Bioenergy and Sustainable Development - Climate Change Mitigation and Opportunities for Sustainability Co-Benefits

Summary and conclusions from the IEA Bioenergy eWorkshop, 23-24 May 2022

Workshop organized by IEA Bioenergy, in collaboration with the Global Bioenergy Partnership (GBEP) and the Biofuture Platform

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Key messages from the workshop

Bioenergy will make an important contribution to climate change mitigation; it represents between 15 and 30% of primary energy supply 2050 in global scenarios that limit warming to 1.5°C. The relative importance of different bioenergy options varies depending on the anticipated development for other non-bioenergy options. Apart from waste and residues, biomass from dedicated cultivation systems will also be needed as bioenergy feedstock.

Deep reductions in net GHG emissions are needed in the coming decades to limit the rate of warming and peak temperature. Carbon dioxide removal (CDR) from the atmosphere can contribute to these near-term objectives and will in addition be unavoidable to counterbalance hard-to-abate residual emissions to reach net-zero emission targets. Bioenergy combined with carbon capture and storage (BECCS) is one of the key CDR options.

As for other products and human activities, judging bioenergy's sustainability requires consideration of a wide range of factors which can be context specific, such as climate and soil conditions, previous land use, biomass feedstock and land management practice, and socioeconomic conditions. Bioenergy is inherently multi-faceted and commonly part of land-based systems that provide multiple products along with other ecosystem services.

Apart from climate change mitigation, bioenergy systems and biomass supply chains can have important environmental and socio-economic co-benefits that can be important motivation for bioenergy deployment. There can also be trade-offs, e.g., with food production and biodiversity, which need to be managed in environmentally and socially sustainable ways through good governance practice.

There are important opportunities for developing countries to shift away from traditional bioenergy and fossil fuels towards modern, sustainable bioenergy as part of a circular economy approach. This can provide opportunities for land-use diversification and employment creation, reduce health problems related to air pollution, and support restoration of degraded lands.

Energy crops can be grown as part of integrated agricultural production systems, such as double cropping, intercropping and agroforestry approaches, or on abandoned, marginal or degraded lands. Integrated land management in agriculture deserves more attention in policy making as well as global modelling studies.

Multifunctional perennial bioenergy crops can be part of improved land and water management practices, adapted to different goals. With relatively minimal intervention, substantial ecosystem benefits can be achieved such as a reduction in eutrophication, soil erosion, and soil carbon losses.

Forest management - including harvesting and managing stem densities and species composition - contributes to rejuvenation and reduced risk of wildfires. Management helps maintain forest growth, allowing sustained harvesting, and managed forests have proven in several locations (e.g., in boreal regions) to perform better than unmanaged forests concerning both carbon stocks and carbon accumulation rate. While the contribution of old forests to net emissions reduction may be small, their conservation may be motivated for other reasons, not the least biodiversity protection.

Communicating on good practice, good governance and win-win approaches is key! We need to inform policy makers how policy design and governance can manage trade-offs, and highlight good practice examples that contribute benefits like rural job creation, supporting ecosystems and creating a local alternative for fossil fuels. Messages should be simple and should connect good practices and good governance approaches with local conditions, in language that is meaningful to the audience.

Executive summary

Luc Pelkmans, Technical Coordinator, IEA Bioenergy

The IEA Technology Collaboration Programme on Bioenergy (IEA Bioenergy) held its biannual workshop on 23-24 May 2022 in conjunction with its Executive Committee meeting (ExCo89). The workshop on '*Bioenergy and Sustainable Development*' was held in virtual form and was organised in collaboration with the Global Bioenergy Partnership (GBEP) and the Biofuture Platform.

The workshop consisted of two separate sessions:

1. Bioenergy and climate change mitigation
2. Sustainability co-benefits of bioenergy beyond climate

Each session consisted of keynote presentations, followed by a panel discussion. The workshop sessions had 244 and 173 participants respectively. The PowerPoint presentations and recordings can be downloaded from IEA Bioenergy's website[1].

IMPORTANT ROLE OF BIOENERGY IN CLIMATE CHANGE MITIGATION

Modern bioenergy is currently the largest source of renewable energy in the world and is expected to grow substantially as one of the complementary tools to limit global warming. The contribution of bioenergy varies between 15 and 30% of primary energy supply by 2050 (compared to current levels of 10%) in scenarios that limit warming to 1.5°C. So, there will be a **significant increase in demand for sustainably sourced biomass**.

Energy conservation and efficiency measures, circular economy approaches, and changes in consumption can provide important climate change mitigation and can also help keep down the pressure on biomass and other renewable resources, as countries pursue ambitious climate goals. Deployment of technologies and systems that do not rely on carbon-based energy and materials, can specifically reduce the pressure on growing demands for biomass as a substitute for fossil resources.

The future importance of different biomass uses depends on both consumption patterns and the competitiveness of biomass options relative to other options. The audience indicated that biomass is expected to be especially valuable in the long term for producing (1) carbon-containing chemicals and materials, (2) fuels for difficult-to-electrify transport options, such as aviation and marine transport, and (3) process heat in industries. Further, biomass uses may increasingly be combined with carbon capture, utilization and storage to extend the use of biogenic carbon and/or achieve net-negative emissions.

Greatest climate benefits are achieved for bioenergy systems when biomass is derived from **waste and residues** (from agriculture, forestry, industries, and municipalities), or from **energy crops integrated within the agricultural, forest and ecological landscape**. Capturing and storing biogenic CO_2 emissions from bioenergy systems would further strengthen their climate performance.
While in the short to medium term deep emission reductions are required for climate change mitigation, it is already clear that carbon dioxide removal (CDR) will be unavoidable to counterbalance hard-to-abate residual emissions to achieve net-zero (CO_2 or GHG) emission targets. There needs to be a healthy mix between nature-based, land-based, and technology-based CDR solutions, with CO_2 pricing being an important instrument to incentivize CDR scaling. **Bioenergy combined with carbon capture and storage (BECCS) is one of the key CDR options, providing stable and permanent carbon storage.**
Near-term targets can be met by economy wide price instruments such as carbon taxes and cap-and-trade systems, which changes the mix of technologies and mitigation options "picked from the shelf". But complementary policy measures, targeting specific technologies and mitigation options, are

[1] https://www.ieabioenergy.com/blog/publications/ws27-iea-bioenergy-eworkshop-bioenergy-and-sustainable-development-climate-change-mitigation-and-opportunities-for-sustainability-co-benefits/

needed to bring new options to the shelf and de-risk investments in early deployment stages, which is necessary for reaching stricter emission reduction target.

Potential risks of bioenergy implementation - particularly related to land use - depend on the context, scale, the way it is implemented, and the speed of implementation. A sustainable increase of bioenergy requires land use governance, policy consistency, and continuity. Energy crops can be grown as part of **integrated agricultural production systems**, such as double cropping, intercropping, and agroforestry approaches. Such integrated systems can produce food, feed, bioenergy feedstocks and other biobased products from the same land area. Moreover, energy crops can also be grown on some marginal, abandoned, or degraded lands, which can **enhance the carbon content of these soils**.
In relation to forest biomass, it needs to be considered that forest bioenergy is an integrated part of the forest product system, in which quality stemwood is used by wood processing industries (sawmills, pulp mills), while residues and lower quality wood tend to be used for energy. It is often claimed that harvesting in forests should be avoided, also outside of high-conservation-value areas, to maintain the carbon stored in the trees. However, experience in the boreal regions shows that active sustainable forest management - which includes harvests for materials and energy - can perform better in carbon storage and accumulation than unmanaged forests (with forest materials/energy providing additional climate benefits compared to their fossil counterparts). **Active forest management contributes to rejuvenation, higher growth, and drastically lowers risk of wildfires, which is becoming more prominent in warming climates.** There are location-specific trade-offs with biodiversity, which need to be managed through sustainable forest management practice.

OPPORTUNITIES FOR SUSTAINABILITY CO-BENEFITS BEYOND CLIMATE

The UN Sustainable Development Goals (SDGs) provide a valuable framework to guide national and international development, addressing environmental, social, and economic priorities. This framework is particularly relevant for the sustainable production of biomass for bioenergy or any other bio-based product in the bioeconomy, where its growth, harvest, collection, storage, transport, processing, and use can have positive and/or negative impacts on people, communities, and ecosystems. Apart from energy (SDG 7), biomass and bioenergy are mainly linked to food (SDG 2), water (SDG 6), jobs (SDG 8), efficient use of resources (SDG 12), climate (SDG 13) and land use (SDG 15). Different bioenergy applications can lead to synergies or trade-offs with several of the SDGs.

Bioenergy is inherently multi-faceted, and its sustainability is therefore context-specific, e.g., depending on the biomass feedstock, previous land use, climate and soil conditions, or management applied. Whether synergies or trade-offs with certain Sustainable Development Goals occur depends strongly on contextual factors. It is clear that some practices are to be avoided, such as extraction of agricultural or forestry residues at rates that cause severe soil degradation, or conversion of high-carbon and/or high biodiversity land into large-scale monocultures. Nevertheless, trade-offs with issues such as land use for food production or biodiversity conservation can be addressed through **good governance and best practice implementation.** Policy incentives should not just be about bridging the price gap with fossil alternatives but should also include safeguards to address potential trade-offs. Nevertheless, with the focus on potential risks, opportunities for co-benefits of sustainable bioenergy (next to energy production) are often overlooked, while they can be very important when considering local perspectives. Some examples of potential co-benefits:

Improving economic opportunities and resilience in rural areas
Biomass sourcing and processing can provide new economic and job opportunities for rural communities and regions. Biomass supply chains from forestry or agriculture typically require more (local) labour than those of fossil-based supply chains, so they have a higher contribution to local economies. Abandoned and degraded agricultural land can be revitalised, providing new sources of incomes for farmers, and improving and diversifying their livelihoods. Overall, increasing economic opportunities in rural areas can stem rural-urban drift, especially of the youth, which is particularly relevant in developing countries.

Improved land management practices and ecosystem services
An increased focus on integrated agricultural landscapes can provide important ecosystem advantages. Multifunctional perennial bioenergy crops can be part of improved land and water

management practices, adapted to different goals, e.g., through riparian buffers, windbreaks or including perennial grasses in crop rotations. With quite minimal intervention, substantial ecosystem benefits can be achieved such as a reduction in eutrophication, soil erosion, and losses of soil carbon. Integrated land management is not well-represented in global assessment models and deserves much more attention in policy making.

Improved local air quality
Using fuelwood, charcoal and organic waste in open fires and basic stoves ('traditional' bioenergy) is a major source of indoor air pollution in developing countries. Replacing these applications with more modern, efficient, and clean burning bioenergy alternatives - based on local, sustainably-sourced biomass - would have tremendous health benefits through the reduction of smoke inhalation in these regions. Similarly, in several countries open-air burning of crop residues is still common practice, leading to serious air pollution. Redirecting these residues to modern bioenergy applications can also have important impacts on local air quality.

Biomass as part of a circular economy approach
Biomass production, sourcing, and its use for materials and/or energy is part of a circular economy approach, providing regenerative resources instead of relying on fossil and depletable resources. The use of waste or residue biomass for bioenergy also contributes to the circularity of agricultural systems and can have co-benefits for surrounding ecosystems in terms of proper waste management.

Communication on good practice and good governance is key!
Enabling environment and supporting policies are always necessary and require awareness among policy makers at various levels. **Communicating good practice and win-win approaches** is key, accompanied by appropriate capacity building and governance. International cooperation and transparent governance structures and procedures are needed to disincentivize negative social and environmental impacts and enable development that responds to needs and perspectives of a wide range of stakeholders.
We need to inform policy makers how policy design and governance can manage trade-offs, and highlight good practice examples on how they can solve existing problems and contribute to benefits such as rural job creation, supporting ecosystems and create a local alternative for fossil fuels. Messages should be simple and should connect good practices with local conditions, in language that is meaningful to the audience.

WORKSHOP
Session 1: Bioenergy and climate change mitigation

Session moderators:
- **Jim Spaeth**, US Department of Energy, and chair of the Biofuture Platform
- **Paolo Frankl**, Head of Renewable Energy Division at the International Energy Agency

Modern bioenergy is currently the largest source of renewable energy in the world and is expected to grow substantially as one of complimentary pathways to support decarbonization initiatives to limit global warming by 1.5°C. Given these trends, it is expected that there will be a significant increase in sustainably sourced biomass as bioenergy systems are adopted under national climate change and circular economy policies. This session examined debates surrounding the contribution of bioenergy to climate change mitigation.

An opening poll was launched to the audience to indicate the most important role that biomass would have at the longer term.

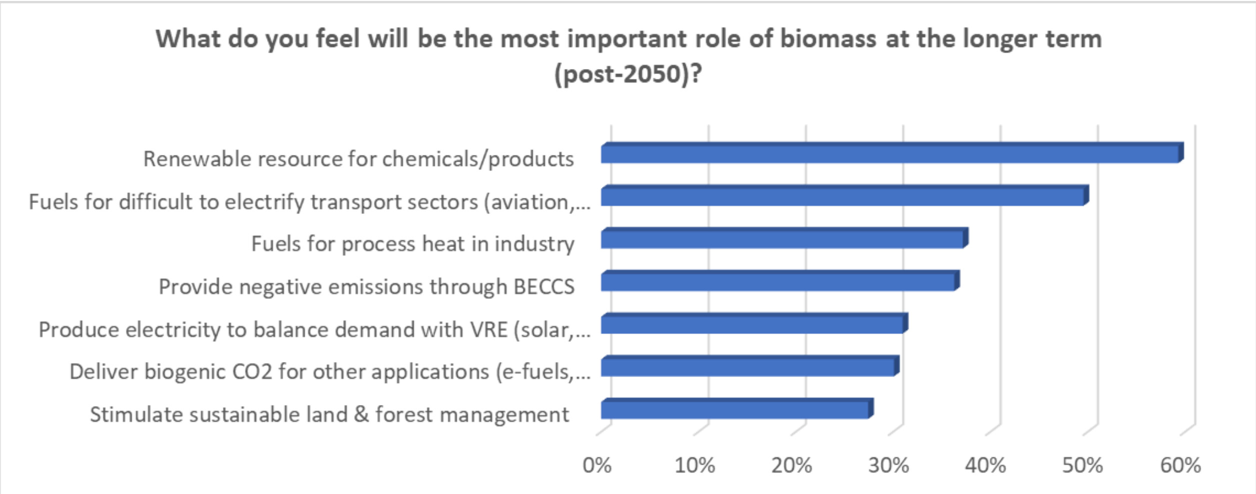

Figure 1: result of audience poll on most important role of biomass at the longer term (max 3 selections per participant – 113 participants answered).

Most support (almost 60%) was for using biomass as renewable resource to produce carbon-containing chemicals and products. Almost half of the participants also highlighted the application as fuel in difficult to electrify transport sectors (such as aviation and marine). Use of biomass for industry process heat and negative emissions through BECCS were indicated by 35% of the participants.
The other options were also considered important, with almost 30% of participants selecting the option.

IPCC CLIMATE CHANGE 2022 WG III REPORT: SOME KEY FINDINGS AND THE ROLE OF BIOENERGY

Andy Reisinger, IPCC Vice-chair WG III (Mitigation of Climate Change)

In April 2022, IPCC Working Group III – Mitigation of Climate Change - published its part of the 6th IPCC Assessment Report[2]. There is evidence that climate policy works if applied consistently; however, staying below 1.5°C global warming is unlikely with current and planned climate actions of the countries around the world. Limiting warming to 2°C is not infeasible, but only with rapid acceleration of mitigation actions. Net negative greenhouse gas (GHG) [3] emissions in the second half of the century would help to recover from a temperature overshoot and draw global temperatures down again to 1.5°C above pre-industrial levels.

The deployment of carbon dioxide removal (CDR) to counterbalance hard-to-abate residual emissions is unavoidable if net zero or net negative GHG emissions are to be achieved. However, CDR cannot substitute for deep emission reductions that are needed in the short term. CDR can contribute to mitigation scenarios in the following three phases (see figure):

(1) *near-term*: contribute to stronger reduction of net emissions
(2) *mid-term*: counterbalance hard-to-abate emissions to achieve net-zero CO_2/GHG emissions
(3) *long-term*: achieve net negative CO_2 and GHG emissions to reduce global temperatures

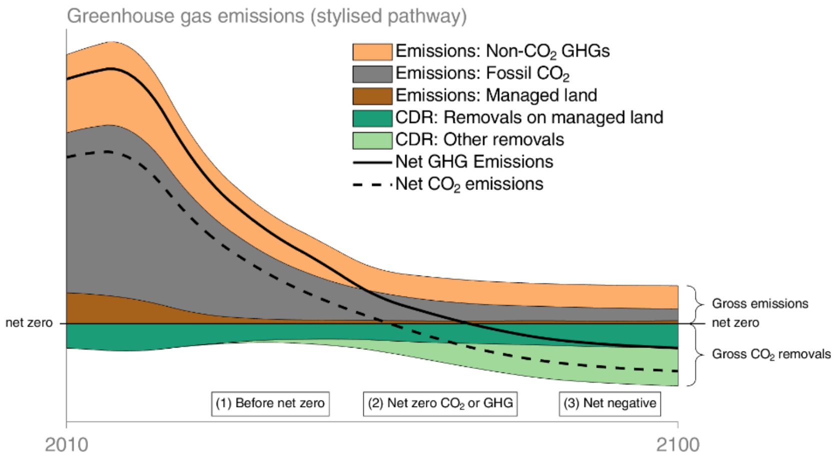

Figure 2: Illustration of the different phases in climate change mitigation. Source: IPCC WG III, 2022

There are different mitigation pathways, but all of them include **substantial amounts of bioenergy**, even the ones which exclude BECCS (bioenergy combined with carbon capture and storage). In scenarios that limit warming to 1.5°C, bioenergy represents between 15 and 30% of primary energy by 2050 - compared to 10% currently - depending on the specific scenario and its assumptions and design. Apart from using waste and residues, this also implies substantial areas of energy crops - up to 500 million hectares of land in the longer term, depending on the scenario and limits posed upon the use of biomass. Energy crops will preferably be grown on marginal or abandoned lands, and as part of integrated agricultural production systems. Integrated Assessment Models struggle with representing mixed land uses, so modelled land-use changes need to be treated with care.

Bioenergy is versatile with strong co-benefits if integrated well across multiple dimensions and scales. However, there is an ambivalence around bioenergy. Potential risks of bioenergy implementation - particularly related to land use - depend on the context, scale, the way it is implemented and the

[2] IPCC WG III - Climate Change 2022: Mitigation of Climate Change. Full report available at: https://www.ipcc.ch/report/ar6/wg3/

[3] GHG emissions includes CO_2 *and* non-CO_2 greenhouse gas emissions, such as CH_4, N_2O

speed of implementation. Managing these risks requires policy consistency and continuity. Participatory stakeholder engagement is needed on land system governance, to agree locally-relevant objectives and approaches to balance multiple competing land uses for food/feed production, energy and bio-based products, and conservation, considering practices such as land sparing/sharing, and also measures that reduce pressure on land such as dietary changes and reduction in food loss and waste, as well as the need for fulfilling livelihoods.

Overall, biomass potentials are not unlimited. Land use and climate policies should be designed to ensure consideration of alternative uses of biomass and encourage optimal use in the specific context.

NECESSITY AND REGULATORY OPTIONS FOR CO2 WITHDRAWAL

Sabine Fuss, Mercator Research Institute on Global Commons and Climate Change (MCC) & Professor at Humboldt University, Germany

As was concluded in the IPCC WG III report (see previous presentation), carbon dioxide removal (CDR) will be unavoidable to counterbalance hard-to-abate residual emissions. The main CDR options are displayed in the following figure. There are differences related to permanence and reversibility of the carbon storage.

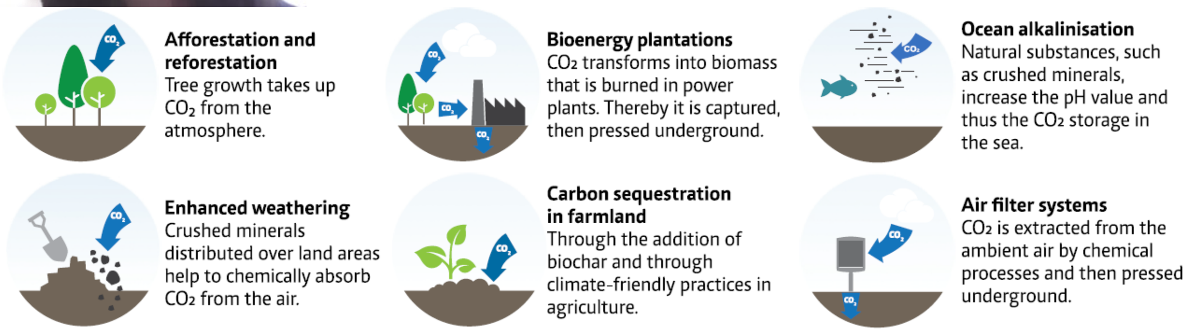

Figure 3: Different carbon dioxide removal (CDR) options. Source: Fuss et al, 2021

Bioenergy combined with carbon capture and storage is one of the key CDR options. There is also a direct connection with biochar – a co-product of biomass pyrolysis - that can be used to store carbon in the soil.
While global models start from a top-down approach and assume that large areas of land can be devoted to bioenergy crops, there is a **need for more bottom-up research to identify concrete opportunities of BECCS**. For example, capturing CO_2 emissions from large industrial biogenic point sources in Sweden could already have a substantial impact on Swedish national CO_2 emissions, at limited marginal abatement cost (often less than 100 €/t CO_2 for capture and storage combined).

CDR needs policy instruments to regulate their deployment, providing incentives that reflect the societal benefit of the various carbon dioxide removal methods. **CO_2 pricing is an effective instrument to incentivize CDR scaling and can lead to a cost-optimal CDR portfolio.** When also accounting for emissions in the land sector, problems with indirect land use change can be substantially reduced. Next to incentives, other externalities – negative, but also positive - have to be addressed through accompanying regulation.

Incentives can be either *result-based* (i.e., based on the actual CO_2 removed, e.g., through geological storage), or *action-based* (i.e., based on measures taken, with an estimation of CO_2 removal, e.g., in land use and forestry), with the latter more uncertain about the actual impact. There is a tendency in many European countries to focus on natural solutions, e.g., afforestation/reforestation, to offset residual emissions in certain sectors. These measures are less costly than technology measures and have some co-benefits, but there are concerns in terms of permanence/reversibility of carbon storage and additionality (does it do more than was already originally planned?), so monitoring and verification are crucial. The low cost of these nature-based solutions is also feared to undermine investment in more expensive mitigation options and technological solutions with more stable and permanent storage, potentially counting on the global South to deliver the needed resources and nature-based offsets. Unwanted interactions between mitigation and removals could, however, be addressed with the right governance architecture, e.g., separating targets.

We need a **healthy mix between nature-based, land-based and technology-based CDR solutions**. Any time we can buy is valuable so we should not dismiss short to medium term carbon storage options; on the other hand, technology-based solutions are also crucial. Learning curve effects for technology-based solutions can be exploited by creating a niche market at an early stage with credible CO_2 prices, e.g., auctioning a portfolio of technology options to reach critical market size and diversity of options (BECCS, DACCS, enhanced weathering).[4]

Before going to the next presentation, a poll related to forest management (in connection to the next speaker) was launched to the audience. Certain groups – particularly eNGOs – often claim that harvesting in forests should be stopped/drastically lowered, also outside of high-conservation-value areas, to maintain the carbon stored in the trees.

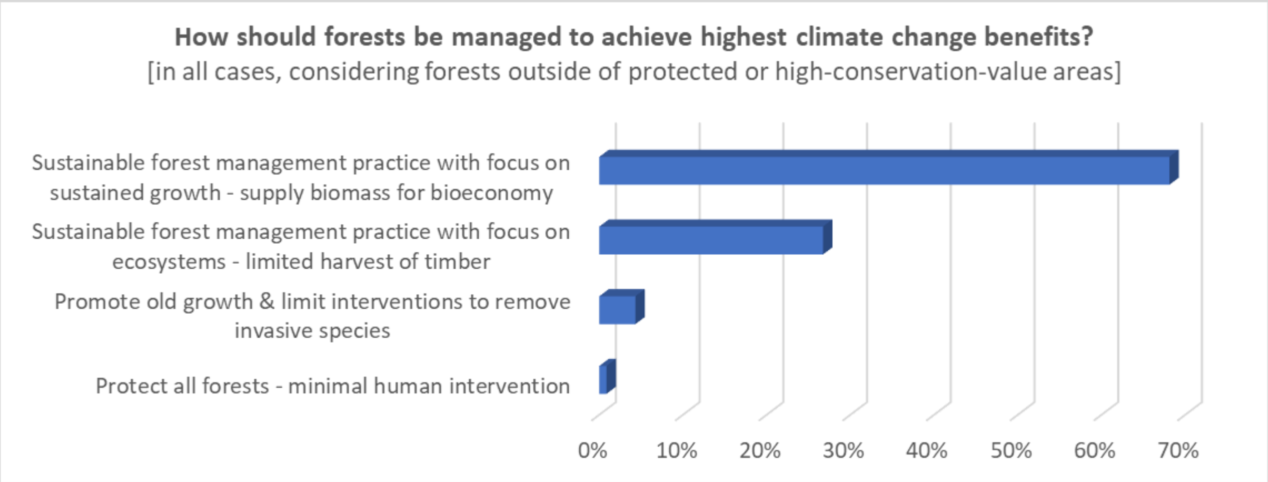

Figure 4: result of audience poll on how forest should be managed to achieve highest climate benefits (one selection only per participant – 116 participants answered).

The audience clearly viewed sustainable forest management practice with focus on sustained growth (including harvesting biomass for bioeconomy areas) as the most impactful for climate change mitigation. Mind that most of the audience had a bioeconomy research background, so the results cannot be considered representative for a wider audience (which is also influenced by media campaigns).

[4] Based on report *Fuss et al. (2021): CO2-Entnahmen: Notwendigkeit und Regulierungsoptionen.* (in German) available at: https://www.wissenschaftsplattform-klimaschutz.de/files/WPKS_Gutachten_MCC_PIK.pdf

SUSTAINABLE BOREAL FOREST MANAGEMENT – CHALLENGES AND OPPORTUNITIES FOR CLIMATE CHANGE MITIGATION

Florian Kraxner, Research Group Leader Agriculture, Forestry and Ecosystems Services at IIASA (Austria), President of the International Boreal Forest Research Association (IBFRA)

A recent study of IBFRA, the International Boreal Forest Research Association, analysed how forestry in the Boreal region can contribute to climate change mitigation.[5] The study compared carbon stock changes of boreal forests from 1990-2017 in six countries/states, and documented the intensity of forest management and incidence of natural disturbances. The forest area in these countries has not (materially) changed during this period.

The figure below shows the carbon stocks in living biomass (dark green) and carbon in cumulative harvests (yellow) in the analysed regions (data for Alaska available up to 2009). The harvested carbon provides long-lived timber (substituting energy-intensive products such as steel), new fibres for paper/cardboard, and residues for bioenergy to displace fossil fuels.

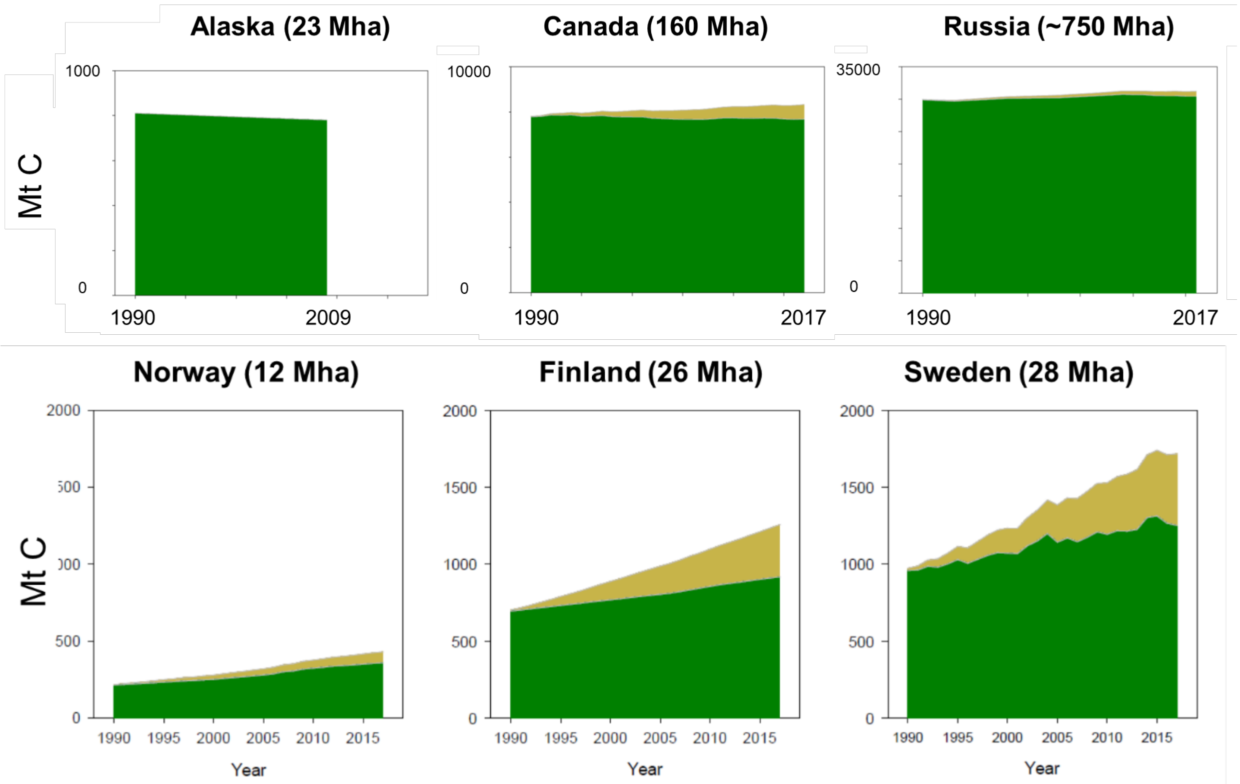

Figure 5: Carbon stocks in living biomass (dark green) and carbon in cumulative harvests (yellow) – data Alaska available up to 2009. Source: IBFRA, 2021.

- In the three Scandinavian countries - where some 70-80 % of the forests are in active management for wood products - there has been a significant accumulation of carbon in living trees and in soils despite harvests of around 1.5 % of living tree biomass per year. Around 0.01 % of the forest land burns every year.

[5] Full report: P. Högberg et al. (2021) Sustainable boreal forest management – challenges and opportunities for climate change mitigation. IBFRA report 2021/11.
Available at: http://ibfra.org/wp-content/uploads/2022/01/rapport-2021-11-sustainable-boreal-forest-management-challenges-and-opportunities-for-climate-change-mitigation-002-1.pdf

- In Canada and Russia, a much smaller fraction of the managed boreal forests is harvested annually. There have been small changes in carbon in living trees and in mineral soils. Around 0.5 % of the forest land burns every year.
- In Alaska, the boreal forests are not harvested, but losses of carbon in fires are large (around 0.6 % per year of the land burns) and there has been a decline in carbon in living tree biomass.

The results demonstrate clearly that active forest management - which includes harvests for materials and energy - in the boreal forest performs better in carbon storage and accumulation than unmanaged forests. It contributes to rejuvenation, higher growth, and has drastically lowered incidence of wildfires (which are becoming more prominent in warming climates). Of course, there are trade-offs with biodiversity (location specific), which are also considered in sustainable forest management practice.

KEY DETERMINANTS OF THE CLIMATE EFFECTS OF BIOENERGY

Annette Cowie, Principal Research Scientist Climate at the New South Wales Department of Primary Industries (Australia)

A fundamental difference between fossil energy and bioenergy systems is that fossil energy transfers carbon from geological storage and causes permanent increase in atmospheric CO_2, while bioenergy systems operate within the short-term biosphere-atmosphere system, with continuous exchange of CO_2.

In the analysis of climate effects, it is important to ask the relevant question. When considering forest biomass, the research question is often expressed as '*How will **GHG emissions** change if forest biomass is used instead of fossil fuels?*'. This implies a narrow system boundary, e.g., only considering smokestack emissions instead of the full life cycle, thereby claiming that burning biomass is worse than coal. Moreover, forest biomass used for energy should not be considered as isolated from other forest products and activities.
A better question is "*how will **atmospheric GHG concentration** change if forest biomass is used instead of fossil fuels, cement, steel, plastics, and other materials?*" Forest bioenergy is an integrated part of the forest product system, where quality stemwood is used by wood processing industries (sawmills, pulp mills); part of the residues and lower quality wood tend to be used within these industries for internal energy requirements, part are converted to chips or pellets which can be used for (district) heating and/or bio-electricity or transport biofuels.

The climate impact of bioenergy systems depends on:
1. ***Feedstock***: whether the biomass is derived from residues (from industry, forestry, agriculture), waste, or dedicated plantings. For the latter category, the production system itself (type of land, need for fertilisers, …) is of crucial importance.
2. ***Technologies and products***: conversion efficiency of the process, but also the fate of co-products, which may displace GHG intensive products or can lead to durable carbon storage (e.g., in biochar or geological storage of CO2 captured).
3. Impacts compared to a ***reference system*** – *i.e., scenario where the biomass is not used for energy* - in terms of how additional use of forest-based biomass for energy influences the forest and soil carbon stocks, land use, the energy system and building products.

Different studies on the climate impact of bioenergy systems, particularly forest-based biomass, have produced varying results. Differences are partly due to methodological choices, particularly the system boundaries considered (in time and space) and the assumed reference land use system and the energy system. For example, some studies consider a 'no harvest' scenario as reference (*which would require regulations/incentives to prevent private forest owners from harvesting*). The overall analysis should not only look at the carbon storage in the forest, but also consider GHG emissions saved through the substitution of fossil fuels and GHG intensive building materials. In some cases there may be an interim period – which could be a few decades – during which the 'no harvest' option appears more advantageous for the climate than the option in which forests are harvested for products including bioenergy. However, growth in conservation forests will saturate as they mature, and risks for disturbances such as wildfires are higher, so there is an inherent uncertainty for the carbon stored in conservation forests.

Greatest climate benefits are achieved for bioenergy systems when:

- biomass is derived from waste and residues, or from energy crops integrated within the agricultural, forest and ecological landscape.
- there is efficient conversion to products and energy carriers, with bioenergy displacing GHG intensive fuels, and co-products displacing GHG intensive products.
- biogenic CO_2 is captured and stored durably.
- biomass demand stimulates enhanced forest management resulting in increased forest carbon storage and uptake, less risks of fires or other disturbances, or revitalisation of degraded lands which can increase carbon in soils.
- bioenergy is used to provide flexibility in the energy system and thereby support the expansion of other renewables (e.g., variable renewables such as solar and wind) to accelerate the energy system transition away from fossil fuels.

PANEL DISCUSSION

The panel session was moderated by Paolo Frankl; all speakers participated.

Just before the panel discussion a third poll was launched to the audience on what policies or actions are needed to stimulate the deployment of bioenergy and BECCS to fulfil their role in climate change mitigation.

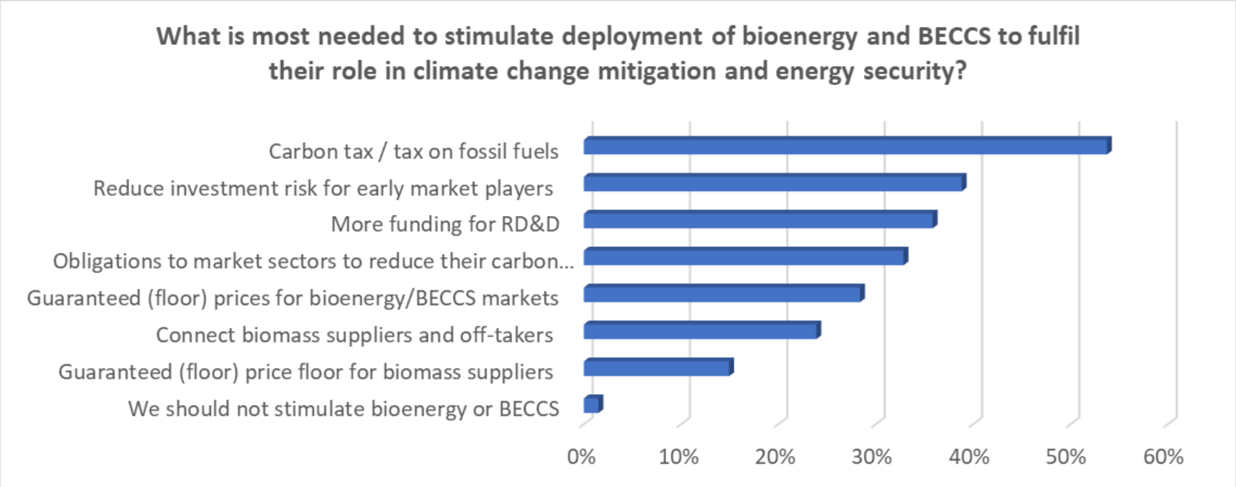

Figure 6: result of audience poll on what is most needed to stimulate deployment of bioenergy and BECCS (max 3 selections per participant – 67 participants answered).

*Top priority indicated by participants is that a **carbon tax or carbon price** should be applied to all fossil carbon extraction and emissions, to internalize their social cost of carbon.*
*Many participants also recognized the need to support R&D and **deployment of new technologies**, and particularly measures to reduce investment risks to bridge the valley of death for early market players investing in new technologies.*
*Other options highlighted by around 30% of the participants were more **market related regulations**, such as obligations for market actors to reduce their carbon footprint, or guaranteed floor prices for bioenergy/BECCS markets to cover risks of low energy prices.*

Specific topics came up in the panel, based on the questions from the audience:

Is land use for bioenergy problematic?
Waste and residues will not be sufficient for the role that is expected from biomass, so there will be a need to use land for energy crops. Land use for biomass production is often emphasized as a negative point for bioenergy/BECCS, although there can also be positive land use changes, e.g., when the cultivation of bioenergy crops leads to higher levels of soil carbon.
Participatory stakeholder engagement is needed on land system governance, to agree locally-relevant objectives and approaches to balance multiple competing land uses for food/feed production, energy and bio-based products, and conservation, considering practices such as land sparing/sharing, and also measures that reduce pressure on land such as dietary changes and reduction in food loss and waste, as well as the need for fulfilling livelihoods.
Energy crops will preferably be grown on marginal or abandoned lands, which can also provide economic opportunities in rural areas and improve the livelihood of farmers. Importantly, energy crops can also increase carbon in soils, revitalising degraded lands and contributing to "Land Degradation Neutrality" (LDN), one of the sustainable development goal (SDG 15.3).
To minimise the risk of adverse effects on food production, energy crops can be grown as part of **integrated agricultural production systems**, through strategies such as double cropping, intercropping, and agroforestry approaches. Such integrated systems can produce food, feed, bioenergy feedstocks and other biobased products from the same land area. They can also enhance biodiversity and mitigate land use impacts such as soil erosion, soil compaction, salinization, and eutrophication of surface waters.
Such integrated land management is not represented in global assessment models and deserves much more attention in policy making.

How can the developing world / African countries seize bioenergy opportunities?
Unsustainable use of biomass (implying overextraction of biomass and inefficient/high polluting use) is a big issue in developing countries. On the other hand, there are large opportunities for bioenergy if managed well, as certain regions have great growing conditions. It is important to develop skills (also to safeguard ecosystems) and work together with local experts in bottom-up initiatives. Best practice examples are important to consider to get a clear picture of what works in a certain region/climate. The aim should not be to keep people out of the forest, as this is part of their livelihoods, but seize opportunities adhering to sustainable conditions.

Climate finance can play a critical role to provide resources to safeguard ecosystems, develop local good practice and provide credible alternatives for traditional use of biomass. Land degradation is often connected to illegal practice, so it is also crucial to enforce land use regulations.

Climate impact of forest biomass – is it compatible with the urgency for climate action?
There may be an interim period when conservation of forests (*particularly forests that are still at growing stage*) looks more advantageous for the climate than managing them. So, the question was posed if, considering the urgency for climate action, it is better to focus on short term impact and stop harvesting from forests. Some arguments were provided:

- Models of carbon increment (sink strength) in unmanaged forests often don't consider the impact of disturbances like wildfire or disease, which are risks that increase with warming climates. So, the picture of 'no harvest' scenarios and the carbon storage and sink provided in unmanaged forests is often too optimistic. The IBFRA study has clearly shown for the Boreal area that unmanaged forests have lower growth and higher levels of wildfire.
- Climate change mitigation does not stop in 2050. Many climate solutions require an upfront carbon investment to achieve important savings in the medium to long term (e.g., battery manufacturing to support electrification of car fleets, building rail infrastructure and district heating networks). Too narrow short-term perspectives can make long-term climate goals more difficult to achieve.
- Dismissing forest products that replace fossil-based fuels and high GHG intensity materials prolongs our reliance on fossil resources, while it is of utmost importance to urgently transition away from fossil resources – for climate and energy security reasons.
- Trees are planted and forests are managed with a long-time perspective (>50 years). With changing climates, the focus in forestry is shifting to more resilient tree species and forest systems as well as finding suitable areas for afforestation. But the main climate impact of these actions

will be in a few decades from now. So, **apart from preventing deforestation, a narrow focus on short term (<10 yrs.) impacts is not appropriate for forest systems**. The focus should be on long term sustainable forest management to keep forests healthy - which includes reducing the risk of forest fires and other disturbances - and sustain production that can be used for the bioeconomy. This goes along with biodiversity objectives, such as the protection of certain areas with high conservation value.

How to convince critics that bioenergy should be part of the portfolio for climate action?
Current debates in the media are often based on simple black-white arguments (e.g., harvesting in forests being perceived as destroying forests, or that any use of land is bad), while the reality is much more nuanced. People often do not adopt a landscape perspective and just conceptualize what happens at tree level, without considering how any harvesting fits in overall forest management. Misconceptions of on-the-ground forestry practice and oversimplifications are creating a difficult atmosphere for acceptance and further deployment of bioenergy.

We should:

- Engage in debates and develop knowledge and approaches to address specific concerns.
- Develop a good 'taxonomy' for scientists. We need to use as simple language as possible to keep issues understandable for the public and policy makers, always starting from a fact-based background.
- Highlight good practices connected with local conditions that people can grasp, instead of talking about theoretical systems/concepts.
- Make it concrete what good land/forest governance and policies mean, preferably in connection to local conditions, and how biodiversity issues are considered.
- Help people understand bioenergy from a system perspective, that biomass is part of sustainable forest management (in conjunction with forest products) or sustainable land management (in conjunction with food) and highlight the specific assets of bioenergy to accelerate the transition away from fossil fuels.
- Avoid playing out climate solutions against each other. We need a healthy mix between nature-based, land-based, and technology-based CDR solutions, thereby recognizing the pros and cons of all options, and their complementarity. The same goes for other options: it is important to stress the complementarity of bioenergy with variable renewables, of renewable fuels with electric vehicles, … The common goal is to reach net zero GHG emissions and phase out fossil fuels.
- It was suggested that in the short run there should be focus on land saving policies and avoiding the increase of demand for land. So, the short-term focus should be to get on with 'no-regret' solutions, without dismissing longer term solutions.

Session 2: Sustainability co-benefits of bioenergy beyond climate

Session moderators:
- **Michela Morese**, Executive Secretary of the Global Bioenergy Partnership (GBEP)
- **Maria Murmis**, Advisor in international cooperation projects and programs at the Ministry of Agriculture, Argentina

The UN Sustainable Development Goals (SDGs) provide a valuable framework to guide national and international development, embodying the importance of developing holistic policies that address environmental, social, and economic priorities. Such an approach is particularly important for the sustainable production of biomass for bioenergy or any other bio-based product in the bioeconomy, where its growth, harvest, collection, storage, transport, processing, and use can have positive and/or negative impacts on people, communities and ecosystems. The presentations in this session considered the impact of bioenergy and biomass supply chains on different SDGs.

As food for thought, the session started with a first poll to the audience on what they felt were the most important potential co-benefits of biomass supply.

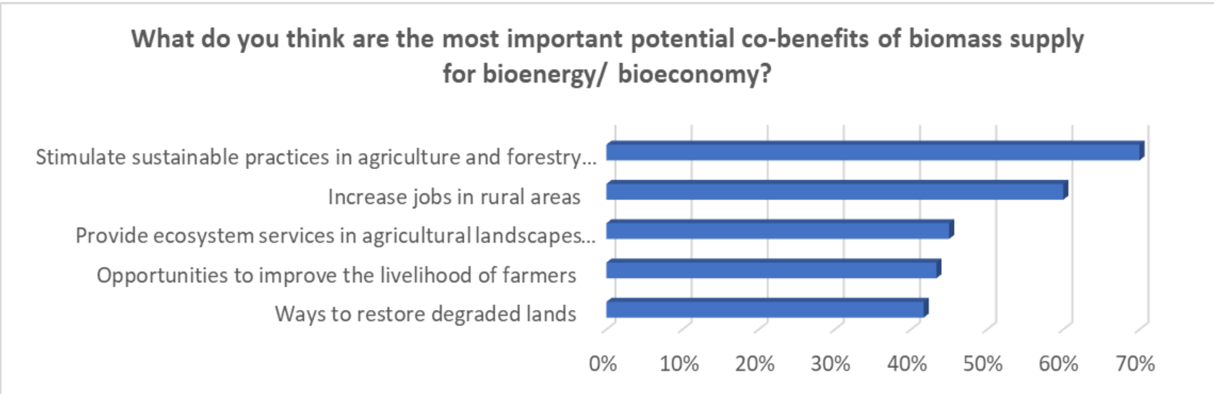

Figure 7: result of audience poll on the most important potential co-benefits of biomass supply (max 3 selections per participant – 60 participants answered).

The participants indicated as most important co-benefit that sustainability requirements coming the bioenergy/bioeconomy side could stimulate sustainable practices in agriculture and forestry. Next to that, socio-economic opportunities (rural jobs, livelihoods), as well as providing ecosystems services all received relatively high support.

LINKAGES BETWEEN SUSTAINABLE BIOENERGY AND SDGS

Olivier Dubois, Senior Natural Resources Officer and Coordinator of the Energy and Bioeconomy Programmes of FAO

Blair et al (2021)[6] evaluated the relationships between bioenergy and related biomass supply chains and the SDGs. In reviewing different case studies, it was found that, apart from energy (SDG 7), biomass and bioenergy is mainly linked to food (SDG 2), water (SDG 6), jobs (SDG 8), efficient use of resources (SDG 12), climate (SDG 13) and land use (SDG 15).

There are many context-specific trade-offs and synergies of biomass supply and bioenergy generation with the different SDGs.

In terms of ***food security*** there are synergies and trade-offs. There may be competition for land use for food and bioenergy. However, biofuel crops also provide protein-rich by-products that are used as animal feed. Moreover, farmers have more options to use their land (also the lower productive parts) which can increase their income and livelihood. Crop-based biofuels are not necessarily good or bad for food security (which is related to food prices, but also farmers' livelihoods); this very much depends on local circumstances.

In terms of ***land use***, some practices are to be avoided, such as overextraction of agricultural residues, conversion of high-carbon and/or high biodiversity land or switching to large mono-cropping. On the other hand, bioenergy is the only type of renewable energy that can contribute to land rehabilitation and soil carbon sequestration through the use of biochar or biogas slurries, mixed cropping systems (e.g., agroforestry, intermediate cropping), phyto-remediation and the use of invasive species as feedstock. Multipurpose use of land (bioenergy + food crops or other types of renewables) can help reduce the land footprint of bioenergy and other renewables. And there are also positive types of land use change.

What matters most is that bioenergy/biofuels are produced in a sustainable way; tools and good practice guidelines exist for that.

Bioenergy is inherently multi-facetted and its sustainability is therefore context specific. Co-benefits of sustainable bioenergy are often overlooked and there are ways to address trade-offs. Policies and regulations should start from a robust and contextualised assessment of the situation and potential, not only based on global models.
It is important to use and improve existing tools (e.g., GBEP indicators, FAO-BEFS approach) to assist in the quantitative reporting and evaluation of bioenergy systems to better inform investors and policy makers and help them go beyond their sectoral silos. A water-energy-food-climate nexus approach is to be applied in developing sustainable bioenergy.

EXAMPLES OF BIOENERGY CONTRIBUTING TO RURAL DEVELOPMENT AND LAND RESTORATION IN DEVELOPING COUNTRIES

Constance Miller, Global Bioenergy Partnership (GBEP)

Developing countries need an immediate but gradual shift away from traditional bioenergy and fossil fuels towards modern, sustainable bioenergy as part of a circular economy approach. Modern bioenergy has many co-benefits across the value chain from biomass supply, pre-treatment/transformation, bioenergy production and use, and the valorisation of by-products.

[6] J. Blair et al (2021). Contribution of Biomass Supply Chains for Bioenergy to Sustainable Development Goals. Open access article in the Journal *Land. Available at:* *https://www.mdpi.com/2073-445X/10/2/181*

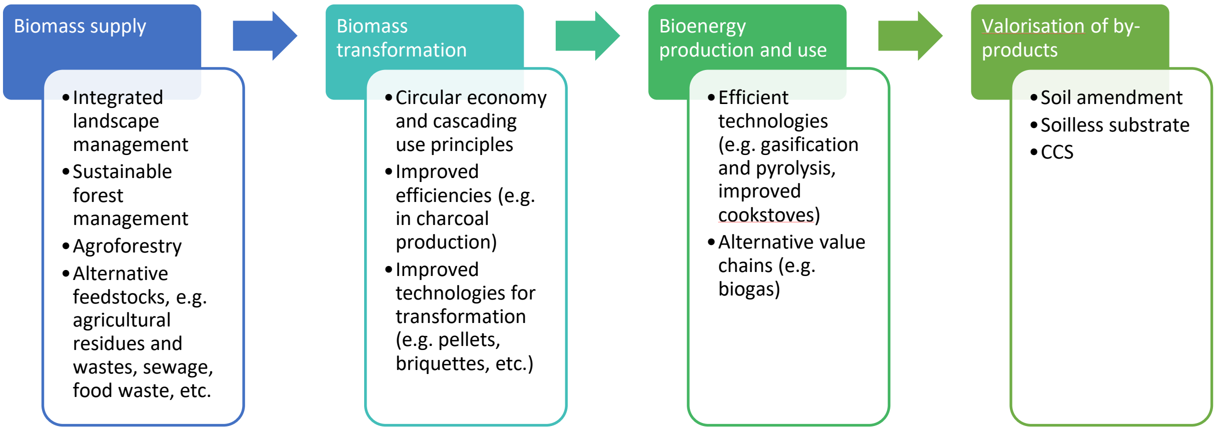

Figure 8: Potential improvements across value chains from biomass supply, pre-treatment/transformation, bioenergy production and use, and the valorisation of by products

GBEP has gained an understanding of these co-benefits in practice, both as part of the measurement of GBEP Sustainability Indicators in various countries[7, 8], but also through the collection of case studies[9]; a few were highlighted in this presentation.

Deployment of micro-gasifier cookstoves for cooking and biochar in Ghana
This concept provides lower cost fuel, reduces health problems, reduces pressures on local forest resources, contributes to community waste management, provides biofertilizer for agriculture and stores carbon in soils through biochar. It also provides direct and indirect job creation in the value chain.
Lessons learned: Access to investors is key, and this should be combined with training to local farmers in making biofertilizer and engagement in process to address agricultural market bottlenecks.

Rural development and land restoration in Kenya - invasive species
This concept reduces pressure on indigenous woodlands and produce sustainable charcoal to meet growing demand. It opens invaded areas for multiple land uses, and results in increased standing biomass, enhanced species diversity and more resilient livelihood systems.
Lessons learned: a conducive enabling requirement is required with appropriate governance of charcoal production.

Valorisation of livestock wastes - biogas from pig manure in Viet Nam
This concept reduces household energy expenditure, reduces the time for collecting fuelwood, reduces exposure to indoor air pollution and related health risks and creates demand for skilled jobs.
Lessons learned: There is a need for awareness raising on the use of biogas and its by-products. Knowledge is to be improved in the operation of anaerobic digestion to ensure benefits and reduce risks (digestate discharge, methane leaks and poor efficiency).

Anaerobic digestion of POME in Indonesia
Palm oil mill effluent is typically left to decompose in open ponds, with high methane emissions and water/soil contamination. This concept would substantially reduce methane emissions and therefore the GHG lifecycle emissions of the main product, reduce the dependency on fossil fuels, reduce soil contamination, improve water quality, and enhance access to modern energy services.

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[7] FAO (2018): Sustainability of biogas and cassava-based ethanol value chains in Viet Nam. Available at: https://www.fao.org/3/i9181en/I9181EN.pdf

[8] GBEP/FAO (2014): Pilot Testing of GBEP Sustainability Indicators for Bioenergy in Indonesia. Available at: https://www.fao.org/3/i4059e/i4059e.pdf

[9] GBEP (2020) Collection of examples: Positive Relationships between Sustainable Wood Energy and Forest Landscape Restoration. Available at http://www.globalbioenergy.org/fileadmin/user_upload/gbep/docs/AG4/AG4_Collection_of_examples_links_sust._wood_energy_and_FLR_June2020.pdf

Lessons learned: POME anaerobic digestion must be incentivised through both waste regulation and biogas/biomethane incentivisation policies.

Some overarching factors that can lead to success:

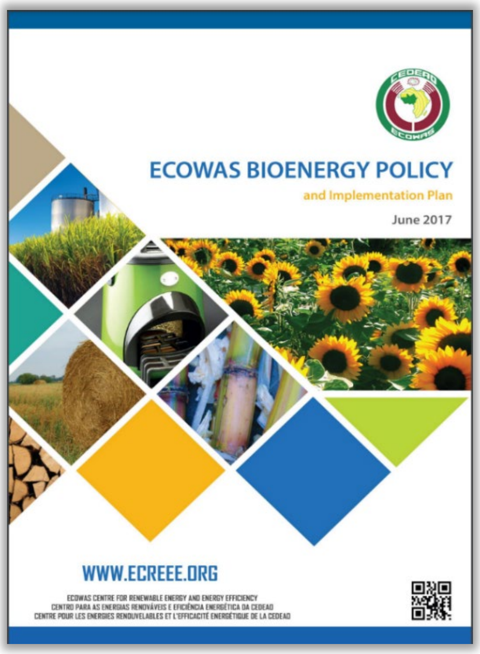
- Understanding of system dynamics to enhance positive synergies
- Short value chains embedded in local stakeholder priorities, focusing on solving existing problems, as identified by stakeholders
- Valorisation of residues and wastes, and with stakeholder ownership
- Accompanied by appropriate capacity building
- Enabling environment and supporting policies are always necessary (requiring awareness among policy makers at various levels).

CO-BENEFITS OF BIOENERGY IN THE ECOWAS REGION (WEST AFRICA)

Bah Saho, Acting Director of the Ecowas Centre for Renewable Energy & Energy Efficiency (ECREEE)

More than 70% of the over 350 million inhabitants of the ECOWAS region rely on bioenergy (firewood and charcoal) for their daily heating and cooking. The production and utilization of biomass is predominantly done by traditional means. Ecological impacts that accompany the sourcing and use of biomass are significant, i.e., forestlands destruction, and health issues with open fires.

West Africa has significant biomass resource potential but while biomass sourced from purpose-grown crops is on the increase in some of the developed world, biomass for energy is still sourced from natural woodlands in this region. Sustainability challenges are huge and prominent, and have
led to policy and regulatory framework developments.



An Implementation Plan for a Regional Sustainable Bioenergy Policy for the Ecowas region was adopted in 2017[10]. It aims to improve food and energy security through the deployment of sustainability criteria in the production, transformation, and utilization of biomass resources. The initiative complements the West Africa Clean Cooking Alliance (WACCA).

The implementation of the ECOWAS Bioenergy Policy promotes sustainability in the regions of livelihoods development. **When bioenergy supply chains are implemented appropriately and integrated with existing systems, they can have overwhelmingly positive contributions towards human livelihoods.** Focus is on setting up agricultural biomass supply chains (energy crops and residues), waste and forest supply chains, promoting sustainable biofuels to substitute fossil fuels and traditional use of biomass.

[10] ECREEE (2017). ECOWAS Bioenergy Policy and Implementation Plan. Available at: http://www.ecreee.org/sites/default/files/ecowas_bioenergy_policy.pdf

The development of bioenergy systems in rural and indigenous communities also provides other socio-economic co-benefits, such as

- employment and income generation
- youth and gender empowerment
- stemming rural-urban drift especially of the youth
- improving health from reduced smoke inhalation (women & children) and
- reduce the danger associated with collection of firewood.

BIOECONOMY CONTRIBUTIONS TO SUSTAINABLE DEVELOPMENT IN LATIN AMERICA AND THE CARIBBEAN COUNTRIES

Eduardo Trigo, Advisor to the Bioeconomy and Production Development hemispheric program of IICA, the Interamerican Institute for Cooperation on Agriculture

The bioeconomy is increasingly recognized as a relevant strategy in the context of the 2030 Agenda for Sustainable Development. It is a strategic contributor to several Sustainable Development Goals in terms of: regenerative and circular economy production models (instead of fossil based); practices that contribute to environmental sustainability and resilience while adding productivity and efficiency; bioremediation to face environmental contamination problems; increased economic activities in rural territories.

Latin America and the Caribbean Countries (LAC) are well positioned to take advantage of what the bioeconomy offers, having high availability of lands with agricultural potential and 35% of the world's total freshwater reserves. The region also has a well-developed base in science and technology, with significant capacities in the biology and biotechnology.

In this context in LAC there are significant developments in key areas for rural development: bioenergy, biotechnology, and carbon efficient production strategies.

- The region is a world leader in *biofuels*, producing 30% of all bioethanol and 20% of all biodiesel in 2019. This had positive impact on the development of rural territories (more stable demand for raw materials) and provided a critical source of jobs.
- The region was an early adopter of *biotechnology*; today it is the leading developing region in agricultural biotech use. Over 80% of the area of major crops (corn, soybean, cotton) is GM based with higher productivity and better resilience.
- The region is also leader in *carbon efficient agricultural production strategies*, with more than 80 million hectares under no-till agriculture. Several certification processes and labels are applied to certify the carbon footprint of food crop and beef production.

Overall, in Argentina, the bioeconomy represents 16% of GDP – creating an added value of 86 billion USD - and 12% of employment.

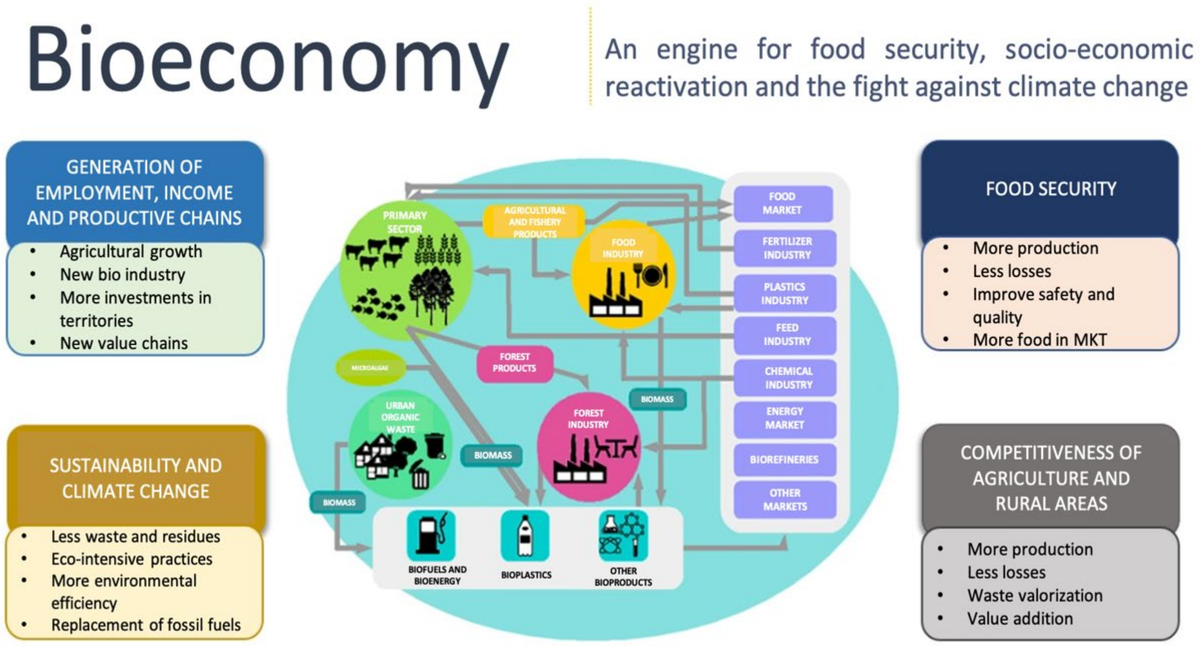


Figure 9: Overview where the bioeconomy can make a difference in socioeconomics, food security, sustainability and climate change, and competitiveness

INTEGRATION OF BIOENERGY CROPS IN AGRICULTURAL LANDSCAPES TO PROVIDE ECOSYSTEM SERVICES

Blas Mola-Yudego, Senior Researcher at the University of Eastern Finland

Ongoing and emerging narratives of climate change mitigation, emerging bioeconomy applications and energy/food independence are adding urgency to the production and use of biomass.

A solution to work towards higher production of biomass is *multifunctional and strategic deployment and planning*. **There is a portfolio of commercially viable biomass production systems (perennial plantations and grasses), which can co-produce several ecosystem services in addition to biomass.** There is a strong scale and spatial dimension to this.

Next to the provision of biomass, multifunctional perennial bioenergy crops can address simultaneously several ecosystem services, such as eutrophication, soil erosion, and losses of soil carbon.[11] Examples of multifunctional production systems are:

- *Inclusion of grass in crop rotations with annual crops*[12]: Applying this to 16% of the crop area in Europe would produce 100 million tonnes (oven dry tonnes - odt) of biomass annually, increase soil organic carbon with 266 million tonnes by 2050 and avoid 46 million tonnes of soil erosion annually.

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[11] Englund et al (2020). Beneficial land use change: Strategic expansion of new biomass plantations can reduce environmental impacts from EU agriculture. Global Environmental Change. Available at: https://doi.org/10.1016/j.gloenvcha.2019.101990

[12] Englund et al (2022). Large-scale deployment of grass in crop rotations as a multifunctional soil-based climate mitigation strategy. Available at: https://doi.org/10.31223/X5KW5J

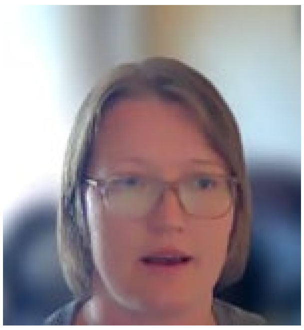
- *Riparian buffers & windbreaks*[13]:
    - Applying riparian buffers on just 0.1% of total crop area in Europe would produce 1.2 million tonnes (odt) of biomass annually and reduce N emissions to water by 13%.
    - Applying windbreaks on 0.3% of total crop area in Europe would produce 3.2 million tonnes (odt) of biomass annually and reduce overall wind related soil loss on agricultural fields by 23%.

Multifunctional perennial bioenergy crops can be part of improved land and water management practices, adapted to different goals. With quite minimal intervention, substantial benefits can be achieved. Applying such multifunctional production systems in relevant locations requires an alternative economic investment of farmers. To fit them in agricultural business models, farmers need to be rewarded (through incentives/subsidies) for the environmental and cultural services provided.

Figure 10: different examples of multifunctional perennial crop production

BIOMASS SUPPLY CHAINS AND THEIR CONTRIBUTIONS TO THE SUSTAINABLE DEVELOPMENT GOALS

- *Bruno Gagnon, Senior Science and Policy Analyst in the Canadian Forest Service at Natural Resources Canada*
- *Jean Blair, Postdoctoral Researcher at Dalhousie University, Nova Scotia (Canada)*



[13] Englund et al (2021). Strategic deployment of riparian buffers and windbreaks in Europe can co-deliver biomass and environmental benefits. Communications Earth & Environment. Available at: https://doi.org/10.5878/yz9j-q902

Bioenergy goes beyond producing energy (SDG 7) and can relate to all SDGs: co-benefits are as important, or perhaps even more important when considering local perspectives.[14]
The contribution to specific SDGs can be either positive or negative and there is no "one-size-fits-all" approach. **Whether synergies or trade-offs occur highly depends on contextual factors, e.g., the biomass feedstock, previous land use, climate and soil conditions, or management applied.**
Best practices and modern technology make a difference and they can be enabled by appropriate governance frameworks.
In a recent report of IEA Bioenergy[15], 37 best practice case studies from 18 countries were selected to demonstrate how biomass supply chains could be implemented to support sustainable bioenergy production, while simultaneously contributing to the SDGs. Case studies covering the four most common biomass supply chains (forest biomass, agriculture residues, energy crops, waste) across different end-uses (transport fuels, heat, electricity) were used to assess the methods, practices and technologies used to sustainably grow, harvest, transport, process and use biomass for bioenergy.

Some potential SDG-related co-benefits (as found in the case studies) are summarised in the following overview:

Forest biomass (harvest residues and wood processing residues)
- Biomass sourced through stand improvement techniques (e.g., thinning) can simultaneously increase growth rates, improve carbon sequestration, and reduce natural disturbances (e.g., wildfires, pests). - Biomass can provide new economic and job opportunities for rural communities and regions. Forest biomass supply chains typically require more (local) labour than those of fossil-based supply chains.
Agricultural residues (harvest residues, as well as food or feed processing residues)
- Redirecting residues to bioenergy from disposal piles and open-air burning can improve local air and water quality. - Removal of a portion of residues from high-yielding agricultural croplands can enable the use of no-till practices which would otherwise be impractical.
Energy crops
- Energy crops integrated into good farming practices, or other land management practices such as landscape management, can improve ecosystem functions by improving local soil and water quality, reducing and filtering agricultural run-off, reducing soil erosion, diversifying land cover, and increasing soil carbon storage. - Energy crops on previously abandoned agricultural land can also provide new sources of incomes for farmers, landowners, and land managers, as well as provide new economic and job opportunities in the community.
Waste biomass
- Waste biomass used for bioenergy can improve both resource use efficiency and waste management, while providing value-added services and products. It also creates co-products, such as fertilizer, that can be used for agricultural purposes to reduce the use of synthetic fertilizer, improving the overall circularity of supply chains.

[14] J. Blair et al (2021). Contribution of Biomass Supply Chains for Bioenergy to Sustainable Development Goals. Open access article in the Journal *Land. Available at:* *https://www.mdpi.com/2073-445X/10/2/181*
[15] IEA Bioenergy (2021). Biomass Supply and the Sustainable Development Goals - International Case Studies Available at: https://www.ieabioenergy.com/blog/publications/biomass-supply-chains-and-their-contribution-to-the-sustainable-development-goals/

An exemplary case study was discussed for Nova Scotia in Canada, aiming to use forest residues to produce heat and power (which is still largely fossil based).
It is important to understand the **local context** to address concerns and communicate benefits. People are concerned about affordability of heat and power, and in general, bioenergy is viewed negatively by many in Nova Scotia because of messages in the media. On the other hand, Nova Scotians want ecological forestry in their mixed wood forests. But the lack of regional markets for low grade wood makes ecological forestry difficult. The closure of a large pulp mill has exacerbated the problem and many jobs were lost.

A targeted messaging and interaction within the municipalities is important, to demonstrate that biomass use for energy does not conflict with ecological forest management, when ensuring that best practices are implemented. A community/municipality owned district heating system could be established based on local biomass fuel, which would provide stable, secure, and low-cost energy, and leads to local jobs and rural development. The money spent for energy stays local.

Figure 11: Synergies and trade-offs of biomass supply and bioenergy generation with different SDGs, based on 37 case studies (source: Blair et al. 2021)

PANEL DISCUSSION

A half hour panel discussion was moderated by Maria Murmis; all speakers participated.

The panel started with a second poll to the audience on what is needed to overcome barriers to seize win-win opportunities.

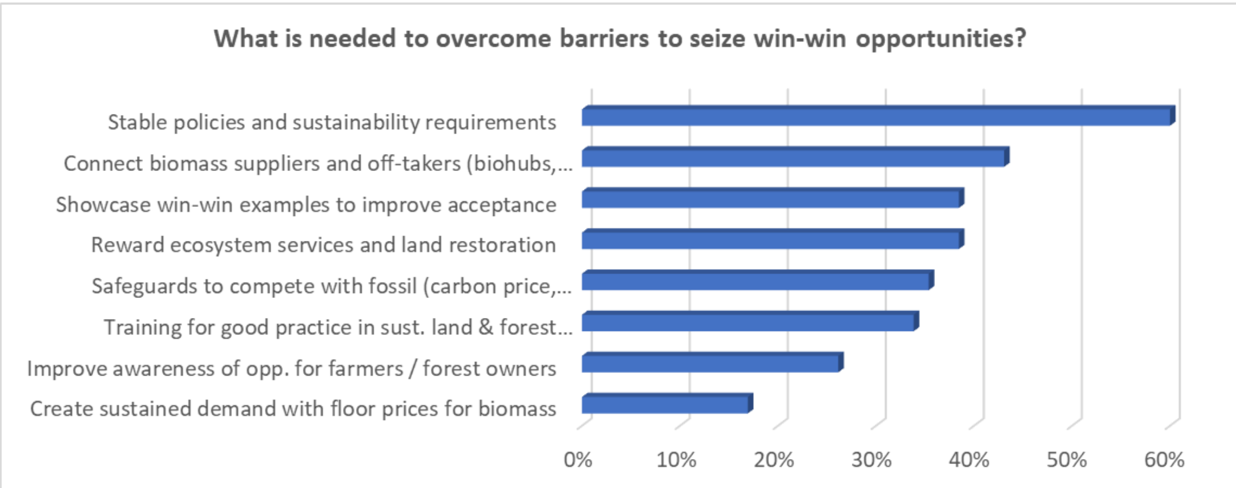


Figure 12: result of audience poll on what is needed to overcome barriers to seize win-win opportunities of biomass supply (max 3 selections per participant – 60 participants answered).

*The participants indicated **stable policies and sustainability requirements** as most important. Other important actions would be to organize connections between biomass suppliers and off-takers, showcase win-win examples to improve the acceptance at public and policy level, and rewarding ecosystem services and land restoration.*
Next to that, providing safeguards (price guarantees, carbon price) to be able to compete with fossil, and training for good practice in sustainable land and forest management were also selected by a third of the participants.

Specific topics came up in the panel, based on questions from the audience:

Have the pandemic and the war in Ukraine changed the picture for bioenergy?
The pandemic has brought attention to the importance of local supply chains, and the geopolitical situation has been an eye opener for our critical dependency on fossil fuels. Countries are now realizing that they must consider their national resources to improve energy security and diversity.
Fossil prices have strongly increased because of the war in Ukraine. While these prices may reduce in a while, it is clear that low energy prices are in the past, which brings a drastic change for the business case of renewables like bioenergy. Bioenergy is strengthened in its role as a sustainable alternative, not just for the climate, but also for energy security.

Is competition with food production an issue?
The issue is not really if crops used for biofuel can be used for food, but it is more about the use of (productive) land. So being ‘advanced’ biofuels derived from non-food crops doesn’t necessarily make them better. In fact, crops that can be diverted back to food markets can make sense as backup in times of shortages. The ability to switch between crops depending on market conditions (and not being constrained by long term perennial crops) also provides more flexibility for farmers.
Demand from crop-based biofuels has not necessarily increased food prices but have acted in some cases as a price floor for specific crops and thereby stabilized prices (because of market diversification), which was positive for farmers. Particularly smaller scale biorefineries, located close to feedstock production, have had a more stabilizing effect on commodity markets. Mind that biofuel crops not only provide biofuels, but also important flows of co-products that are used for animal feed (replacing long distance imports of protein feed).
So, crop-based biofuels are not necessarily bad for food security. Nevertheless, we should avoid opposite generalisations that the effect is always positive, as the impact always depends on local conditions and what share of crop production is used for biofuels. The trend to go for abandoned / marginal land, as well as integrated agricultural production systems, such as multiple cropping, or intercropping across seasons clearly reduces potential negative impacts on food security and can in fact have very positive impacts.

How should we communicate co-benefits of positive bioenergy practices?
Bioenergy means something different per country, with different biomass sources in focus, as well as different types of bioenergy (biofuels, biogas, industry heat, bioelectricity, residential heat). This also implies that the audiences may understand things in a different way, so a more targeted approach is likely required. It also makes a difference if the audience has connections with or understandings of forestry or agriculture.
It is difficult to fight negative perceptions, when misconceptions, half-truths and bad extremes are regularly spread in the media, thereby influencing perceptions of the public and policy makers. Such perceptions even play against clearly positive examples like the use of residues.
Communication should be adapted to align with the main development priorities of a country/region. We need to explain how good practice examples contribute to benefits like rural job creation, supporting ecosystems and creating a local alternative for fossil fuels, and then further link this with an explanation of how certain bioenergy policies could incentivise good practices and contribute to these objectives. It is particularly important for people to make a concrete connection/recognizability to such examples and reflect how they are impacted by these co-benefits. Messages should be kept simple, but it is important to get the points across.

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