Sustainability of bioenergy supply chains

Summary from an inter-Task workshop 18-19 May 2017, Gothenburg, Sweden

IEA Bioenergy

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Summary report from an inter-Task workshop, 18-19 May 2017, Gothenburg, Sweden

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Executive summary

The IEA Bioenergy inter-Task project on "Measuring, governing and gaining support for sustainable bioenergy supply chains" organized the Gothenburg Workshop to present and reflect on preliminary results of its ongoing work, structured in three main objectives:

1. Assessing the sustainability of various biomass and bioenergy supply chains, and limitations of a global, uniform, harmonized sustainability framework.
2. Compare and assess the legitimacy of a variety of approaches on how to govern and verify sustainability of biomass and bioenergy supply chains in different conditions.
3. Understand perceptions and underlying motivations of stakeholder groups regarding bioenergy, and inform dialogues and discussions to gain trust in the sustainability of bioenergy.

The workshop audience consisted of both IEA Bioenergy members and informed stakeholders from industry, policy, academics, the NGO community, and others. From the overall workshop discussions, the following main "take-home" messages were derived:

- It is necessary to see bioenergy in the broader context of the bioeconomy, as part of larger sector-based industries where a portfolio of material, food and energy products is produced. Understanding this context is necessary to avoid simplistic views of the "food-vs.-fuel" and indirect land use change issues.
- The landscape as an integrative view is the key analytical scope for sustainability analysis, and respective approaches and tools are available.
- IEA Bioenergy aims at providing credible guidance for regulatory decisions through science-based information. The concern was whether IEA Bioenergy actively ensures that they are not seen as biased in advocating for bioenergy, but as a provider of objective, science-based information.
- There are different answers about the sustainability of bioenergy depending on the evaluation framework, generally due to differences in underpinning assumptions. Conclusions are often similar when assumptions coincide.
- Last but not least, it was also emphasized that there is a need to engage more actively with other organizations working on closely related topics, such as ISEAL and its membership.

With regard to the specific project objectives, the workshop resulted in the following key outcomes:

Measuring sustainability (Objective 1)

- The ongoing scientific debate on sustainability and carbon neutrality is confusing and raises doubt about the credibility of all forms of bioenergy. Industry wants clear guidance on what is sustainable biomass, and legislation and certification are needed for consumer confidence.
- Certification at product or producer level cannot deal with cumulative impacts. There is a need for landscape-scale assessments, and regional ("territorial") certification may be helpful to develop.
- Consensus is lacking on the significance of tipping points, payback time, iLUC, and appropriate calculation metrics. This creates uncertainty, especially for policy-makers. Scientists need to explain the issues clearly for a non-technical audience.

- We recommend quantifying the global and regional amount of biomass for which there is high confidence that sustainability standards are achieved, and other biomass for which there is greater uncertainty about impacts.
- Substantial deployment of bioenergy is required in most scenarios that meet climate targets, and the stronger the climate target, the more bioenergy is needed. The extent to which Bioenergy with Carbon Capture and Storage (BECCS) will be required to meet stringent climate targets is discussed more and more, but currently not agreed.
- Time needs careful consideration in LCA approaches: Total GHG emissions determine cumulative radiative forcing and therefore the temperature impact, but policies promoting early reductions can be important to create incentives for low carbon energy solutions. Time is also relevant in some circumstances: depending on biomass volumes; forest carbon stock changes are important.
- Change (increase or decrease) in forest carbon stocks due to introduction of biomass harvesting for bioenergy needs to be considered, and they can be influenced by management.

Sustainability governance and stakeholder involvement (Objectives 2+3)

- Collection of big data, use of apps, etc. can support sustainability governance, for documentation of sustainable practices. Various technologies are needed for the collection of data to improve management and standards, from precision farming technologies to simple mobile phones.
- It should be considered how can larger actors be incentivized to support smaller actors?
- Risk analysis and management and risk-based approaches are topics that need to be further developed in the project.
- Clarification is needed for the role of communication in creating trust and confidence among actors, and the role of researchers in this process.
- The extent to which standards promote and incentivize continuous improvement should be investigated. Understanding of, and linkage between, continuous improvement and adaptive management needs to be developed.
- For the synthesis on governance issues, it should be considered that different approaches exist. Even though for example Canadian and US forest governance systems are very different, their goals are similar. Both nations have extensive and complex regulatory frameworks at federal, state/provincial and local levels.
- Monitoring data at all levels might be useful for documenting sustainability of bioenergy.
- We should consider the extent to which certification systems improve practices on the ground, with secondary feedstocks constituting a specific challenge for tracing sustainability characteristics.
- Ultimately, achieving sustainability is an ongoing process rather than an end-point state, and thus also sustainability governance systems must continue to evolve.

Final roundtable and conclusions

- Participants agreed that the workshop content was informative, and that the communication was the greatest value. The workshop allowed participants to test ideas, and served as a forum to find common ground. Yet, more NGOs and policy makers are needed in the dialogue.
- The struggle is to bring all the information to government and the public, in a way that is trust-worthy. Yet, trust can only be earned, not demanded.
- "Truth" vs. evidence – beware of the terminology: science does not provide "truth", and does not judge what is "best", but it should inform policy/decision makers and stakeholders.
- Agreement was reached on the importance of context when evaluating the sustainability of bioenergy systems, based on the conditions and options in a given time and place.

Because of this, tools and methods need to be flexible to those various conditions, and this can lead to important progress e.g. in analyzing sustainability of bioenergy at the landscape scale, in a way that integrates impacts from forestry and agricultural systems.

- More research is needed to understand critical thresholds, for example, how much residue can be removed and yet maintain nutrients for plant growth.
- Information generated by IEA Bioenergy can be important for reaching consensus, for example around the US-EU bioenergy supply chains. IEA Bioenergy can serve as a living laboratory, providing inputs to development of RED II, North American-EU supply chains, and certification systems.
- To further communicate outcomes of this project, a communication strategy should be developed, with clear ideas about how stakeholders should be informed and how the experts in the project can be part of this strategy.

PROJECT AND WORKSHOP INTRODUCTION

Social and environmental effects of liquid and solid biofuels production continue to be scrutinized. The public debate is heated with opinions on "sustainability" often being based on a mix of science, perceptions, emotions and political agendas. The criteria selected to define 'sustainable bioenergy' inherently depend on the views and priorities represented by those involved in the process of selecting the criteria and defining the term. Discussions among such actors has shown that it is hard to reach consensus on several issues, especially for complex topics such as indirect land-use change, competition for land with food production, forest carbon accounting and sustainable forest management. It adds to the controversy that sustainability criteria and metrics differ between different feedstocks, different end-uses, and even amongst the different scales of end-uses. There are also no criteria for aviation, shipping and biomaterials in existence today. Another part of the controversy is caused by the different approaches to governance and the partial or perceived failure of these systems to ensure the sustainability of bioenergy supply chains.

In order to address these challenges, the IEA Bioenergy inter-Task project on "Measuring, governing and gaining support for sustainable bioenergy supply chains" is pursuing three main objectives:

- *To provide an overview and examples of calculation methods and tools to assess the sustainability of various biomass and bioenergy supply chains and discuss the needs, possibilities and limitations of a global, uniform, harmonized sustainability framework.*
- *To compare and assess the legitimacy of a variety of approaches on how to govern and verify sustainability of biomass and bioenergy supply chains in different conditions, including the effectiveness and cost efficiency of these systems.*
- *To understand the perceptions and underlying motivations of stakeholder groups in relation to their positions on bioenergy and inform dialogues and discussions, in order to avoid misconceptions and gain trust in sustainability of bioenergy.*

The project was started in 2016, and a multitude of studies have been initiated, focusing largely on the agricultural, forestry and biogas sectors. The main aim of the workshop was to share preliminary project results from the work carried out under the three objectives with an audience of both IEA Bioenergy members and informed stakeholders from industry, policy, the NGO community etc. Part of this aim was also to obtain feedback on results and approaches, identify possible knowledge gaps within the context of the overall project aim, and to address this information in the remaining project period until end of 2018. The workshop was organized in different sessions, see program below, and the discussions in the different sessions were captured by different rapporteurs. The feedback given by the audience was used as input to further guide the ongoing project. The various project outcomes will be published both in the form of concise and easily accessible documents, i.e. short reports and webinars, and in several peer-reviewed scientific papers (published ideally open access).

Via the presentations (available ***here***) and this summary, we would like to share the workshop contents and discussions, as a basis for a continued dialogue with those participating in the workshop, as well as other interested persons and organizations. Readers are welcome to contact the coordinators for further input and discussion, see contact information at the beginning of this document.

During the general discussion with participants after the project and workshop presentation, several points were made:

- *Most importantly, the discussion concluded that it is necessary to couch bioenergy in the broader context of the bioeconomy, as part of larger sector-based industries. This is due*

to the bioenergy sector's sensitivity to cost competitiveness for feedstocks, and the subsequent uncertainty for what end use biomass will ultimately be utilized.

- *Also, the audience discussed the need for IEA Bioenergy to remain neutral if it should act as a scientific organization to provide credible guidance for regulatory decisions. The concern was whether IEA Bioenergy actively ensures that they are not seen as biased in advocating for bioenergy, but as a provider of objective, science-based information.*
- *Last but not least, it was also emphasized that there is a need to engage more actively with other organizations working on closely related topics, such as ISEAL.*

PROGRAMME

Thursday 18 May 2017		
09.00-09.15	General workshop & project introduction. Presenter: Martin Junginger	
09.15-09.30	Introduction to Objective 1. Presenter: Annette Cowie	
09.30-09.45	Introduction to Objective 2. Presenter: Inge Stupak	
09.45-10.00	Introduction to Objective 3. Presenter: Uwe Fritsche	
10.00-10.30	General discussion on approaches	
10.30-11.00	Coffee	
	Objective 1 **Measuring sustainability**	**Objective 2 and 3** **Governance and stakeholder involvement**
11.00-11.30	P1. Comparison of tools for assessing greenhouse gas emissions savings of biofuels. Presenter: Helena Chum	P8. Trust and legitimacy in sustainability governance of bioenergy supply chains. Presenter: Maha Mansoor
11.30-11.55	P2. How to analyse ecosystem services in landscapes. Presenter: Oskar Englund	P9. Drivers and effectiveness of sustainability governance of agricultural crop production at EU level. Presenter: Niclas Scott Bentsen
11.55-12.20	P3. Relating ecosystem Services to indicators of progress toward a sustainable bioeconomy Presenters: Virginia Dale and Keith Kline	P10. Sustainability governance of agriculture-based bioeconomy in Canada. Presenter: Tat Smith for Charles Lalonde and Maria Wellisch
12.20-12.45	P4. Delphi survey approach for the identification of sustainability indicators and environmental impacts of forest biomass harvesting for a biorefinery: Case study in Québec. Presenter: Ichrak Lakhdhar	P11. Incorporating policy, market and technology in sustainability governance of agriculture-based biofuel and bioeconomic development in the US. Presenter: Jianbang Gan
12.45-13.45	Lunch	
13.45-14.45	Discussion: possibilities and limitations of a global harmonized framework to assess sustainability of biobased production	Discussion: governance of sustainability of agri-based bioenergy and the bioeconomy
14.45-15.15	P5. Assessing the climate effects of forest bioenergy systems: Swedish case study. Presenter: Olivia Cintas	P12. Bridging ecosystem services and sustainable bioenergy indicators in agricultural landscape with stakeholders Presenters: Keith Kline and Virginia Dale
15.15-15.45	P6. Assessing climate effects of forest bioenergy systems: A Canadian case study of unloved wood. Presenter: Evelyne Thiffault	P13. Modeling improvements in sustainability of corn stove removal and through energy crop integration into agricultural landscapes. Presenter: Shyam Nair
15.45-16.15	Coffee	
16.15-17.00	Discussion: Results and methodology approaches in the Swedish and Canadian case studies	Discussion on documentation and perceptions of sustainability of agri-based bioenergy in the US
17.00-18.00	Report back from sessions and discussion of findings	

Friday 19 May 2017			
	Objective 1 **Measuring sustainability**	**Objective 2 and 3** **Governance and stakeholder involvement**	
08.15-09.00	P7: General discussion on methodologies to assess the climate effects of bioenergy systems	P14 (A&B). Sustainability governance and role of stakeholders in the different market phases of biogas development in Germany with a view to other countries. Presenters: Kay Schaubach and Daniela Thrän	Role of stakeholders' perceptions for bioenergy sustainability: Case of forest biorefinery in La Tuque, Quebec. Presenters: P15 Patrice Mangin P16 Léonard Nkunzimana P17 Biljana Kulišić
09.00-09.30		Discussion of governance and perceptions of sustainability of biogas	
09.30-10.00	Coffee		
10.00-10.30	P18. Linking measurement and governance: wood pellets from the southeastern United States. Presenters: Virginia Dale, Keith Kline, Don Hodges, & Neelam Poudyal		
10.30-11.00	P19. Measuring, Documenting, and Communicating the Sustainability of Supply Chains within the Wood Pellet Industry of the Southeast U.S. Presenter: Brian Kittler		
11.00-11.30	P20. Governance of sustainable forest management and bioenergy in Ontario. Presenter: Tat Smith, for Quentin Cheung		
11.30-11.45	Coffee		
11.45-12.30	Discussion of governance and perceptions of sustainability of forest-based bioenergy		
12.30-13.30	Lunch		
13.30-14.30	P21. Positions, perceptions and vision of stakeholders on bioenergy sustainability Thuy Mai Moulin, Uwe Fritsche, Martin Junginger and Ulrike Appler		
14.30-16.00	P22. Roundtable with various stakeholders & common conclusions		

MEASURING SUSTAINABILITY (O1)

P1: Comparison of tools for assessing GHG emissions savings of biofuels

Helena Chum presented a comparison of tools for assessing greenhouse gas (GHG) emission savings from using biofuels (see Figure 1 for the selection process for GHG emissions calculators for energy crop production), including BioGrace I-4d, GHGenius (version 4.03a), and GREET (2015, 2016). The results showed that these tools calculate the same level of emissions from the same biofuel pathways, if assumptions and input data are corrected to be identical. BioGrace is the EU regulatory calculator and not a model aimed at investigating emissions from various pathways. GREET and GHGenius update model results as the national energy system changes, for example, if tar sands or fracking develops to make increased contributions. The Brazilian model, Virtual Sugarcane Biorefinery (VSB), had been updated with current inventory input data and practices, in order to compare its results with the three models mentioned above and see if all models would get to the same output results for sugarcane ethanol. Another study currently carried out by Utrecht University focused on comparing different LCA allocation methods for biojet fuel.1 In addition, significant progress in sensitivity analysis is needed to explore plausible ranges of expected GHG emissions. Another study showed that some models have been developed to carry out Life-Cycle Assessments (LCA) and Carbon Footprint calculations for energy crops cultivation, but lack data to reflect agricultural management practices, e.g., rotation effects over time2 . The UNEP/SETAC Life Cycle Initiative continues to expand the public model EcoInvent version 2.2 with updated country inventory data.

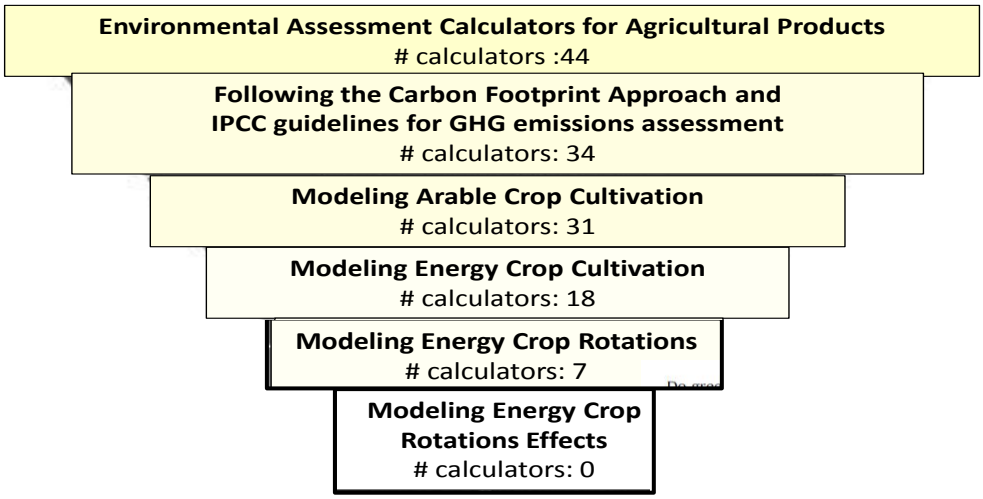


Figure 1 Selection process for GHG emissions calculators for energy crop production[2]

Discussion:

- *Harmonisation of methods for quantifying climate effects of bioenergy would be beneficial for trade (producers currently needs multiple studies for different markets)*
- *But different jurisdictions have different objectives, so agreement on harmonisation is not likely.*

[1] [de Jong, et al., 2017. Biotechnology for Biofuels, 10(1), 64]

[2] [C. Peter et al., 2017. Renewable and Sustainable Energy Reviews, Volume 67, 461]

P2: How to analyse ecosystem services in landscapes

Oskar Englund presented a study on how to analyse ecosystem services (ES) in landscapes3. The study reviewed existing studies (see Figure 2) and identified and assessed methods for mapping ES in terrestrial landscapes and clarified the associated terminology. The presentation pointed out that a strategic introduction of bioenergy crops in the landscape can enhance the supply of additional ESs such as retention of agrochemicals and maintain/restore soil quality and species habitats. The assessment showed that LCA tools are currently inadequate for identifying many impacts from biomass production, as a provisioning ES. It also showed that the effects are spatially explicit and depend on many factors such as the type of landscape, land use history, crop types, specific location, management system, etc. Therefore, appropriate methods for a geo-explicit quantification of the effects are necessary. The paper concluded that a high level of spatial detail and accuracy is necessary for mapping ESs at the landscape scale. The assessments can thus be challenging in terms of data collection, computation capacity, and validation. It is difficult to generalise with regard to which methods are most appropriate. An IEA Bioenergy publication will be produced that summarizes the work done. While the work funded within the inter-Task project is coming to an end, further studies of the quantification of ES in landscapes are planned. The exact direction of this further work depends on the character for funding. It is anticipated that there are multiple opportunities for integrating bioenergy production systems into landscapes to improve conditions for multiple ES, not the least in uniform agriculture landscapes.

Recommendations from the audience:

- *Further investigating the impacts of growing and harvesting biomass in the landscape on various ES, as well as investigation of costs and economic impacts.*
- *Using the lessons learnt from case studies to inform dialogues and policy development.*
- *Creation of more data for investigation of diverse ecosystems functions and production of ES.*

[3] Englund, O., Berndes, G., Cederberg, C. (2017). How to Analyse Ecosystem Services in Landscapes — a systematic review. Ecological Indicators, 73:492-504

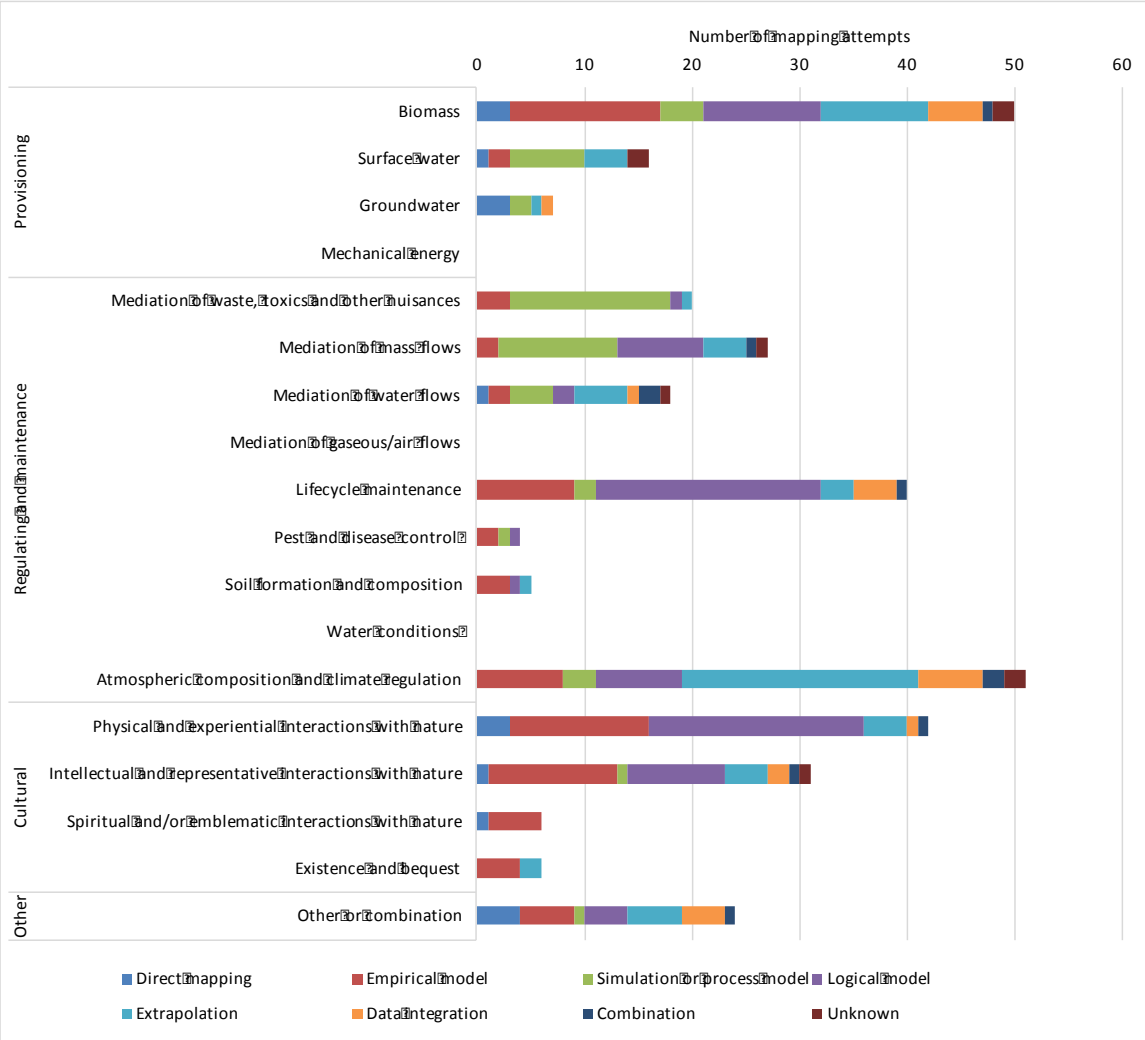


Figure 2 **Number of times different (groups of) ES have been mapped at a landscape scale in publications included in a systematic literature review[3]**

P3: Relating ecosystem Services to indicators of progress toward a sustainable bioeconomy

Virginia Dale and Keith Kline presented a study that related ecosystem services to indicators developed to measure progress toward a sustainable bioeconomy. The study compared ecosystem services with the indicators identified to measure, for example, carbon sequestration and climate regulation, water quality and quantity, biological diversity, air quality; productivity, and socio-economic well-being. The presentation also illustrated the use of the assessment approach, TEEB (The Economics of Ecosystems & Biodiversity), for identifying ecosystem services with local and regional stakeholders, from farm level, through the biofuel supply chain, to end-users and policy makers (see Figure 3). Recommended practices include avoidance of negative effects through identification and conservation of priority biodiversity areas and careful site selection for feedstock production; consideration of environmental effects; monitoring, assessing and reporting key sustainability metrics in timely fashion; and communication with stakeholders in order to obtain their feedback on opportunities and concerns.

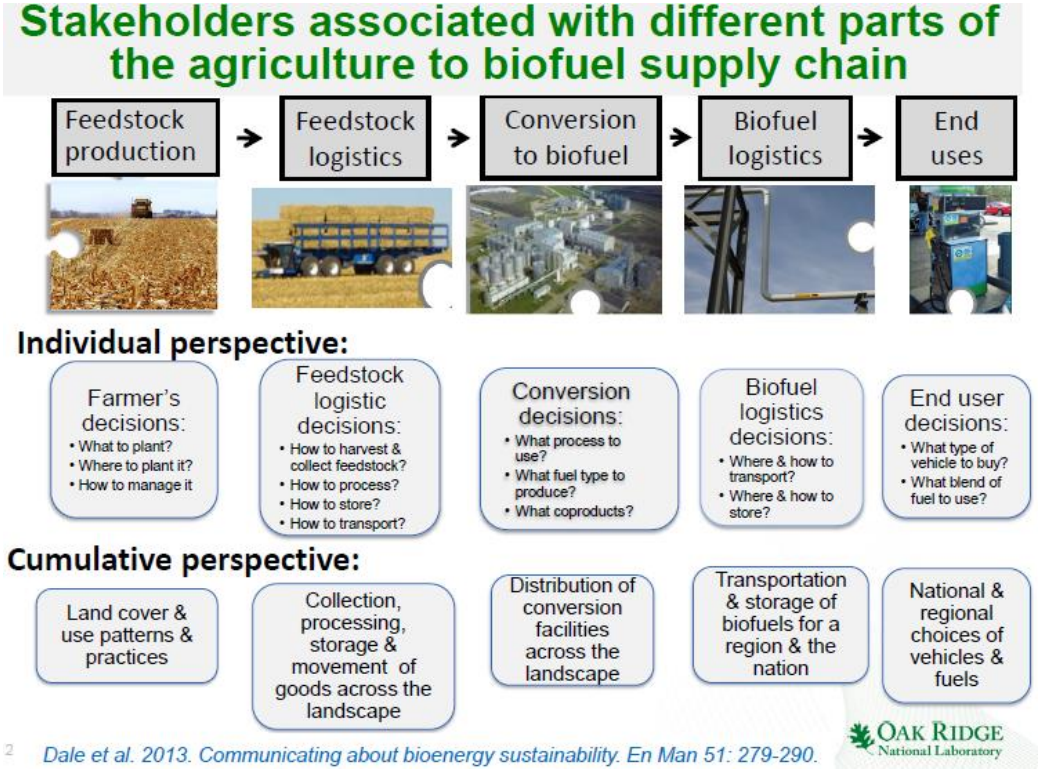


Figure 3 **Stakeholders associated with different parts of the agriculture to biofuel supply chain (Kline and Dale 2017)**

Recommendations from the audience:

- *Investigate costs for implementing systems to assess production of ecosystem services and identify more cost-effective tools and approaches*
- *Investigate costs and benefits from bioenergy production at different scales.*
- *Compare scope of ecosystem services considered by US and EU bioenergy systems.*
- *Clarify which indicators are most important for particular contexts.*
- *Investigate legislation and policies for sustainable development (agriculture and forestry) in order to analyse the sensitivity of bioenergy and bioeconomy sector development to this factor.*

P4: Delphi survey approach for the identification of sustainability indicators and environmental impacts of forest biomass harvesting for a biorefinery: Case study in Québec

Ichrak Lakhdhar presented a Delphi survey approach for identification of sustainability indicators and environmental impacts of biomass harvesting for a biorefinery, based on a case study in Québec. For the construction of the biorefinery in La Tuque, Canada, sustainability of biomass production as well as environmental impacts of biomass harvesting on ecosystems are the two major concerns. A Delphi survey will be applied to develop and test the usefulness of sustainability indicators that can be used for the planning of forest biomass harvesting operations. Through several rounds of surveying, the Delphi method uses the knowledge of experts to identify and synthesise responses on the relevance of indicators, in order to reach consensus and identify areas of disagreement.

Recommendations from the audience:

- *Consider expertise, opinions and recommendations from diverse expert groups, especially for issues where there is low consensus among experts.*
- *Share lessons learnt with similar bioenergy projects.*

The commenter introduced the discussion on possibilities and limitations of a global harmonized framework to assess sustainability of bio-based production, by highlighting that tools to calculate GHG emissions are necessary, as it is important for bioenergy sector to document sustainability of its practices and show that the sector is developing in the desired manner. He noted that the first presentation was very useful in showing that goals and approaches differ among calculations tools. He also noted that the second presentation was interesting in presenting bioenergy production as an ES and showing that data are still needed to evaluate the multiple ES produced in bioenergy systems. The third presentation provided detailed information on defining indicators and criteria for selected ES and identifying what the most important sustainability issues are (in the US?). The fourth presentation gave a good example for the future of how various sustainability issues can be identified and managed for the establishment of a biorefinery. The involvement of local stakeholders proves to be important for the project development and its potential success.

P5: Assessing the climate effects of forest bioenergy systems: Swedish case study.

Olivia Cintas' presentation comprised an overview of a study into the potential for forest bioenergy to contribute to Sweden's goal to achieve climate-neutrality by 20504. The study modelled the national energy and forest sectors, under 3 scenarios differing in `terms of biomass extraction and forest management. Results were presented with respect to impact on Sweden's carbon budget to 2100 consistent with 2-degree target. Forests could be a significant contributor to achieving the target, through C sequestration in biomass, soils and wood products, and supply of energy for electricity, heat and transport. Sweden could even become "net negative". The CO2 budget approach is a complementary perspective to LCA modelling – both are useful to inform decision-making.

Discussion:

- *Is there good basis for assumed increase in growth with forest management? Yes, based on trial results – response to fertiliser and improved genetics; assumptions well-accepted by forest researchers.*
- *In the US, increased wood demand led to increased forest volume.*
- *Mitigation value of C storage in wood products: varied opinions on magnitude of benefit.*
- *Some concern expressed about biodiversity and soil disturbance effects from removal of stumps. Related to this, it was informed that Task 43 will present a report summarizing findings from a Swedish 8-year research programme on stump harvesting*[5]*.*

[4] Cintas, O., Berndes, G., Hansson, J., Poudel, B.C., Bergh, J., Börjesson, P., Egnell, G., Lundmark, T., Nordin, A. (2017). The potential role of forest management in Swedish scenarios towards climate neutrality by mid century. Forest Ecology and Management, http://dx.doi.org/10.1016/j.foreco.2016.07.015

[5] The report is now available on the Task 43 website: http://task43.ieabioenergy.com/publications/stump-harvesting-climate-environment-impact-iea-bioenergy-tr2017-02/

P6: Assessing climate effects of forest bioenergy systems: A Canadian case study of unloved woods

Evelyne Thiffault is investigating the potential to use low-quality/degraded trees as feedstock for bioenergy. Currently, low-quality woods are sometimes harvested and windrowed, and slowly decompose, or they are left standing, which may hinder further management of the area. What is considered low-quality is a subjective categorisation, and is based on perspective and context. There are large volumes of low-value wood due to damage by natural disturbances, past management practices or undesirable species. Removing low-quality roundwood for bioenergy could improve forest management and thus enhance production of high value sawlogs. The calculation of GHG savings of bioenergy depends on the assumed reference use of biomass: Compared with windrowing, using degraded whole trees for bioenergy gives a payback time of 12 years, or 23 years if trees would have been left standing. Removing low-value trees for bioenergy can also provide climate benefits by mobilising the forest value chain, which has not yet been considered in GHG calculations. However, there could be biodiversity implications of harvesting degraded trees, as they often serve as hotspots for many species of insects and birds. Strong governmental regulations can make sure biodiversity (along with soil and water) is protected, for example by requiring that a number of degraded trees/snags are preserved.

General discussion:

- *The ongoing scientific debate on sustainability and carbon neutrality is confusing and raises doubt about the credibility of all bioenergy.*
- *The industry wants clear guidance on what is sustainable biomass.*
- *Industry wants legislation and certification to provide consumer confidence and thereby give stability to the industry.*
- *Certification at product or producer level cannot deal with cumulative impacts. There is a need for landscape-scale assessments. Perhaps this could be handled through regional certification.*
- *There is lack of consensus on significance of tipping points, payback time, iLUC, spatial scale of assessment, appropriate calculation metrics. This creates uncertainty, especially for policy-makers.*
- *Perhaps we could quantify the amount of biomass available for which we have confidence in its sustainability, and quantity for which there is greater uncertainty over its impacts.*
- *Scientists need to explain the issues clearly for non-technical audience.*
- *The probable need for BECCS in order to meet climate targets is not widely known.*
- *There are uncertainties with all the approaches used to estimate climate effects of bioenergy – LCA, integrated assessment models, Carbon budget approach. So it is desirable to apply several approaches, to inform decision-making.*

Photo: E. Thiffault, Université Laval, Quebec, Canada

P7: General discussion on methodologies to assess the climate effects of bioenergy systems

Annette Cowie kicked off the general discussion with a presentation on "Understanding the climate effects of bioenergy systems". She pointed out that the integrated assessment modelling undertaken for the IPCC's fifth assessment report (AR5) shows that substantial deployment of bioenergy is required in most scenarios that meet climate targets, and the stronger the climate target, the more bioenergy is needed. The basics of bioenergy carbon accounting were investigated in early publications by Marland & Schlamadinger, and Task 38 has since then organized many workshops on the issue, prepared several ExCo reports; and published several responses to controversial papers criticising bioenergy, including the recent response to the Chatham House report.

One important aspect not covered in traditional LCA approaches is consideration of time: generally emissions are simply summed over the time frame of assessment. However, Task 38 has emphasised inclusion of timing of emissions and removals from bioenergy systems. Total CO2 emissions determine cumulative radiative forcing and therefore temperature impact, but policies promoting early reductions can be important to create incentives for low carbon energy solutions. Other aspects she highlighted were:

- *Tipping points, which have been suggested as a reason for early mitigation are no longer considered a strong argument – it is not really clear that there are "cataclysmic events" such as due to methane release from melting permafrost, in the foreseeable future*
- *Different starting points for analysis give different results (ie start the calculation when tree is planted or has grown)*
- *Consideration of scale: results differ depending whether considering tree, stand, estate/landscape...*
- *Counterfactual: assumptions about reference land use, energy system affect the results*
- *System effects: role of bioenergy in stabilising grid to allow expansion of intermittent renewables role of bioenergy in transformation pathways*

- *Finally, she highlighted the anticipated role of bioenergy with carbon capture and storage (BECCS) in AR5, to deliver negative emissions.*

A general discussion covered the following points:

- *Bioenergy is complicated, but it is important to synthesise a "Simple story" so that the basics of bioenergy can be communicated to policymakers and the public.*
- *The details are relevant in some circumstances: timing is relevant depending on volumes; forest carbon stock changes are important; temporary emissions from bioenergy have similar climate impacts to short-lived forcing indicators*
- *UNEP/SETAC has proposed that LCA should apply two different metrics for climate change assessment GWP100 and GTP100, as they each give different information. IPCC provides values for both.*
- *Change (increase or decrease) in forest C stocks due to introduction of bioenergy needs to be considered, and can be influenced by management*
- *The baseline with which bioenergy is compared should include climate change impacts on disturbances of forests (fires, pests...) and typical management of forests in order to put bioenergy uses into that context and consider ways to reduce risks.*
- *When considering the "total planet", C balance forest rotation length is not relevant*
- *Policy makers what a simple answer – but the uncertainty should be highlighted.*

One of the participants with an industrial background made the following points:

- *Consider emotional context/ties of people to trees/forests - this won't go away, as beliefs are relevant*
- *Who makes the decision as to what is the "best"?*
- *Scientific "dissent" versus leadership: difference between lobbying/campaigning, advocacy and education...*
- *bioenergy is actually improving forest management: more thinning and maintaining forests, and enhancing production vs. inducing LUC...*
- *Bioenergy offers an option to use mill residues, slash etc., which would have burnt anyway. Thus, there is no "pulse" emission compared to the reference scenario.*
- *models vs. real life*
- *renewal of energy infrastructure over larger scales (country or regions such as the EU): old plants are shut down due to age or not being economical and new bioenergy plants replacing the old ones (e.g. inefficient coal plant) have higher efficiencies and/or are introduced into the infrastructure in ways that makes more effective use of the primary energy.*

Discussion:

- *Continue open discussion ("neutral" position"), but be aware that a "defensive strategy" is different from "bad news"*
- *Provide orientation on how much of which bioenergy has without doubt a good GHG balance (non-controversial), and how much and which is "carbon-uncertain"*
- *Tell positive stories, visualize*
- *Consider other facts: e.g. biodiversity - harvesting old growth in Sweden*
- *"Truth" vs. evidence - beware of the terminology: science does not provide "truth", and does not judge what's "best" - but should inform policy/decision makers and stakeholders*

SUSTAINABILITY GOVERNANCE AND STAKEHOLDER INVOLVEMENT (O2/O3)

Session on agriculture

P8: Trust and legitimacy in sustainability governance of bioenergy supply chains.

Maha Mansoor presented a conceptual framework for understanding the state of trust and legitimacy in sustainability governance systems and how to improve these parameters (see Figure 4 and Figure 5). The first part of the three-step analysis framework addressed the identification of the actors involved in developing a governance system. The second part analyzed the level of acceptance of a governance system through a generalized four-phase approach. The separation between phases was based on the level of uptake and proliferation of the governance systems, ranging from low-medium acceptance to an ideal condition with full acceptance. The third part of the framework was a set of five yet incomplete components created to identify the gaps of trust and legitimacy due to the system design, including prescriptiveness and precision of the included standards, supply chain control systems, monitoring requirements, enforcement systems, and levels of transparency and communication.

	Description	Input	Throughput	Output
Phase I: Initiation	Creation of the first few sustainability governance systems	Low - Limited participation from all relevant stakeholders in the creation of the first governance system	Low - No standards in place to determine the adequacy of the processes	Low - firms closest to standards meeting them
Phase II: Widespread Use	Proliferation and governance systems available; broader use of the governance systems	Low - The total increased number of governance systems leads to increased participation from different Sectors although not from all actors	Low/Medium - The proliferation and widespread use is leading to some systems to have better processes than others	Low - creation of standards intended to capture firms farthest from the initial standards. Not much change in action.
Phase III: Strategic Progress	Consolidation or reconfiguration of governance systems to increase uptake and legitimacy of system	Medium - Intentional increased levels of participation from all actors to increase legitimacy and use	Medium - Intentional reconfiguration of system, such as by meeting international standards, in order to better processes	Medium - Consolidation of governance systems or reconfiguration of systems to effect real change
Phase IV: Accepted Legitimacy	Trust in and legitimacy granted to governance systems as authorities over sustainability of governance systems	High - All actors feel adequately represented in the governance institutions	High - All actors trust the governance processes	High - All actors feel that rules are adequately ensuring the sustainability of bioenergy

Figure 4 **Conceptual model for development of sustainability governance (Mansoor et al. 2017)**

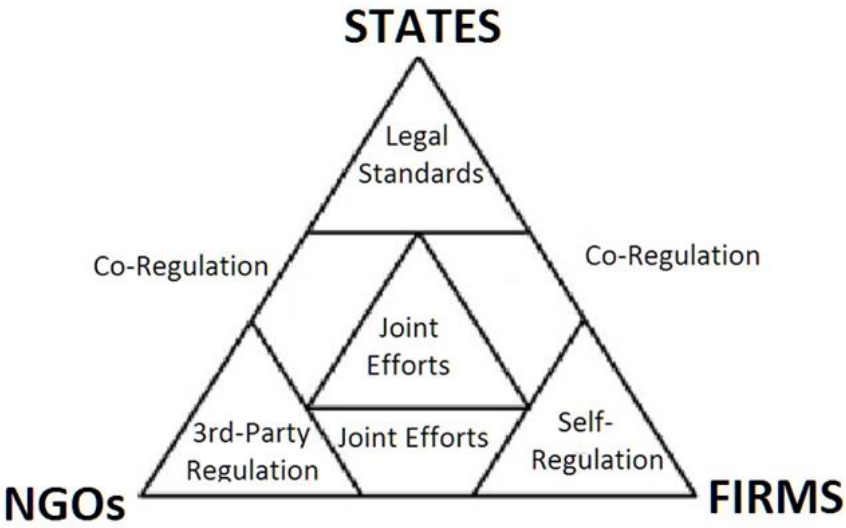


Figure 5 **Classification of types of governance by the involved actors (Abbot and Snidal 2009, modifield by Mansoor et al. 2017)**

Recommendations from the audience:

- *The second part of the framework received the most attention. The audience questioned whether an end-point of full legitimacy existed, and recommended that the framework be adjusted to display a circular trajectory, instead of a linear. The circular trajectory should include adaptive management cycles and displays a process with continuous improvement. It was discussed that the phases mainly depend on the market uptake of the new feedstock utilization system.*
- *The market proliferation level system can also be taken to classify the proliferation status in different countries and to transfer experiences from one country to another.*

P9: Drivers and effectiveness of sustainability governance of agricultural crop production at EU level

Niclas Scott Bentsen introduced a study on drivers and effectiveness of sustainability governance for agricultural crop production in Denmark and at the EU level (see Figure 6 for the development of the land use status of agriculture and forestry in the EU and Denmark). The study reviewed the development of environmental sustainability governance for crop agriculture in Denmark and the EU, with much national regulation in EU member states stemming from EU regulations. Danish agriculture is heavily regulated with regard to environmental issues, through specific Danish legislation and implementation of EU legislations such as the Common Agricultural Policy (CAP), the Water Framework Directive, and Habitat Directive. Future work will focus on evidence that legislations have led to measurable changes in environmental impacts of agriculture over time, and discussions of the results in the context of a sustainable bioeconomy.

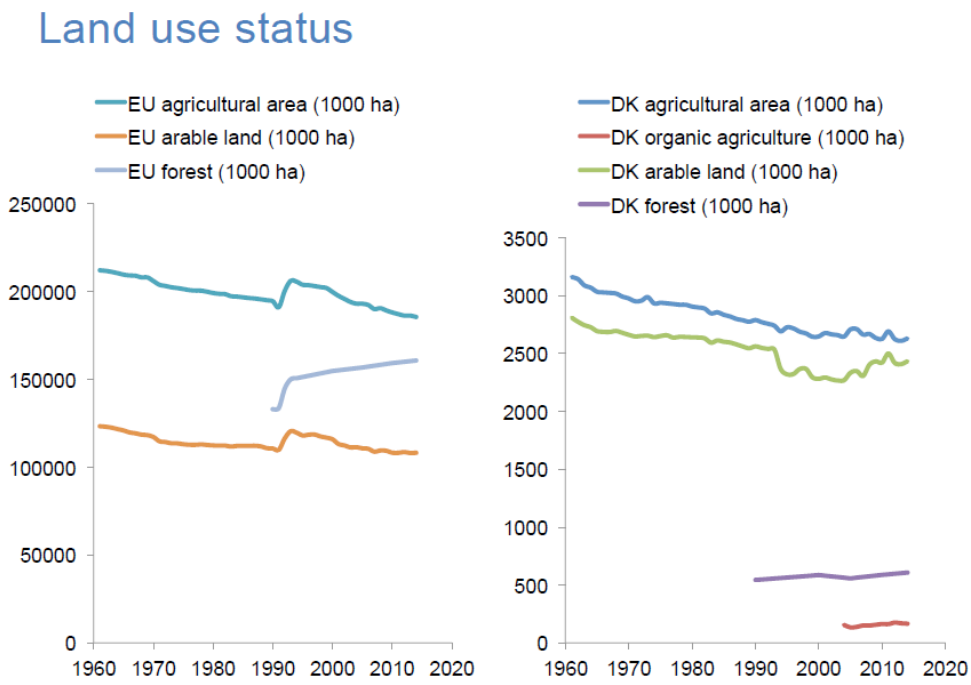


Figure 6 **The development of the land use status of agriculture and forestry in the EU and Denmark**

Recommendations from the audience:

- *Reconcile seemingly contrasting data, with some showing more pressure on land and others less use of agricultural land.*
- *Consider what it means to existing EU governance systems if bioenergy feedstock production can decrease pressure on land, for example by intensification of the production, so that less land is needed to produce the same amount of products.*
- *Discuss if river basin plans required by the EU also analyze impacts of bioenergy feedstock systems (i.e. include developments of pesticide use, herbicide use and crop rotation into the assessment).*
- *Explain more in detail how biodiversity is measured in the EU, and discuss how long time it is needed to monitor biodiversity before you can see a change in land use. Consider if it will relate to the indicator species and their reproduction over time.*
- *Discuss the connection between EU goals for biodiversity and water quality and the associated monitoring.*
- *Biogas production from manure has the potential to reduce impacts on water quality from livestock production.*

P10: Sustainability governance of agriculture-based bioeconomy in Canada

Tat Smith presented a study on sustainability governance of the agriculture-based bioeconomy in Canada, on behalf of Charles Lalonde and Maria Wellisch.

Leadership in Canada with respect to the adoption of sustainability schemes for agricultural biomass feedstocks is quite different than those in Europe where state actors are providing leadership. In Canada, compliance with sustainability schemes is food market driven and not regulated. As Canada is largely dependent on agricultural export markets, actors in the various commodity groups are very conscious of the international perceptions and requirements for sustainability in regards to agricultural practices. Bioproducts represent a very small portion (less than 5%) of the end-use destinations of Canadian agricultural production.

Canadian agricultural opportunities in the bioproducts space arise from the use of grains and oilseeds for ethanol and biodiesel production, and the use of crop residue and purpose grown biomass for biochemicals and biomaterials. While federal and provincial government policies

specify renewable energy content for transportation fuels, there is a need for policy to support the development of biomass into biogas, renewable natural gas and other forms of bioenergy. Currently, the incentive to produce and harvest crop residue and purpose grown biomass for bioenergy is relatively small, and bioenergy markets have not been established for these feedstocks.

Approaches to sustainability emerge from three perspectives: environmental legislation and labour codes, environmental monitoring and modeling of agri-environmental indicators, and science-based Best Management Practices (BMPs) (see Figure 7). Legislation is orchestrated at both the federal and provincial levels which address natural resources, agriculture, the environment, and working conditions. Nationally, legislation provides broad protection to the environment while at provincial levels, legislation is more specific to address water use and quality, land use, nutrient management etc. While legislative frameworks exist, none of the agricultural BMPs are based in legislation but rather in science. Farmers as owners and stewards of the land have interest to use BMPs to preserve land quality and value as farmland is often transferred within families and farmers are keenly aware of the role of healthy soils in providing long-term productivity. BMPs also have win-win scenarios to increase production efficiency and output.

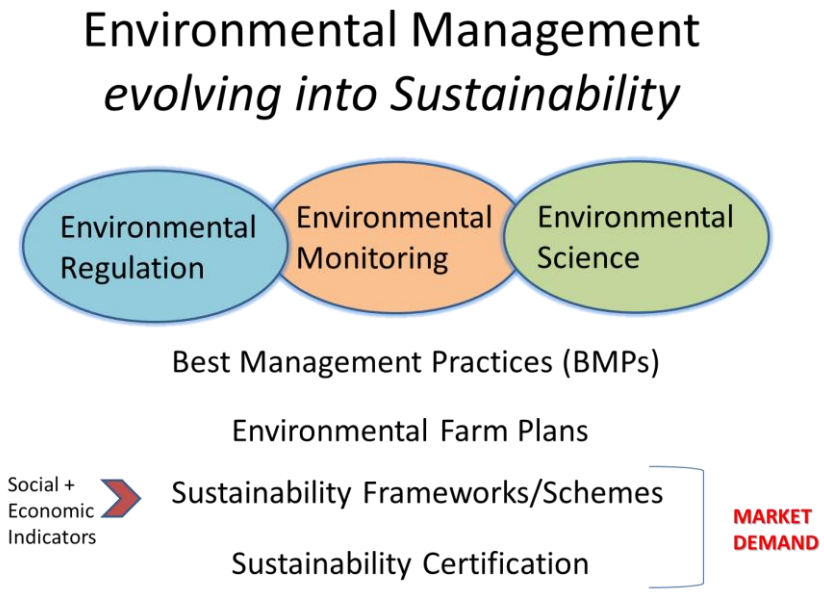


Figure 7 **Elements of emerging sustainability governance for environmental management in Canadian agriculture (Lalonde & Wellisch 2017)**

Currently there are several sustainability initiatives underway and at various stages of development in Canada. Incented through federal grants, various commodity areas (grain, pulse, livestock) are developing systems to meet market needs. Industry – government discussions on such sustainability schemes occur through "roundtables" where criteria and system governance parameters are discussed. Farmers are willing participants in these discussions but exercise caution as commodity market price margins are low and there is also reluctance to share farm level data with the value chain. The use of regional aggregate data offers a potential to avoid conflict on individual farm data sharing.

The Canadian study will examine different actors in the agricultural sustainability governance space, how they interact, how systems become reality in the food system and how these can support the emerging bioeconomy sector.

Recommendations, based on comments from the audience:

- *Consider if there are linkages to collection of big data, use of apps etc. This seems to be a strong trend that can link to sustainability governance for documentation of sustainable practices. Currently, there is an increase in average farm size as agribusiness is more and more often taking over from family farming. This means that there is a higher probability that such data can be collected. In many ways, food producers are urging such collection of data, but it is a question how to do it without too large costs.*
- *Consider if all these sustainability initiatives are complicating things, or if it is a result of sustainability becoming mainstream and genuine interest in making legitimate claims about the sustainability of crop production.*
- *Consider mentioning bioenergy crops in the presentation, perhaps to compare with the US, and discuss their potential in a system, where all drivers are currently coming from the bioeconomy sector, including food production, with no separate legislation or criteria for bioenergy.*
- *Consider how the sustainability initiatives guarantee their standards (certification schemes, expert qualification etc.).*

P11: Incorporating policy, market and technology in sustainability governance of agriculture-based biofuel and bioeconomic development in the US.

Jianbang Gan presented a study on the incorporation of policy, markets and technology in sustainability governance of agriculture-based biofuel and bioeconomic development in the US. The annual US EPA target for biofuels is, together with tax exemptions and other incentives, a major driver for biofuel production. The corn area and harvest have increased, as is the case for soybean, while the area planted with wheat has decreased. The question is what level of biofuel target is sustainable. This has not been well examined, for example if the target of 36 billion gallons will cause expansion and intensification of agricultural land use, and if yes, to what extent. Both land-use expansion and intensification could lead to sustainability concerns. Additionally, there is a complex web of relationships and interactions among policy, markets and technology (see `

Figure 8). We need to understand the inter-relations between the drivers, in order to understand how we can govern them. We must also understand the tradeoffs between different sustainability criteria and what is acceptable in this regard. The study will emphasize on key concerns and keep the focus as simple as possible.

Recommendations, based on comments from the audience:

- *Including more economic aspects is very appealing and creates a strong framework.*
- *The recent DOE "2016 Billion-Ton Report" and accompanying "Volume 2, Environmental Sustainability Effects of Scenarios" from Volume 1 (DOE 2017) include spatially explicit economic analyses addressing points raised by the speaker about sustainability and agricultural area (e.g., U.S. agricultural area continues to decline slowly as biomass production increases). The two reports examine how a billion-ton Bioeconomy, which could support far more than 36 billion gallons of biofuels per year, can also help achieve other environmental objectives.*
- *Find the sweet spot between simplicity and complexity when considering how to define the key concerns. Stakeholders must come into play for this.*
- *Consider the effects on land use change, changes in crop rotation (and related management such as pesticide application) and landscape design.*

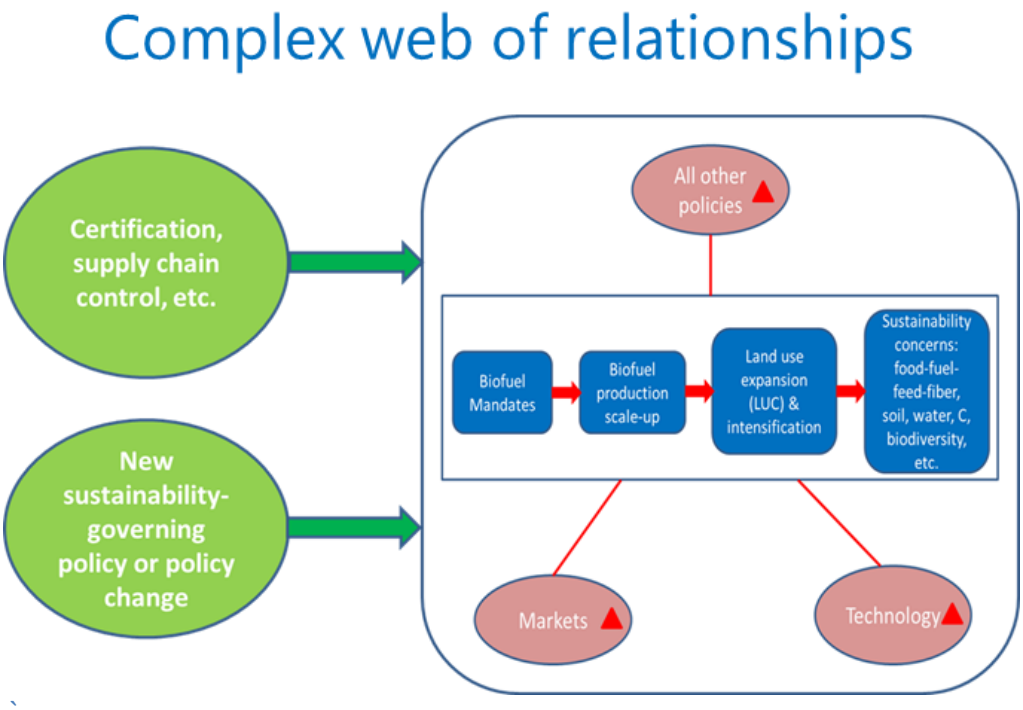


Figure 8 **The complex web of relationships that will be affected and react when sustainability governance is introduced (Gan 2017)**

The commenter noticed three broad themes through the four presentations by Maha Mansoor, Niclas Scott Bentsen, Tat Smith, and Jianbang Gan. First, the importance of governance systems continuously improving and allowing for learning mechanisms rather than designing them as static end-points. Next, the commenter noted that there are major differences in governance systems between EU and North America, with concomitant impacts on trust and legitimacy – the former has a top-down approach which does not always guarantee trust (cf. Brexit), while the latter has a bottom-up approach where the industries creating the systems will often be seen as biased. Finally, the point was made that there seems to be an increasing potential to use big data for the purpose of governance, as more and more cooperation's own land and they can afford to invest in machines that can do precision farming. They are expected to save money, which will make it a business case to investment in such equipment. A point was also made that there is a need to move from large-scale to small-scale incorporation of governance systems despite the variety of different actors and responsibilities in the supply chain.

The audience first focused their discussion on the topic of continual improvement. An audience member reminded that standards are often best educated guesses. Another mentioned that certification is a bar, where you are either in or out and that many get certified without changing their management. It was questioned if standards should focus more on continual improvement. Another pointed out that frameworks for continual improvement are already built into several of the existing governance frameworks, with the standard itself being a hypothesis, which is tested over time through required adaptive management. Based on monitoring and other information it can be decide if the 'hypothesis' should be rejected or accepted. This is a robust system where we can continuously 'test' and check the standards, based on monitoring, observations and experiences by stakeholders. In connection with this, many should be brought into the discussion, including indigenous peoples. A German representative described the impact of the shift of the quota for biofuels in the transport sector in Germany from used amounts of biofuels to achieved GHG emissions reductions as creating a strong incentive for improvements in the supply chains. This observation suggests that dedicated benchmarks (i.e. minimum specific GHG reductions of biofuels - i.e. 60%, 70% etc.) are needed to see if standards create barriers or incentives for reaching the desired goals. In response to this, it was mentioned that, for the large actors, standards are often an incentive to improve, but for the small actors it is a barrier. There is thus a need for tiered approaches to governance, with specific areas of responsibilities, and a mechanism

that incentivize larger actors' support to smaller actors. Otherwise, there is a risk of larger actors suppressing smaller actors, as long as they can stay above the thresholds. Points were made that there are many examples where requirements depend on the size of the operation, and that it is needed to look for the supply chain pin points of influence. These actors essentially decide how the supply chain develops, and these actors must be addressed.

It was added that sustainability is also about identifying risks throughout the supply chain, even if there is a lot of uncertainty when you should quantify these risks. It is important to transparently show if it is not possible to estimate risks, or if they are being estimated indirectly, for example by use of indicator species. Another mentioned approach was the use of risk management tools, as you want to take risks out of the supply chain. In this manner, it may become a reward system that can lead to transformational change and development of new business opportunities. Risk assessment is thus important and it is needed to apply approaches that are as robust as possible, given the conditions. It should also be considered to which extent small sub-system can be considered sustainable in isolation. Risk-based approaches have also emerged as something new in relation to verification of sustainability standards. There are different understandings of risk assessment, and we need to develop this concept, and clarify how it is can be defined, how it is understood across time and space, which are the various approaches to assessing risk, and how it may be communicated.

Concerning the data collection, it was brought forward that there are other opportunities than expensive precision agriculture by large actors. Every smart phone has a GPS that can be used to identify locations. This can already help the farmer to know more about the climate, the slope etc. in a certain site, also for small actors e.g. in Africa. You can link such information to guidance for application of fertilizer and other. It was mentioned that there is a risk in terms data ownership and safety. It is very likely that data will be used if analysis is cheap and accessible, even if you need algorithms that might be expensive. On the other hand, much technology that includes such algorithms is already on the market, e.g. when you buy a tractor.

Recommendations from the audience:

- *Clarify the extent to which standards promote and incentivize continual improvement.*
- *Develop the understanding of, and linkage between, continual improvement and adaptive management.*
- *Consider how incentives can be introduced for larger actors to support smaller actors.*
- *Risk analysis and risk-based approaches are topics that need to be further developed in the project.*
- *Consider the role of various technologies for collection of data needed to improve management and standards, from precision farming technologies and to simple mobile phones.*

P12: Relating ecosystem services and sustainable bioenergy indicators in agricultural landscape with stakeholders

A presentation by Keith Kline first reviewed the multiple governance systems in place for promoting more sustainable production from agricultural systems in the U.S. and the suite of sustainability indicators being applied by the U.S. Department of Energy (DOE) for bioenergy development. The overview of laws and regulations included the role of conservation easements, which are legal structures for protecting conservation uses of land in return for tax credits. Then three case studies were reviewed: 1) The East Tennessee case study completed to assess effects of different planting locations of switchgrass; 2) the "Enabling sustainable landscape design for continual improvement of operation bioenergy supply chain," a multi-disciplinary project underway with support of DOE; and 3) approaches to identify stakeholder priorities when assessing bioenergy. Keith presented a framework to define the goals, contexts, and methods to be identified by the relevant stakeholders. The framework emphasized continual improvement. The

presentation was supported by a series of recent publications. It concluded with a discussion of proposed criteria for assessing approaches to sustainability governance and standards.

The East Tennessee case study examines trade-offs among profit, indicators of water quality, and soil erosion. It illustrated that careful selection of where to plant a relatively small area with perennials such as switchgrass, can make a big difference when considering environmental effects and profit margins. The approach tested using a spatial optimization model demonstrated the ability to identify where balanced approaches could meet multiple goals simultaneously. The research project ended when demand for switchgrass fell after the conclusion of 3-year out-grower contracts. The results highlighted the potential negative environmental consequences if management focused only on profit without considering other effects.

The DOE landscape design project recently initiated and involves many partners over a five-year period. Coordinating many different actors is a demanding role handled by a private company leading the overall effort, Antares Inc. The project aims to document the effects of different cellulosic supply chain options to support two large ethanol facilities in Iowa that initially plan to utilize corn stover as feedstock. The project facilitates access to government programs that support planting perennials and helps farmers identify where perennials would be most beneficial to reduce risk and losses on individual farms.

The DOE landscape design project provided examples for collecting stakeholder inputs through many different methods. Low cost ways to collect information from stakeholders were tested, to utilize existing data on water quality and farm issues. The project also interviewed key informants and identified groups concerned with biodiversity. Preliminary results illustrated stakeholder concerns based on kick-off meetings and other surveys in the area initially prioritized productivity, soil quality, and profits. It was noted that stakeholders, their goals and priorities, may change over relatively short time frames as markets and other conditions change. Iterative consultation with stakeholders may uncover additional concerns over time. Many farmers consider corn stover to be a valuable soil conservation resource but recognize that high yield areas result in "too much of a good thing" and that it can be beneficial to remove a portion of stover in some places. However, lacking secure markets and price guarantees, there is little interest in dedicated "energy crops." The work has received attention in other counties that now try to use the same approach.

The presentation stressed that the science of sustainability indicates this is not a "state" but an aspirational goal, and measurement is always relative. The legitimacy of governance will depend on ownership and understanding of the governance process. People are less likely to trust what is done by others or what they do not understand. The ASTM International Standard E-3066a (2017) provides guidance for assessing relative sustainability in a consistent manner and builds in a process for continual improvement, which is an essential element of initiatives aiming to increase sustainability. The experience is that when there is ownership, stakeholders will be more willing to participate and develop more consistent assessments of energy options.

Recommendations from the audience:

- *Consider if there is a tradeoff between effectiveness of governance and stakeholder involvement, as balancing many goals may lead to less effectiveness in achieving any one of them.*
- *Consider the time and resources needed to roll out an assessment system – are they realistic?*
- *Consider what is needed to gain support for switch grass and how it may contribute to dealing with water quality issues?*
- *How can nutrient pollution be dealt with beyond what is being achieved through BMPs, as the problem is persistent over time?*
- *Address the need to get better measurements of what is actually coming off the fields versus other sources of nutrients in waterways.*

P13: Modeling improvements in sustainability of corn stove removal and through energy crop integration into agricultural landscapes.

Shyam Nair presented a modeling study on how to improve sustainability of corn stover removal and integration of energy crops into the agricultural landscapes. The purpose of the study was to determine how the scientific legitimacy of the production can be improved by use of the LEAF model. LEAF puts knowledge about sustainable production into action by providing a deployable, national baseline framework that can be calibrated to the local level (Figure 9 for a comparison of a baseline vs. two bioenergy scenarios). The aim is to increase the productivity of the land and the sustainability of soil use, focusing on (1) the soil fertility, (2) the soil carbon, (3) reduction of nitrate losses, and (4) preserving the water quality of the watershed. An earlier model measured soil erosion and soil carbon loss from storm events, which increased the robustness of the findings. It was found that a considerable amount sustainable biomass can be produced in certain areas, including where the soil is less fertile through the introduction of energy crops in those areas. It was found that a considerable amount sustainable biomass can be produced in certain areas, but not where the soil is less productive. It is important to understand the variability that can occur within counties and within farm fields, and employ better data to make better decisions.

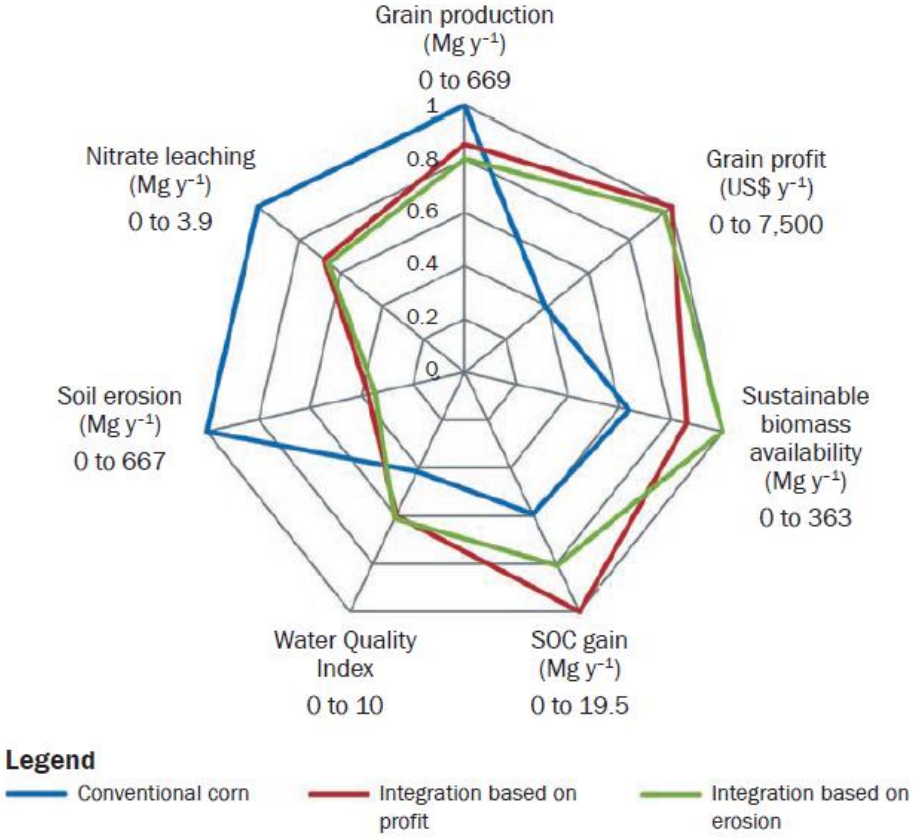


Figure 9 **Comparison of the economic, production, and environmental performance metrics of the conventional corn scenario to two integrated bioenergy scenarios (Bonner et al. 2016, cf. Nair et al. 2017)**

In the discussion, the study received positive comments, with one scientist noting that "he is jealous of all the data". The discussion also addressed the purpose of certification systems, and how governance systems can be appealing to smaller-scale farmers. A question was repeated from a previous discussion how sustainability can become part of an ongoing process rather than be assumed to be an end-point state. Although it was noted that bioenergy's impact is small in the larger picture, others reminded that bioenergy is having international credibility problems. For example, hypoxia in the Gulf of Mexico is being linked to bioenergy, due to the production of corn and harvest of corn stover. However, growth of bioenergy crops like miscanthus and switchgrass can serve to retain the nutrients in the soil and reduce nutrient loading from agricultural

watersheds. Production of these energy crops can therefore serve to minimize impacts such as hypoxia. Thus, we need governance systems that are accountable, and have obligations that lead to improvement. In the European case, the energy producers are tasked with task of ensuring sustainability.

Biogas

Kay Schaubach and Daniela Thrän addressed sustainability governance and the role of stakeholders in the different market phases of biogas development. It was a case study from Germany with a view to other countries. The presentation was based on two related studies. Daniela provided an overview of the development of the biogas sector in Germany. It included an overview of the compromising aspects of biogas (feedstocks and production processes), a framework for classifying the market phases of the biogas development, and an application of this framework to German biogas development. In Germany, biogas development began in 2000 when the feed-in tariff program was enacted through the Renewable Energy Act. The main conclusions were that there has been a phased development of the biogas sector, which is comprised of the following 3 phases: (1) early testing, (2) consolidation (stricter regulations, optional market integration), and (3) market integration (full market exposure through auctions, see Figure 10). The interesting points that came out of the development include unintended consequences for increased livestock production. The hotspots for biogas were located where there is intensive meat production, and a discernable increase in maize production intended for biogas resulted after opening up agricultural land use for non-agricultural purposes (therefore no land-use change issues).

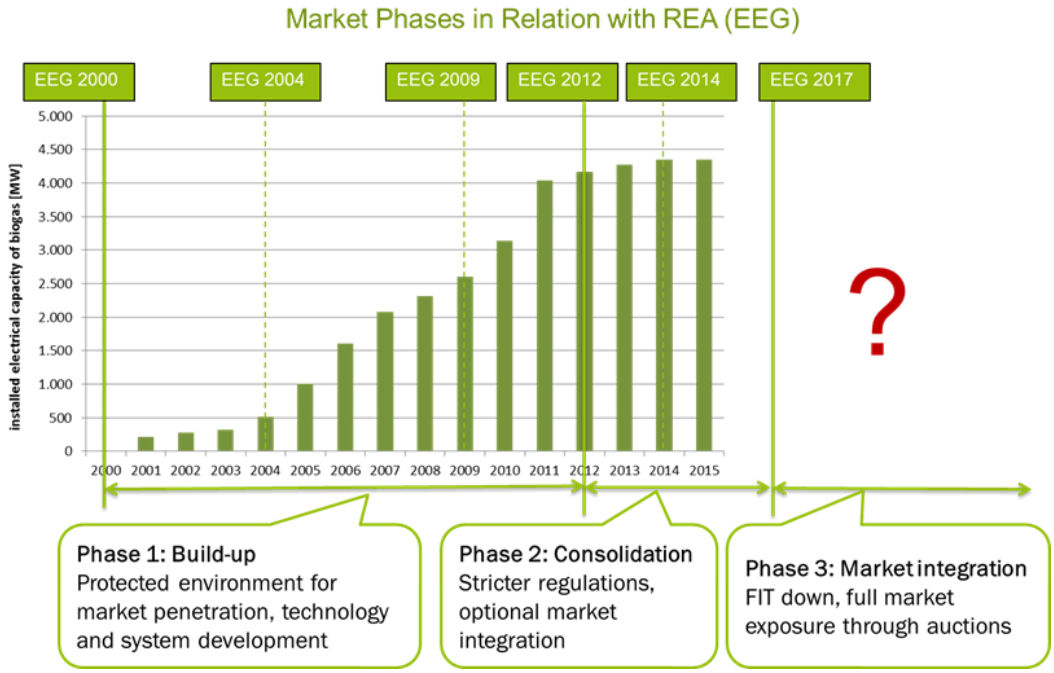


Figure 10 **Hypothesis on phases in biogas development kicked off by changes in governance (Thrän and Schaubach 2017)**

Kay presented the results from a study on stakeholder engagement within the biogas supply chain. Four hypotheses were put forward that (1) comparable legal frameworks would be applicable for other European countries due to similar top-down governance systems, (2) there are different results due to with different implementation strategies, (3) stakeholders perceptions of sustainability of biogas are comparable in European countries, (4) perceptions of sustainability are embedded in decision making criteria. A stakeholder questionnaire was sent to 743 of the

8000 biogas operators in Germany (with a Danish version planned for 2017). Some opinions expressed by the majority of the respondents were (1) that energy crops should be used for bioenergy production, (2) policymakers should use more scientific information, and (3) that compliance with bioenergy sustainability criteria should be voluntary (see Figure 11).

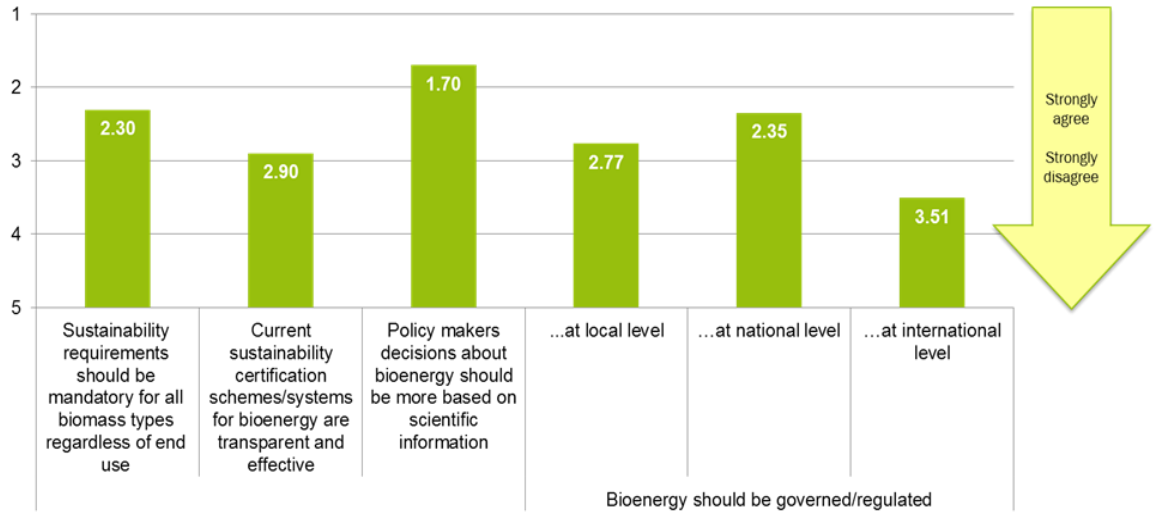


Figure 11 **Preliminary results from survey. Stakeholder opinions about governance of bioenergy (Thrän and Schaubach 2017)**

The important points from the discussion were:

- *The major sustainability issues to include for biogas are increased transportation, odour, too much maize in the countryside (visual increase in maize production).*
- *Leakage issues related to the biogas plants needs to be addressed, although a monitoring system to address this was introduced in 2009. However the emissions from manure storage are typically significant higher*
- *The drivers for developing sustainability criteria are: (1) land use change (LUC) (should we be subsidizing maize fields)? (2) Overall greenhouse gas reductions (is it worth it)? (3) And how will the German landscape look like?*
- *Farmers shifted their vacant land to produce energy crops in the 2000ies, as they were restricted from using the land for agricultural crops under EU set aside land control systems.*
- *A major positive effect is, that the nutrients in the digestate is used by farmers and substitute mineral fertiliser*
- *In regions with a high specific livestock production the additional use of digestate can lead to an oversupply with nutrients. Therefore, digestate transport has been realised in some cases*

Forestry

P15: La Tuque project: a strategy for stakeholders issues considerations.

Patrice Mangin presented results from the La Tuque project on a strategy to consider stakeholder issues. The background for the study is that the Canadian government aims to reduce the national GHG emissions, and province of Quebec needs to develop a sustainable strategy. Quebec imports a high share of its total energy consumption (56%) and also high petroleum consumption (41% of the total). Therefore the energy policy of Quebec is to reduce the consumption of petroleum products by 40% and increase bioenergy production with 50% by 2030. La Tuque was selected to produce "drop-in" quality biodiesel and/or jet fuels using forest residues as feedstock. This includes low quality stems left at the roadside at the time of harvesting, for which there are no other uses ('un-loved wood'). Plans were to use 1.2 Mt/year, which would lead to a CO2 emission reduction of 0.575 Mt/year. It is important to consider technological, policy and economic aspects to ensure the success of the project. As forest residues come from government owned forest properties, the long-term biomass supply is guaranteed. It is important that all stakeholders get aligned on sustainability issues to attain a mandate in Quebec for moving the project forward. The industry, federal and provincial governments, policy makers, and research organizations need to work together around this.

An attendee asked if the 'unloved wood' is being used in La Tuque biorefinery project, but the author answered that the project only uses forest residues so far. If there is less demand for pulp and paper industry and construction, more forest residues and wood will become available for bioenergy production.

P16: Role of Stakeholders' expectations on Sustainability of Bioenergy: Case Study of La Tuque. Québec

Leonard Nkunzimana presented a study using a fuzzy AHP approach to assess preferences of the La Tuque community as it is planning a wood-based biorefinery. The study emphasised the stakeholders' role in bioenergy planning along the supply chain, and it reinforced that bioenergy projects need to interact with the community during the whole life of the project. For the La Tuque project, the expectations of the local community are being reviewed by use of a hierarchy of goals, criteria and alternatives. It was concluded that the fAHP can help to focus the efforts of the project developer to the set of preferences. It can also provide a basis for dialogues among all involved parties.

There was a question how stakeholders are defined, and the author answered that this study focuses on the local community, which include several categories of stakeholders (general public, forestry workers, aboriginal, etc.). One comment highlighted that communication is important for the development and progress of bioenergy projects. A co-author added that for La Tuque, there are media strategies available. Information about the project is often published in local newspapers to inform and get more support from the public.

P17: A fuzzy AHP approach to assess preferences of La Tuque community towards wood based biorefinery

Biljana Kulišić further explained the methodology used in La Tuque, about stakeholders' expectations in relation to sustainability of bioenergy. There is currently a lack of relevant and reliable information on stakeholders' expectations, even if there is a need to address sustainability concerns to safeguard bioenergy investments in La Tuque. Within stakeholder groups, experienced and knowledgeable individuals were identified along the forest biomass supply chain in La Tuque and semi-structured interviews were carried out with these representatives. The results were analysed through simple ranking and fAHP, leading to a priority ranking of sustainability issues. Creation of new business opportunities and economic empowerment were preferred issues to be addressed, according to the interviewed stakeholders. Other priorities included creation of new sources of income for individuals and enterprises in order to keep the youth in the local

communities (see Figure 12).

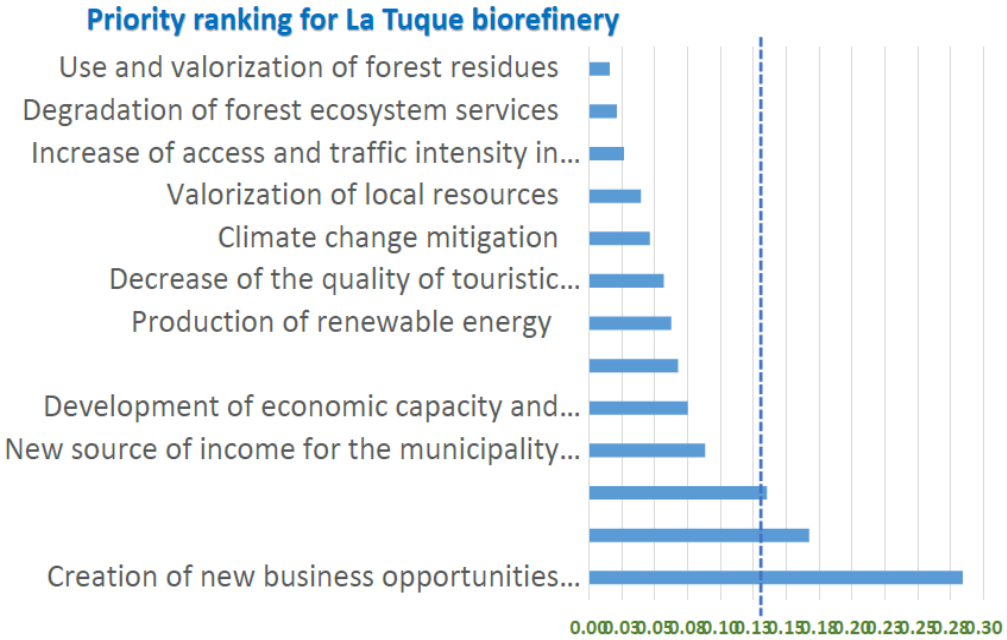
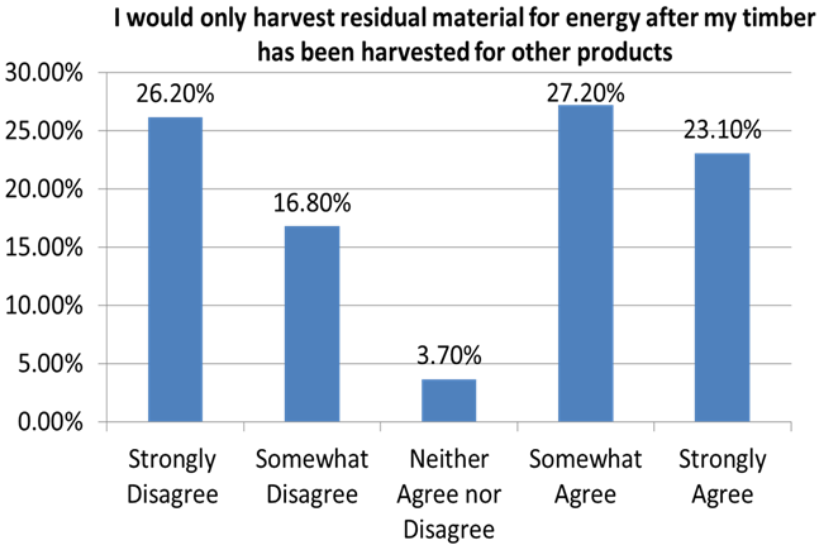


Figure 12 **Priority ranking by stakeholders for La Tuque biorefinery (Kulišić and Thiffault, 2017)**

In the general discussion, the audience noted that NGOs have a strong voice in general, and that a communication strategy is therefore important for these debates. The scientific community can play a role by sharing informative details about costs and benefits of projects. Another attendee commented that the La Tuque project, with its governmental support and planned media strategy, will be successful in establishing bioenergy production and bringing benefits for the local community.

P18: Linking measurement and governance: wood pellets from the southeastern United States.

Virginia Dale and Keith Kline presented on the linkage between measurements and governance in relation to wood pellets from the south-eastern United States (SE US), based on results from a survey (see Figure 13). There are mainly private forest lands in the SE US, with two-thirds of these being owned by non-corporate entities (mainly families). Less than 3 percent of the wood products from the SE US goes to wood pellet markets, and the main pressure on forests is rather due to urban development. The survey focused on governance systems at the macro-level, and it described the types of stakeholders involved, the indicator categories, and the measurement systems used by private noncorporate landowners and identified issues of interest to these landowners. Half of the land owners were interested in selling forest residues for bioenergy, and it was recognized as an opportunity for job creation, profit, and maintaining healthy forest conditions. Some private noncorporate forest landowners were enrolled in management or stewardship plans (<50%) and some had logger training or they employed best management practices, but very few had certified forests. However, mills that produce pellets require feedstock to originate from sites supervised by logging professionals trained in wildlife habitat conservation, water quality, and other best management practices (BMPs).



(Hodges et al. in prep)

Figure 13 **Preliminary results from survey of non-industrial forest owners in southeastern US on harvesting of wood energy from their land (Dale et al. 2017)**

To examine effects of this recent expansion of the pellet industry on forest conditions, the US Department of Agriculture Forest Service (USFS) Forest Inventory and Analysis (FIA) annual survey data for 2002 to 2014 was used to analyze changes in timberland trends since 2009 for two fuelsheds supplying pellets to the ports of Chesapeake, Virginia, and Savannah, Georgia. These are the fuelsheds from which the majority of pellets in the SE US are shipped to Europe. This analysis revealed that the Chesapeake fuelshed had significant increases in acreage of large trees and harvestable carbon after 2009. Furthermore, the timberland volume within plantations increased in the Chesapeake fuelshed after 2009. The Savannah fuelshed had significant increases in volume, areas with large trees, and all carbon pools after 2008. Increases in carbon in live trees for the Chesapeake fuelshed and all carbon pools for the Savannah fuelshed for the years before and after 2009 provided empirical support to prior estimates that production of wood-based pellets in the southeast US can enhance greenhouse gas sequestration. Both fuelsheds retained more naturally regenerating stands than plantations; however the number of standing dead trees increased within naturally regenerating stands and declined within plantations (but only significantly for the Savannah fuelshed). While the decrease in the number of standing dead trees per hectare for the Savannah fuelshed plantations after 2009 warrants investigation into its effects on biodiversity, others have recommended thinning and hardwood mid-story control within pine plantations to provide habitat for regionally declining bird species, which is consistent with use of biomass for energy and reducing the risk of fire. While all energy use affects the environment, these results show that benefits accrue when sustainable forest management provides wood pellets for energy that keep fossil fuel in the ground. Using wood for bioenergy can reduce inefficiencies, improve forest habitat, retain forests as forests, provide jobs, and lower carbon emissions and mitigate the effects of global climate change. It is essential to consistently monitor and assess forest conditions to assess changes, for exports of wood-based pellets for the southern US are expected to grow. Continued analysis of annual FIA data should provide a scientifically valid approach for ongoing assessment.

The audience noted that the questions asked must be revisited as perceptions change. Additionally, it was emphasised that there must be adequate communication of the context for bioenergy, i.e. the 'whole picture' of bioenergy deployment, to the broader public.

P19: Measuring, Documenting, and Communicating the Sustainability of Supply Chains within the Wood Pellet Industry of the Southeast

Brian Kittler presented a study on how sustainability of wood pellet industries in Southeast U.S. is measured, documented, and communicated. This presentation focused on drivers of sustainability governance, the specific schemes that are being used, challenges to show compliance with standards, which types of documentation that is being used, and how the company policy and its implementation is communicated to the public. The study was based on structured interviews with eight bioenergy companies representing the majority of the pellets exported from the southeast U.S. to Europe, finding that complex supply chains exist and that systems used across the sector differ in the degree to which primary feedstocks (i.e. pulpwood and logging residues) and secondary feedstocks (i.e. forest product residuals) are procured by suppliers such as landowners (large industrial and family forests), sawmills, wood brokers, etc. (see Figure 14). Due to a paucity of certified acres, the overarching model being adopted is a risk-based evaluation within biomass feedstock sourcing—principally the Controlled Sources system of the Program for Endorsement of Forest Certification (PEFC) and the Controlled Wood system of the Forest Stewardship Council (FSC). Additionally some are applying mechanisms to encourage additional certification of forestland within their supply area (e.g. supplier quotas and landowner education) and are using supply chain auditing and monitoring internal to the company. It was found that a few consultants completed most of the risk assessments and audits needed for the companies to get certified, but also that this did not involve higher levels of due diligence as has traditionally been the case. Brian also emphasized that the role of bioenergy within the broader forest industry is poorly understood in the public, and that the industry recognize its lack of expertise in communication, and there are also costs involved. Some industries rely heavily on trade

associations for communication, but they are less credible with detractors. Some companies commit themselves to transparency and open processes, but public consultation processes are often poorly implemented. The next step of this work includes site visits to review auditing reports, and analysis of the governance complex using the conceptual framework presented by Mansoor et al.

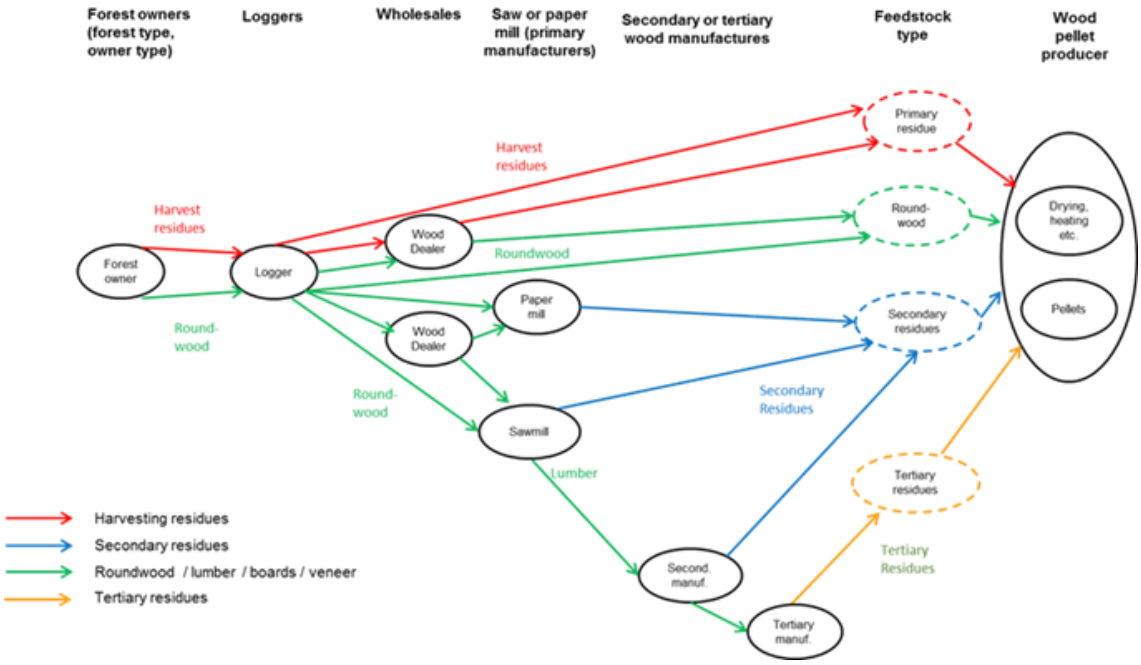


Figure 14 **Model used for mapping of feedstock flows for several wood pellet supply chains in southeastern US (Kittler et al. 2017)**

In the discussion, it was emphasized that the industry must develop communication skills to adequately describe what is happening in a transparent, open, and efficient manner. It was noted to be interesting that the risk assessments completed for FSC Controlled Wood and the Sustainable Biomass Program (SBP) were usually the same risk assessment using the same or nearly the same data.

P20: Governance of sustainable forest management and bioenergy in Ontario

Tat Smith presented a study on governance of sustainable forest management and bioenergy in Ontario. It is anticipated that Ontario might supply more wood pellets in the future. The Canadian situation is very different that of the US; the majority of managed forests are owned by the Crown; and there is a serious economic crisis facing the forest sector. Forest bioenergy could perhaps help by providing markets and incentives for innovation and market expansion, but intensified forest management can also have consequences. There is a series of Acts in Ontario that address sustainability of forest management. The Crown Forest Sustainability Act of 1994 is central. There is also a series of provincial forest management manuals that management must follow; so governance is comprehensive, and it is mandatory to follow the requirements. Continual improvement and adaptive management are written into the management guides and it is included in the certification programs. Check-review processes are formally required by the provincial audits, with also research informing periodic review of BMPs fitting into this process. SFM monitoring that measures every tract comprehensively is not taking place, but data are collected for compliance/implementation monitoring (BMPs), effectiveness monitoring (limited number of sites, with rigorous research), and validation monitoring. Sustainable forest licenses, FRLs, are based on modelling of yield and acceptable AAC levels. Consultation is taking place with indigenous First Nations and other citizens, which supports the input legitimacy of policies, while the output legitimacy is supported by the monitoring systems. About 78% of the land is certified under CSA, FSC, and/or SFI. While some lands do not have certification, others have dual and

triple certification, as a risk mitigation strategy. The biomass supply is driven by the traditional forest sector, and the resources available are harvest and mill residues, and 'unloved' wood. Large amounts of biomass are available, e.g. hardwoods for which there are no markets. The amounts available for timber are even much greater, and the challenge is generally to develop timber markets (see

Figure 15). When merchantable stands are harvested, large tonnages of residues are available after harvesting.

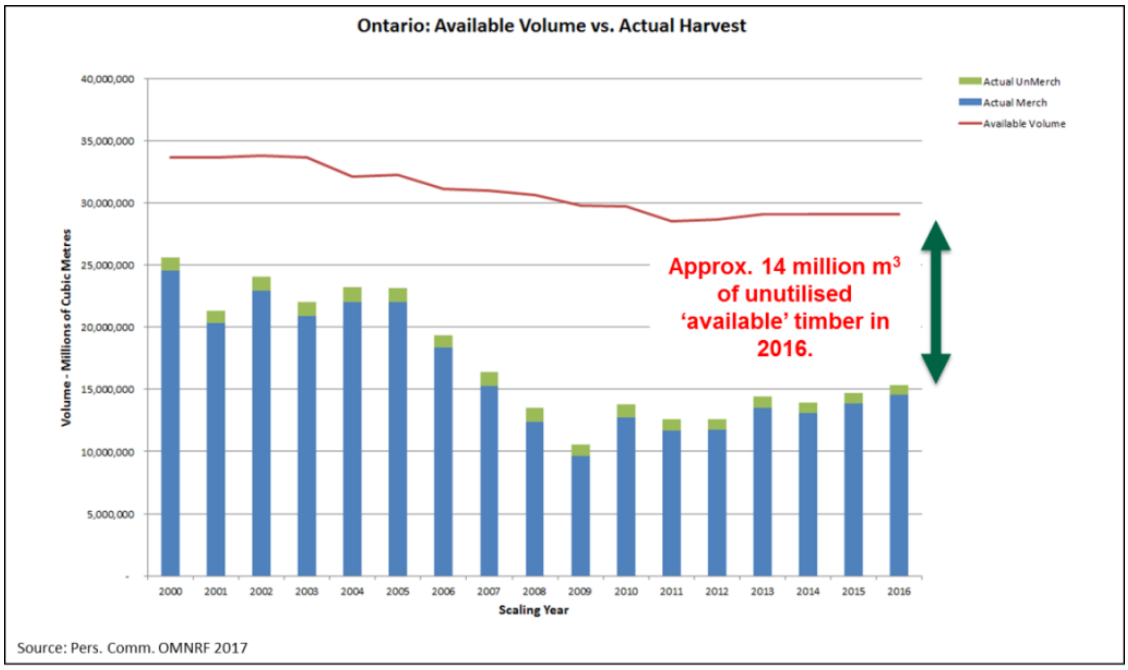


Figure 15 **Annual Allowable Cuts and annual actual cuts in Ontario (Cheung & Smith 2017)**

The policy analysis used a methodology similar to that described by Mansoor et al., and the different types of governance are classified into voluntary and mandatory, substantive and procedural, etc. The system in Ontario can be viewed as a 'gold standard' for management and sustainability governance, in the sense that management planning is very thorough (e.g. cost to write an approved plan is approximately CAD 1 million) and compliance monitoring is conducted during both mandatory provincial audits and voluntary certification audits (see Figure 16).

Forest certification monitoring requirements are extensive; guidelines are periodically revised in an adaptive management cycle that provides the feedback needed for continual improvement; revisions are informed by the latest scientific standing. Certification standards ensure that no controversial sources are harvested. However, long-term forest rotation lengths and uncertainty regarding management outcomes demands continued diligence in testing hypotheses in rigorous long-term research programs, as we have not evaluated forest management through one or two rotations. There is also a need to recognize that as new legislation and international agreements are ratified, e.g. the Endangered Species Act, UN Declaration of the Rights of Indigenous Peoples (UN DRIP) and associated requirement for the Free, Prior and Informed Consent (FPIC) for indigenous peoples, and requirements of the revised EU Renewable Energy Directive, if finally adopted by EU, continual revision to federal, provincial policies and revision of forest certification standards will be required to maintain the legitimacy of sustainability governance for forest bioenergy supply and value chains.

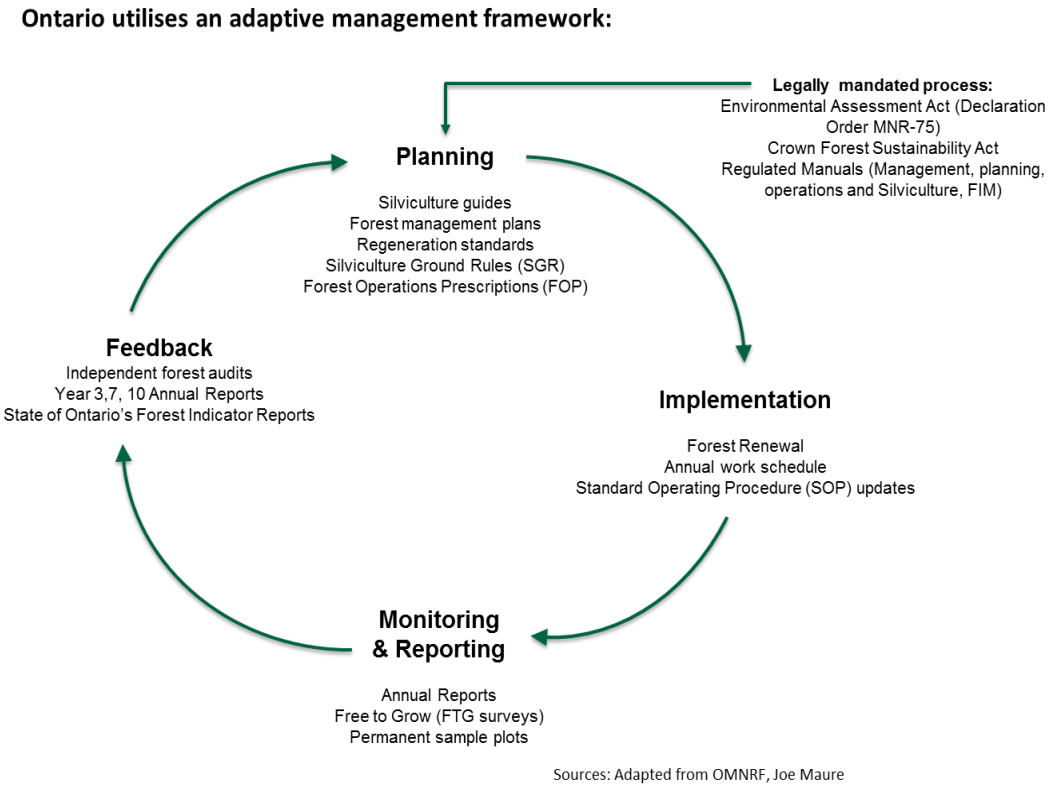


Figure 16 **Governmental governance framework for forest management in Ontario (Cheung & Smith 2017)**

The audience asked if there are overlaps between forest management and other activities, such as gas and oil development and clearing for roads, and how that is dealt with in the forest management plans. Tat answered that it is a problem, especially in Alberta. There are major impacts from other sectors, and bioenergy is only a small component. It adds to the level of complexity that is out of the hands of forest managers, and it is not a very level playing field.

The general discussion for the forestry session as a whole was introduced with the question why all wood pellets in the US and Canada are not used domestically. Another commented that his view had roughly been that Canada is regulated and the US is not, but that these presentations were good illustrations of how the Canadian and US systems are being managed, and that, essentially, these two countries are trying to achieve similar outcomes. Another attendee noted that it is interesting to see how the supply chains use voluntary systems to communicate to customers, which help to verify conformance. When based on a good research framework, the biomass sustainability frameworks leverage existing systems, also forest management certification and the chain of custody. One might think that these systems are competing, but there is also a great synergy. It was noted that communications are important, and that there is an important role for researchers to play there. It was furthermore mentioned that it is interesting to see how important these frameworks are in order to continue improvements, and that also certification systems are required to update their systems. The IEA Bioenergy Task force also takes an important role in its working to update and inform the bioenergy society.

An attendee added more insights that stood out, for example some of the connections between Virginia's and Brian's presentations, with the take-away message being that there are different approaches being used for the same region, in independent ways, as they have slightly different goals. The data from the Forest Inventory and Analysis National Program (FIA) and land owner surveys illustrate two ways sponsored by the U.S. government to systematically collect and analyze information that is publicly available for researchers and other interested parties.

For advanced bioenergy, it is a question how to make sure that what is being done is also credible. It is important to make sure that there are collaborators involved to give their perspectives. There

are different reasons for why forest owners might or might not be harvesting their forest. It was questioned what would happen if these markets for pellets did not exist, and what would be the counterfactual. It was emphasized that we should remember that our current knowledge is not final, and we need to continue to improve these systems in the future. Compliance monitoring, effective and validation that are very actionable way; these studies give tangible and useful examples for policy makers of how the systems are being used on the ground.

A member of the audience added that it is worth remembering that FIA etc. were not set up for the industry or for bioenergy, but rather because we care about our forests and want to know what is happening to them on the ground. Another said that voluntary certification systems leverage those data. Using an example from New Zealand, it was noted that also simpler tools are needed. Yet another said that there are different governance mechanisms, but that no system will provide all the information that decision makers need. Certification is for example not good for understanding what is needed at aggregated levels. Another attendee expressed that we have a lot of data, and know how we to do things sustainably, but also that we have not communicated things well, yet. It was questioned how we can improve the communication on how things work in practice.

A question was directed to Brian, to ask about the detailed analysis of certification systems, if there is proof that adopting those systems has improved something on the ground. Brian said that his study was not designed to check that. However, the biggest challenge is tracking secondary feedstocks back to a specific harvested forest tract. He said that there is a way to deal with it, and that it will be important to demonstrate what the impacts are and build legitimacy and trust in society, also for these feedstocks. A question was asked if it is necessary for the wood pellet plants to understand the forest, and another responded how important this is, if they should communicate such matters to their customers and society. An attendee noted that what happens is probably a reinforcement of good practices, rather than something completely new. Another said that having bioenergy steer sustainability of the forest management is like a tiny tail wagging a big dog, but also that concern about bioenergy from environmental NGOs have had a positive effect. Virginia confirmed that bioenergy has made us think about forests in a new way, such as looking at biodiversity in wood piles, or when you take them away. It is not the most obvious place to look for biodiversity, as piles are results of logging, but we are creating habitats and we may be taking them away. It was furthermore mentioned that there is a wide range of NGOs that are more or less well balanced in their views, but also that there is a tiny portion from whom we cannot take anything for granted, not even when forests are certified. It was emphasized by another attendee that in this interface between business and sectors, it is very important that all get together, in order to listen and raise problems and challenges, even if it is maybe less useful for the solutions. NGOs want businesses to take their concerns seriously, while business want NGOs to understand the business conditions; they must come together, with researchers as a linking group. The keyword is balance.

General recommendations extracted from the above discussion:

For the synthesis on governance issues, consider that even if the Canadian and US systems use entirely different approaches, they try to achieve similar goals. Both nations have extensive regulatory frameworks and complicated legal structures at federal, state and local levels. It is not as simple as one has regulation and the other has not.

Consider to which extent all systems in a region are competing or act to create synergy in moving towards a common goal.

Consider the role of communication to create trust and confidence among the actors, and the role of researchers in this process. Among other, communicate these studies as tangible examples of how governance systems are being used on the ground, as it is something that decision makers can use.

Consider the positive contributions from NGOs, and continue the communication, as dialogues must continue to improve balance.

Consider that different systems are used at different scales, have different origins and goals, and thus play different roles, but that all monitoring data at all levels might be useful for documenting sustainability of bioenergy.

Consider the extent to which these systems improve practices on the ground, with secondary feedstocks constituting a specific challenge with tracing.

Consider the role of pellets plants for communication of sustainable forest practices, as they are closer to forest owners and managers, compared to actors further down in the supply chain, such as energy companies.

SUPRANATIONAL STAKEHOLDER PERCEPTIONS (O3)

P21: Positions, perceptions and vision of stakeholders on bioenergy sustainability

The final presentation by Thuy Mai-Moulin addressed positions, perceptions and visions of stakeholders on bioenergy sustainability, with the goal to understand these and provide recommendations on how to gain support for sustainable bioenergy value chains. The objectives were four-fold: (1) identify stakeholders associated with different value chains, inside or outside the chains, (2) communicate with stakeholders via questionnaires, (3) analyze and compare stakeholder positions, and (4) provide recommendations. There were five sections of the questionnaire, and 171 respondents who had filled in an online questionnaire. The preliminary results showed that social media were the most used source of information about bioenergy, while deemed the least reliable, while scientific studies were thought of as most trustworthy, but used less as source of information by stakeholders. Most survey respondents consider themselves to be intermediately well-informed and believe that the general public is less well-informed. Most respondents thought it is relatively important that the public is involved in bioenergy, but also said that policies should not be based on the public opinion, but rather on scientific facts. When asked under which condition they support the bioenergy sector, respondents using biomass for other purposes than bioenergy (e.g. for panel boards or pulp & paper) perceived less positive impacts of bioenergy on creation of local jobs and the local working environment than all other stakeholder groups (see Figure 17). This stakeholder group and the general public also worried about deforestation and over-exploitation of forests. Residues from agriculture and forestry are acceptable feedstock resources by most groups, but not energy crops from agricultural land. Reduction of GHG emissions was found to be an issue of relatively high importance among respondents, as was energy security. With the exception of industries already using biomass primarily for conventional purposes such as timber, many respondents thought that insufficient economic stimulation and market incentives are in place to support bioenergy. Policy frameworks and markets lack the stability required to support a growing bioenergy sector. More policy support in terms of targets for GHG emission reductions, environmental goals and SFM are also important.

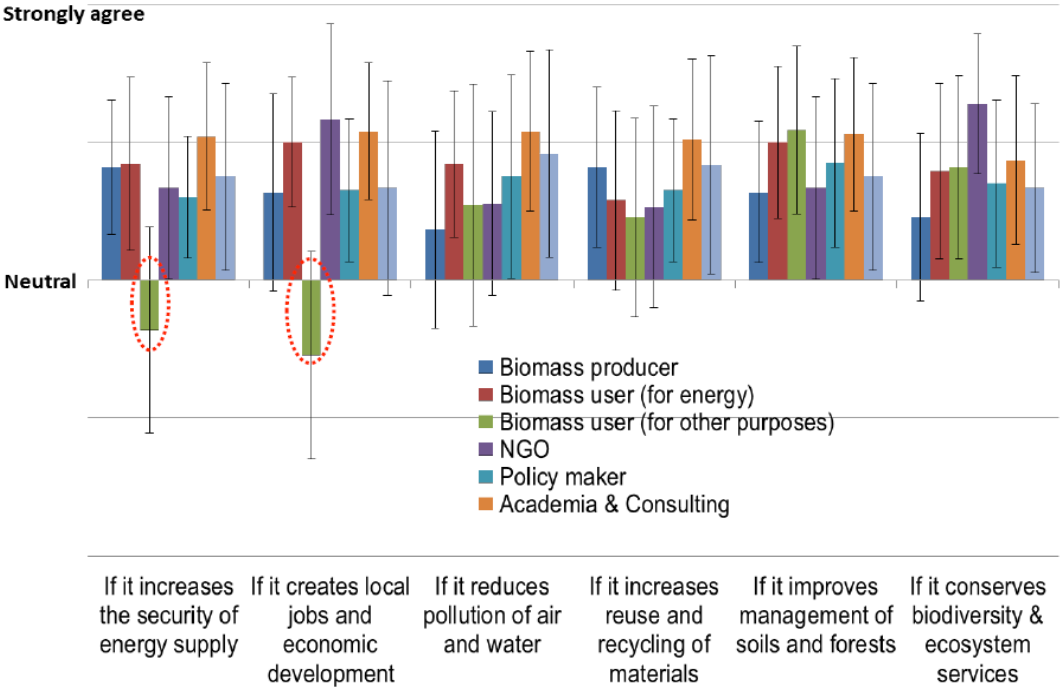


Figure 17 **Level of support by various stakeholder groups provided bioenergy provides specific benefits – preliminary results from an online survey (Mai-Moulin et al. 2017)**

A complementary investigation of viewpoints and positions among supranational stakeholders' – e.g., international organizations such as the Food and Agriculture Organization and other branches of the United Nations system, multi-lateral development banks, European Union officials, etc., - is on-going. That activity will continue over coming months. Outreach is being done electronically and through personal interviews. The team hopes to confirm the preliminary results and clarify responses in time to develop a report to be available in 2018.

The investigation of supranational stakeholders' viewpoints is on-going, and will continue confirm the preliminary results and clarify some responses. Personal interviews will also be conducted, with final results expected early next year.

The commenter introduced the discussion, by mentioning that in the past, a project in a Nordic country analyzed a proposal that biofuels be refined to have the same properties as coal, as it would then be possible to co-fire in existing boilers. However, the project also showed how difficult it is to communicate about bioenergy and climate. An important question is how we can improve carbon accounting and verification methods, particularly on impacts of substitution. Another important concern is biodiversity effects and certification of the biomass origin. Global and national standards for biodiversity are confusing and could be improved, and we should be looking for technical innovation to address these issues. A question is how to measure these parameters? The audience was asked what would be their primary priority to improve. One attendee answered that it would be great if there was "a universal standard plug outlet, so that no adapters would ever be needed, i.e. one plug that fits them all", for any wood that supplies electric power.

Another attendee asked, "Should we assess effects of a final product, or look more broadly on system effects on the landscape?" The point being that it is important to recognize that these are two distinct questions. There was agreement that we need better communications on these topics. An answer was given that we need to seek balance between economic development and desired environmental future, with the key still being communication. We need a "game changer" in communication and we can learn from NGOs, as they are effective communicators.

One attendee commented that there is need to "govern for sustainable forestry." With increasing demand for forest products, the challenges increase. And debate becomes more polarized, and we need to be careful and figure out how to move toward convergence. Forest futures group in Sweden is perhaps one example where they start by agreeing on facts. We need to separate facts from opinions, but also processes where different types of stakeholders meet and talk. Another added that we need long term strategies and although complex issues will take time, being transparent and supporting continual improvement would be a path forward.

Another view was that we should get away from complex things that people do not understand, and focus on things that simpler and less controversial. One question was raised whether we can use the power of consumers, and the marketplace? The answer of one attendee was the GHG information already available (evidence, complexity, and issues of communication). We should use power of science to better structure the problem, lay out trade-offs, and underscore the opportunities, as controversies also offer opportunities. In the beginning, all were keen to learn about these issues, but this is no longer the case in Europe and the USA, but there are other parts of the world, where they see the opportunities, and the same things that are not seen as controversial.

One participant raised the question whether we could engage stakeholders to define what their desired future for a specific sourcing area is. There are examples for engaging stakeholders to discuss planning and future vision for public lands but not so much for private lands. One supporting example is the Land Conservancy Cooperatives (LCC) in USA which are beginning to try to bring private and public landowners together for this sort of visioning and planning. Another mentioned that we must also keep in mind that about 80% of what landscapes look like is more or less given by traditions.

The final question was highlighted on what we want future landscapes to look like. Some responses were that there is fear and concern, as many people simply want things to be and look like they did in the past. It was mentioned that there are various fora, which need to be considered for gaining trust and legitimacy. Legitimacy is granted to trusted figures, who people feel they know, often via local connections. Certification schemes already have comprehensive stakeholder involvement, and we should use the existing processes and meetings to move things forward. It is needed to be part of the local political and decision-making process to build trust.

ROUNDTABLE AND CONCLUSIONS

The moderator asked the panel of five people to highlight how we can make progress, and where common ground can be reached for moving towards sustainable bioenergy. The first panel member replied that it is fairly straight forward, as we should talk to each other as done in this workshop. He said that the contents had been great, but also that the communication was the real value. This is a forum where you can test your ideas, and it serves as a place to find common ground. It would be ideal if we could have a set of facts that we could agree on.

The second panel member said that this was his first exposure to IEA, and that he was amazed with the interdisciplinary approach, the different scales, and the very different topics. He suggested that project teams are "feedstock" in relation to public objectives, as what he heard could serve public policy and other developments. Customers for bioenergy products are beyond IEA Bioenergy, but this group could provide information to a wider audience. He asked if the project team has a strong theory of change, if we are looking for transformations that seek to use renewable sources for a sustainable energy system. Such theory can guide how to communicate the material and the data most efficiently.

The third panel member said that in Canada, the pulp and paper it is not doing too well, so a game changer is needed. For this, facts are needed that people can rely on. Much of this work has been done, but there is a need to understand the stakeholders' views, in order to develop the new industry sector. Currently, more NGOs and policy makers are missing for the dialogue.

The fourth panel member said that such dialogues are also crucial at the EU level. It is a hot topic in Brussels, and discussions have been that we need to consider the variation and the local conditions. This is seen in work with multi-stakeholder dialogues, for biofuels. It has been close to consensus for agricultural and industrial residues, but not for forest residues. Currently, work is ongoing with NGOs and policy makers.

The fifth panel member said that a take-away for him is that there is lots of knowledge to be accessed, which can be important for the ministries. The project has already accomplished a lot, but the problem for the minister is that he has to convince the parliament. The struggle is to bring all the information to the government and the public, in a way that it is trust-worthy. He also emphasized that IEA Bioenergy is very much looking at sustainability from a bioenergy point of view, but there is a need to view sustainability in the context of the bioeconomy. Anything helpful information is wanted and should be used to support how we can approach sustainability and create trust. The work is also useful for the IEA Bioenergy road map.

The panel member said she appreciated the opening presentation by Mansoor et al., as it was helpful for understanding the different types of sustainability governance, and through this, how to improve different approaches for governance pertinent to specific contexts. Such information can be applied to more than bioenergy, and thus this inter-Task project can help advance understanding of sustainability governance more broadly. She suggested that the terminology and insights gained from Objective 2 should help inform the whole inter-Task group. She also observed that there is growing agreement on the importance of context when evaluating the sustainability of bioenergy systems, based on the conditions and options in a given time and place. Because of this, tools and methods need to be flexible to those various conditions. She commended the important progress that has been made on analyzing bioenergy at the landscape scale, integrated with forestry and agricultural systems. However, there is still a lack of clarity on how to reconcile the context-specificity of bioenergy with the need for some universal metrics to address trans-local issues, such as trade and GHG reduction goals.

The moderator asked what we can do next, and how the panel members can help, and what we can learn from the many initiatives that exist. A US-based panel member mentioned that the recent biomass resource assessment study, the 2016 Billion Ton Report, has provided more

confidence about the potential for growing the U.S. bioeconomy, as it is clear that more biomass can be produced, with environmental benefits. The study looked at biomass production from multiple sectors as well as potential environmental effects, such as effects on water, biodiversity, soil carbon, etc. More research is needed to understand critical thresholds, for example, how much residue can be removed. A question was asked if the process to develop the report had created more trust in the US, and what gives more credibility to such processes. It was answered that trust and credibility was improved by collaborating with many agencies and academia, which created more robustness. However, it is still a very technical report, which poses challenges for communicating the results while also maintaining the nuances.

The moderator asked how we can transform the information, if it is needed to go for a media campaign. A panel membered answer that this is part of the solution, but also that we should bring the information directly to policy makers, the people working with UN Sustainable Development Goals (SDG), and all people involved at policy levels. There is a need to communicate a more balanced and positive picture. For example, we know that locally things are driven by development and this creates an opportunity for telling people that bioenergy practices can create benefits. He said it is not in the hands of IEA to make a big media campaign, but that the Renewable Energy Outlook is a good place to communicate and provide information for policy formulation. There is only no trust that bioenergy is sustainable.

The moderator asked how the bioenergy sector can work more with communication experts. An attendee involved in transportation biofuels said there is a need to consider this. When developing communication strategies, there is a need to look at what information is out there, and at what stage it is. In her experience there is a scientific divide. IEA bioenergy should be neutral and objective and listen to both sides, and try to understand where the different views come from, and this takes us back to communication. There is sometimes a huge gap between scientific communities, and it is important that they talk to each other, and find out why they disagree. If science to should be seen as having objective views, it is also needed to understand why is the scientific community divided, that we can benefit from having a more constructive debate.

A panel member said that we need to communicate best practice examples to those putting bioenergy under scrutiny, or ask which information they are missing. He is hoping that whatever information is missing, it will come, but also that points of disagreement among scientists should be identified, in order to establish common ground. Bioenergy can make progress once scientists agree, and once there is coordination of relevant policies in different jurisdictions. A wish for Christmas would be agreement on what is sustainable bioenergy.

The moderator asked the panel if there is something they would like to see from the project, before it ends. A panel member said that the information generated by IEA Bioenergy can be important for reaching consensus, for example around the US-EU bioenergy supply chains. He said that he heard a lot about carbon, but also biodiversity is a very important issue. He could wish that IEA Bioenergy would be a living laboratory, providing inputs to development of RED II, North American-EU supply chains, and certification system. But he also did not hear much about climate change negotiations, where science ought to play a big part.

The moderator asked a panel member what more is needed, when we have the Sustainable Biomass Program (SBP), which has already tried to be inclusive of different approaches to address sustainability. The panel member said that millions of tons of SBP compliant material is already being burned, and that trust must be deserved. It comes through behaviors, reporting, transparency and engagement. Trust can only be earned, not demanded. When it comes to controversies in science, he referred to Helena Chum's presentation, which showed how different answers were given by different models, but also that when you understand what is behind the differences and correct accordingly, then they give the same results. We get different answers depending on the frameworks, and we need to understand the assumptions. Then things are often not so different. Unfortunately, a lot of these models are opaque. Considering forests, we also

need to remember that pellets are just one product, and they are tiny component of the forestry sector, and they will never be a large component. We must also respect that this complicates things for modelers. Pellets can only move the needle a little bit, and the value of IEA Bioenergy research is crucial.

A scientist in the audience asked if scientists have to explain where we agree and disagree. Experiences show that science can never deliver one uniform fact to you. Review will only give the picture at a certain point in time, and disagreement is part of the scientific process. You should not wait for a full consensus from science before you make decisions. A panel member added, that most of us believe in hard science, but also that this is not hard science, because much is in the assumptions. Another scientist said it is probably better not to share findings in public, until some level of consensus has been researched.

Another scientist thanks for all the feedback, and said that as a group, we are looking for things we can add to the project. He heard that there is satisfaction, but also that we need to communicate more, identify more opportunities, and that the project, based on that, should review the game plan for communication. There are substantive things to share from the output and we should consider how to have impact.

An attendee addressed the need for putting things in a context and to view the biomass supply curve in terms of risk. We should be able to say e.g. that we can get 100 EJ with low risk, and 145 EJ with more risk. There is a need to resolve things that are uncertain, as we do not need to spend more time on things that we know about. We should allow people to move on, and encourage scientists to think about this topic in terms of risk.

A scientist said that we have lots information in IEA Bioenergy, but also we do not have an information expert. It is worth considering about getting such people involved. They would be able to better communicate examples of good experience, and would know what kind of words to use, be careful to talk about sensitivity analysis, be precise, but be careful to use words that are being understood differently. IEA Bioenergy could benefit from a communication expert.

An attendee reminded that there are organizations which already have develop outreach plans for bioenergy, which address the public, policy makers, and non-IEA Bioenergy countries. Each of those audiences needs to receive the messages, but it is an 'ecosystem' and there are interactions. If IEA Bioenergy chose to professionalize their communication, then such organizations can take the messages forward to higher and deeper levels. However, it is important to remember that we need to ensure the integrity, and not create certain outcomes, but best advice. A panel member from the bioenergy sector advised that IEA Bioenergy need a communication plans and a strategy, and that there are a lot of plans, but not very much strategy. He suggested hiring an expert in communications, as communication is not a single event, but a continuous process. However, communication starts with a strategy. IEA Bioenergy must have the experts to understand its issues; if experts do not understand the communication strategy, then the expert is useless. It was informed that IEA Bioenergy is working on a communication plan, together with other organizations, and that this plan is based on knew knowledge. There is a need to get some good expertise involved, but it is also a very big task. A panel member asked if the IEA Bioenergy strategy has a vision, and, again, that the strategy must be based on a theory of change. It was informed that the vision is that bioenergy can contribute, and the strategy is to have this message reach decision makers and influence policy makers.

An attendee mentioned that not communicated in the right way is only a tiny part of the explanation of why messages are not positively received. There are elements in communication in marketing, that we often forget, and these are the elements that create credibility. The sender of the message is an important element, as any perception of bias is also important. Professionalism and communication experts are all over the place, but there are many other factors that are important, such as carefully selecting the person that carries the message forward.

The topic was changed by another participant who said that societies need to be resilient to climate change and that part of the issue is, that no bioenergy can be produced if no land is available. We need to be careful in not wasting so much land, and instead make more land available. Land will only become available when agencies are on board, and it was suggested to take action to restore degraded lands, or action to improve food crop yield in developing countries, as many can agree to this. We do not know how this will impact bioenergy, but directionally this should make land available. Resilience strategies are rarely controversial.

Another participate said that this is all about climate mitigation, but we should also deal with climate adaptation. Mountains in the USA are accumulating 9 million tons that can be mobilized for bioenergy. This is less controversial material and we should think about stories where mutual benefits can be identified and risk is low. In connection with this, it was also mentioned that assumptions about how the land will be used in the future might make the whole difference, and that we need a science-based approach for setting assumptions, and a standard practice for documenting assumptions. It was mentioned that in this sense, we can learn from the ITCC practice.

Policy is difficult, and an attendee told a story about a policy maker that went up with a balloon, and first sees nice yellow fields of rapeseed, but then loses his bearings while he drifts through clouds of iLUC. As he descents, he sees a man and asked him where they are. The man said that they are 100 m above the ground, and the policy maker asked if he is a scientist, as it was very accurate information, but useless. The scientist asked the man in the balloon if he is a policy maker. The policy maker asked how he could know. The man responds that this is obvious: the policy maker embarked on a journey without checking the weather forecast in advance, then asked questions and complained when the correct answer was given to him. As a lesson from this story, we should explore how policy makers interpret the information they receive from the scientific community. Ultimately, we know as scientists where we disagree, as we can pinpoint the assumptions, but policy makers get mixed messages. Also, scientists are also optimists or pessimists with regards to the merits of bioenergy, and do not agree (and never will), and this also needs to be communicated. IEA Bioenergy has for a long time been a body for exchanging knowledge about technical issues. However, we are becoming more and more communicators informing policy makers and engaging with stakeholders. This workshop was part of this engagement, and also provided valuable input and feedback for the intertask project. It was encouraged attendees wanting to be further involved in the project work should let the project leaders know about it.

Thank you to all for excellent and very valuable discussion and advice, which will be put to practice within the project.

IEA Bioenergy

Further Information

IEA Bioenergy Website
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