How to enable sustainable biomass use for transport and other bio-based sectors?

Key findings

- Greenhouse gas (GHG) emission and sustainability standards for biomass and low-carbon feedstocks vary greatly between policies for different sectors.
- Energy and transport sector policies address the production and sourcing of biomass with a strong focus on GHG emission reduction, including upstream supply chain emissions, and land use criteria including carbon stocks in soil and standing biomass.
- Wider environmental implications such as ecosystem services, land management and biodiversity are included, but do not provide a clear accounting framework.
- Policies and regulations for emerging bio-based sectors follow United Nations Framework Convention on Climate Change (UNFCCC) guidelines, using Intergovernmental Panel on Climate Change (IPCC) default factors that consider biomass as carbon neutral; hence, biomass has an emission factor of zero and sustainability implications beyond GHG emissions are considered at a very limited level.
- Voluntary certification schemes are used to fill some of these sustainability accounting gaps for the non-energy and non-transport sectors, and are a common voluntary requirement for the due diligence of UK industry.
- There is a gap in sectoral policies to acknowledge cross-sectoral interfaces, in particular for biomass and resource use, as well as possible co-products and co-benefits.
- Different sectors using the same feedstock and resources, but reporting their GHG emissions and sustainability standards at different detail and with different thresholds, limits comparability and fair competition between different sectors.
- A multi-level governance approach could help to overcome the challenges of sector-specific policy frameworks for bio-based industries.
- A multi-level governance approach would support the best use of biomass and facilitate positive trade-offs and enable climate change mitigation and sustainability across all bio-based sectors.

Introduction

Many countries have developed roadmaps and strategies for the transition to a low-carbon bioeconomy to tackle climate change and build a sustainable future. The concept of bioeconomy, which is based on the utilisation of renewable biological resources, is not new. Societies have always used bio-based resources to generate energy, produce food and materials, and build houses and infrastructure.

Energy and transport are two main sectors utilising biomass to reduce emissions and support climate change mitigation. Increasingly, the chemical, construction and manufacturing industries use biomass to create bio-based products and materials to replace fossil- and mineral-based materials.

With the urgent need to mitigate climate change, protect the environment, support economic development and improve the welfare and wellbeing of societies, the concept of a bioeconomy becomes increasingly important. However, the transition from a fossil fuel to a bio-based economy and society needs to consider the sustainability implications of biomass use in order to enable benefits and mitigate negative impacts across all bio-based sectors and for society as a whole. Such a transition is only possible with the support of institutional and regulatory frameworks.

Within the current landscape of biomass utilising industries, different sectors have regulatory frameworks with different ways of accounting for climate change and sustainability impacts. In light of the growing importance of renewable bio-based resources and materials, it is essential that the same emission standards and sustainability criteria are established across all sectors and are harmonised where appropriate and possible.

What is bioenergy?

Bioenergy is energy generated from organic matter of plant and animal origin such as agricultural and forest residues, energy crops, wood or organic wastes. Bioenergy is considered a low-carbon renewable energy, as the natural process of photosynthesis within plants locks atmospheric carbon dioxide (CO_2) into organic matter. When the biomass is used to generate energy, this recently sequestered CO_2 is released back into the atmosphere. This means there is a removal of CO_2 at the point of plant growth and a release of this CO_2 at the point of energy conversion [1].

Biomass feedstocks can be converted using different bioenergy pre-treatment and conversion technologies to generate electricity, heat, transport fuels, solid, liquid and gaseous energy carriers, as well as materials and chemicals.

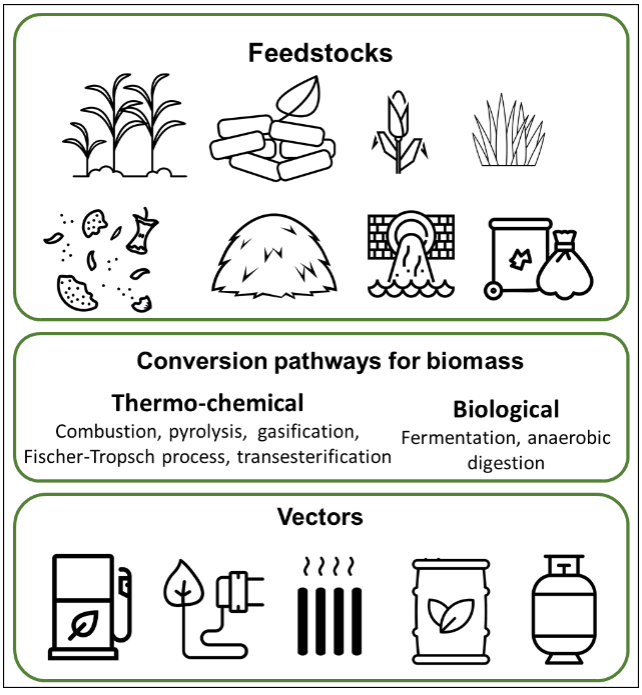

Figure 1: Bioenergy feedstocks, conversion pathways and vectors

Bioenergy in the UK

Bioenergy can make a valuable contribution to the transition to a sustainable and low-carbon future in the UK and globally. In 2018, two-thirds of the UK's renewable energy was provided from bioenergy (including electricity, heat and transport fuels). The other renewable sources in the UK are wind (22%), solar photovoltaic (PV) and active solar heating (5.%), deep geothermal and heat pumps (5%), and hydro (2%) [2].

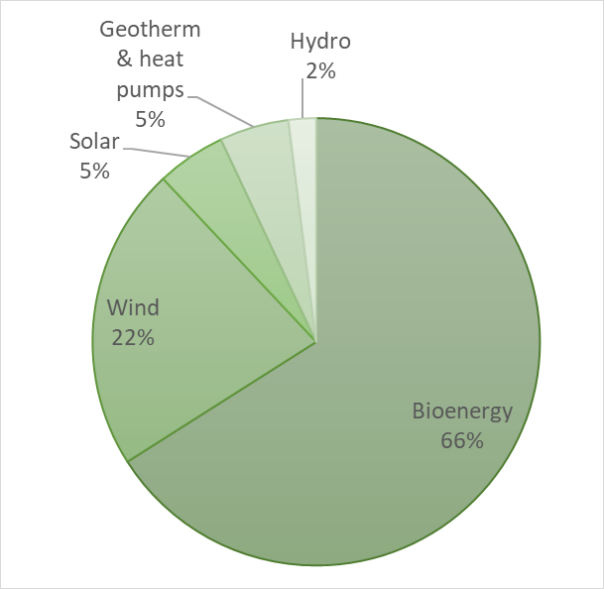

Figure 2: Share of renewable energy in the UK (2018) [2]

To support and regulate the use of bioenergy and biofuels, the UK has implemented a number of different policies for the relevant sectors producing electricity, heating and cooling, and transport fuels.

About 4% of the UK's transport fuels are supplied from renewable fuels. Biodiesel (60%) and bioethanol (33%) are the dominating renewable transport fuels in the UK [3]. The Renewable Transport Fuel Obligation (RTFO) is currently the UK's primary mechanism for supporting and increasing the role of biofuels in the transport sector.

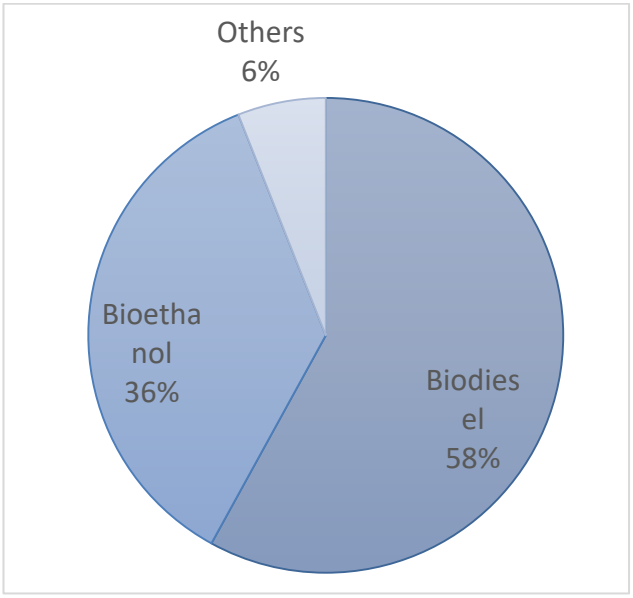

Figure 3: Share of renewable transport fuels in the UK (2019) [3]

Policy frameworks in the UK

The UK's policy landscape includes international and national frameworks and measures.

Climate change targets

The United Nations Framework Convention on Climate Change (UNFCCC) agreements, including the Paris Agreement [4] to keeping a global temperature rise well below 2 degrees Celsius, set the overall climate change targets for the EU and member states.

The UK implements these agreed targets in its domestic legislation and policies. The UK's Climate Change Act (CCA) [5] builds the legislative framework to keep the UK on track for its agreed climate change targets across all sectors. These international and national agreements and legislation guide the UK's national policy instruments to implement and meet the UK's and EU's climate change targets.

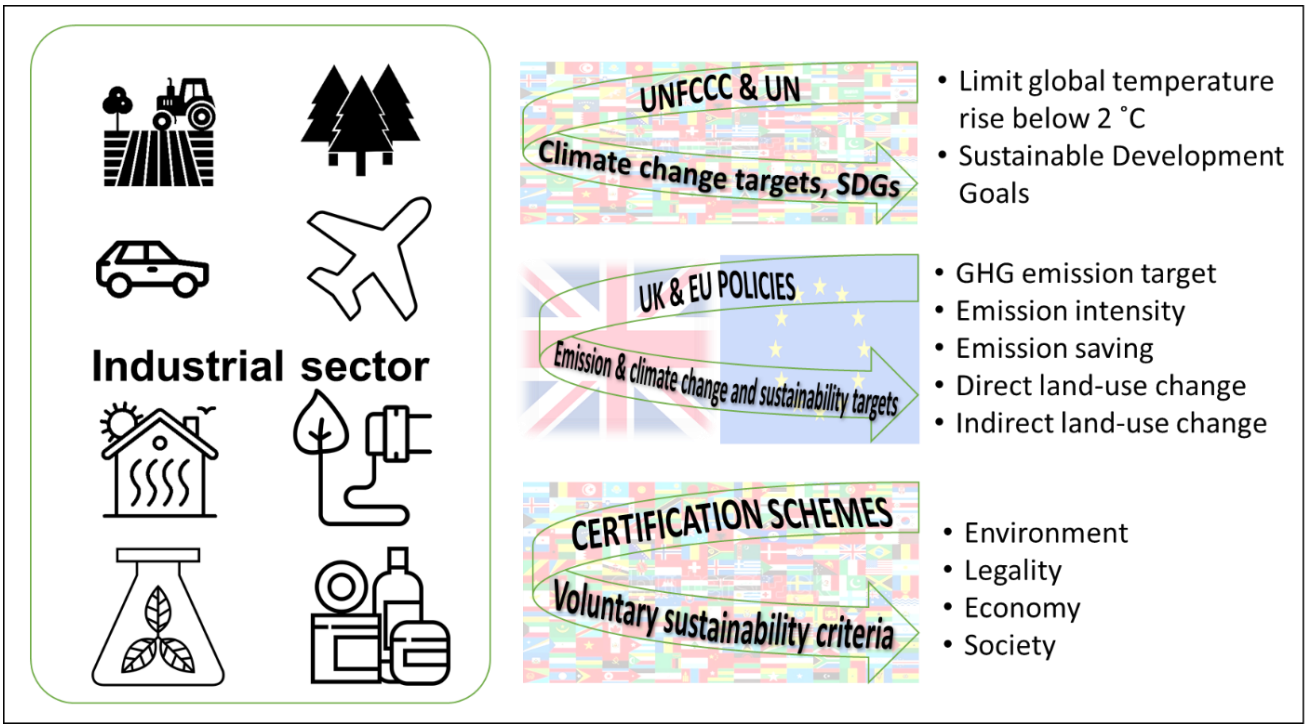

Figure 3: Bio-based sectors and relevant institutional instruments and measures to support climate change and sustainability

Sector policies

The EU's Renewable Energy Directive (RED II) [6] sets the climate change and sustainability framework for the renewable energy sector, including transport fuels. Under the Paris Agreement and RED II, the UK has agreed to a national contribution for climate change mitigation and renewable energy deployment. The key targets of RED II are [6]:

By 2020:

- 15% of total energy comes from renewables (20% in the EU);
- 10% of energy used in transport must come from renewable sources.

By 2030:

- At least 32% of gross final energy consumption comes from renewable sources;
- GHG emissions have to fall by 40% compared to 1990 levels;
- At least 27% of renewable energy has to be consumed in the EU;
- At least 14% of the total energy employed in transport has to come from renewables.

The different UK energy sectors have to comply with these policy measures. In the case of the transport and energy sectors, policies focus on GHG emissions and sustainability criteria, including land use, biodiversity and ecosystem services.

The key policies for the renewable energy sector in the UK are:

- Renewable Transport Fuel Obligation (RTFO) [7] for the transport sector;
- Renewables Obligation (RO) [8] for power generators;
- Renewable Heat Incentive (RHI) for heat generation [9].

The key categories of UK policies addressing renewable and bio-based energy, materials and services are:

- GHG emission;
- Emissions from direct (DLUC) and indirect land-use change (ILUC);
- Maintaining and minimising harm to ecosystems, biodiversity and high carbon stocks in soil, forest and other ecosystems

Other sectors that draw on bio-based feedstocks are, for example, the forestry, agriculture, chemicals, construction and materials industries, with each sector having their specific policies addressing sector-specific requirements and standards.

Key differences in policy frameworks of bio-based sectors

The most relevant policies for the UK's bio-based sectors focus on GHG emission and sustainability standards for biomass and low-carbon feedstocks.

However, the way this is accounted and reported for can vary greatly between the different sectors. In the energy and transport sector, biomass and low-carbon feedstocks have been used for many years. Policies with details on different sustainability standards are implemented addressing the production and sourcing of biomass with a strong focus on GHG emission reduction, including upstream supply chain emissions and land use criteria including a focus on quantifiable carbon stocks in soil and standing biomass. Wider environmental implications such as ecosystem services, land management and biodiversity are included, but do not provide a clear accounting framework.

The policies for other and emerging bio-based sectors follow UNFCCC guidelines, using IPCC default factors that consider biomass as carbon neutral; hence, biomass has an emission factor of zero. Moreover, sustainability implications beyond GHG emissions are considered at a very limited level.

Sector	Transport & Energy				Agriculture & Forestry		Other sectors	
Policy	RED II	RTFO	RO	RHI	Basic payment scheme	EU Timber regulations	Chemical industry	Construction industry
GHG emission target	●	●	●	●	◆	◆	◆	◆
Emission thresholds	●	●	●	●	◆	◆	◆	◆
Direct land-use change	●	●	●	●	▲	◆	◆	◆
Indirect land-use change	●	●	◆	◆	◆	◆	◆	◆
Sustainable land management	▲	▲	▲	▲	●	◆	◆	◆
Eco-system services	▲	▲	▲	▲	●	▲	◆	◆
Biodiversity	▲	▲	▲	▲	●	▲	◆	◆
Protection of high carbon stocks	●	●	●	●	●	●	◆	◆
Legal sourcing	▲	▲	●	●	◆	●	◆	◆
ETS	◆	◆	◆	◆	◆	◆	●	●
Acknowlegdment of certification schemes	●	●	●	●	●	●	●	●

Figure 4: Matrix of GHG emissions and sustainability criteria in different sector policies (shaded areas indicate the focus of sustainability criteria. ● = accounted criteria, ◆= not applicable, ▲ = considered but not directly accounted

Agriculture and forestry as feedstock-producing sectors have very different institutional frameworks, mainly focusing on land management, soil quality and health, and environmental aspects like ecosystem services, biodiversity, and maintenance and improving of above- and below-ground carbon stocks.

However, while farmers are encouraged to reduce emissions or contribute to renewable energy supply, there are no direct measures where farmers have to report GHG emissions from farming or land use change. In comparison, forest polices focus on the legal production and sourcing of wood.

In general, there is a gap across all sectoral policies to acknowledge cross-sectoral interfaces, in particular for biomass and resource use, as well as possible co-products and co-benefits.

In other words, while different sectors use the same feedstocks and resources, the sustainability standards and criteria vary significantly and do not address cross-sectoral impacts. This limits comparability and fair competition between the different sectors.

Harmonisation approach for GHG and sustainability criteria in bio-based sectors

In order to support a fair cross-sectoral approach for biomass use, the best use of feedstocks and resources, and to enable sustainability across all bio-based sectors, a harmonisation approach is recommended.

A multi-level governance approach (Figure 5) could overcome the challenges of sector-specific policy frameworks for bio-based industries.

This approach would consist of the following levels:

- A common policy approach for biomass feedstocks, which all sectors utilising biomass have to comply with, supporting fair opportunities and responsibility between the different sectors.
- A decision-making gateway linking feedstock regulations and sector-specific policies enabling the best use of biomass across the different sectors.
- Sector-specific policies setting standards and criteria for sectoral downstream processes, specific to each sector.
- Climate change legislation and sustainability targets building the umbrella framework for overarching targets across all sectors and related policies.
- Certification schemes that provide an additional level of governance and support good and fair practices along the entire supply chain considering multiple upstream and downstream processes and opportunities. This would also create additional understanding of substitution or replacement effects and possible counterfactuals.

Biomass feedstocks are the lowest common denominator across the different bio-based industries. While different types of biomass require different sustainability standards, which is already addressed in the EU and UK's energy sector policies, each feedstock category would have the same sustainability criteria for its production and sourcing.

A common approach at the level of biomass production and sourcing would create a level playing field, addressing cross-sectoral aspects like GHG emissions, land use and sustainability of biomass. A common framework for feedstock sustainability would provide biomass producers and biomass users with a coherent approach and support the best use of biomass and facilitate positive trade-offs across all bio-based sectors.

Following a common feedstock policy, a flexible multi-criteria decision-making gateway would support the best and most feasible uses of feedstocks. This gateway would link the levels of feedstock production and feedstock use, and hence connect a common feedstock sustainability framework with sector-specific policy measures.

At the gateway level, biomass users would need to show compliance with the common feedstock sustainability framework and how the feedstock will be used in their specific sector. The gateway approach would support the understanding and acknowledgment of interfaces, benefits and challenges between and for the different sectors. It would consider alternative uses and consequences of using a feedstock for a particular application. This would support the best use of biomass across the different sectors.

A multi-criteria assessment model could provide sustainability benchmarks for different biomass, biomass uses and applications could allow industry to evaluate and report the sustainability performance of their own process, benchmark it against other applications provided by the model. Such a model could be built around sustainability standards and follow sustainability indicators similar to certification schemes, or the GBEP sustainability indictors, as well as including harmonised sustainability scores and benchmarks agreed across different government departments.

This decision-making gateway is a flexible approach that considers different aspects of sustainability, biomass availability and mobilisation, technical application, scale, spatial and temporal aspects, and alternative feedstock use as well as replacement impact, such as emissions savings, from biomass use.

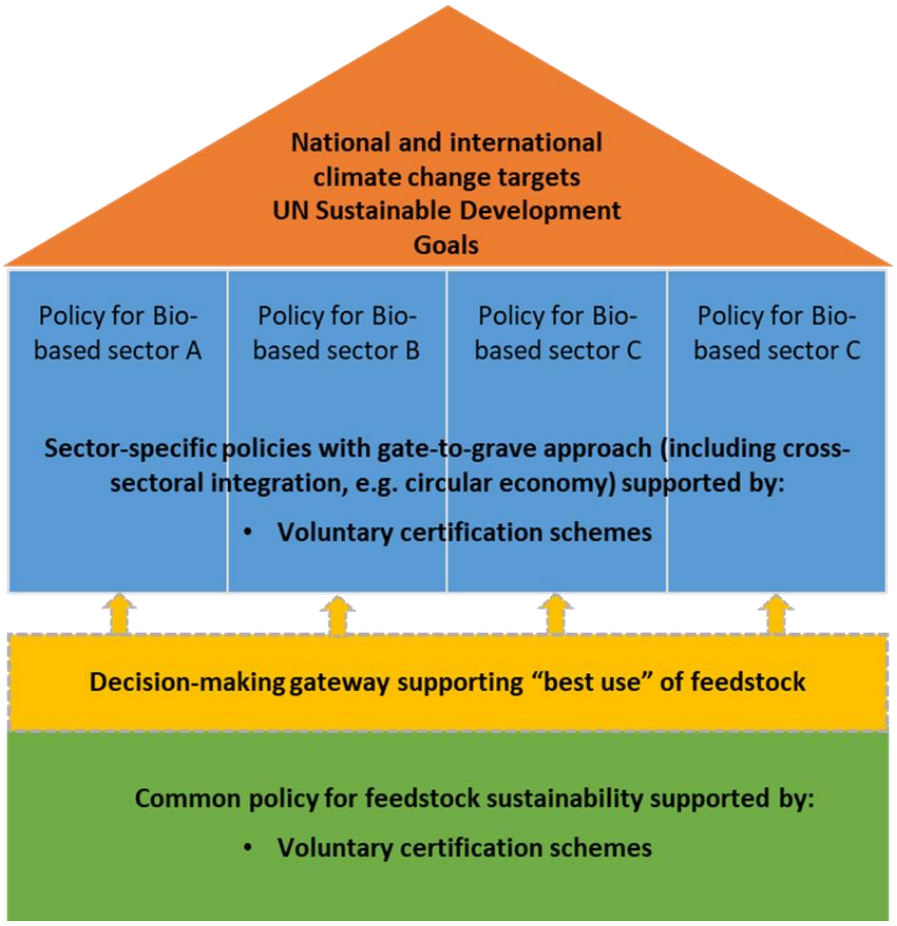

Figure 5: Multi-level governance approach for bio-based sectors

At the sectoral level, policies would address processes, practices and supply chains as current institutional frameworks do. At the sector level, a harmonisation of standards might not be feasible or desirable. Sector-specific policies would address downstream impacts of biomass use and product application, which will vary between sectors. Hence, at this level, policy measures and instruments should address sustainability aspects of sector-specific applications and final use of biomass, and bio-based products and services.

Climate change policy should support GHG emission and sustainability targets across all sectors. These, as they already do, would provide a coherent governance level across all sectors including overall GHG emissions and sustainability thresholds with which all sectors have to comply.

This includes the role of biomass not just as a renewable source but also to support net-zero emissions targets. A stronger inclusion of sustainability efforts of UN organisations like the Sustainable Development Goals (SDGs) [10] would support sustainability beyond carbon. While climate change mitigation is part of the SDGs, a wider sustainability umbrella would create high-level sustainability standards across all pillars of sustainability and support a fairer transition to a sustainable bioeconomy.

Certification schemes would provide an additional level of governance and would support good and fair practices along the entire supply chain considering multiple upstream and downstream processes and opportunities. This would also create additional understanding of substitution or replacement effects and possible counterfactuals. For example, some certification schemes require a much more detailed and stringent accounting along the full supply chain, including biomass production and sourcing than current UNFCCC accounting frameworks.

Conclusion

With the urgent need to tackle climate change and build a sustainable low-carbon future, the use of biomass plays an important role in generating energy, providing transport fuels, and producing chemicals and materials. With the existing and increasing demand for biomass across various sectors, common institutional approaches for the best and fair use of biomass is required. The current UK and international governance frameworks can be improved by taking a “best use” approach for biomass that sets the same standards across all sectors for biomass production and biomass sourcing and related resources like land use. The “best use” approach would also require that cross-sectoral interfaces and consequences of biomass production and biomass use are considered to enable and maximise climate change mitigation. As biomass production has a strong impact on land, water, ecosystems, biodiversity and communities, in particular rural ones, coherent sustainability targets beyond carbon and climate change need to be included.

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