# Sustainability governance for bioenergy and the wider bioeconomy

SNS
Nordic Forest Research

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It addresses the following main question, which is examined through a set of more detailed sub-questions:

> ***How do sustainability governance systems for bioenergy and the bioeconomy need to develop in the future to best support the sustainable development of society as a whole?***

**Can sustainability governance continue to pave the way for further bioenergy deployment?**
In the last decades, bioenergy has been an important means to increase the amount of renewable technologies in the energy system in several countries. Policies seeking to achieve greenhouse gas emission-reduction goals have been the main drivers of this development, with the underlying assumption that bioenergy is a sustainable alternative to fossil fuel-based energy. However, public concerns about the sustainability of bioenergy have grown since the early 2000s. This has led to the emergence and consolidation of an increasing amount of private, national and EU-wide sustainability criteria, and a diversity of public and private regulatory systems to implement these (Hansen et al. 2021, Larsen et al. 2019, Stupak et al. 2021, Titus et al. 2021, Varnagirytė-Kabašinskienė et al. 2019). These systems have been critical to the acceptance and implementation of bioenergy systems. However, in spite of the governance systems in place, public acceptance of bioenergy as sustainable energy technology is still a challenge. Hence, sustainability governance systems must continue to develop to remain relevant and legitimate, if bioenergy and the bioeconomy should contribute to a more sustainable development in the future.

**What biomass can be accepted as sustainable bioenergy feedstock in the future?**
In the middle ground between unreserved bioenergy proponents and abolitionists, others propose that secondary industrial bio-residuals, tertiary wastes of biological origin, and primary forest harvesting residues are sustainable bioenergy feedstock (EC 2021, Mather-Gatton et al. 2021). Generally, these sources do not trigger the same concerns as food crops or merchantable stem wood, which have alternative uses for products, materials and chemicals of greater economic value and sustainability benefits (Hansen et al. 2021). At present, low-quality and small dimension stem wood tend to fall in between these two stools; it is less clear if such wood is a product, byproduct, or bio-residual, from harvesting. Practical forestry commonly works with 10-30 wood assortments, or more, based on species, log and top size, wood quality, and the most common international, regional and local end-uses. If "bio-residuals", or "stem wood", should be used as terms to define what biomass is sustainable or to be avoided, their definition is critical to achieve the intended outcomes.

**How to define bio-residuals as a resource eligible for sustainable bioenergy production?**
The definition of bio-residuals would have to vary depending on the geographical context if unintended impacts and missed opportunities are to be avoided. For example, the proximity to other wood processing industry will influence whether a certain type of woody biomass is a bio-residual or not. The critical distance to the industry may also depend on local infrastructure and available technologies in the whole supply chain.


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Another challenge is that definitions are moving targets as an increasing number of societies turn their attention to re-use and recycling as part of a circular bioeconomy, away from extraction of finite natural resources that are more energy intensive. Common perceptions of sustainability associated with the bioeconomy rely on the assumption that new low-carbon impact products, materials, and chemicals will be based on residual streams for raw materials. Some types of residuals will no longer be seen as waste streams, but as raw materials for a circular bioeconomy. Along with new technological opportunities, the perceptions of what a "bio-residual" is will change, as will the types of feedstock acceptable for sustainable bioenergy production. Political intervention that changes the profitability of certain feedstock for a certain end-use may also contribute to changes in what is perceived as a bio-residual.

There is as such no 'one size fits all' definition of bio-residuals. On the other hand, allowing multiple decentralized definitions increases risks of leakage, with poorer possibilities for control and higher reliance on trust and actors understanding and respecting the intent of the concept. This challenge must be addressed, for example by exploring the use of price ratios, and requiring that the ratio between the price of energy biomass relative to other assortments should be as low as possible. It may also be worth exploring "critical necessity" versus "nice-to-have". In specific critical situations, it may be meaningful to shift the balance towards more necessary energy at the expense of less needed uses.

**Will forestry and agriculture change to management systems of higher or lower intensity?**
If biotechnology continues to develop opportunities for use of residual biomass for high-value goods, the pull on biomass feedstock supplies, and the pressure on ecosystems, is likely to increase, possibly through land use change or intensification of the forest and agriculture production systems (Hansen et al. 2021). This will increase both primary and secondary industrial residual streams of low value biomass with no other use than bioenergy.

To the extent that policies support setting aside land as unmanaged or choose to manage land primarily for other goals than raw material production, for example for biological diversity, pressures on biomass supplies might be exacerbated. This would increase the need to develop and adapt sustainability governance systems that target management of remaining land (Titus et al. 2021), especially if production systems intensify, for example with increasing use of soil preparation, fertilization, pesticides, irrigation, genetic selection and modification, and shorter rotation lengths in forests. Adaptive governance systems supported by monitoring and evaluation systems are helpful for timely adaptation to new conditions. We suggest exploring the opportunities to improve sustainability governance systems at local, national, and global scales by incorporating adaptive features that help to keep them relevant and legitimate (Stupak et al. 2021).

**Are upgraded "glocal" bioenergy value chains part of the solution?**
Recent events, such as the Covid pandemic, have revealed the immense vulnerability of humanity to threats, with great inequality in impacts across social groups, for example by race and level of wealth. Vulnerability is exacerbated by a high level of global connectivity and high population density in cities and urban areas. The crises strengthened the already existing public demand for more sustainable lifestyles and practices as well as more equality, especially among younger generations.


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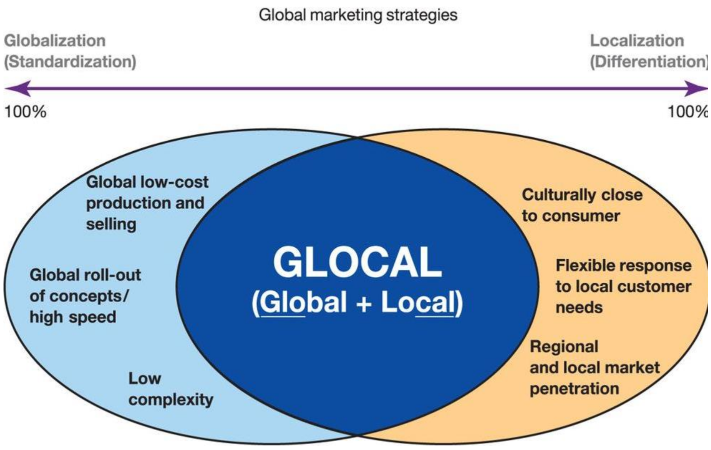


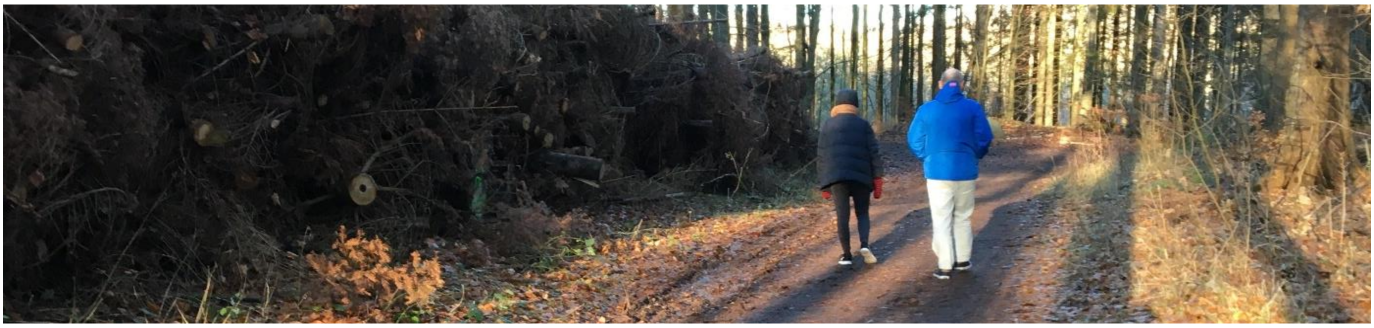

*Figure 1. The overlap of globalization and localization is defined as glocalization. Source: Hollensen and Møller (2018), p. 464, with permission, license number 5057290198477.*

If societies choose to react to the observed vulnerability and inequality, we might increasingly see incentives to upgrade global value chains to high value-added activities with larger upstream, local benefits. Such a win-win situation with simultaneous local and global benefits is conceptualized in the term "glocalization" (Fig. 1).

It is important to be aware that economic upgrading of producers does not necessarily lead to socio-economic upgrading of workers. For example, there is evidence from northern Norway that local benefits and control of production are important factors if potential global benefits of bioenergy should be realized (Hansen et al. 2021). This suggests a need to explore how policy interventions can effectively ensure local influence and reduce poverty, where relevant. Sustainability governance systems must be anchored locally, while also meeting the needs of the global trade.

**Emerging topics to be investigated by sustainability governance science**

Sustainability governance for bioenergy has come a long way, but game changers seem just around the corner. Climate change and threats to biodiversity significantly changed the sustainability agenda some decades ago in 1992 when international conventions were adopted at the Earth Summit in Rio (Lier et al. 2022). Now the time has come to focus additionally on security of the supply chain and energy systems due to the vulnerabilities revealed by the pandemic, recent political instability, and political history, as in the case of the Baltic countries (IEA 2019, 2021, EC 2021). Future research on sustainability governance should investigate opportunities for new supply chains that balance the benefits of international trade with security and socio-economic benefits for the local populations that live closest to the ecosystems, while still achieving critical global environmental goals. The limitations to the effectiveness of current sustainability governance for bioenergy make it relevant to investigate and discuss if these systems can be embedded into existing and new governance regimes for the broader forestry and agriculture sectors, and for the landscapes as a whole. It is also relevant to examine the opportunities for framing existing governance by a legally binding international agreement on the overall principles for sustainable production and use of biomass resources and raw materials (Stupak et al. 2021). The public debate on the balance between protection, conservation, and productive forestry and agriculture needs to continue as adequate public support is a precondition for adoption of new policies and governance, but it is hard to imagine a future sustainability transition without a more bio-based economy.





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***For more information, please see the following publications:***

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