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Opinion

Determining the Benefits of Biomass: Who Wins, and Who Loses?

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Abstract: Beyond the technical challenge of using biomass to achieve net zero, non-technical factors also impact the likelihood of biomass succeeding in displacing fossil fuel use, such as social, environmental, and economic challenges. The political bioeconomy in the United Kingdom (UK) has supported a small but significant role for biomass within the country's energy mix, with policy determining who benefits, and who will continue to benefit, from its use. The revised UK Biomass Strategy of 2023 signalled how the government perceives biomass looking forward, and the commitment to a cross-sectoral sustainability framework has the potential to support a redistributive policy that creates new winners in the UK biomass sector. Maximising the redistributive effects of policy is hindered by the siloed nature of policymaking around biomass and undermined by a lack of social legitimacy, both of which must be addressed to enable biomass to contribute towards decoupling the UK's economy from fossil fuels and to ensure a sustainable transition.

Keywords: biomass; bioenergy; policy; net zero; sustainability; bioeconomy; political economy

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1. Introduction

Biomass plays a small but significant role in the United Kingdom's energy mix, contributing ~12% of total electricity production, representing ~50% of the total renewable electricity produced. This is primarily made up of production from the combustion of wood pellets at the UK's largest power plant, Drax. Beyond that, several policy incentives aimed at stimulating markets for various forms of bioenergy, such as the Renewable Heat Incentive, the Renewable Transport Fuel Obligation, and the Renewables Obligation, have encouraged bioenergy deployment in the UK. This has created winners, such as those generators who have capitalised on the generous subsidies provided under these schemes and phased out their coal usage to convert their plants to run on biomass. However, with schemes ending and no clear subsidised future in sight, who will continue to benefit from biomass in the UK as we look to achieve net-zero greenhouse gas emissions by 2050?

2. UK Biomass Policy Challenges

The UK released its revised Biomass Strategy in the summer of 2023 [1], signalling the direction in which UK biomass is headed, determining how the government perceives biomass going forward, and how it will be utilised to serve a variety of agendas including energy security, job creation, sustainability, and net zero. Within the new strategy, there is a great emphasis placed on biomass sustainability, including a commitment to a cross-sectoral framework for sustainability, focusing on the limited use of this sustainable biomass supply in "harder-to-decarbonise" sectors such as aviation and shipping. It acknowledges the wide variety of biomass feedstocks and applications available, remaining technology-agnostic, but recognises the growing importance of bioenergy with carbon capture and storage (BECCS) to generate negative emissions.

But beyond the technical challenge of utilising a variety of biomass feedstocks, from residual agricultural, process, or forestry materials to purpose grown crops, the success of

these feedstocks in displacing fossil fuel use is heavily reliant on support from our political and economic structures. The literature on the success of renewable energy transitions demonstrates that non-technical factors, such as the existence of a social contract between a government and the people to provide energy to the nation, have a significant impact on the success of the renewable energy technology displacing fossil fuel use within society [2] (see Figure 1). This is because the transition to renewable energy is a process of environmental, social, and economic change, as well as a technical one. This is more significant for biomass compared to other renewable sources of energy, such as solar and wind, as it involves the interaction with, and extraction of, biomass from the natural environment. Therefore, the politics and economics of biomass, sometimes termed the "political bioeconomy", govern the interactions between social, environmental, and economic systems linked to biomass extraction and will determine where wealth and inequality are generated within biomass supply-chains, where value is applied to or extracted from the biomass, and who benefits. This is crucial when considering the UK's context, as the Biomass Strategy signals a new direction of travel, and any new policy as a result will generate trade-offs within the UK's biomass sector. If new policy is aimed at improving UK biomass sustainability, this will create new winners and losers who will be motivated to engage in policy design differently, as these trade-offs have the potential to change where the benefits of biomass use are currently accrued in the biomass sector and to whom the profits are going.

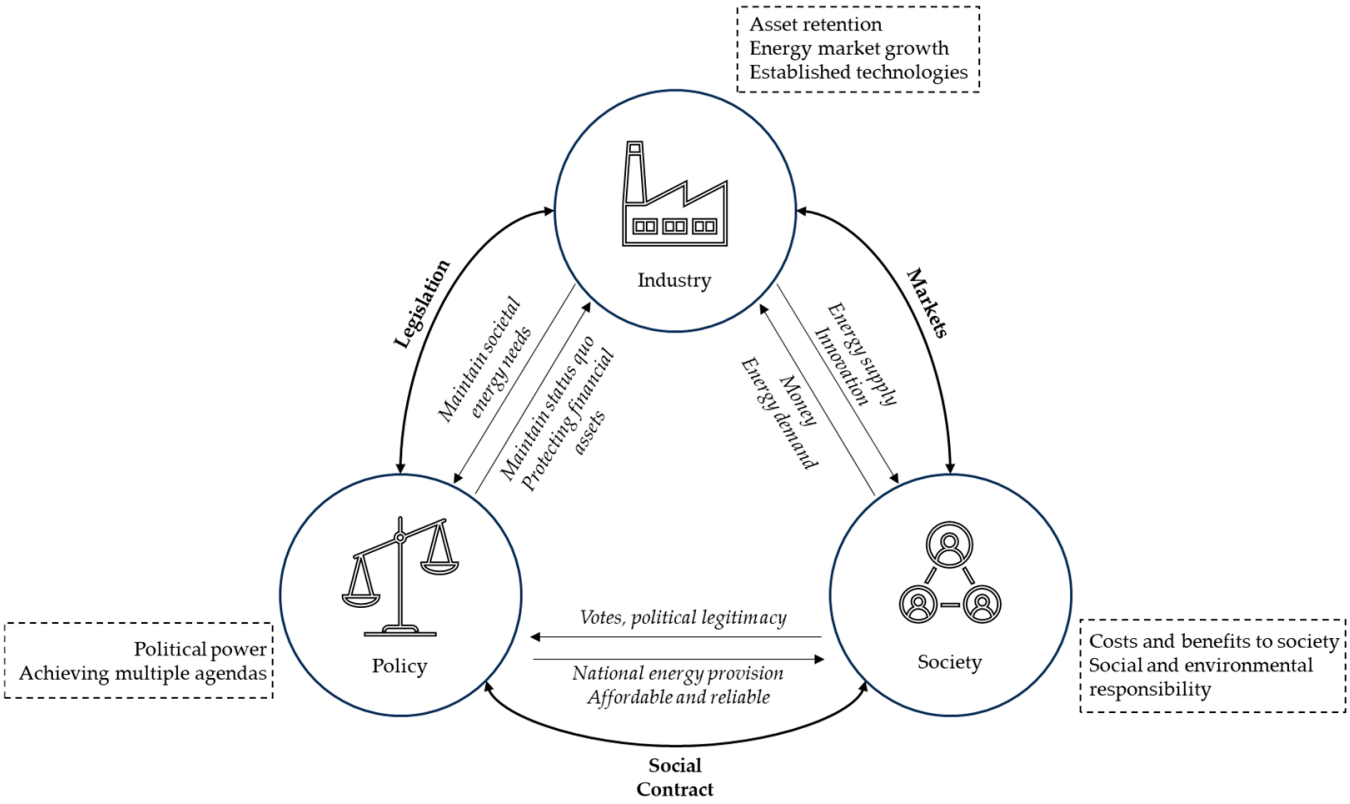

Figure 1. Interactions between policy, industry, and society, governed by legislation, markets, and a social contract, contextualising the non-technical factors impacting policymaking.

In the same way that biomass has a small but significant role to play in the UK's future net-zero energy system, much of the policy that has spurred on the deployment of bioenergy in the UK has not been biomass-focused; it is just that the policy incentives included different forms of bioenergy within their criteria. Policies were aimed at stimulating the development of a broad range of renewable energy technologies, such as wind and solar, including various forms of bioenergy such as biofuels, biomass heating systems, and bioelectricity. The difficulty with engaging in biomass policymaking is the siloed nature

of the different policy remits held across various government departments. Whilst the Department for Environment, Food, and Rural Affairs (Defra) is responsible for agricultural and forestry policy, biomass feedstocks from those sectors are required by the Department for Energy Security and Net Zero (DESNZ) (formerly the Department for Business, Energy, and Industrial Strategy), whose remit covers energy policy, and the Department for Transport (DfT) who are seeking the supply of biomass for biofuels. Therefore, when engaging with policymakers on biomass, it is unhelpful to consider them as simply 'policymakers'; they are not a homogenous group. Whilst each department takes its cues from overarching government policy, they all have their own agendas, objectives, and perspectives, and the actions of one department will have implications for the others. Each wants to draw benefit from utilising the limited supply of biomass resources available to the UK for their advantage, without much consideration for their counterparts in other departments. A cross-sectoral framework on sustainability could facilitate an increased focus on the cross-departmental impacts of biomass policy changes, but trade-offs will still occur between conflicting department objectives, depending on the overarching government policy of the time.

In addition to variation between different government departments and their intentions for biomass in the UK, there is also variation across different bio-based sectors. This is particularly noticeable in the way that greenhouse gas (GHG) emissions and sustainability standards are measured, both of which are the primary focus of policy relating to biomass feedstocks. Established sectors, such as the energy and transport sectors, have differing sustainability standards with regard to the sourcing of biomass for producing energy and fuel, whilst both have a strong emphasis on achieving GHG emission reductions (see Figure 2). Beyond GHG emissions and sustainability standards, policies often include environmental factors such as ecosystem services and biodiversity, but they are not quantified under an accounting framework. Reflecting the siloed nature of government policy design around biomass, whereby different departments are seeking to utilise the same biomass resource to achieve differing outcomes (such as decarbonising energy, decarbonising transport, generating agricultural growth, or developing carbon removals), different bio-based sectors also lack a consideration of cross-sectoral impacts. This impacts not only the sourcing and use of biomass feedstocks but the potential for creating co-benefits and coproducts too [3].

Given the disparate nature of both the development of policy on biomass and the bio-based sectors working to utilise biomass feedstocks, the commitment in the revised UK Biomass Strategy to a cross-sectoral framework on sustainability is welcome. This cross-sectoral framework is an opportunity to go beyond the linear utilisation of biomass that the UK currently practises, funnelling imported biomass into large-scale facilities to produce renewable electricity and move to a more circular model with consideration for cross-sectoral feedback loops. It is clear from the UK Government's "Public Dialogue on the role of biomass in achieving net zero" that the public are concerned that the revised Biomass Strategy could be "dominated by the profit motives" of the large incumbent energy companies [4]. Therefore, for this sustainability framework to mobilise legitimacy within the eyes of the public, it must consider engagement with local communities (such as further public dialogue exercises, clearer communication strategies, or collaboration with academia) across the UK to ensure the bioeconomy is integrated into society at large, by distributing and communicating benefits more widely.

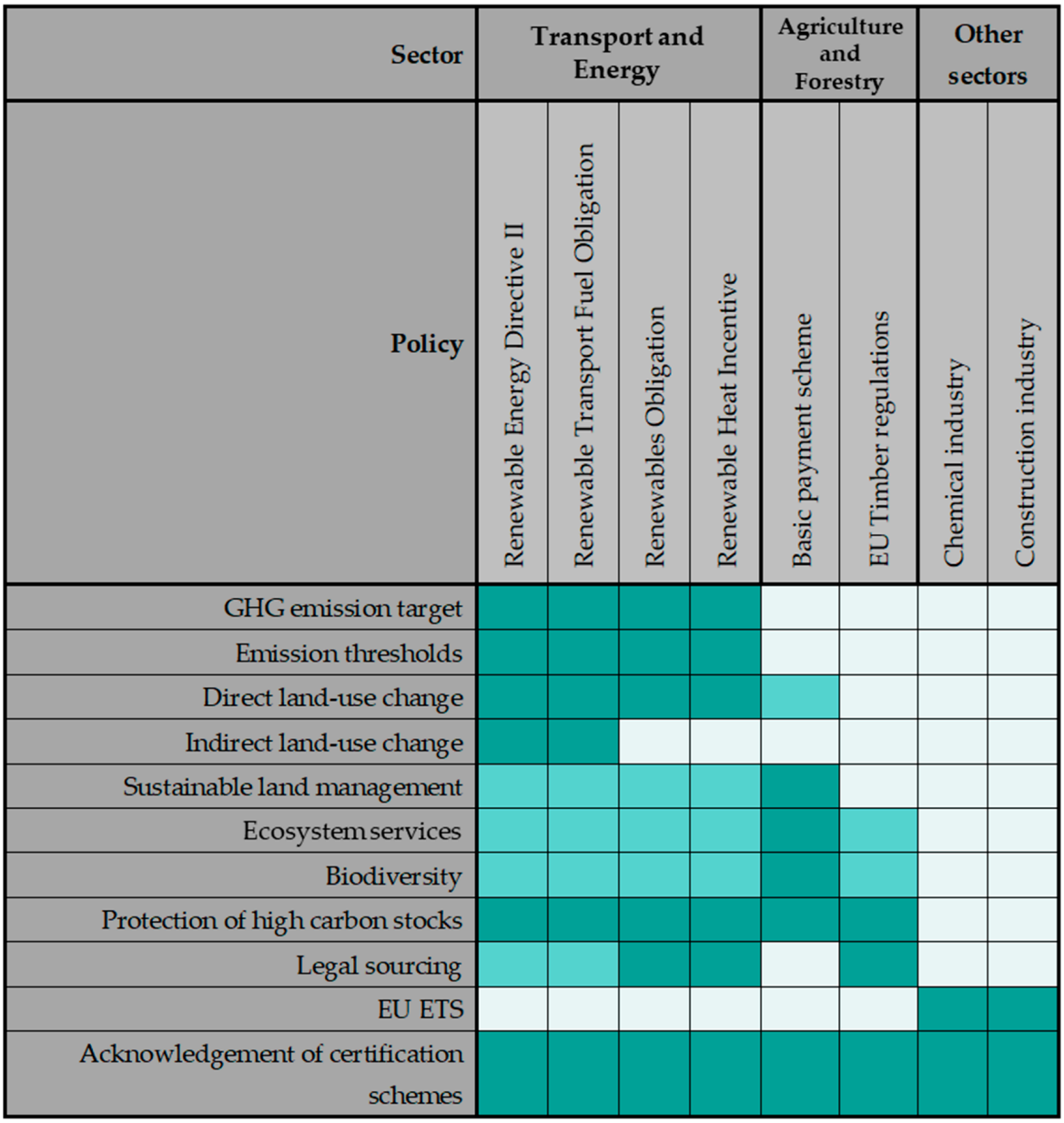

Figure 2. A matrix of criteria in different sector policies applicable to biomass. Darker shading indicates that the criteria are accounted for, lighter shading indicates that the criteria are considered but not directly accounted for, and the lightest shading indicates that the criteria are not applicable within the policy. Adapted from Cucuzzella et al. (2020) [3].

3. Biomass Systems Supporting Sustainability and Society

Who will benefit, and how, will be determined by how policy navigates competing interests and how it decides which sustainability criteria should be focused on. The import of biomass into the UK for renewable electricity production has enabled the energy system to move away from a reliance on coal, thus fulfilling the focus on GHG reductions but raising questions about other sustainability factors, such as air quality. Given the diversity of biomass feedstocks and applications, there are a variety of factors involved when determining the sustainability of a given system, considering the interlinkages between natural, social, and economic systems that biomass brings together. For example, different applications of biomass to displace fossil fuel use within society will have varied consequences for social and economic systems, such as employment opportunities, infrastructure, and innovation. However, there will likely be consequences for environmental systems too,

such as biodiversity, water, and land use if this requires the cultivation of different biomass feedstocks. These interlinkages are unavoidable given the nature of biomass extraction from our natural systems.

Despite there being arguments for bioenergy projects beyond a primary focus on emission reduction, such as benefits for soil health and improved energy access, there are also risks associated with carbon stocks and the technoeconomics of projects that frequently crop up [5]. It is these trade-offs that policymakers will have to tackle if aiming to maximise sustainability benefits in support of public policy agendas, such as net zero (see Figure 3).

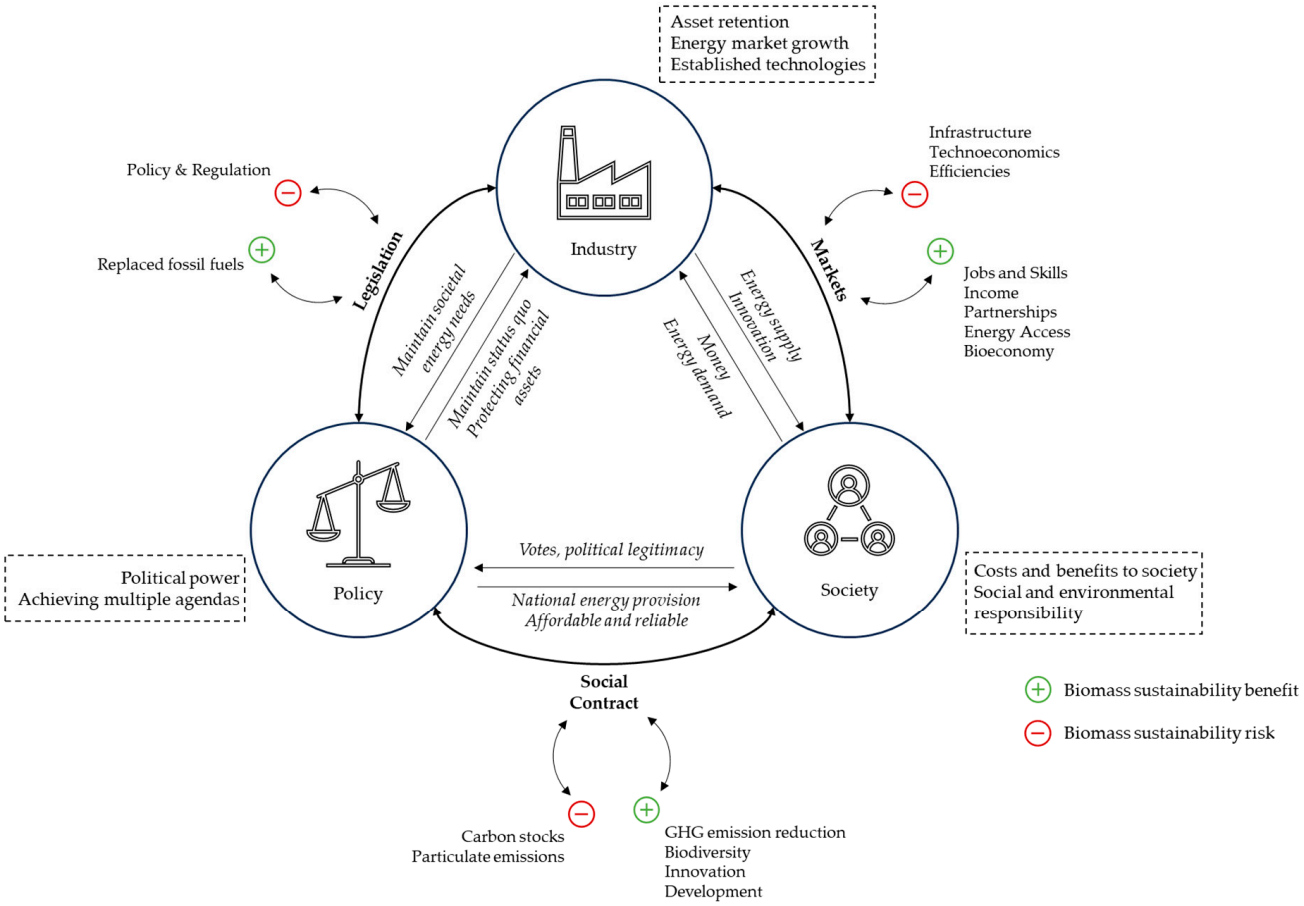

Figure 3. Situating biomass sustainability trade-offs from Welfle et al. (2023) [5] within the interactions between policy, industry, and society, in the context of how the relationships are governed by markets, legislation, and a social contract.

The beneficiaries of utilising biomass to achieve net zero will also be determined by system design, incentivised by different policy mechanisms. Within each system, not only is there a diverse set of factors involved, but there is also a diverse set of stakeholders. Therefore, optimising a system to deliver energy in an efficient way, or the highest level of carbon captured, will lock in different costs and outcomes for different stakeholders [6]. Achieving a particular policy objective by incentivising bioenergy systems to maximise outputs towards that goal creates trade-offs, winners, and losers. Understanding how and why these decisions are made, and who is involved in making them, will highlight inequality in the design of policy around biomass and where this undermines sustainability efforts.

4. Conclusions

Utilising biomass to decouple economies from fossil fuels has the potential to put into practice alternative forms of economics, with redistributive qualities, that both tackle

inequality and mobilise a wider set of actors to support transitions away from fossil fuels. However, increasing the number of beneficiaries through policy change introduces a level of complexity that is not present when dealing with the kind of single-asset, large-scale projects that are favoured by policymakers in the UK. This complexity presents a challenge to siloed policymaking in the UK, which is not set up to address or consider the cross-sectoral impacts of policy changes and lacks a joined-up approach.

The diversity of actors involved is further complicated by a diversity of factors too, particularly the challenge of balancing biomass sustainability trade-offs in the pursuit of net zero. Biomass supply-chains, from feedstock to fuel for energy or fibre for bio-based industries, involve many different actors who are set to win or lose, if policy aims to adjust certain aspects of the system to achieve net zero. Feedstock producers, such as those from the agricultural or forestry sectors, are likely to be impacted differently from energy and bioproduct producers, who benefit from the conversion of biomass to valuable vectors. Beyond the technical challenge of optimising biomass systems and supply-chains to achieve goals such as carbon reductions or removals, energy access, or bioproduct creation, there are social, environmental, and economic challenges to overcome too.

To determine who benefits from the continued utilisation of biomass to achieve net zero requires an understanding of the UK's political bioeconomy, warranting further study into where the inequalities lie within UK biomass systems. These inequalities will illuminate where policy mechanisms will impact future biomass deployment and who sets to benefit from such deployment. This will enable the assessment of sustainability implications and trade-offs across the environmental, social, and economic factors impacting biomass use in the UK and will contribute to understanding the impact of policy on industry and society in relation to markets and the social contract for energy provision. This is timely, given the revised UK Biomass Strategy's commitment to a new, cross-sectoral framework on sustainability and the challenges facing the social legitimacy of continued biomass use in the UK.

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