Measuring, governing and gaining support for sustainable bioenergy supply chains

Main findings and recommendations

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Authors

Martin Junginger, Göran Berndes, Annette Cowie, Uwe Fritsche, Tat Smith, Inge Stupak

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1. Introduction

Several systems to define and monitor performance and progress towards sustainability of bioenergy have been developed for implementation at different scales, including operations, landscapes or jurisdictions. Some are formalised systems (e.g. GBEP 2011; RSB 2016; ISO 2015; ASTM 2016; SBP 2019) while others are inputs made through the scientific literature (McBride et al. 2012; Dale et al. 2015; Lattimore et al. 2009; Mead & Smith 2012). Even if much has been achieved, there are still challenges associated with understanding, defining, measuring, and governing and communicating sustainability of bioenergy (IEA Roadmap 2017). This has led to very different perceptions of sustainability of bioenergy in society, with a pronounced lack of trust in potential benefit within some groups (Mai-Moulin et al. 2019).

In light of these challenges, the IEA Bioenergy inter-Task project on "Measuring, governing and gaining support for sustainable bioenergy supply chains" was formed to synthesise works of a number of IEA Bioenergy Tasks, including Task 37, 38, 39, 40, 42 and 43. The project aimed at addressing the following questions:

1. Objective 1: How to measure and quantify progress towards more sustainable practices?
2. Objective 2: How to improve the input, output and throughput legitimacy of existing and proposed governance systems?
3. Objective 3: How to engage more successfully with the broad range of stakeholders so that policies and sustainability governance are perceived as legitimate and helpful for build-up of social capital, trust, and support among all stakeholders?

The project was started in 2016 and completed by the end of 2018. A multitude of studies were initiated focusing largely on the agricultural and forestry sectors, and on biogas systems. The aim of this final compact summary paper is to share the main findings and recommendations from the work carried out with regard to these three questions. More comprehensive summaries of the work performed, including details on individual case studies, are available in the form of three comprehensive summary reports addressing each of the three objectives (Berndes et al., 2019; Stupak et al., 2019; Junginger et al., 2019). A shorter summary is available with presentation of three illustrative case studies and some general conclusions (IEA Bioenergy, 2019). The initial multitude of studies is being published as scientific articles or IEA Bioenergy reports. References to these are provided in the three comprehensive summary reports and on the website of this intertask project.

2. Summary of main findings and recommendations

2.1 MEASURE AND QUANTIFY PERFORMANCE AND PROGRESS TOWARDS MORE SUSTAINABLE PRACTICES

Integrated assessments and the importance of modelling approach

Based on the combined portfolio of studies undertaken in Objective 1, an overall conclusion is that assessment approaches need to reflect that existing and emerging bioenergy systems are commonly integrated with other biobased systems and associated land uses. Several complementary methodologies may need to be combined to address relevant aspects along all sustainability dimensions and to facilitate efficient utilization of biomass resources and improved sustainability performance. The methodologies addressed in this summary report are examples of those suitable for assessing bioenergy and other biobased systems.

Several of the Objective 1 studies investigated how assessment approaches can influence results as well as conclusions about sustainability of bioenergy. The varying biophysical, social and economic context of analyses and policy objectives influence the formulation of research questions as well as the methodology approach (e.g. spatial and temporal scales) and parameter assumptions, e.g., which (fossil) fuels are substituted and what reference scenarios are chosen to compare with bioenergy scenarios. It has been shown that the methodology approach is in itself a critical factor behind results and conclusions across different case studies (see, e.g., Cintas et al. 2017 and Bentsen et al. 2017). Disagreement among studies can also be explained by differences in assumptions about the values of uncertain parameters (Pereira et al. in review).

Climate impacts

Concerning forest bioenergy systems, our work shows that the climate effects of forest based bioenergy systems need to be assessed in the specific context where bioenergy policies are applied and bioenergy is produced. Studies that assess bioenergy systems as single entities, in isolation from the context where bioenergy and other biobased products are produced and used, do not capture the full climate effect of implementing such systems. For example, studies that analyse carbon flows at individual forest stand level may provide useful information within the limited boundaries of the studies, e.g., allowing benchmarking of different pathways on a common scale. But their limited scope reduces their usefulness for informing policy making. A specific drawback of stand-level assessments is also that the forest system is represented by a prescribed sequence of events (e.g., site preparation, planting or natural regeneration, forest thinning and other silvicultural operations, final felling) despite that these events in reality occur simultaneously across the forest landscape. Due to this, studies that apply stand level assessments can be misleading as a model for the forest sector and its overall impact on climate.

It is also influential when the modelling of the carbon impact is started. For example, if the carbon accounting is started at the time when biomass is extracted from a stand and used for bioenergy, i.e., commencing with a pulse emission followed by a phase of sequestration, there will be – by design – often an initial net GHG emission. Conversely, if the carbon accounting is started at the time when a stand has recently been planted with new trees, the forest system will be characterized by a period of net carbon sequestration which ends when the stand is harvested and the sequestered carbon is "returned" to the atmosphere. Landscape level assessments that capture all carbon flows in the landscape throughout the accounting period avoid such system boundary effects on the assessment outcome. In relation to the objective to mitigate climate change, the management of forests needs to consider the contributions from forest carbon sinks, carbon storage in forests and forest products, and wood harvesting to produce forest products that substitute for fossil fuels and other products such as cement. Thus assessments should ideally consider the full product portfolio, take full account of all the types of forest management operations that occur across the landscape, and include realistic representations of the age-dependence of forest growth rates so that it is considered that carbon accumulation rates diminish as forests age.

Landscape level studies can consider how forest management operations, and the production and use of forest products, affect the strength of forest carbon sinks and the amount of carbon that is stored in forests and in forest products over time, i.e. the biophysical dynamics of the landscape. Integrated modelling approaches that also capture economic dynamics and interactions with the biophysical environment can be used to study how forest management will vary depending on the characteristics of demand, forest structure, climate, forest industry profile, forest owners' views about emerging bioenergy markets, and the outlook for other forest product markets. Such studies can reveal how adjustments across affected systems (including the forest, product uses, markets and processing technologies) influence the development of forest carbon stocks and GHG emissions.

Ecosystem services

Land management decisions reflect the balancing of economic, ecological, and social objectives. A study of methods for assessing and mapping ecosystem services in landscape revealed a significant diversity in methodological approaches and an inconsistent terminology. But we also found harmonization initiatives, such as the new International Classification of Ecosystem Services (CICES) classification system, developed by the European Environment Agency (www.cices.eu). In summary, it was found that methods that use readily-measured proxies (indicators) to represent key variables have the advantage that they are much less complex than, for example, direct mapping with survey and census approaches, or empirical production function models. But there are disadvantages, such as the risk of generalization error, so they should be validated with empirical data to confirm their suitability for specific landscape-scale studies. Given the importance of high resolution and need for more complex methods and validation, most ecosystem services assessments with a landscape scope will need to limit the number of ecosystem services included in the study. To ensure that the most relevant ecosystem services are included, it is essential to involve stakeholders in the selection process.

Translation of ecosystem services into the CICES classification system is in most cases relatively straight-forward. But the comprehensiveness and use of more technical terms in CICES may create a barrier for communication and interaction with those that lack in-depth understanding of ecosystem services. Given the importance of stakeholder involvement in assessments of ecosystem services, this is a clear disadvantage. It may therefore be beneficial to review the wording or to complement the typology with alternative, less technical, descriptions. This can preferably be coordinated with other initiatives that aim to inform policies and everyday practices, such as the Nature's Contributions to People (NCP) concept developed by the Intergovernmental Scienxce-Policy Platform on Biodiversity and Ecosystem Services (IPBES) see Diaz et al. (2018).

In summary, recommendations include the following.

1) Use indicators that inform about the effects of bioenergy systems on global warming on different time scales. Related to this, it is desirable that methods are developed to consider non-GHG climate forcers (e.g., albedo and aerosols) as these can be as important as GHGs.
2) It is important to involve relevant policy makers and stakeholders in defining policy-relevant research questions, e.g., in defining objectives, scope and selecting reference scenarios, and in reflexive processes during the research itself ("transdisciplinarity"). This would increase the likelihood that there is agreement about the assessment framework, and that results are relevant, correctly interpreted and become useful in the policy development process.
3) It is important that the design of the assessment framework and assumptions about parameter values are transparent and are open for discussion. It should be clear which spatial and temporal scales are applied and why these are appropriate for the purpose.
4) Use integrated modelling to get more realistic assessments, considering that the climate impacts of forestry depends also on the dynamics of the economic system and industrial structure.
5) For assessment of impacts on ecosystem services, involve stakeholders in the selection process to ensure that the most relevant ecosystem services are included.
6) Translate technical descriptions of assessment frameworks into plain language, to properly inform a broader audience.
7) Proxy-based methods have an advantage of being much less complex than many other methods for assessing ecosystem services, but they are often unsuitable for landscape-scale studies. They must be validated using local empirical data, and their limitations recognized.
8) If third-party models are used, it is imperative that these are properly evaluated on their suitability for the specific project beforehand, and also calibrated and validated using empirical data.

2.2 GOVERNANCE FOR BIOENERGY DEPLOYMENT

Governance to deploy sustainability benefits offered by bioenergy

As bioenergy sector development seems closely linked to governmental policies throughout different phases of market development, success will often depend on stable, long-term political strategies, with well-tailored financial, technical and administrative support systems (e.g. quota systems, preferential taxes, investment subsidies, research and development (R&D), education and training and collaborative efforts). However, it is also important to continuously monitor and assess the situation against agreed criteria, in order to adjust governance systems and/or (financial) incentives when necessary, or discontinue these when they are no longer needed. Frequent reviews of the performance of laws, regulations and other parts of the governance system against their ability to achieve intended goals can help to stimulate involvement of stakeholders, which may be especially critical in the introduction phase. Identifying the most legitimate, efficient and effective combination of instruments again requires involvement of policy makers and other stakeholders, with decisions that are informed by careful analysis. Such analyses should address the economic, environmental and social impacts of alternative renewable energy technologies and their use in combination in the particular context.

Legitimate, efficient and effective governance of sustainability

Sustainability governance has often developed in response to challenges and opportunities identified in connection with market development, or due to changes in societal needs and priorities. It tends to emerge with various time lags compared to sustainability concerns, depending, among other, on the mechanisms in place to identify and document them. Such time lags may be critical to the realization of the opportunities offered by bioenergy, if perceptions grow that concerns are not being addressed through governance. Monitoring systems and platforms for stakeholder communication and exchange of experiences and information, embedded in adaptive approaches, are means to create trust by ensuring that emerging sustainability concerns are addressed in a timely manner. Special concerns arise for international supply chains. In this case, the private bioenergy and certification sectors currently play distinct roles in the development and implementation of sustainability governance systems, while governments sometimes provide the overall sustainability frameworks. However, this creates multilevel governance structures, which may again confuse and create very variable perceptions of what is being achieved. The multiple layers of governance are at the same time unavoidable when trying to address civil society demand for prescriptive regulations that are easy to understand, also for complex and diverse global supply chains, while at the same time recognising that locally based decision-making is needed to address concerns appropriately in a local context.

Identifying the most legitimate, efficient and effective governance design in a particular context require involvement of relevant stakeholders. Decisions about governance system design should consider, for example, owner structures and culture in the region or country, and that these parameters may be dynamic. Considering challenges arising from misunderstandings, or biased and unreliable information about the sustainability of bioenergy, we suggest that governance systems be rigorously designed and implemented based on data and facts, as a necessary basis for building trust in the sustainability of bioenergy practices in the long term.

Decisions on governance design should also be informed by careful analysis of experiences with existing requirements and future scenarios, to understand what is most desirable and effective, e.g., mandatory or voluntary measures, incentivising policies or those based on command and control approaches, prescriptive or less prescriptive requirements, and the use of management unit level or risk-based approaches to verification. To some extent, any verification system will include an element of formal or informal risk assessment. In order to increase transparency, we suggest movement towards formalised risk assessments.

More integrative sustainability frameworks

Financial incentives for bioenergy are sometimes conditionally linked to land-based environmental sustainability criteria, but trade-offs and disagreement about major concerns are not always addressed in a transparent and effective way. Hence, innovative solutions are needed to address the most critical trade-offs and disagreements in a way that is suitable for governance purposes. We suggest that standards and sustainability governance develop as follows.

1) include sustainability governance as an integrated part of bioenergy deployment, in adaptive frameworks, which continuously monitor and assess the situation, and revise policies against agreed sustainability criteria;

2) formalize the elements of risk assessment which are inherent in any governance system, for increased transparency;

3) include transparent and comprehensive assessment methodologies, which distinguish between fossil and biogenic carbon and consider both changes in net GHG emissions due to product substitution and changes in carbon stocks in ecosystems and wood product pools in an integrated framework; this may help to show transparently how large fossil carbon emissions associated with bioenergy and reference systems are, and how GHG savings from product substitution are possibly linked to temporary changes in carbon stocks;

4) apply systems that collect consistent information at appropriate levels about biomass flows from production in the field to end-of-life, including re-use and recycling, and across borders; such information is critical to holistically assess climate and other impacts of bioenergy in the context of the larger sectors;

5) include calculation frameworks and standards which include the impacts of the larger sectors to which bioenergy development is linked, e.g., agriculture, forestry, waste handling, nature conservation, etc., in order to more transparently address the economic, environmental and social impacts of bioenergy in the context of the impacts from these other sectors;

6) develop methodologies and indicators which can clarify when bioenergy is the most desirable option for use of biomass resources, which alternative bioenergy technologies and products is preferable, and how bioenergy can be integrated with other renewables to support decarbonization; and

7) last but not least, continuously observe new developments in peoples' and societies' concerns, including possible conflicts, for governance systems to adapt in a transparent and timely manner.

2.3 SUCCESSFUL STAKEHOLDER ENGAGEMENT

Based on the combined portfolio of case studies in objective 3, it is concluded that public awareness of bioenergy in general is rather low, and information from academia and consulting is most trusted.

Include social stakeholders and increase stakeholder awareness

In new local bioenergy projects, such as forest biomass in La Tuque and Canada, better informing and involving the public in advance helped to identify concerns and expectations. Such involvement might help to address concerns and thereby generate more support for bioenergy projects. Information about economic benefits and participation and inclusion in bioenergy projects seems to be often neglected in planning and communication, and yet, these aspects are typically of high priority for many local stakeholders. It also became clear that external stakeholders concerned with social topics are typically less involved than those focusing on environmental aspects, such as eNGOs. Engagement with and inclusion of civil society organizations (e.g., land owner organizations and labour unions) in the discourse may help to broaden the dialogue by directing attention to positive social effects alongside potential negative trade-offs and risks. These organization also have the opportunity to communicate through their comprehensive networks.

Use best practice examples

Local biogas projects in Germany mostly met resistance from many stakeholder groups in recent years. Conflicts between the stakeholders included especially landscape aesthetics. One approach suggested to reduce such conflicts is so-called best practice examples. Farmers have been able to reduce local conflicts without certification and standards by finding a compromise between local perceptions of undesired impacts and the profitability of a commercial biogas plant operation. An example included plantings at the edge of the energy crop field with the purpose of improving the perception of landscape aesthetics by the residents and to promote biodiversity in the region. Other examples creating win-win situations for operators and residents included biogas plants delivering heat to nearby households and giving the residents the possibility to discard their bioorganic wastes at the plant. Sharing of economic benefits and fostering communication and good relationships has been shown to increase trust and understanding among stakeholders.

Establish and implement sustainability safeguards

The analysis of supranational stakeholder views underlined that bioenergy market uncertainties and unresolved sustainability issues are the two main barriers to further bioenergy development. Social acceptance of bioenergy projects is also a real challenge to the bioenergy industry. Moreover, large-scale sustainable mobilisation of biomass feedstocks and governing the sustainability of the increasing global trade are further challenges for the bioenergy sector to overcome in the medium- and long-term future.

The establishment and implementation of sustainability safeguards thus remains important for a diverse stakeholder group, as a condition for granting support for the development of the bioenergy sector. Critical sustainability issues include the reduction of GHG emissions, under stringent criteria with regard to air and water pollution; high levels of reuse and recycling of materials; appropriate soil and forest management; and the conservation of biodiversity and maintenance of ecosystem services. Sustainability criteria addressing these issues have already been implemented for the energy sector in some EU Member States and can be relevant also in other countries if existing governance systems are considered insufficient. The respondents of the online survey indicated that in order to enhance and gain further support for the bioenergy sector, sustainability requirements covering social, and additional economic and environmental aspects should be mandatorily implemented for all types of biomass regardless of end use. However, it remains to be seen whether mandatory implementation will ultimately lead to more stakeholder acceptance, generally, and how realistic and rapid implementation for other end-uses is. The views of traditional wood product industries, and novel biochemical and biomaterial industries, are different, as they partly consider competition with bioenergy for feedstocks as problematic, especially due to subsidies available for bioenergy.

View on potentials of energy crops versus residues

The survey also indicated low support for energy crops on agricultural land. This may reflect common concerns about food production for an increasing global population in coming decades. Or it may be linked to negative perceptions of direct and indirect land use change caused by bioenergy, or to negative perceptions of intensive agriculture in general. The issues have been popularized by media campaigns. The low support for energy crops is problematic, as the world desperately needs investments in land management to improve soil, water, forests and related ecosystem services (e.g., Fargione et al. 2018; Woods et al. 2015) and energy crops could contribute to these goals in some parts of the world (Kline et al. 2017). Some marginal agriculture lands are valuable from biodiversity and landscape aesthetics points of view (Shortall et al. 2019). But there are extensive areas of degraded and marginal agricultural lands where establishment of appropriate cultivation systems can provide biomass for bioenergy while helping to restore land productivity (e.g., Woods et al., 2015). It is important to communicate that the outcome of planting energy crops will always depend on the local conditions and priorities. This includes to highlight examples of beneficial land use change where establishment of suitable crop cultivation systems can provide biomass while mitigating environmental impacts of current land use. The indirect effects triggered by bioenergy, as well as possible ways to reduce risks and rather assure achievement of benefits, need to be explained and communicated better.

Many respondents of the global survey indicated that they preferred the use of forestry and agricultural residues, rather than decided energy crops or plantations, presumably because the environmental impact is perceived as lower. However, forestry stakeholders in the US indicated that the economic benefits of harvesting and selling residues are low, showing that it is often difficult to reconcile different sustainability objectives.

Recommendations for further work

Further work on stakeholder engagement, involvement and perceptions should address the following issues.

1) The measurement of trust for specific purposes, e.g. trust in government, social license to operate etc.; how should this be done?
2) The role and modes of communication for creation of trust and confidence among different groups of actors, and the role of researchers for communication; which role and modes are most effective for which groups, depending for example if communication takes place at local, regional, national or international levels.
3) The extent to which sustainability standards and respective certification systems promote, incentivize and communicate continuous improvement in a transparent and effective manner should be investigated. Monitoring data at all levels are useful for documenting sustainability of bioenergy production and use and should be part of the assessment and communication with stakeholders.
4) Supranational stakeholders' recognition of local governance systems already in place; it is desirable to avoid overlapping systems as this implies unjustifiable burden. However, views on specific sustainability issues may differ between producing and importing regions. In such situations, producers may decide to meet additional requirements to get access to export markets.
5) There is no one single approach to assessing progress toward sustainability in any particular setting, but there are common patterns. These general attributes include active stakeholder engagement throughout the bioenergy production process; transparent sharing of information about the social, economic, and environmental costs and benefits; ongoing monitoring; and working together towards identifying and implementing better practices.

3. Continuation and way forward

The project "Measuring, governing and gaining support for sustainable bioenergy supply chains" has created a wealth of findings, which led to recommendations for policy makers and others involved with measuring, governing and communicating sustainability of bioenergy. The findings also raised questions that needs further work. The new IEA Bioenergy Task 45 – Climate and sustainability effects of bioenergy within the broader bioeconomy – will, among other, build their work on the results of this project during the 2019-2021 triennium. One key goal of the Task is to increase understanding of the environmental, social and economic effects of producing and using biomass for bioenergy, within the broader bioeconomy. A central aspect concerns the development and application of science-based methodologies and tools for assessing the effects of biobased systems, as well as the communication with stakeholders at various levels. More information about Task 45 can be found at http://task45.ieabioenergy.com/.

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