views on how and when that transition could happen.

We are also seeking views on the potential to scale up domestic biomass production. Scaling up our domestic biomass supply chain will provide security of supply, greater supply chain transparency and accuracy of lifecycle emissions calculations, as well as ensuring we do not have an overreliance on imported biomass.

We need to ensure stringent controls are in place to mitigate or avoid risks to biodiversity and the natural environment. We also value the importance of food production, both to our food security and to our economy. Careful consideration is required to ensure that our land can provide the vital platform to help us realise our many ambitions.

We want to capitalise on the opportunity that developing a strong domestic supply chain can bring, including for a just transition from some more traditional land uses. The increase in our domestic production will likely have to be met by planting of perennial energy crops. Decisions on opportunities to scale up biomass production should align with and support Scotland's goals for protecting and restoring nature and will need to take into consideration the many other demands of our land.

Introduction

When using sustainably sourced material, bioenergy can convert organic material into a renewable energy source. The organic material, often referred to as biomass feedstock, can be processed to give a direct energy output, such as producing heat from combustion, or refined to produce a liquid biofuel or biogas.

The bioenergy sector is currently a vital part of Scotland's circular economy, generating value from waste and by-products. We believe there are additional resources which could be available for energy generation and want to see these utilised where they can facilitate a transition away from fossil fuels.

Purpose

The purpose of this draft Bioenergy Policy Statement is to set out the role that we see bioenergy having in Scotland's journey to net zero. It signals what the Scottish Government see as the short, medium and long term role for bioenergy, how the use of bioenergy can help Scotland get to net zero and highlights the actions that still need to be taken to enable this.

Bioenergy has many applications across heat, power, industry and transport, with a diverse range of mature and emerging technologies, which can be used to convert organic matter (biomass) into energy and could permanently remove carbon dioxide from the atmosphere when used with carbon capture technology. This makes bioenergy a complex policy area with diverse stakeholder interests.

Bioresources are often a by-product of agriculture, forestry, manufacturing or industry and should be utilised to displace fossil fuels, reduce emissions and reduce use of raw materials. Where feasible, carbon capture and heat recovery for use both on and offsite should also be added to the process.

The versatility and ability of bioenergy to act as a 'drop-in' fuel, make it valuable in displacing fossil fuels in the short term. In the longer term, developing technologies give it significant potential for delivering negative emissions[1]. This draft Bioenergy Policy Statement sets out what we see as the key priorities for this diverse sector.

The draft statement is presented in two chapters, the first covering the use of bioenergy and the second considering the potential domestic supply of biomass feedstocks. Consultation questions appear at the end of each

[1] Negative Emissions occur when CO2 is removed from the atmosphere and sequestered.

section within the chapters and are listed at the end of the draft statement (at Annex A on page 34).

Context

In our 2021 Bioenergy Update we set out the current role of bioenergy and how that may change as we move towards a net zero future. We identified the complex interdependencies throughout the biomass supply chain, as well as the potential competition for finite resources. The Update set out the importance of a strategic deployment of bioenergy technologies to ensure available resources are used in the most effective way. We highlighted the emerging role for Bioenergy with Carbon Capture and Storage (BECCS) as integral to achieving the negative emissions potential which will make net zero possible.

Since the publication of the Bioenergy Update, we have published our draft Energy Strategy and Just Transition Plan, which set out our vision for an energy system which delivers affordable, resilient and clean energy supply. It also set out that although Negative Emissions Technologies (NETs), such as BECCS, will be critical for reaching net zero. These technologies cannot be used to justify unsustainable levels of fossil fuel extraction or impede Scotland's just transition to net zero.

There is a need for bioenergy to be scaled up and be used where it has the greatest impact in reducing emissions. The Climate Change Plan update (CCPu) described the need for increased use of BECCS in the future, acknowledging that further assessment is needed of the availability, sustainability and fairness of this increased bioenergy use in Scotland.

In our Bioenergy Update we outlined the need for more evidence to understand the availability of biomass feedstock and the trade-offs which need to be considered when scaling up production. We also committed to investigate the existing and emerging technologies which could help to deliver a net-zero energy system. The relationships between our energy system, net zero ambitions and use of land must be managed carefully to ensure that development is sustainable and delivers opportunities for a fairer, greener future.

Climate Change Plan (CCP)

The next Climate Change Plan (CCP), covering the period 2025 to 2040, is currently being produced with a final plan to be published no later than March 2025. The Scottish Government must set out within the CCP what policies and proposals will produce the required emissions reductions to meet annual statutory targets.

This draft policy statement sets out the parameters that need to be considered when setting bioenergy use now and in the future. It identifies what we think the priority uses of bioenergy are in the short, medium and long term, and sets out the potential domestic biomass supply that could be available as feedstock for energy production. It examines how available domestic biomass feedstock could be increased by planting energy crops. It also acknowledges the potential constraints on the use of bioenergy, the importance of having strict sustainability criteria and that biomass feedstock production and use should facilitate key sustainable development goals.

The modelling that underpins the CCP has been updated to reflect our greater understanding of the constraints on availability of sustainable biomass feedstock and technology readiness.

Chapter 1: Bioenergy Use

Bioenergy has many applications across heat, power, industry and transport, with a diverse range of mature and emerging technologies. In this chapter we set out a series of draft guiding principles for bioenergy use, as well as our high-level view of where we see demand for bioenergy in the short, medium and long term.

We recognise that the use of, and demand for, bioenergy will evolve as new technologies, market opportunities and evidence develop. The following therefore represents our initial thinking on future bioenergy use in Scotland, and we are seeking your views through the consultation on this draft Policy Statement.

In our Bioenergy Update we committed to setting out a strategic framework (guiding principles) for bioenergy. We worked with our internal Bioenergy Policy Working group to identify these principles. We have also been working with the UK Government as they developed their Biomass Strategy and our draft principles for use of bioenergy are closely aligned with that Strategy. These principles should be considered when sector specific policies related to bioenergy use are being developed. These draft guiding principles are:

1. Use of biomass must comply with stringent sustainability criteria (including land criteria and greenhouse gas emissions reduction criteria). The current use of biomass should meet existing criteria relevant to the sector in which it is used. Longer term we expect biomass use to meet the new cross-sectoral sustainability framework to be developed by the UK Government. Biomass use should also be independently monitored and verified to ensure best practice and the highest standards are upheld.

2. The bioenergy sector should prioritise the use of available waste feedstocks. The use of biomass must comply with the principles of a

circular bioeconomy and a cascading use of biomass. For example, wood should first be used where it can deliver the highest economic and environmental benefit (for example in construction), then life extension, reuse and recycling of the wood should be sought before finally its use in bioenergy applications. Availability of bioresource has many constraints and we should ensure that any feedstock has no wider residual value within society before being utilised for energy.

3. Use of biomass should be prioritised towards practices where there are limited options to replace fossil fuels. This recognises there are areas of the economy which are hard to decarbonise and as such bioenergy should be used in those specific areas.

4. Use of biomass must support emissions reduction and the pathway to net-zero by 2045. This includes application of carbon capture technology as soon as feasible to do so. Notwithstanding the principle above, short term uses in hard to decarbonise sectors should not mean longer term alternative solutions are not developed.

5. Use of biomass must comply with all environmental regulations as set out by the Scottish Environment Protection Agency (SEPA).

6. Biomass feedstock production and use of bioenergy technologies should facilitate these sustainable development goals:
    - Scotland should be a world leader in affordable and clean energy.
    - We have a globally competitive, entrepreneurial, inclusive and sustainable economy.
    - We have thriving and innovative jobs and fair work for everyone.
    - We will focus on creating a more successful country, with opportunities for all of Scotland to flourish, through increased wellbeing and sustainable and inclusive economic growth.
    - Scotland is recognised for its leadership in encouraging and promoting a more circular economy.
    - We will tackle climate change and by 2045 will transition to a net zero emissions Scotland for the benefit of our environment, our people and our prosperity.
    - Enhancing and protecting Scotland's biodiversity and ensuring the health of its environment is critical in the fight against climate change and ensuring the environmental, social and economic benefits they bring for future generations.

1.1. Priority use for bioenergy

Having declared a climate emergency in 2019, the priority use for bioenergy should be facilitating carbon removal via Bioenergy with Carbon Capture and Storage (BECCS) technologies, as they are the cheapest method of delivering engineered negative emissions. There will be a number of other specific roles across heat, transport and industry where biomass can displace fossil fuels.

At a high level, our priority uses for bioenergy are similar to those set out in the UK Biomass Strategy.

- In the short term there will continue to be demand for biomass to be used in power, heat and transport. Where possible, we support early adoption of Carbon Capture Utilisation and Storage (CCUS) paired with bioenergy applications.

- In the medium term, most bioenergy should begin to transition away from unabated uses of biomass where possible, to uses such as BECCS, which are critical to meeting net zero.

- In the longer term BECCS will be the priority role and could make significant contribution towards net zero. There will be limited use in some hard to decarbonise sectors that cannot deploy BECCS.

Scotland's bioenergy sector, however, differs from England's in terms of scale. Our largest biomass power plant is 55 MW, compared to the Drax (4 x 645 MW) or Lynemouth (420 MW) power plants in England. Our wood fuel supply chains are efficient and for the most part based on domestic supplies, and we have a large number of distilleries, including many located in remote or island locations. The by-products of whisky production can be used to generate energy or they can utilise biomass to displace fossil fuels.

The recently published Negative Emissions Feasibility Study shows that across the uses of biomass, some early movers will deploy carbon capture and storage to deliver negative emissions from 2030 onwards, as well as other approaches to removing CO2 from the atmosphere such as biochar. We expect the use of biomass to increasingly be prioritised for emissions removals. A list of potential BECCS technologies can be found in Annex C.

Bearing in mind the draft guiding principles set out above, we set out below, for consultation, our high-level expectations on the sectoral uses of bioenergy now and in the future. This demonstrates how we expect bioenergy use to change over time, and in a way which supports our overall aim for bioenergy to be used where it has the greatest impact on reducing emissions.

Short to medium term (out to 2035)

We see the current sectoral uses for bioenergy from now until the mid-2030s as:

Power – Existing biomass power and biomass / biogas Combined Heat and Power (CHP) plants. New biogas CHP plants which utilise waste resources.

Heat – Biomethane injection to the gas grid, local district heating schemes or for emergency back-up systems using biogenic feedstock. Biomass or biofuels may be the only solution for existing properties that are currently not suitable for clean heating systems.

Transport – Biofuels for Heavy Duty Vehicles (HDV) and Heavy Goods Vehicles (HGV), maritime or agricultural vehicles. Use of biomass for Sustainable Aviation Fuel (SAF) production and use of biofuels for rail transport where electrification of lines is not currently possible.

Industry – Distilleries and breweries, pulp and paper mill, wood panel and pellet production, fuel switching from fossil fuels with potential for linking to future CCS (Carbon Capture and Storage) infrastructure.

Wherever possible we expect locally available resources to be used to meet the demands of the area. We would expect early movers from across the applications listed above to deploy carbon capture technology during the short to medium term, out to 2035.

Longer term (beyond 2035)

The longer term (post-2035) use of bioenergy should prioritise BECCS applications where possible, and the majority of biomass uses should deliver negative emissions, but specific timing and detail will depend on how technologies develop.

Power – Electricity generation and hydrogen production. Both technologies having been identified as having potential for being used with carbon capture and with recoverable heat being used - for example offsite in district heating schemes.

Heat – Limited use in district heating and potentially biomass / biofuel heating systems in existing homes where no other clean heating solutions are suitable.

Transport – Resources directed towards aviation and synthetic fuel production with CCS.

Industry – Use of BECCS within distilleries and breweries, pulp and paper mill, wood panel and pellet production and the cement industry.

Biochar is another emerging use of biomass which can sequester carbon and we will continue to explore the opportunities for use in agriculture and the applicability to, and opportunities in, the carbon market.

Bioenergy is cross cutting in nature, affecting a wide range of policy areas from across the Scottish Government and a whole systems approach is required when considering the optimal contribution that bioenergy can make to the energy system. We provide more details below on how bioresources are currently used within the energy sector and how this may change over time.

Questions on preferred uses and principles for use of bioenergy

1. Do you agree with the overarching principles for use of bioenergy, as set out in this document on page 7?

2. Do you agree with the priority uses of bioenergy, as set out in this document on page 10?

1.2. Current use of bioenergy – technology types

Power and Combined Heat and Power (CHP)

Currently, the majority of Scotland's wood fuel is directed towards large combined heat and power plants. This aligns with our view set out in the 2017 Scottish Energy Strategy, that biomass should be used in heat only or combined heat and power schemes to exploit available heat and local supply. This is due to greater efficiency compared to power only. CHP typically has an efficiency of over 80%.

Markinch Case Study

Markinch combined heat-and-power (CHP) plant began operating in 2014. The 55 MW site in Markinch, Fife predominantly uses recovered wood waste to generate electricity. Excess heat from the site is used to produce hot water to fuel the Glenrothes Energy Network that benefits 55 homes (including sheltered accommodation), 9 business units, Fife Council's corporate headquarters and a theatre complex. Markinch is the largest biomass-fuelled power station in Scotland.

In 2019, the Scottish Government provided £8.6 million in funding towards the Glenrothes Energy Network, via the Low Carbon Infrastructure Transition Programme.

Heat in Buildings

The majority of Scotland's renewable heat currently comes from bioenergy, with 67% from biomass and 16% from biomethane injected to the gas grid (biomethane currently accounts for 1.65% of Scottish gas demand).

For buildings, biomass boilers that burn wood pellets, chips or logs are a well-established heating technology, which have been successfully supported through the UK Government's Renewable Heat Incentive (RHI) schemes. The schemes have closed for new applications but final payments for domestic participants may run until 2029 and for non-domestic participants that could be 2041. Sustainability of feedstock for these schemes can be guaranteed by purchasing through the Biomass Suppliers List (BSL).

The Woodfuel Demand and Usage in Scotland report carried out a review of woodfuel consumption by installation size category in 2021 (see table below).

Installation size category	Number of installations	Percentage of installations	Wood fuel consumption (oven dried tonnes)	Percentage of wood fuel consumption
Domestic	4,771	57%	50,000	3%
Small non-domestic	2,598	31%	110,000	7%
Medium non-domestic	935	11%	229,000	15%
Large non-domestic	58	1%	1,103,000	74%
Total	**8,362**	**100%**	**1,491,000**	**100%**

In order to meet our legal obligation to reach net zero the heating systems in the vast majority of our buildings will need to be changed from polluting heating systems to clean heating systems. Some households and businesses are already doing this, with around 5,000 people per year installing heat pumps and around 33,000 buildings connected to heat networks.

We have been consulting on proposals for a Heat in Buildings Bill which set out our proposals to make new laws around the heating systems that can be used in homes and places of work. The consultation reconfirmed our plans that the use of polluting heating systems will be prohibited after 2045 and, as a pathway to 2045, those purchasing a home or business premises will be required to end their use of polluting heating systems within a fixed period following completion of the sale.

We recognise that as a renewable, and potentially net zero, energy source bioenergy may represent the best option to help decarbonise some homes for which clean heating systems are not suitable.

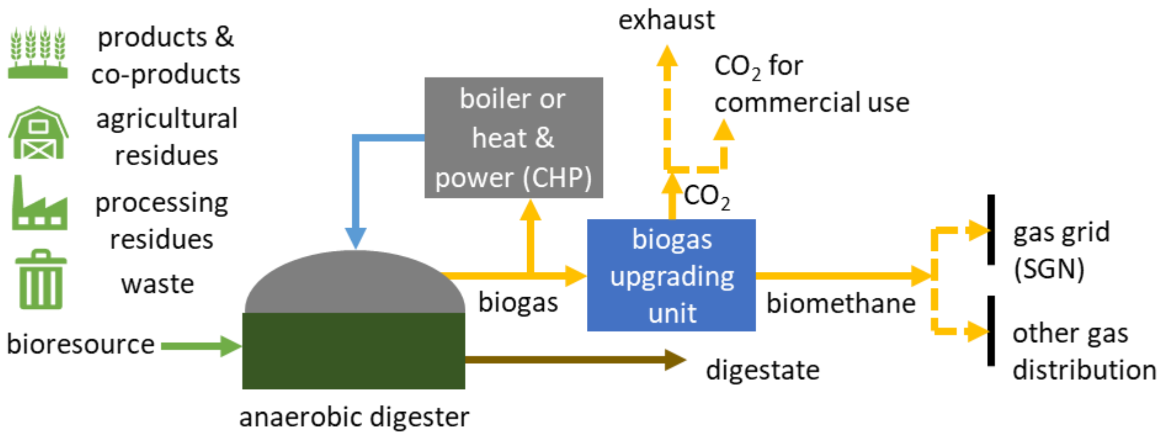
The use of solid biomass for heat is well-established in Scotland but biofuels such as BioLPG, also known as biopropane, renewable dimethyl ether (rDME) and Hydrotreated Vegetable Oil (HVO) could also potentially be used in some homes where zero direct emission options are not suitable. Similarly, there may be heat networks with limited options for back up heat sources and biofuels may be the most appropriate option. They can either be blended with fossil fuel or 100% renewable. These fuels can be produced from a number of bioresources, including used cooking oil, animal fat, vegetable oil or forest residues. These bioresources must be sourced sustainably and verified by an independent Monitoring, Reporting and Verification (MRV) process.

We want to ensure that owners who have taken the proactive step of installing renewable bioenergy systems are fairly treated. This is why, in addition to permitting extra time for those currently using bioenergy to meet the clean heat element of the Standard, we have been seeking views on whether a more flexible approach to the use of bioenergy under future regulations is needed. The Delivering net zero for Scotland's buildings – Heat in Buildings Bill consultation collected responses until 8 March 2024 and we will use the responses to inform our approach to bioenergy in future regulations.

From April 2024, new buildings will not be allowed to use bioenergy systems unless these are part of a heat network or as emergency backup. The New Build Heat Standard only applies to systems used for heating and cooling. This does not apply to industrial process heat.

Anaerobic Digestion (AD)

Anaerobic Digestion (AD) uses wastes, residues and food/feed crops as feedstock. These biogenic materials are broken down in a container, without the presence of oxygen, to produce biogas and digestate. The biogas can be upgraded to biomethane and then injected to the gas-grid, used as a fuel for transport or to provide industrial heat.



Graphic credit NNFCC: Assessing the Scottish anaerobic digestion market based on agricultural waste. Details of this diagram can be provided upon request.

Section 2.3 will provide more detail on the available domestic feedstock, but there could potentially be an additional 2 TWh/year of feedstock which is suitable for processing via AD that is not currently being utilised.

At small farm scale, manures and slurries can be collected and processed to provide biogas for heat and power. Research into the processing of farming waste through anaerobic digestion found that these materials typically have a low energy yield but if avoided emissions are taken into account, they can generate electricity with a zero or negative carbon footprint.

A number of distilleries have deployed AD plants, using draff, pot ale syrup and other spent grains as a way of producing biogas and an effective way to reduce their emissions. For urban areas, food waste and sewage sludge can be used as feedstock for AD plants.

The digestate left at the end of the anaerobic digestion process can be used as organic fertiliser, which offers better nutrient management and placement than using manure or slurry. Using digestate can also help to protect farmers from volatile prices of synthetic fertiliser, which is made from natural gas, as well as reducing reliance on imported fertilisers.

When biogas from AD is upgraded to biomethane, this provides a cleaner, more energy dense fuel. During the upgrading, it also provides an opportunity to capture CO2 during the process. The captured CO2 can then be utilised in the food and drinks sector, or in the emerging biotechnology and chemical sectors. Development of carbon capture and storage with AD plants has also been identified by the Negative Emissions Technologies (NETs) feasibility study as a possible way of kickstarting the sector.

AD case study

The Outer Hebrides Local Energy Hub is a multi-sector partnership comprising the Bakkafrost, Pure Energy Centre, Community Energy Scotland, and Comhairle nan Eilean Siar (CnES). The project was supported by Local Energy Scotland through the Scottish Government's Local Energy Challenge Fund.

The project uses fish waste from the local food processing plant, feeds this into an anaerobic digestor, using the resulting biogas in a CHP unit. The power output is combined with the energy from a local turbine and will be used to power a hydrogen electrolyser, with the resulting oxygen used to feed salmon. The hydrogen will power a fuel cell CHP which provides heat and power to the salmon hatchery. Some of the hydrogen will also be used to fuel a refuse truck which can collect more waste for biogas production.

The UK Government's Green Gas Support Scheme (GGSS) has replaced the Non-Domestic Renewable Heat Incentive (RHI) in providing support for production of biomethane, although the Non-Domestic RHI scheme can pay for up to 20 years. The GGSS is targeted at utilising food waste for biomethane production, but other feedstock is permitted so long as 50% is classified as waste. With the ban on biodegradable municipal waste going to landfill due to be in place in Scotland from 2025, this should divert more waste biogenic resources towards AD plants.

Biomethane injection to the gas grid currently contributes 920 GWh per year and, as set out in our Heat in Buildings Strategy, we need to see an increasing blend of biomethane in our gas grid over the next decade. The GGSS has now been extended to allow applications until 31 March 2028.

The next iteration of the GGSS needs to be in place as soon as this scheme ends to ensure continued support. The following scheme should also take a wider system view, incorporating Ofgem's statutory net-zero duty. Utilisation of waste such as manures and slurries, which are a source of emissions, should be a priority and would help to reduce agricultural emissions. The addition of carbon capture technology should be encouraged through any new scheme.

Transport

The Scottish Government expects that renewable electricity and hydrogen will facilitate the net zero transition of most forms of transport. However, there are sectors where zero emission technologies are not yet available for widespread deployment. This includes long distance Heavy Goods Vehicles (HGV), maritime, aviation and mobile agricultural machinery.

In the short term we see the most effective use of bioenergy for reducing emissions from transport to be 'drop in' biofuels, which can be blended with fossil fuels, in aviation, HGVs, maritime, rail and mobile-agricultural machinery until other zero emission technologies mature.

In the medium term, biofuels may be used at a higher blend but as the bio content increases there may be requirement for new vehicles to be adopted. In the medium to long term, we recognise that bioresources have potential to be used in development of Sustainable Aviation Fuel (SAF). To this end, we are forming a short life working group to evaluate these opportunities, alongside consideration of other advanced fuels which may develop.

The development of biofuels for transport is currently supported through the UK Government Renewable Transport Fuel Obligation (RTFO). Under the RTFO, large suppliers of relevant transport fuel in the UK must demonstrate that a percentage of the fuel they supply comes from renewable and sustainable sources. Biodiesel accounts for 47% of fuel supplied under the RTFO, of which 93% is produced from used cooking oil (UCO).

Feedstocks under the RTFO are restricted by the 'crop cap', which sets an upper limit on the amount that food or feed crop-derived biofuels can contribute towards fulfilling an individual supplier's obligation. This limit will decrease from 3.67% in 2023 to 2% from 2032 onwards. This crop cap excludes dedicated perennial energy crops. The RTFO compliance guidance outlines the sustainability criteria that approved suppliers must meet, similar to the EU's Renewable Energy Directive. This also includes a requirement for biofuels to achieve at least 65% greenhouse gas emissions saving. Suppliers must also be able to demonstrate a complete chain of custody in order to evidence that these criteria are met in full.

Mobile agricultural machinery

Mobile agricultural machinery produced 0.9 million tonnes of carbon dioxide emissions in 2021. This equates to 11% of total agricultural emissions. Electric alternatives to fossil-powered machinery (for heavy-duty, high-powered tractors, sprayers and combine harvesters) are currently limited as their size, power output and operational uses make them economically unviable to operate at present.

Research which considered the decarbonisation of mobile agricultural machinery in Scotland indicated that replacing fossil-diesel with biodiesel could equate to either a 4.18% reduction of CO2e emissions with a B5 blend, or a 16.2% reduction with a B20 blend. Using only biodiesel (B100), by 2035 carbon emissions from mobile agricultural machinery could reduce by 83.6%, if all vehicles are compatible with this higher biodiesel content. Despite being compatible with existing machinery, biodiesel can corrode engine parts faster and be more difficult to store than fossil-diesel.

Purpose-built machinery could achieve 77% reduction in carbon emissions by using biomethane as a fuel. This is most likely to be achievable on larger-scale farms, or where co-operative agreements exist between different farmers and land managers that have greater access to waste feedstocks, residues and anaerobic digestors.

To reflect the need for reducing emissions from mobile agricultural machinery, we have committed through our Programme for Government 2023-24 to hold a roundtable on decarbonising rural machinery and equipment. This will contribute towards developing policy ahead of the upcoming Climate Change Plan.

Heavy Goods Vehicles (HGV) and Heavy Duty Vehicles (HDV)

Case Study: biomethane HGVs

CNG Fuels currently operate four HGV biomethane compressed natural gas (bio-CNG) refuelling stations in Scotland, with plans to establish a network of 60 sites across the UK by 2026. Their site at Eurocentral Industrial Estate, near Bellshill (pictured) is capable of refuelling up to 450 trucks per day. Refuelling an HGV with bio-CNG typically takes 5-7 minutes to deliver 500 miles of range.

Biomethane is sourced from a variety of RTFO-approved suppliers across the country and groups such as the John Lewis Partnership, Royal Mail and Warburtons use the sites to power their HGV fleets.

Trains

The Scottish Government committed to decarbonising rail transport by 2035 in our Rail Services Decarbonisation Action Plan 2020. A rolling programme of electrification will deliver this on the majority of Scotland's rail network. However, biofuels may serve as a transition solution to reduce emissions in areas awaiting full electrification or until other technologies, such as battery electric, are further developed.

Aviation

Aviation is a sector that will take longer to decarbonise as zero emission options such as battery or hydrogen-power have lower energy density than conventional aviation fuel. This may limit the initial range of some electric and hydrogen-powered aircraft when they become available for commercial services.

The UK Government intends to introduce a Sustainable Aviation Fuels (SAF) mandate in 2025, equivalent to at least 10% (around 1.5 billion litres) of aviation fuel to be made from sustainable sources by 2030. Eligible fuels will be waste-derived biofuels (using feedstock such as Used Cooking Oil (UCO), agricultural and forestry residues, animal fats), recycled carbon fuels (making use of unrecyclable plastic and waste industrial gases) and power to liquid (PtL) fuels (combining hydrogen with CO2 to produce synthetic fuel).

The SAF mandate does not allow the use of food, feed or energy crops, in order to address concerns over sustainability and competition with food supply. The use of hydro-processed esters, fatty acids (HEFA), also known as Hydrotreated Vegetable Oil (HVO) is expected to be capped to ensure that resources are not diverted from supplying renewable fuel to road transport.

Replacing or blending conventional aviation fuel with drop-in, synthetic and Sustainable Aviation Fuels (SAF), would lower emissions from the sector. A 100% blend could theoretically achieve around an 80% reduction in carbon emissions. However, there are unlikely to be sufficient biomass feedstocks available to achieve this, and so a mix of SAF fuels will be required.

Industry

Industries in Scotland which are currently using bioenergy include paper mill, wood panel manufacture, distilleries, breweries and the wood pellet producers themselves. These sites primarily use biomass for heat or Combined Heat and Power (CHP), with the heat being used for industrial processes and the feedstock often being part of the onsite processing (such as sawmills/distilleries etc). Many of these sites could be suitable for adding carbon capture technology, when that becomes feasible.

1.3. Bioenergy with Carbon Capture Utilisation and Storage (BECCS)

Due to limited zero emission options, or because they are inherent in a process, there will be residual emissions across the economy from agriculture, transport and industry. Nature based solutions for absorbing greenhouse gas emissions, such as woodland creation or peatland restoration, can provide carbon stores and provide wider benefits for biodiversity but cannot be deployed at a scale needed to offset all the residual emissions across Scotland's economy. According to the balanced pathway in the Climate Change Committee's (CCC) 6th Carbon Budget, nature-based solutions will need to lock away 39 MtCO2/year across the UK by 2050. Engineered emissions reductions will be required to capture 58 MtCO2/year. Extensive amounts of land would be required if only relying on nature-based solutions.

We want to see bioenergy used where it can deliver the greatest emissions reductions, and this would be through the use of carbon capture technology. Research which considered the opportunities for CO2 storage around Scotland concluded that there is vast potential in the North Sea, estimating that up to 46Gt of CO2 storage in Scottish waters. This would be enough capacity to store at least 200 years of Scotland's CO2 output.

Developing carbon capture technologies will help to make the most of our natural resources, providing new opportunities and a just transition for communities in the North East. Without NETs technologies it will be impossible to offset residual emissions from across the economy. We therefore want to encourage a move away from unabated burning of biomass wherever possible.

In 2023 the UK Government consulted on Decarbonisation Readiness (DR) proposals which would provide more flexible and clear decarbonisation pathways for all new build combustion power plants, including biomass. The proposals include:

- Removal of the 300 MW minimum capacity threshold
- Moving DR requirements from the planning consent process to the environmental process
- Inclusion of both new build and substantially refurbished combustion power plants

These plans would only apply to England.

The Scottish Government have already set out in the National Planning Framework 4 that Energy from Waste (EfW) facilities must provide an acceptable decarbonisation strategy and that a functional heat network be developed wherever possible. We want to align policy across all combustion technologies and seek views from industry on most suitable decarbonisation pathway for Scotland.

Questions on phasing out unabated combustion of biomass

3. Do you agree with the intention to phase out unabated combustion of biomass?

4. Should there be a minimum threshold at which carbon capture should be considered for bioenergy technologies and should refurbishment of plants also be included?

5. From what date should any mandate to consider carbon capture technology be implemented for bioenergy plants?

6. Should decarbonisation options other than fitting carbon capture and storage technology be considered suitable as part of decarbonisation requirements for biomass plants, for example use of waste heat as part of a combined heat and power (CHP) plant or heat network?

1.4. Development of BECCS in Scotland

The development of BECCS technologies in Scotland is highly reliant on the Acorn Transport and Storage (T&S) project. This will provide the infrastructure which would make BECCS feasible in Scotland. Led by energy consultants Storegga, the project focuses on the St Fergus gas terminal, which is ideally located to utilise existing offshore and onshore pipeline infrastructure to access offshore storage locations (including the Goldeneye field), all of which are necessary for CCS.

Establishing a Scottish CCUS cluster requires success in the UK Government's CCUS cluster sequencing process which aims to establish four clusters, with an ambition to capture and store 20-30 MtCO2 per year by 2030. Success provides access for projects to the £1 billion CCUS Infrastructure Fund, Business Revenue Model Support, and UK Government underwriting of storage liability. In July 2023, the UK Government announced that the Acorn T&S project is 'best placed' to meet its Track 2 objectives and in December 2023, the UK Government stated that initial engagement had started with the Acorn Project, and that in early 2024, Acorn will be asked to submit 'anchor phase' plans for assessment (to include details of how at least 2 emitter projects can connect to Acorn by pipeline, and also show how the system can be expanded) along with provisional 'buildout phase' expansion plans.

There are a range of BECCS technologies which are at various stages of development. Biomethane production sites and the fermentation process are already suitable for commercial deployment of carbon capture. Power and CHP have been demonstrated at a number of locations across the globe, with plans in place for commercial deployment. Fitting post combustion carbon capture technology to energy from waste sites is also at a similar stage of development. Biochar production and bio-hydrogen are at earlier stages of development.

As well as being technically viable, any new BECCS technology would have to be economically viable. The UK Emissions Trading Scheme (UK ETS) aims to increase the financial incentive to reduce emissions. The possible inclusion of greenhouse gas removals within the UK ETS could encourage deployment of carbon capture, when the technology is more developed, and give greater confidence to investors.

A literature review carried out by the UK Energy Research Centre found that costs for BECCS in the UK would be between £70 - £130/tCO2 when using local biomass, and between £150 and £200/tCO2 when using imported biomass.

Modelling carried out to assess the optimal sites for BECCS power plants found that the transport of domestic biomass by road would likely be limited to within 100 km, in order to limit transport costs and emissions.

The UK Government have also been consulting on Business Models for Greenhouse Gas Removals. This could support a range of technologies using a contract for difference model, where investors would receive a guaranteed strike price for energy or carbon despite any fluctuations in the market price. Any revenue received over and above the strike price would be returned to the Low Carbon Contracts Company (LCCC).

With many bioenergy sites nearing the end of their Renewables Obligation (RO) contracts and looking to make decision on future investment, it is vital that UK Government provide clarity on dates and criteria for future support schemes.

Our Programme for Government 2023-24 confirmed our commitment to work with industry to accelerate decarbonisation and create energy transition opportunities at major industrial sites with support of the Scottish Industry Energy Transformation Fund, the Energy Transition Fund and the Emerging Energy Technologies Fund.

1.5. Opportunities and barriers

All pathways to net zero require some form of negative emissions technologies and bioenergy is unique, when deployed with carbon capture technology, in being able to generate energy and remove greenhouse gases from the atmosphere.

BECCS technologies are still developing and the full process through to storage has only been demonstrated in a few places worldwide. New markets are also developing for utilisation of the CO2 but the scale of demand is still unclear.

Utilising existing supply chains to develop the NETs sector provides a long-term market for resources which would otherwise become waste, helps preserve jobs and provides a means for these sites to achieve emissions reductions.

Distilleries, breweries and biomethane production sites already have established technologies which can capture CO2, which is often utilised in the food and drink sector. When CO_2 storage becomes available, they present opportunities to be early adopters to help establish a NETs industry in Scotland, although this would be with relatively small volumes of CO_2 capture.

Existing power and industry sites have the potential to deliver the greatest amounts of negative emissions by retrofitting carbon capture technology. EfW sites are also suitable for fitting carbon capture technology, in order to generate negative emissions (where waste incinerated is biogenic).

Many of the policy levers to support development of bioenergy technologies are not devolved and we need greater certainty from the UK Government on where their priorities lie, particularly around the development of BECCS technologies. Uncertainties around timings for the Acorn project along with a lack of support mechanisms have curbed interest from investors to put forward the significant capital investment that would be required for new projects.

With interest in BECCS growing across the globe but only a limited number of companies involved in the supply of carbon capture equipment, there is a risk of supply chain delays. There may also be a limited workforce with the necessary skills to deliver CO_2 storage, although Scotland's oil and gas sector already have similar skill sets and could benefit from new opportunities.

The increased demand for bioresources and potential impacts that could have on biodiversity and ecosystems are set out above. Monitoring, reporting and verification is critical, and processes must be credible in order to provide the public with confidence in the merits of increased use of biomass across the energy system. The public also need to have faith that the lifecycle analysis of emissions is accurate, that projects will deliver genuine negative emissions and that the carbon is safely stored.

Chapter 2: Bioenergy – Supply and Production

Biomass feedstock comes in many forms and has great flexibility in how it can be processed. We define biomass as organic matter that can be used as a fuel.

Bioenergy is an integral part of a circular economy. Biogenic wastes and residues that are existing sources of emissions can become valuable resources. The majority of biomass used for energy comes from trees and other vegetation but other biogenic material, such as manure, food waste or used cooking oil can also be used. Different biomass feedstocks have different sustainability implications, but we are clear that biomass must only be used where it can be shown to be sustainable.

The Climate Change Committee (CCC) state in their Biomass in a Low Carbon Economy report that "the preferential use of BECCS […] is consistent with our assessment that applications involving long-term storage of carbon offer the best use of finite biomass feedstocks from a carbon perspective."

The BECCS Task and Finish Group provides the following description of how the BECCS process works and the types of feedstocks that can be used:

- BECCS relies upon the thermo- or biochemical conversion of biomass to supply an energy service, and the addition of CO2 capture and storage (CCS) to recover biogenic CO2 and geologically sequester it, thus permanently removing it from the atmosphere.

- BECCS can use a variety of biomass feedstocks, from dedicated energy crops to waste-derived biomass, and agricultural and forest residues. The biomass conversion process can include combustion, gasification, digestion, or fermentation to deliver electricity, heat, liquid or gaseous biofuel, or hydrogen.

Sustainable biomass is a finite resource and with demand expected to increase as we move to a net zero future, Scotland must prioritise its use to ensure we maximise its value in reducing our emissions and in displacing fossil fuels.

2.1. Biomass Sustainability

Whilst combustion of biomass does produce emissions at the point of use, these emissions are part of the biogenic carbon cycle. Carbon that was absorbed from the atmosphere when the plants grew is returned when combusted, unlike fossil fuels where the carbon that has been stored underground for millions of years is released and is primarily responsible for the observed increase in atmospheric CO2 concentrations.

For biomass to be considered as a low carbon fuel it should comply with strict land and greenhouse gas criteria (together known as sustainability criteria). Land criteria focus on the land from which the biomass is sourced and the greenhouse gas criteria account for the life cycle emissions of the biomass. Harvesting, processing, storage and transport emissions of the biomass feedstock must also be accounted for when calculating the Greenhouse Gas (GHG) emissions savings.

Well managed forests or energy crops can reabsorb carbon emissions from combustion in a relatively short time, resulting in lower net emissions. This is not possible from primary woodland, and wider biodiversity and ecosystem impacts should be included in the sustainability criteria along with potential societal impacts.[2]

Scotland has planted over 50,000 hectares of woodland since 2018, with a mix of native species and fast growing conifers. A recent report by Forest Research suggested that conifers can capture up to eleven times as much carbon as broadleaved woodlands in the short term.

Felling Permissions are required to fell trees in Scotland and applications will be assessed against the Sustainable Forest Management principles as set out in the UK Forestry Standard. The majority of the harvest from Scottish forestry is softwood, with about 12% of this being brash and small roundwood which is used as wood fuel. Section 2.2 provides more detail on domestic biomass supply.

The UK Government support schemes already have strict biomass sustainability criteria – which have been based on the EU's Renewable Energy Directive sustainability criteria. We support and agree with the UK Government's ambition to strengthening the strict criteria, where required, and continuing to deliver genuine greenhouse gas savings. As set out in the UK Government's Biomass Strategy, we support their key commitment to develop a cross-sectoral sustainability framework, and we urge the UK Government to develop this as soon as possible.

The National Audit Office have recommended that greater resources are directed towards monitoring and demonstrating compliance. These actions would provide greater transparency and trust that all sectors are meeting the highest standards possible. We will work with the UK Government as these important commitments are implemented.

2.2. Competition for supply

The use of bioenergy has been forecast to increase under nearly all pathways to net zero. The International Energy Agency (IEA) suggests an increase of 8% per year until 2030 and more than 80 countries have policies in place which support the use of biofuels.

[2] The Supergen Bioenergy Hub have developed a Bioeconomy Sustainability Indicator Model (BSIM) which can help map the sustainability of any bioeconomy project against 126 indicators. Ensuring the sustainability of biomass resources helps to minimise any risks, such as deforestation, whilst still delivering progress in achieving the UN's Sustainable Development Goals.

We are increasingly seeing incentives that support bioenergy technologies, such as under the U.S. Inflation Reduction Act and the European Green Deal. These incentives and subsidies, alongside the increasing number of commitments from countries to reduce their emissions, will continue to increase global demand for sustainable biomass and likely push market prices up.

The Climate Change Committee's "Delivering a reliable decarbonised power system" report recognised this and stated that any over-reliance on imported biomass may jeopardise our ability to meet our net zero targets and risks taking a greater than fair share of the finite resources available.

The projected growth in demand for bioenergy also highlights the importance of Monitoring, Reporting and Verification (MRV) to ensure that only sustainably sourced bioresources are being used.

On top of the expected increase in biomass demand, the fragility of supply chains for biomass were brought into focus following Russia's illegal invasion of Ukraine. The sudden imposition of sanctions on Russia emphasised the risk of sourcing biomass from volatile or undemocratic regimes. Prior to this, there were significant amounts of biomass pellets being imported to the UK from Russia. This underlines the need to ensure our future energy system is resilient, diversified, and that we have constant access to a variety of reliable, sustainable energy supplies.

It is important for Scotland to further develop a stable and sustainable domestic supply of biomass as we look to increase the use of bioenergy in our energy system. A strong domestic supply chain can help to provide energy security, transparency and accurate lifecycle emissions calculations.

2.3. Domestic biomass availability

Following the publication of the Bioenergy Update in 2021, we commissioned a review of the potential domestic bioresource, including a forecast of what could be available out to 2045. The research looked at the availability of both dry and wet bioresources and the potential to increase them.

The research found that 12.5 TWh of domestic biomass is currently available for bioenergy; of which 8.9 TWh is actually used. It also found that the amount available could be increased to 13.9 TWh by 2030 and 16.3 TWh by 2045.

For dry biomass, to 2030, the greatest portion of the increased potential was from sawmill residue, and then between 2030 and 2045 the potential increase would be reliant on land use change to perennial energy crops. (Figure 1.1)

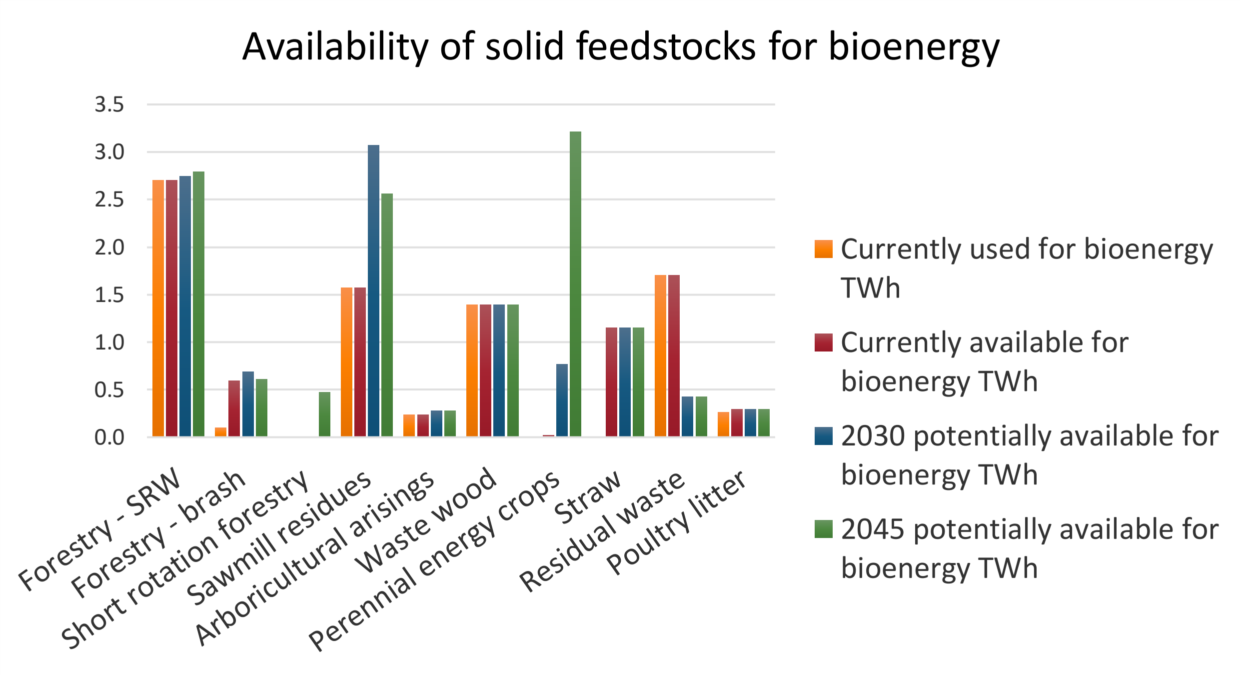


Figure 1.1 – Source: [Comparing Scottish bioenergy supply and demand in the context of net zero targets (climatexchange.org.uk).](#) Details of this chart can be provided upon request.

The research suggested no expected increases in the availability of wetter resources up to 2045 (primarily used in anaerobic digestion for biogas and biomethane production), but that many of the currently available resources are underutilised. (Figure 1.2) There are small amounts of other wet feedstocks available, totalling 0.08 TWh, which include some other distillery by-products, whey, fish and shellfish waste, and animal by-products.

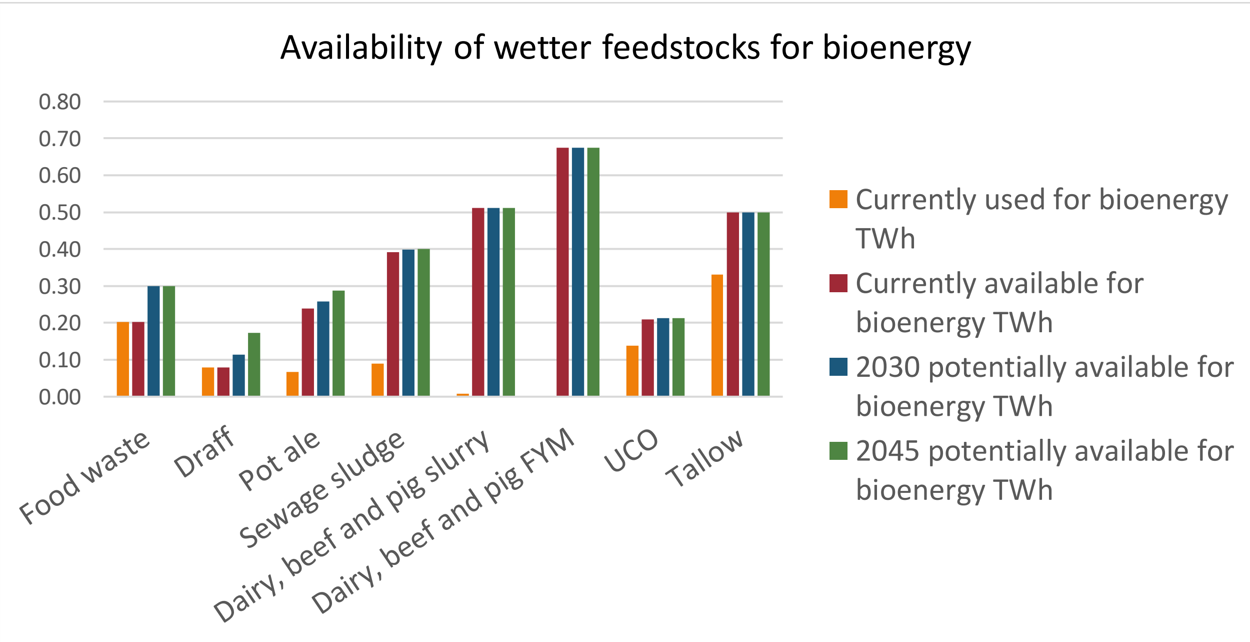


Figure 1.2 – Source: [Comparing Scottish bioenergy supply and demand in the context of net zero targets (climatexchange.org.uk).](#) Details of this chart can be provided upon request.

Consideration needs to be given to the locations in which bioresources are produced versus where they are going to be used. The wetter bioresources can be more difficult and costly to transport. Although solid bioresources are easier to transport, road transport is currently a significant source of emissions and is more expensive the further the distance travelled.

The findings from the research of the potential domestic bioresources align reasonably closely with the pathways as set out in the Climate Change Committee's (CCC) 6th Carbon Budget estimates for Scotland's bioenergy demand. The CCC set out an increase in demand from 7.6 TWh in 2020 to 10.3-23.5 TWh in 2045. The findings from the research suggests that our potential domestic production in 2045 could meet the CCC's expected demand in 2045. (Figure 1.3)

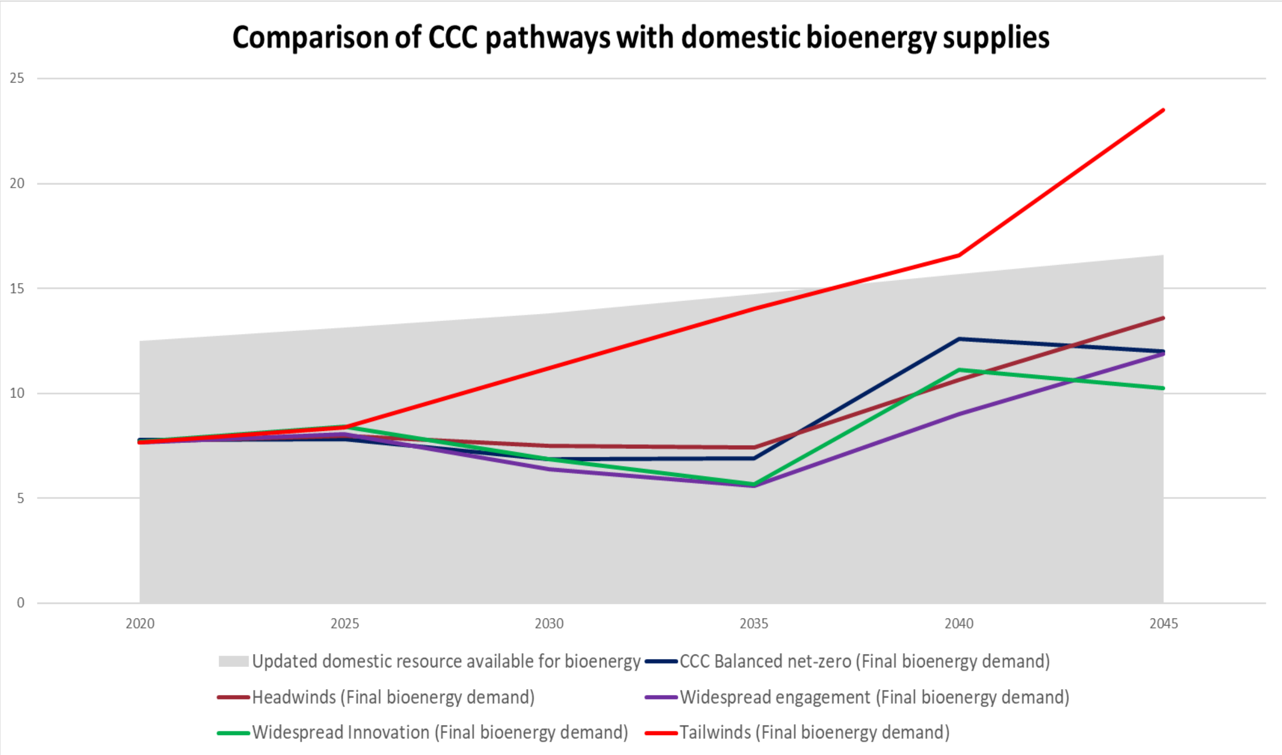


Figure 1.3 – Source: Comparing Scottish bioenergy supply and demand in the context of net zero targets (climatexchange.org.uk). Details of this graph can be provided upon request.

2.4. Perennial Energy Crops

Perennial energy crops (generally Short Rotation Forestry (SRF), Short Rotation Coppice (SRC) and Miscanthus, which can be referred to as second-generation feedstocks) are non-food plants that are cultivated for the purposes of energy production. See Annex D for more details on these crops.

Willow coppice and Miscanthus plantations. Photo credit Crops for Energy

Perennial energy crops have the potential to improve output on currently less productive land. They can be grown on land that is polluted or prone to flooding, and can help build resilience to extreme weather.

Fast growing bioenergy crops can quickly accumulate large quantities of carbon above and below ground, helping to remove carbon from the atmosphere. The fallen leaves and branches also add organic matter to the soil. The roots continue to grow throughout the lifetime of the plant, storing carbon in the soil even after each harvest. All of this could help to reduce emissions from agricultural land when delivered as part of a strategic land management plan.

Biomass Connect have been carrying out trials and research to gain further understanding of the potential impacts on biodiversity and ecosystems from planting various types of energy crops. Willow has been found to attract pollinators and when integrated within an agricultural landscape they can help improve biodiversity. Planting different types of willow can also help to improve habitats for birds.

Evidence suggests that the impact of bioenergy crops on biodiversity is context-dependent. A meta-analysis led by the University of Southampton found that non-food bioenergy crops improved farm scale biodiversity, compared to food-based agricultural land use (managed grasslands or arable crops). These biodiversity benefits were due to reduced management intensity, provision of features more similar to natural ecosystems, and increasing complexity or heterogeneity in the landscape.

However, this meta-analysis highlighted trade-offs for food production, since the reported benefits to biodiversity are based on the assumption that food-based agricultural land is freed up for their deployment. If agricultural land is not used and bioenergy crops are instead grown on natural ecosystems, this could also negatively impact on biodiversity.

Implications for biodiversity are therefore complex and context-dependent. Careful planning and protections will be required to manage the potential synergies and trade-offs between goals for bioenergy, biodiversity and food production. This highlights the importance of taking a joined up approach to tackling the climate and nature emergencies while also supporting future food security.

2.5. Scotland's potential for perennial energy crops

In 2020 we commissioned research on perennial energy crops and their potential in Scotland. The purpose of this study was to review and identify the potential constraints for increasing domestic production of energy crops on low-grade agricultural or underutilised land.

The following assumptions were made in the research:

- For SRC and Miscanthus, the better-quality land was excluded with the focus being on land criteria 4.1 - 6.1. (see Annex E – Macaulay Land Capability for Agriculture (LCA) classification)
- Elevation and slope angle were considered, anything too high or steep was excluded.
- Soil type - it was agreed to exclude soil types which had high organic matter contents (peat), soils which were excessively shallow or stony and those which had a marine or estuarine influence (saline) as these were deemed unsuitable for agricultural purposes.
- Land currently used for forestry was excluded.
- Waterbodies were excluded.
- Protected land – for either cultural, scientific or biodiverse reasons was excluded.

The research found that theoretically a significant amount of land in Scotland is suitable for planting of energy crops, around 900,000 ha. The review of the potential domestic bioresource built on this research and found that the following levels of planting were realistic in Scotland, when taking into account the other demands on our land and the need to deliver negative emissions. (Figure 1.4)

Year	Crop	Energy Output	Land requirement
2030	Short Rotation Coppice (SRC)	0.8 TWh/yr	26,999 ha
2045	Short Rotation Coppice (SRC)	3.2 TWh/yr	75,250 ha
2045	Short Rotation Forestry (SRF)	0.5 TWh/yr	15,008 ha

Figure 1.4 Source: Comparing Scottish bioenergy supply and demand in the context of net zero targets (climatexchange.org.uk)

3.7 TWh/yr of energy would be sufficient to heat 300,000 homes every year, 12% of households in Scotland.

Understanding the impact that planting energy crops may have, depending on where they are located, is an important consideration. The Macaulay Land Capability for Agriculture (LCA) classification was developed to better represent what was possible on each piece of land, based on biophysical properties (see Annex E).

Scotland has 5.4 million hectares of agricultural land with over 80% of calorie production coming from land capability classes 2 to 3.2. The research into perennial energy crops in Scotland identified that the greatest areas of calorie production could be avoided by restricting SRC and miscanthus to land classes 4.1 - 6.1.

The findings indicate that planting of perennial energy crops could be done at a scale to meet future demand without significantly impacting on food security. However, land managers will have site specific insights on how land is best used given its location, local demands and economic returns.

2.6. Integrating energy crops to Scotland's landscape

There is a limited amount of land which is suitable for growing bioenergy crops and consideration needs to be given to other priorities which this land must meet – such as food/feed production, housing, woodland creation, peatland restoration, nature restoration and protection of ecosystems. All of these demands require careful consideration, and a balance must be struck to ensure we can maximise the amount of sustainable domestic biomass produced without significantly impacting wider land use needs and opportunities.

The Scottish Government has already set out a number of actions that will determine how we use our land in the future:

- We have committed to create 18,000 hectares of new woodland per year from 2024/25.
- We are providing £250 million to support the restoration of 250,000 hectares of degraded peat by 2030. (24% of the degraded peatland in Scotland)
- We have set an ambition to increase onshore wind capacity from just over 9 GW currently to 20 GW by 2030, and we are looking to set 4-6 GW ambition for solar.
- As part of our Biodiversity Strategy, we are committed to protecting at least 30% of land and sea for nature by 2030.
- Through the Vision for Agriculture, we are committed to working with farmers and crofters to meet more of our own food needs sustainably and to farm and croft with nature.

On top of these actions, and as set out above, we also need to maximise the amount of domestic biomass which can be sustainably produced. This must only be done where it does not negatively impact wider land use needs and requirements, and development of the bioenergy sector must align with and support Scotland's goals for protecting and restoring nature. High quality food production and rural development are also priorities which need careful consideration when assessing impacts of land use change.

The EU's Renewable Energy Directive (RED) contains sustainability and greenhouse gas (GHG) emission criteria which apply to the production of biofuels, bioliquids and biomass fuels. It sets out the types of land that should be protected and should not be considered for the planting of energy crops. These land types are:

- Primary forest or other woodland
- Areas designated for protection of rare, threatened or endangered ecosystems or species
- Wetlands
- Peatland
- Highly biodiverse grasslands

Building on the principles set out in the EU Directive, and taking account of Scotland's existing land use policy and the evidence base set out above, this draft Bioenergy Policy Statement is consulting on the following principles that can help guide sustainable development of perennial energy crops and align with our commitments to protect our land for nature:

1. Native energy crop species should be prioritised over non-native;
2. Cropping cycles should be as long as feasible and economically possible;
3. A diverse mix of crop species and crop structures should be used;

4. Regenerative farming principles which focus on protecting and improving soil health should be used.

Scottish Forestry would require an Environmental Impact Assessment (EIA) be carried out if planting SRC in a sensitive area, such as a National Park or protected area, and if over 2 hectares in a National Scenic Area. Where no part of the land is in a sensitive area the threshold for an EIA is 20 hectares.

An agricultural EIA would be required if ploughing unimproved land or if there were material re-structuring of agricultural land.

The Vision for Scottish Agriculture outlines our aim to transform how we support farming and food production in Scotland to become a global leader in sustainable and regenerative agriculture. Any future planting of energy crops should align with these principles and with our commitment to tackle the biodiversity emergency in Scotland.

The Agricultural Reform Routemap provides further clarity on how we intend to deliver the ambitions set out in the Vision. This includes new conditions being introduced from 2025 and the introduction of the new agricultural support framework to deliver high quality food production, climate mitigation and adaptation, and nature restoration.

Although Short Rotation Coppice (SRC) and Miscanthus are supported by the existing agriculture support, there has not been sufficient market demand to encourage uptake. We expect this to change in the future.

We are committed to co-designing future rural support schemes and in doing so will seek to ensure opportunities for energy crops are considered, and future rural support does not create any barriers.

Increased biomass production will need to provide economic opportunity for rural communities, farmers, crofters and land managers. Supporting skills development and good quality jobs which can encourage people to work in rural areas could ensure that local communities are actively involved and genuinely benefit from new land uses that support net zero.

We are currently conducting further research in collaboration with ClimateXChange on the economic and just transition opportunities that energy crops may present, such as income diversification for farmers and land managers. This project will build on the previous land use research outlined above, that identified land potentially suitable for planting energy crops. It will also consider the enablers and barriers that influence the economic viability of energy crops. In this way, we will investigate the just transition opportunities for farmers and land managers at both lower, farm-scale and greater levels of planting. This research will also help to inform discussions on a Just Transition for Land Use and Agriculture.

Consultation questions on increasing domestic biomass production through the planting of energy crops (Short Rotation Coppice (SRC), Short Rotation Forestry (SRF) and Miscanthus):

7. The Climate Change Committee (CCC) advise that the UK will need 700,000 hectares of perennial energy crops by 2050 to meet their pathway to net zero. How much could Scotland contribute towards this figure and what evidence is available to support your view?

8. What would encourage you to use biomass from domestic perennial energy crops as a feedstock?

9. What are the opportunities or challenges to growing energy crops and what would encourage planting at a commercial scale in Scotland?

10. Can you provide best practice examples which could help integrate energy crops within the landscape and within the agriculture sector?

11. Can you provide best practice examples which could help restore and regenerate biodiversity, alongside energy crops?

Annex A – Consultation questions

1. Do you agree with the overarching principles for use of bioenergy, as set out in this document?

2. Do you agree with the priority uses of bioenergy, as set out in this document?

3. Do you agree with the intention to phase out unabated combustion of biomass?

4. Should there be a minimum threshold at which carbon capture should be considered for bioenergy technologies and should refurbishment of plants also be included?

5. From what date should any mandate to consider carbon capture technology be implemented for bioenergy plants?

6. Should decarbonisation options other than fitting carbon capture and storage technology be considered suitable as part of decarbonisation requirements for biomass plants, for example use of waste heat as part of a combined heat and power (CHP) plant or heat network?

7. The Climate Change Committee (CCC) advise that the UK will need 700,000 hectares of perennial energy crops by 2050 to meet their pathway to net zero. How much could Scotland contribute towards this figure and what evidence is available to support your view?

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9. What are the opportunities or challenges to growing energy crops and what would encourage planting at a commercial scale in Scotland?

10. Can you provide best practice examples which could help integrate energy crops within the landscape and within the agriculture sector?

11. Can you provide best practice examples which could help restore and regenerate biodiversity, alongside energy crops?

Annex B – Responding to this consultation

We are inviting responses to this consultation by 12 June 2024.

Please respond to this consultation using the Scottish Government's consultation hub, Citizen Space. Access and respond to this consultation online at https://consult.gov.scot/energy-and-climate-change-directorate/draft-bioenergy-policy-statement-consultation.

You can save and return to your responses while the consultation is still open. Please ensure that consultation responses are submitted before the closing date of 12 June 2024.

If you are unable to respond using our consultation hub, please send your response, including the completed Respondent Information Form to: BioenergyPolicy@gov.scot

Handling your response

If you respond using the consultation hub, you will be directed to the About You page before submitting your response. Please indicate how you wish your response to be handled and, in particular, whether you are content for your response to published. If you ask for your response not to be published, we will regard it as confidential, and we will treat it accordingly.

All respondents should be aware that the Scottish Government is subject to the provisions of the Freedom of Information (Scotland) Act 2002 and would therefore have to consider any request made to it under the Act for information relating to responses made to this consultation exercise.

To find out how we handle your personal data, please see our privacy policy: https://www.gov.scot/privacy/

Next steps in the process

Where respondents have given permission for their response to be made public, and after we have checked that they contain no potentially defamatory material, responses will be made available to the public on Citizen Space. If you use the consultation hub to respond, you will receive a copy of your response via email.

Following the closing date, all responses will be analysed and considered along with any other available evidence to help us. Responses will be published where we have been given permission to do so. An analysis report will also be made available.

Comments and complaints

If you have any comments about how this consultation exercise has been conducted, please send them to the contact address above.

Scottish Government consultation process

Consultation is an essential part of the policymaking process. It gives us the opportunity to consider your opinion and expertise on a proposed area of work.

You can find all our consultations online: Citizen Space. Each consultation details the issues under consideration, as well as a way for you to give us your views, either online, by email or by post.

Responses will be analysed and used as part of the decision making process, along with a range of other available information and evidence. We will publish a report of this analysis for every consultation. Depending on the nature of the consultation exercise the responses received may:

- indicate the need for policy development or review
- inform the development of a particular policy
- help decisions to be made between alternative policy proposals
- be used to finalise legislation before it is implemented

While details of particular circumstances described in a response to a consultation exercise may usefully inform the policy process, consultation exercises cannot address individual concerns and comments, which should be directed to the relevant public body.

Next steps

The Scottish Government will review responses to the consultation and the issues raised during engagement with stakeholders to inform development of the final version of the Bioenergy Policy Statement.

Annex C – Overview of Bioenergy with Carbon Capture and Storage (BECCS) technologies

BECCS Power and CHP

Retrofitting post-combustion carbon capture technology on plants which are currently utilising biomass feedstock would help in reducing emissions while still being able to benefit from utilisation of the available biomass resources.

BECCS power plants can be used to deliver baseload, or continuous power output. This would deliver the greatest emission reductions particularly where heat is recovered and used on or offsite, for example, in heat networks.

BECCS plants could also provide an alternative source of dispatchable power, which provides resilience and flexibility to our electricity system to complement other renewable generation technologies. At present, dispatchable power is provided by unabated fossil fuel power stations. BECCS power would have access to an alternative income from flexibility markets while removing carbon from the atmosphere.

Industrial sites which have ready access to bioresources could operate BECCS (CHP) whilst meeting emission reduction targets and benefiting from the UK ETS. Scotland currently has three medium sized biomass power plants which, if retrofitted with CCS, could represent a significant BECCS contribution. Research on NETs technologies estimated that over 95% of their emissions are biogenic, which could result in significant yearly negative emissions.

BECCS Energy from Waste

BECCS energy from waste (EfW) operates in a similar way to BECCS power plants, producing either power and/or heat, but using waste (usually household and commercial) as a feedstock rather than only biomass. Also, like the BECCS power generation process, waste may be initially combusted with subsequent capture of CO2, or gasified.

Managing waste using EfW produces emissions in the form of CO2, however, depending on the composition of waste, these are generally lower than landfill, which produces methane through degradation of biodegradable waste. A Zero Waste Scotland report found that, on average, sending one tonne of municipal waste to EfW in Scotland in 2018 emitted 246 kgCO2e/t, which is 27% less than sending it to landfill, although this is dependent on waste composition, which can vary and is likely to change over time.

Waste should be treated according to the waste hierarchy, which prioritises waste prevention, reuse and then recycling over energy recover, through EfW for example, and disposal. Circular economy and waste policies aim to treat materials as far up the waste hierarchy as possible, resulting in a continued reduction and minimisation of waste sent for energy recovery or disposal.

BECCS Biomethane

Capturing CO2 from upgrading biogas to biomethane is a well-established technology. Advance combustion technologies such as gasification or pyrolysis can also be used and allow carbon capture when the resulting syngas is upgraded to biomethane. Both techniques can utilise a range of residues, by-products and waste as feedstock.

BECCS distilleries and breweries (Fermentation)

The fermentation process at breweries and distilleries produces CO2 which could easily be captured. Bioethanol production also features a fermentation stage and would allow carbon capture. These processes require sugary or starchy feedstock.

BECCS Hydrogen

Biohydrogen can be produced by removing carbon from biomethane or from gasification of biomass, where biomass is heated without combustion to produce syngas. The syngas can be used to produce heat and power or upgraded to hydrogen.

Biochar

When biomass is heated in the absence of oxygen, such as when processed via pyrolysis or gasification, it can produce biochar. This charcoal like substance can be applied to soil as a means of storing the carbon and improving soil quality. There are a number of other potential uses for biochar which may develop, such as wastewater treatment, flood mitigation, green cement and to improve energy output from AD plants. Further research is required to establish the permanence of storage and optimum use for the product.

Annex D – Types of perennial energy crops

When we refer to perennial energy crops, we primarily mean the following:

Short Rotation Forestry (SRF)

Short Rotation Forestry (SRF) uses fast growing species of trees on rotations of 8 to 20 years (depending on species and site) to produce wood specifically for bioenergy. SRF plantations can be established on marginal arable land, permanent grassland and rough grazing. There are currently only trial plots of SRF in Scotland.

Short Rotation Coppice (SRC)

Short Rotation Coppice (SRC) includes willow (or poplar) grown using a short rotation coppice (SRC) technique, where trees are cut down to stumps and allowed to grow again from their base. Once planted SRC takes up to four years to reach maturity, after which it is harvested at regular intervals - typically four years for willow SRC. After about 20 to 25 years the crop is removed.

Miscanthus

Miscanthus is a woody grass, which after it has matured (2 years), is harvested every year. Miscanthus can serve multiple uses, such as livestock bedding, before becoming a feedstock for AD.

Annex E – Macaulay Land Capability for Agriculture (LCA) classification

Land Capability Class 1 –3.1 - Land in these classes, often referred to as prime agricultural land, is capable of being used to produce a wide range of crops. The climate is favourable, slopes are no greater than 7 degrees and the soils are at least 45cm deep and are imperfectly drained at worst.

Land Capability Class 3.2 - 4.2 - Land in these classes is capable of being used to grow a moderate range of crops including cereals (primarily barley), forage crops and grass.

Land Capability Class 5.1 - 5.3 - Land in this class has the potential for use as improved grassland. A range of different limitation types, either operating singly or in combination, can restrict the land capability to this class.

Land Capability Class 6.1 - 7 - This land has very severe limitations. This land is either steep, very poorly drained, has very acid or shallow soils and occurs in wet, cool or cold climates zones. In many circumstances, these limitations operate together.

Land Capability Class	Land Area (ha)	Degraded Peat (ha)	Potentially viable for woodland expansion (ha)[3]	Potentially viable for energy crops (ha)	Calorie Production (% of total Scottish calories produced)
1	2,800	-	3,200	2,400	0.5%
2	142,100	200	150,300	135,000	16.7%
3.1	368,900	7,900	385,700	282,900	36.2%
3.2	545,200	9,800	572,500	262,000	30.6%
4	617,100	34,200	625,300	131,500	10.1%
5	905,600	313,700	796,300	175,400	3.2%
6	2,610,100	1,043,700	931,300	40,700	2.0%
7	142,900	51,800	25,100	-	0.1%

[3] Figures for woodland expansion also included some non-agricultural land.

Glossary of Terms

Anaerobic Digestion (AD): A collection of processes by which microorganisms break down biodegradable material in the absence of oxygen. The process is used for industrial or domestic purposes to manage waste and/or to produce fuels.

Bioeconomy: The bioeconomy means using renewable biological resources from land and sea, like crops, forests, fish, animals and micro-organisms to produce food, materials and energy.

Bioenergy: Refers to heat or electricity produced using biomass or gaseous and liquid fuels with a biological origin such as biomethane produced from biomass.

Bioenergy with Carbon Capture and Storage (BECCS): BECCS is a negative emissions technology, and if proven at scale, would help achieve Scotland's net zero targets, compensating for residual emissions in hard-to-decarbonise sectors.

Biogas: Gas produced by AD consisting of 50-65% methane and 35-50% CO_2, with very small amounts of other gases such as water vapour, hydrogen sulphide, ammonia and siloxanes.

Biogas upgrading: A process to remove most non-methane gas from biogas to generate biomethane at >95%

Biogenic: Substances which are produced by living organisms are termed biogenic.

Biomass: Refers to any material of biological origin used as feedstock or products (e.g. wood in construction to make chemicals and materials, like bio-based plastics), or as a fuel for bioenergy (heat, electricity and gaseous fuels such as biomethane and hydrogen) or biofuels (transport fuels).

Biomethane: A form of gas that is produced by processing biomass It can be used for the same purposes as natural gas, like producing heat, electricity or transport fuel, and can use the same infrastructure for transmission and end-user equipment.

Carbon Capture Utilisation and Storage (CCUS): (CCUS) encompasses the methods and technologies required to capture carbon dioxide (CO2) from large emitters, such as biomass or fossil fuel power plants and industrial processes, and either convert this into new commodities (utilisation) or transport it for safe and permanent storage deep underground in a geological formation.

Circular Economy: A circular economy is one that is designed to reduce the demand for raw material in products; to encourage reuse, repair and manufacture by designing products and materials to last as long as possible, in line with the waste hierarchy.

Co-design: Co-design relies on an inclusive and participative engagement process that empowers specific groups and people in society, to directly influence policy decisions and actions. The aim is to ensure that plans reflect their needs and circumstances, and the barriers they face.

Combined Heat and Power (CHP): Cogeneration of both heat and electricity.

Decarbonisation: A process which reduces the amount of carbon dioxide (CO2) being emitted into the atmosphere. It requires a shift from use of fossil fuels to renewable and low carbon sources.

Digestate: The material remaining after the anaerobic digestion of a biodegradable feedstock.

Dispatchable power: Energy generation which can be available on demand.

Energy Security: Energy security can be defined as having sufficient energy generation to meet the volume and type of energy demand at any point, and having the means to get that energy to the point of use.

Gasification: A process that converts organic, or fossil fuel-based, carbonaceous materials into carbon monoxide, hydrogen and carbon dioxide.

Heat Networks: Heat networks distribute heat or cooling from a central source or sources and deliver it to a variety of different customers such as public buildings, shops, offices, hospitals, universities and homes. By supplying multiple buildings, they avoid the need for individual boilers or electric heaters in every building.

Just Transition: Just transition is both the outcome and the process for a fairer, greener future for all, in partnership with those impacted by the transition to net zero.

Negative Emissions Technologies (NETs): (NETs) are an emerging field of technologies that remove greenhouse gases from the atmosphere and, utilising carbon capture and storage, sequester them permanently. NETs can include forms of Direct Air Capture with Carbon Storage (DACCS), Bioenergy with Carbon Capture and Storage (BECCS) or other more experimental means such as enhanced weathering or biochar. NETs can be considered one form of Greenhouse Gas Removals (GGRs), which also includes natural sequestration methods such as afforestation. It can also be used interchangeably with Carbon Dioxide Removal technologies (CDR).

Net Zero: The balancing of greenhouse gas emissions against greenhouse gas removals with the net result being zero. This can also be referred to as carbon neutral.

Primary woodland: Woodland that has never been cleared by human activity. Can be referred to as undisturbed or unmanaged.

Renewable Heat Incentive (RHI): A financial incentive from the UK Government to promote the use of renewable heat. There is both a domestic and non-domestic scheme.

Renewable Transport Fuel Obligation (RTFO): This supports reducing greenhouse gas emissions from vehicles by encouraging the production of biofuels.

Terawatt-hours (TWh): A Watt-hour is a unit of work or energy equivalent to the power of one watt operating for one hour. A Terawatt-hour is equal to one trillion watt-hours.

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