IEA Bioenergy
Technology Collaboration Programme

Opportunities of bioenergy and biofuels in developing economies

Summary and conclusions from the e-Workshop, held on 22-23 May 2023

Workshop organized by IEA Bioenergy, in collaboration with UNIDO

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Key messages from the workshop

- For developing economies, sustainable bioenergy fits within the overall goal to restore landscapes, fight energy poverty, increase energy security and ensure energy access, which is preferentially broadly based on local renewable energy sources.

- Replacing traditional use of biomass with more efficient and clean bioenergy solutions more than offsets rising energy services demand in developing economies. In other words, a more efficient use of biomass means that much less biomass is needed to provide the same energy services.

- Given the unique features of biomass supply and bioenergy systems - which go much beyond the sole aim of producing energy - it is important to take a holistic approach and consider options that target multiple climate and development goals and benefits at the same time, in terms of clean energy access, development opportunities and avoiding environmental consequences of the current fate of biobased waste and residues.

- Residues which would otherwise decompose or be burned in the field – which now leads to important air quality problems - can be utilised, invasive plants that disturb ecological functions can be removed, or abandoned and degraded agricultural land can be revitalised, providing new sources of incomes for farmers, and improving and diversifying their livelihoods.

- A great potential exists for biofuels in emerging economies of Latin America, the Caribbean region, Africa, and Asia as these regions have a growing demand for sustainable energy, plentiful local resources, and substantial amounts of degraded, abandoned, and underutilised land which can be revitalised to produce both food and biofuels. Sustainable intensification in agricultural land use also has great potential, e.g., under climate-smart agroforestry approaches.

- The main challenges in implementing bioenergy projects in developing economies are related to the policy and regulatory framework, financing, feedstock supply, capacity building and communication. It is important to make best use of experiences from different regions around the world. The demonstration of real business cases needs more attention in the Global South.

- An enabling policy environment, good prospects for market offtake, and improved access to finance are key for the required investments in biofuels production in developing economies. Viable business models / cases are key to mobilize investment, in particular from the private sector. Stable, supportive government policies are essential to provide the right investment signals. Successful bioenergy deployment also necessitates cross government coordination.

- The international community can help developing countries in their transition to clean energy and seize the opportunities they have. International programmes supporting clean energy access, as well as international climate financing are important tools to support these transitions. It is important to exchange international experiences and share key learnings from the past decades.

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Executive summary

Luc Pelkmans, Technical Coordinator, IEA Bioenergy

The IEA Technology Collaboration Programme on Bioenergy (IEA Bioenergy) held its biannual workshop on 22-23 May 2023 in conjunction with its Executive Committee meeting (ExCo91). The workshop on '*Opportunities of bioenergy and biofuels in developing economies*' was held in virtual form and was organised in collaboration with the United Nations Industrial Development Organization (UNIDO).

The workshop consisted of three separate sessions:

1. Supporting clean energy transitions and improved energy access in emerging economies
2. Biomass supply opportunities and sustainability of supply
3. Sustainable biofuel production

Each session consisted of keynote presentations, followed by a panel discussion. Over 560 unique participants in total from all over the globe followed one or more sessions of the workshop. The PowerPoint presentations and recordings can be downloaded from IEA Bioenergy's website[1].

Access to clean and efficient heating and cooking

Generally, biomass is one of the most important local renewable energy sources, particularly in developing countries. However, many developing economies still rely heavily on 'traditional' bioenergy use for cooking and heating in inefficient and highly polluting devices or open fires; these practices can have severe health impacts. Moreover, the demand for fuelwood and charcoal and its inefficient use puts pressure on biomass availability and can be a driver for deforestation in certain regions.

Universal access to affordable, reliable, and modern energy services is one of the key Sustainable Development Goals for 2030. However, it is expected that around 2 billion people will not have access to clean fuels and technologies for heating and cooking by 2030. There is an urgent need to make the shift towards renewables based electric cooking and cleaner 'modern' bioenergy solutions, including bioethanol, biogas and quality devices relying on solid biomass – based on sustainably sourced biomass. **Replacing traditional use of biomass with more efficient and clean bioenergy solutions more than offsets rising energy services demand in support of clean energy transitions**. In other words, a more efficient use of biomass means that much less biomass is needed to provide the same energy services.

For developing economies, sustainable bioenergy fits within the overall goals to restore landscapes, fight energy poverty, increase energy security and ensure energy access, which is preferentially broadly based on local renewable energy sources. **Bioenergy is a strong catalyst towards the development of local and regional circular bioeconomy**. It has the potential to strengthen agriculture and industry sectors contributing to overall economic development and would lead to an improved self-reliance in energy. It would therefore contribute to the achievement of several Sustainable Development Goals (SDGs) and national climate commitments.

Holistic approach

Bioenergy needs to be considered at system level. The system contains:

- feedstock mobilisation: the way feedstock growth and harvesting fits in sustainable landscape management, or the way it fits in a performing waste management system;
- the collection of these resources and transport to decentral or centralized processing;
- the conversion of biomass resources through a wide spectrum of conversion technologies;

[1] https://www.ieabioenergy.com/blog/publications/ws29-opportunities-of-bioenergy-and-biofuels-in-developing-economies/

- the distribution of the different products to heterogenous off-take markets.

All parts come with their unique contexts, challenges and opportunities which go much beyond the sole target of producing energy. That is what makes bioenergy systems special compared to other renewable energy sources.
Given the unique features of bioenergy it is important to take a holistic approach and consider options that target multiple climate and development goals and benefits at the same time - in terms of clean energy access, development opportunities and avoiding environmental consequences of the current fate of biobased waste and residues. Identifying solutions should be data driven, with the articulation of finance gaps.

Win-win opportunities in biomass supply

Biomass can be made available as a residue from food or wood processing (in cascading approaches); through the cultivation or restoration of marginal or abandoned lands; via crop rotations, the combined production via climate-smart agroforestry; or the valorisation of waste and industry, forestry, and agricultural residue streams. Moreover, the by-products of bioenergy systems - such as digestate as a co-product from biogas - can play an important role in local developments.

The sustainable production and use of biomass resources from agriculture, forestry or landscape management can offer environmental benefits as well as new economic and job opportunities for rural communities and regions. It is key to consider co-benefits and win-win opportunities of setting up biomass supply chains in a context specific approach, considering the local/regional/national situation, and connected to the biomass feedstock itself and existing value chains. Several opportunities were presented in the workshop: residues like rice straw in Asia which would otherwise decompose or be burned in the field – which now leads to important air quality problems and massive methane emissions - can be utilised; invasive plants that disturb ecological functions can be removed, or abandoned and degraded agricultural land can be revitalised, providing new sources of incomes for farmers, and improving and diversifying their livelihoods. Biomass supply is to be considered in the context of the wider bioeconomy, not just energy. Overall, increasing economic opportunities in rural areas can stem rural-urban drift, especially of the youth, which is particularly relevant in developing countries.

The first real action should be to **look at the country context and organise a dialogue with all relevant stakeholders to get multistakeholder engagement**. Thereby gaps and barriers can be identified which need to be overcome to realize local potentials and concrete measures proposed, such as capacity building and raising awareness on the opportunities to improve local livelihoods.

Sustainability is key in a wider sense. It is important to get things right before scaling; this requires a rigorous analysis of sustainability aspects (greenhouse gas profile; energy needs, …), and have third party verification of the sustainability of biomass supply chains. The different dimensions of sustainability need to be considered and are equally important: environmental, social, and economic. Particularly in rural areas in developing countries the social dimension is very important.

Biofuel production

A great potential exists for biofuels in emerging economies of Latin America, the Caribbean region, Africa, and Asia as these regions have a growing demand for sustainable energy, plentiful local resources, and land availability to produce both food and biofuels. They also have considerable potential for sustainable intensification in agricultural land use, e.g., under climate-smart agroforestry approaches.

As developing economies see a growing demand for transport, new developments should be considered for their transport sector to avoid a growing reliance on fossil fuels. **In regions with high biomass productivity, opportunities may arise to produce biofuels for national or even international markets, such as the aviation sector.** Certain developing countries already have a history in the

production, use and trade of biofuels. A precondition for this expansion of biofuels production is that sustainability safeguards are applied.

Sustainable aviation fuel (SAF) is one of the major growing biofuel markets in the next decades. One of the key barriers for SAF production in (most) non-OECD countries is the need to find new sources of financing and leverage existing ones. While feedstock potential exists, high risk premiums for financing drive up SAF costs in developing countries. Driving down risk premiums for SAF production would be a major factor in reducing the costs of producing SAF in these countries.

Supporting bioenergy and biofuels deployment in developing economies

The fundamental question is how countries can be supported to make the most efficient use of their indigenous resource potential, being it virgin or waste resources. Clean energy deployment and sustainable resource management in developing and transition countries are challenging, rarely because of technology in the narrow sense, more often because of various broader issues. **The main challenges in implementing bioenergy projects are related to the policy and regulatory framework, financing, feedstock supply, capacity building and communication.** It is important to make best use of experiences from different regions in the world.

One of the biggest challenges in developing countries is to find financing for biofuel and bioenergy projects and reduce the risk premium for such investments. **To motivate private finance, viable business models, stable policies, de-risking and creating multiple revenue streams from the biomass processing is needed.** Successful bioenergy deployment necessitates cross government coordination. Governments must consider feedstock supply, investment costs, economic impacts, infrastructure compatibility, technical standards, trade policies when developing biofuels policies. A long-term strategy helps identify challenges and opportunities. Moreover, **stable, supportive government policies are essential to provide the right investment signals.** A holistic and integrated national plan, with data-driven geospatial planning, helps to de-risk investments and unlocks access to finance. Many research and feasibility projects need to move into demonstration projects with efficient supply chains, so people can get a feel of the practice.

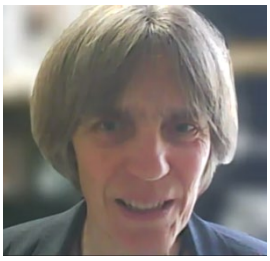
Role of the international community

The international community can help developing countries in their transition to clean energy and seize the opportunities they have. International programmes supporting clean energy access, as well as international climate financing are important tools to support these transitions. **It is important to exchange international experiences and share key learnings from the past decades**. The international community can collect experiences and compress them into dos and don’ts. We should not forget about failures; often these can teach us more than success stories. International organizations can also have an important role to show opportunities and alleviate misunderstandings on issues like food versus fuels.

An enabling policy environment, good prospects for market offtake, and improved access to finance in developing economies are key for the required investments in biofuels production. Moreover, secure biomass supply chains are a key prerequisite; this also requires connecting stakeholders in biobased value chains and assuring sustainability governance. Other key tools are capacity building, technology transfer and awareness campaigns that can show good practice examples. IEA Bioenergy is glad to join forces with other international organizations such as UNIDO, the CEM Biofuture Platform, FAO, GBEP, IRENA, SEforALL and others in the international community to help developing countries in their transition to clean energy and seize the opportunities they have.

WORKSHOP

Session 1: Supporting clean energy transitions and improved energy access



This session was moderated by **Dina Bacovsky**, Head Biofuels at BEST - Bioenergy and Sustainable Technologies (Austria) and Chair of the IEA Bioenergy TCP; and **Tareq Emtairah**, Director of the Division of Decarbonization and Sustainable Energy at UNIDO.

Dina Bacovsky welcomed the participants on behalf of IEA Bioenergy. She emphasized that there are great opportunities in developing countries to put land and residues to use, create rural income and move to clean and modern energy provision and to improve energy access in developing economies.

Tareq Emtairah in his opening remarks emphasized that there is a tremendous role for developing and least developed economies to leverage their biomass resources to bridge the energy access gap. The fundamental question is how countries can be supported to make the most efficient use of their indigenous resources, being it virgin or waste resources. In the last 10 years UNIDO did several technical assistance projects looking at the utilisation of biomass resources for energy use, either in the power sector, for transport fuels, for clean cooking, or for gas. The experience has not always resulted in consistent outcomes. The landscape is quite diversified and heterogenous, and bioenergy needs to be considered at system level, starting from the way feedstocks growth and collection fits in landscapes, through a wide spectrum of conversion technologies, up to a central or decentral distribution and heterogenous off-take markets, each with their unique contexts and challenges. That is what makes bioenergy systems special compared to other renewable energy sources. Learning from experiences and knowledge transfer is key to scaling up.

Bioenergy in emerging economy clean energy transitions

Jeremy Moorhouse, International Energy Agency (IEA)

Sustainable bioenergy is a pillar in the clean energy transitions in emerging and developing economies. By 2050, modern bioenergy supplies 16% of energy in the IEA's sustainable development scenario, helping provide liquid, gaseous and solid fuels compatible with existing infrastructure. This implies that modern bioenergy needs to triple from 2020 to 2050.

Traditional biomass use in open fires and inefficient equipment represented 7% of energy supply in emerging economies in 2021. This practice needs to be phased out, particularly for the health consequences it has.
Modern bioenergy – liquid biofuels, biogas and solid biomass use in efficient devices - supports energy access, especially for clean cooking: In the IEA's Sustainable Africa Scenario, bioenergy supplies 90% of clean cooking energy by 2030 in Sub-Saharan Africa. Replacing traditional use of biomass with more efficient and clean cooking solutions more than offsets rising energy services demand to 2030 in support of clean energy transitions, see Figure 1. In other words, a more efficient use of biomass means that much less biomass is needed to provide the same energy services. This reduces the pressure for unsustainable biomass sourcing practices.

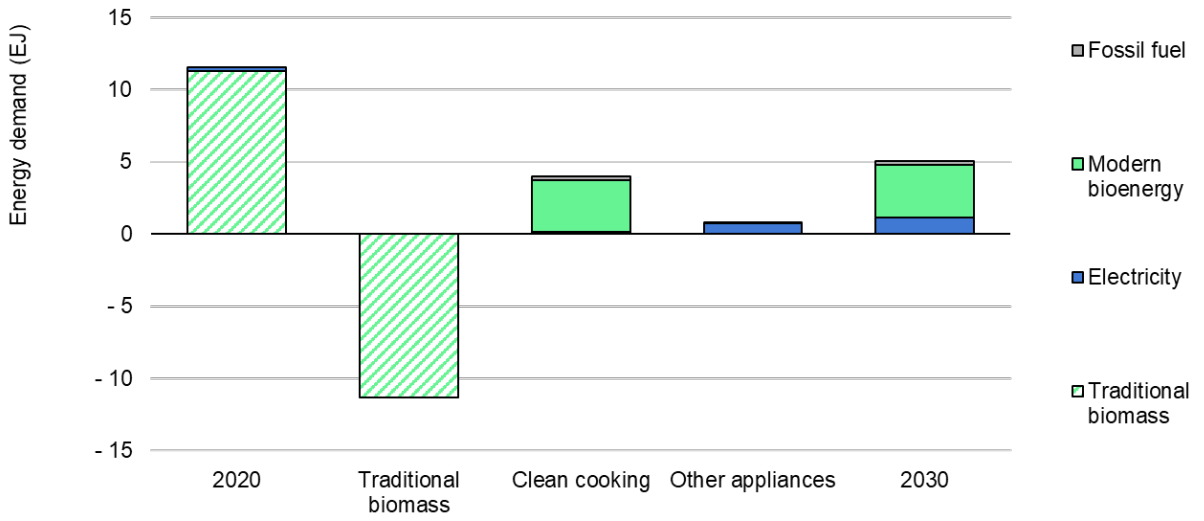


Figure 1: Change in residential energy demand by fuel type in sub-Saharan Africa, 2020-30, Sustainable Africa Scenario. Source: IEA (2022) Africa Energy Outlook 2022

Successful bioenergy deployment necessitates cross government coordination. Governments must consider feedstock supply, investment costs, economic impacts, infrastructure compatibility, technical standards, and trade policies when developing biofuels policies. A long-term strategy helps identify challenges and opportunities. Moreover, stable and supportive government policies are essential to provide the right investment signals.

An opening poll was launched to the audience to indicate for three developing regions which sector they considered would have most benefits in the use of modern bioenergy.

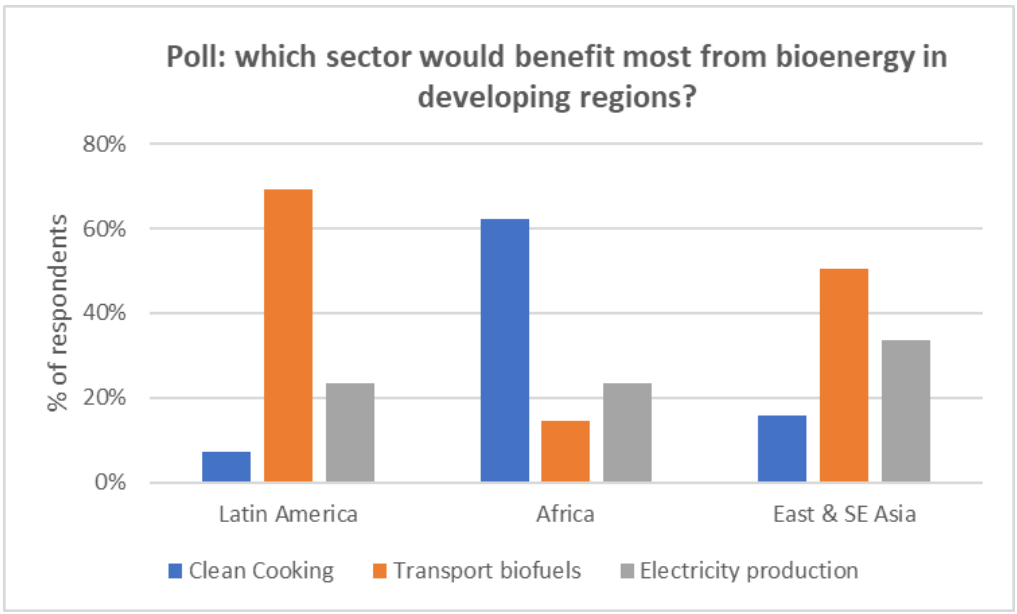


Figure 2: result of audience poll on which sector they considered most important for bioenergy in different developing regions. (Indicate 1 per region - 124 participants answered).

The answers depended on the respective region: in Latin America, most is expected from transport biofuels; In Africa, clean cooking came out as the most promising use of bioenergy; in Asia both transport biofuels and electricity production (replacing coal) came out as important. Overall, it shows that we are not looking for a one-size-fits-all solution, but priorities will depend on local circumstances.

Integrated energy access planning - unlocking action and finance for clean cooking in developing countries

Cristina Dominguez, SEforALL

SEforALL provides technical assistance to governments to develop an Integrated Energy Access Planning (IEP), ensuring an integrated approach for achieving energy access targets. In addition to the traditional electricity access assessment, components of clean cooking and medical and agricultural cold chains can be also evaluated in an IEP. The latter two tend to receive much less attention than electricity access but are also highly important.

A holistic and integrated energy access national plan, with data-driven geospatial planning, helps to de-risk investments, enabling the efficient and effective implementation of energy interventions by unlocking access to different financial opportunities.

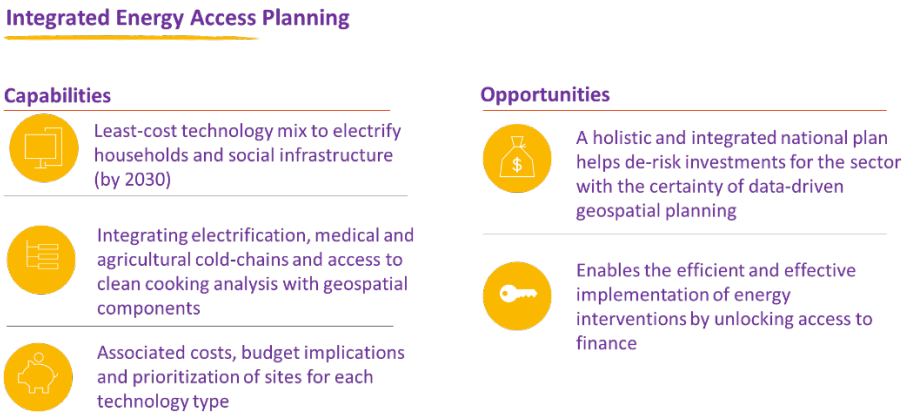


Figure 3: features of a SEforALL Integrated Energy Access Planning (IEP). Source: SEforALL

SEforALL co-developed IEPs for Nigeria and Malawi; the ones for Rwanda and Madagascar are under development.[2] In the case of Malawi, the national maximum potential for bioethanol, pellet/briquette, and biogas fuels under the IEP scenario equate to a total of 155%, 101%, and 28% of total household energy demand in 2030, respectively. This represents an underutilized opportunity that should be explored. Moreover, solutions like biogas and bioethanol provide spectacular improvements in air quality.

While IEPs can significantly improve the enabling environment, the next step is to raise the finance and bring in partners to implement the plans. Apart from the data-driven insights provided by an IEP, the key ingredients to success for an effective implementation are sectoral buy-in; a strong regulatory environment; private sector participation; sustained capacity development; and key partners coming together to collaborate.

[2] IEP's available at: https://sdg7energyplanning.org/

The role of bioenergy in the clean energy transition and sustainable development: lessons from developing countries

Jossy Thomas, UNIDO

Sustainable Development Goal 7.1 (SDG7.1) aims to ensure universal access to affordable, reliable, and modern energy services by 2030. While improvements have been made compared to 2010, both indicators in SDG 7.1 are off track for the 2030 target. The expectation is that by 2030 still between 0.67 and 0.76 billion people will not have electricity access (SDG 7.1.1) and 1.9 to 2.1 billion people by 2030 will not have access to clean fuels and technologies for heating and cooking (SDG 7.1.2), most of them relying on traditional use of biomass.

Bioenergy has a very promising future in developing economies as only a fraction of its potential has been exploited so far. That potential can be achieved without tapping into food crops or experiencing competition with food production. Moreover, bioenergy is a strong catalyst towards the development of local and regional circular bioeconomy. It has the potential to strengthen agriculture and industry sectors contributing to overall economic development and would lead to an improved self-reliance in energy. It would therefore contribute to the achievement of several SDGs and national climate commitments.

Solid biomass is one of the most used forms of bioenergy. It has been and still is traditionally used for cooking or heating in many countries, especially in developing countries (DCs) and in least developed countries (LDCs). Gaseous or liquid forms of biofuels, such as biogas and bioethanol, are increasingly available and used, as biogas/biofuel projects are being implemented all around the world, using increasing amounts of performant conversion technologies.

Figure 4: Biogas plant in Naivasha, Kenya. Source: UNIDO

The main challenges in implementing bioenergy projects are related to:[3]

(1) the policy and regulatory framework: lack of conducive policies, indirect support for fossil fuels; discontinuity of some policies;
(2) financing: high investment costs; reluctance of banks and climate finance entities to finance bioenergy projects; reluctance of utilities to buy power from small producers; unfair competition from subsidized fossil fuels;
(3) feedstock supply, process, and technology: lack of proper feedstock availability assessment; availability of bio-residues often overlooked; lack of skills and training in (imported) new technologies;
(4) capacity building and communication: lack of understanding of bioenergy technologies; investors not understanding the importance of a secured feedstock supply; lack of experience in similar types of projects.

[3] UNIDO (2021). The role of bioenergy in the clean energy transition and sustainable development: Lessons from developing countries. Available at: https://www.unido.org/sites/default/files/files/2021-07/New-Publication-Bioenergy.pdf

Promoting renewable energy and resource efficiency in Developing and Transition Countries

Stefan Nowak, REPIC Platform (Switzerland)

The energy crisis of 2022 has increased the vulnerability of developing countries. Moreover, the needed transition towards sustainable energy supply is still challenging worldwide.

REPIC stands for Renewable Energy, Energy and Resource Efficiency Promotion in International Cooperation. It is a common initiative and platform of four Swiss government agencies. The platform is operational since 2004 and has meanwhile supported about 200 projects in more than 50 countries. It focuses on realistic, sustainable, and market-oriented projects that reflect local needs for identified beneficiaries.

So far 31 bioenergy related projects have been supported, and 26 projects related to resource efficiency, often related to bio-waste. Examples of considered feedstocks are cattle manure, rice straw, coffee waste, palm oil production residues, and coconut husk.

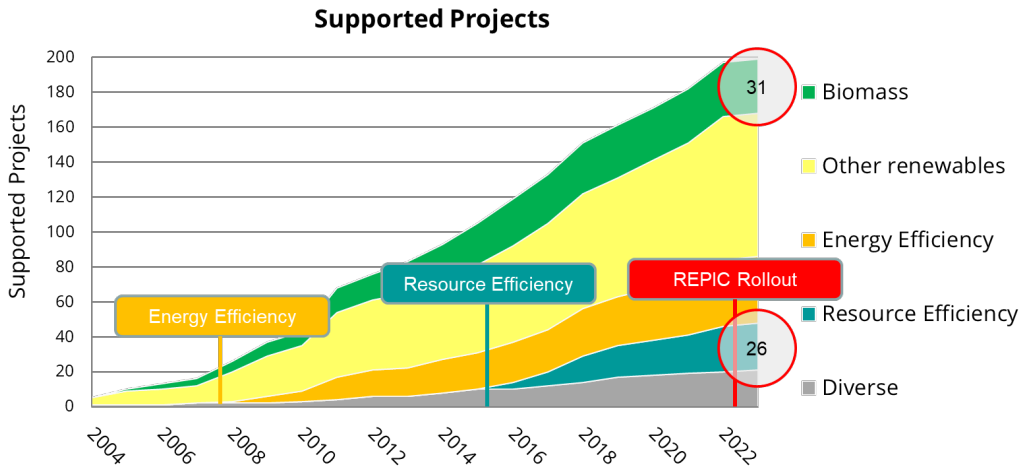


Figure 5: number of supported projects through REPIC, by theme. Source: REPIC Platform[4]

Clean energy deployment and sustainable resource management in developing and transition countries are challenging, rarely because of technology in the narrow sense, more often because of various broader issues. It is important to make best use of experiences from different regions in the world.

Some of the key learnings:

- Technologies need to be adapted to the local conditions; durability and sustainability of processes and components are critical.
- Socio-economic aspects including viable business models are key; customers need to be identified and involved.
- Non-technical risks need to be systematically assessed. Challenging contextual conditions may appear, e.g., COVID-19, political changes, or unforeseen weather extremes. Failures often relate to most unexpected reasons.
- Cultural differences in various dimensions matter. Good cooperation needs time and helps building trust.

[4] More information available at https://www.repic.ch/en/

LEAP-RE - Long-Term Joint European Union - African Union Research and Innovation Partnership on Renewable Energy

Léonard Lévêque, LGI Sustainable Innovation (France)

The LEAP-RE programme, which is supported by the European Union, is dedicated to advancing renewable energy technologies in Africa and promoting their widespread adoption through innovative research and development, collaboration, and education. Currently, the programme supports 31 projects, with involvement of over 220 partners from more than 30 countries.[5]

Its goal is to empower communities, organizations, and individuals to make sustainable energy choices, reduce dependence on fossil fuels, and mitigate the impacts of climate change.
A thematic priority of LEAP-RE is to support innovative solutions for priority domestic uses (clean cooking and cold chain) to address challenges related to traditional cooking systems and promoting sustainable biomass harvesting and collection.

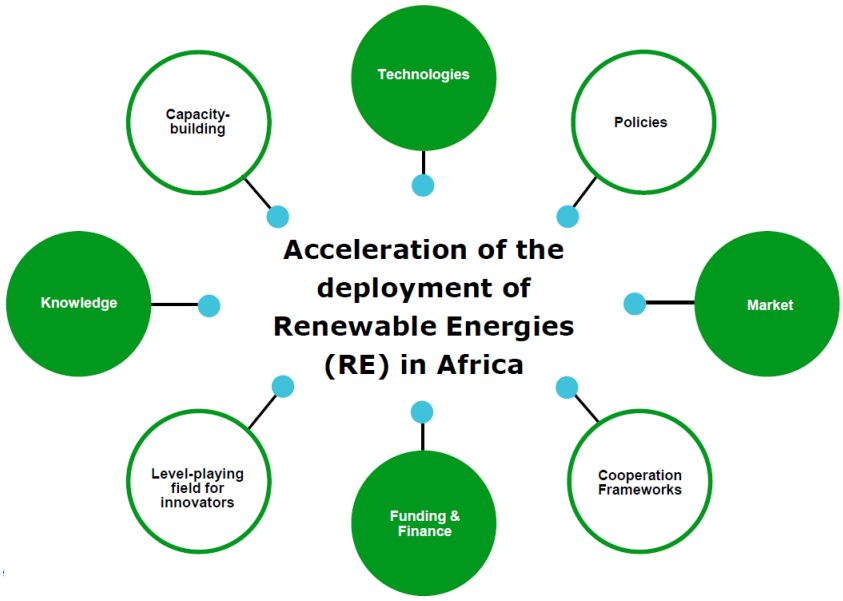


Figure 6: Support areas of LEAP-RE for the deployment of renewable energies in Africa. Source: LEAP-RE

One of the projects supported by LEAP-RE was presented by *Fatma Ashour of the University of* Cairo (Egypt): PyroBioFuel.

The aim of PyroBioFuel is to create a unique knowledge infrastructure that supports decentralized, sustainable, and cost-efficient conversion of biomass to sustainable fuels, relevant to both Europe and Africa. Biomass feedstock availability is dependent on the region; it is essential to consider biomass regionalization. Feedstocks vary according to countries and seasons, ranging from virgin biomass, waste biomass and energy crops, agricultural waste, bagasse, corn stover, wheat husks, wood wastes, rice straws, paper mill discards, etc. Around 5.2 million tonnes (dry matter) of crop residues are available in Egypt at a cost of 40-60€/ton. This is an important source of material that can be used for the bioeconomy.

[5] More information available at https://www.leap-re.eu/our-portfolio/

The PyroBioFuel project aims to design and validate innovative processing technologies, including a compact catalytic Fischer-Tropsch synthesis reactor and a hydrocracking reactor that will increase the efficiency of the fuel conversion process.

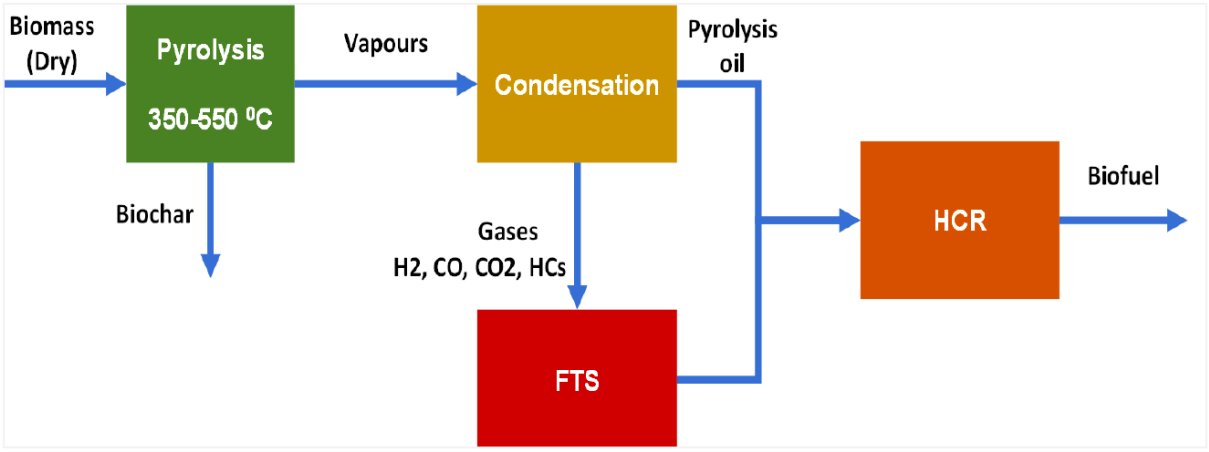


Figure 7: simplified block diagram of the PyroBioFuel concept. Source: PyroBioFuel

The expected outcome from PyroBioFuel is the development of technology advances that significantly contribute to increasing the viability of advanced biofuels and energy in the EU and Africa through reliable, inexpensive stand-alone system architectures that can be easily deployed in off grid African rural and remote areas.

As a starter for the panel discussion a second poll was launched to the audience on what the international community can do to support clean energy transitions in developing economies.

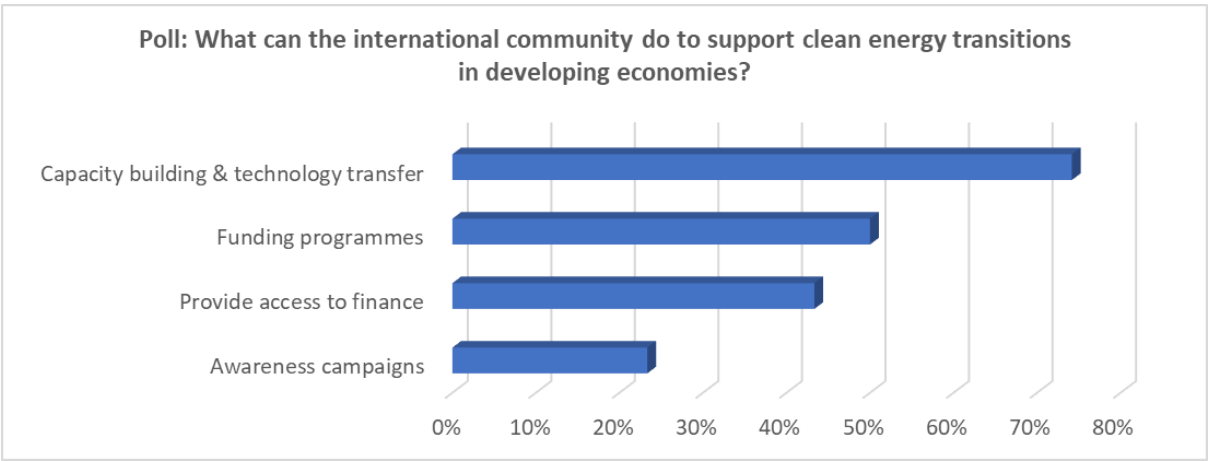


Figure 8: result of audience poll on what is most needed to stimulate deployment of bioenergy and BECCS (max 2 selections per participant – 120 participants answered).

The participants could choose between four options. The results show a clear preference for capacity building and technology transfer, followed by funding programmes and access to finance.

Panel discussion

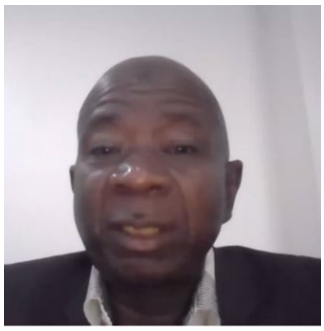
The panel session was moderated by Tareq Emtairah; all speakers participated.

The panel discussion was also centralised around the role of the international community to support developing countries to overcome hurdles towards clean bioenergy solutions. Main conclusions:

- Given the unique features of bioenergy it is important to take a holistic approach and **consider options that target multiple goals and benefits at the same time** - in terms of energy access, clean energy access, development opportunities and avoiding environmental consequences of the current fate of biobased waste and residues. Identifying solutions should be data driven, with the articulation of finance gaps. The need for financing should be coordinated between local and international institutions. National agendas and priorities should be considered. In any project it is worthwhile to conduct a feasibility study, which not only considers techno-economics aspects, but also investigates environmental (e.g., health impacts) and social impacts (e.g., impact on employment and local development).
- What is also important is to **learn from experiences**. There have been several initiatives, and the devil is often in the detail. The international community can collect experiences and compress them into dos and don'ts. We should not forget about failures; often these can teach us more than success stories.
- We are currently at the stage of scaling; many bioenergy technologies have already been demonstrated. **Technology transfer** is needed to make these available to developing countries, with the background that technology options may need to be adapted to the local needs. This also requires **capacity building**, in which the international community can certainly help.
- For scaling up, **financing is a major hurdle**. With an increasing levels of financing requirements in energy transitions, it will not just be a matter of government funding, but a **shift to private capital** will also be necessary. The international community can also help to open these finance flows, e.g., through climate finance. There is a concern that climate financing mechanisms put low or no priority to bioenergy options. This needs rethinking, considering the important role of bioenergy in all low-carbon energy scenarios, such as the IEA net zero emissions by 2050 roadmap. A concern is also that climate financing is mostly interested in projects that bring large carbon savings, which disfavours small scale initiatives.
- When it comes to bioenergy, there will always be questions about feedstock supply, impact on food production, land use and biodiversity impacts. The conditions to mitigate potential risks need to be clear, particularly for project developers that need to have a long-term perspective for their investment. The international community can also be guiding for the **sustainability framework** that needs to be applied. Moreover, misunderstandings on issues like 'food versus fuel' need to be tackled. Both food and domestic energy are important in integrated production systems. A good land use planning is of added value, e.g., initiatives such as agro-ecological zoning can reconcile production and environmental goals.
- In many countries **waste is a largely underutilized potential**. There are great opportunities, e.g., for the expansion of biogas, or energy recovery from municipal waste. This also implies the deployment of waste management systems, i.e., setting up (source separated) collection systems to avoid waste dumping and providing technological options to process the waste, instead of landfilling.

Session 2: Biomass supply opportunities in developing economies and sustainability of supply

This session was moderated by **Mark Brown**, Director of the Forest Industries Research Centre at the University of the Sunshine Coast (Australia), Task Leader of IEA Bioenergy Task 43 (Biomass supply); and **Bah Saho**, Principal Programme Officer Alternative Energy and Energy Access, ECOWAS (Economic Community of West African States), former director of ECREEE, the ECOWAS Centre for Renewable Energy and Energy Efficiency.



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.

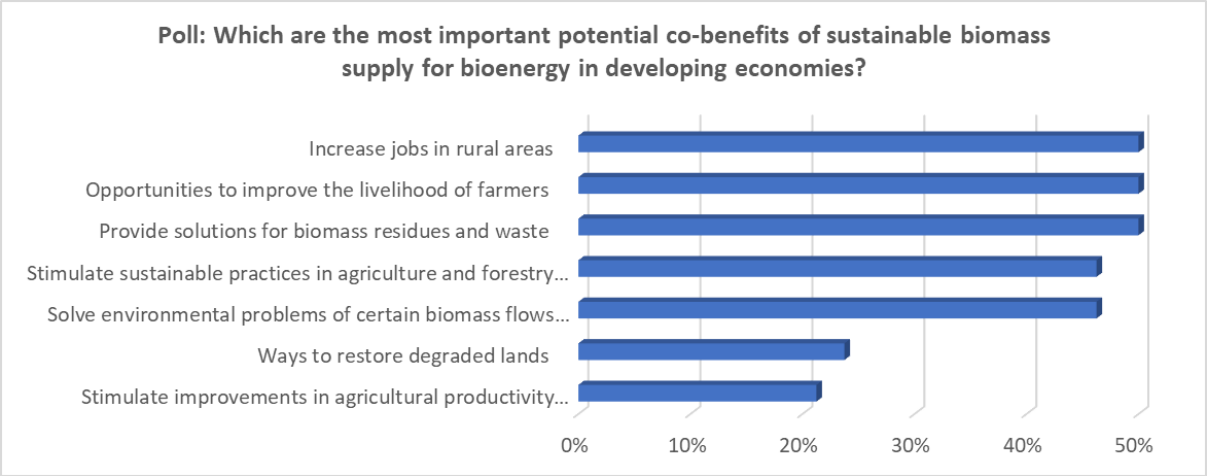


Figure 9: result of audience poll on the most important potential co-benefits of biomass supply (max 3 selections per participant – 80 participants answered).

Overall, the results of the poll show that the workshop participants recognize a broad range of co-benefits of biomass supply systems, ranging from socio-economic impacts in rural areas, solving environmental problems of the current handling of certain biomass or waste fractions and stimulating sustainable practices in agriculture and forestry.

New sustainable bioenergy value chain using rice straw in India to avoid open burning

Michela Morese, FAO

An estimated 500 million tons of crop residues are generated annually across India. While wheat straw is largely used for animal feed or animal bedding, rice straw is burnt as a way to quickly and cheaply dispose them off. There is only 20 days between two cropping seasons, so time is limited to take care of the residues. In the Punjab region alone, around 15.4 million tonnes of rice straw is burnt in the fields. This is damaging soils and leads to massive air pollution.

Crop residues can be a valuable resource, with potential local in-situ uses, but also for ex-situ uses in industry to produce energy, fuels, chemicals or biobased materials.

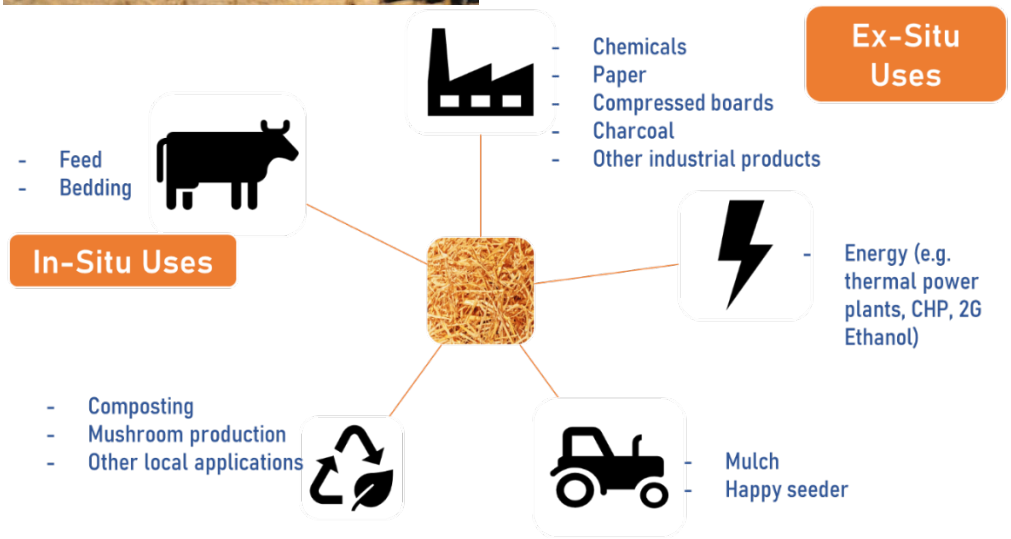


Figure 10: in situ and ex-situ use options of rice straw in India. Source: FAO[6]

While the broad policy framework is in place in India, straw burning continues. For ex-situ uses, the challenge is the short time frame between the 2 cropping seasons (around 3 weeks) to collect, mobilize and store the residue for industrial uses. This requires setting up a supply chain structure from harvesting and baling, through collecting bales in collection centres for temporary storage, up to aggrigation centres which act as wholesale point.

Even just using 30% of the available rice straw can provide a major contribution to decarbonisation targets, through the production of pellets to substitute coal for power generation; the conversion to advanced ethanol to contribute to the E20 target by 2025; and the production of compressed biogas (CBG) which can also be used as transport fuel. At current price levels, producing pellets or making CBG is profitable in most districts in Punjab; producing advanced ethanol is only profitable in a few districts.

Overall, the production of energy and fuels from crop residues is a technically and economically viable option, which contributes to energy decarbonization targets and leads to improved soils

[6] FAO (2022). Establishing residue supply chains to reduce open burning – The case of rice straw and renewable energy in Punjab, India. Available at: https://www.fao.org/3/cb9659en/cb9659en.pdf

and clean air. Taking the best from these opportunities requires providing strong incentives to farmers to stop burning and increasing awareness that residue is not a waste, but a resource, which also provides opportunities to diversify farmers' incomes. Developing value chains and infrastructure to collect and store crop residues is key to seize these opportunities.

Bioenergy for landscape restoration and livelihoods in Indonesia

Himlal Baral, CIFOR-ICRAF

CIFOR-ICRAF and partners investigate the opportunities to restore degraded forests and landscapes while producing bioenergy (and foods) using climate-smart agroforestry methods.
This approach can simultaneously help to achieve other national targets such as food and energy security in rural and isolated locations, greenhouse gas emissions reductions, and providing multiple ecosystem services. The lessons and good practices can be scaled up and scaled out in many islands in Indonesia and other parts of Asia.

Key questions are:

- How can sustainable bioenergy be developed to avoid the food-energy-environment trilemma with alternative feedstocks while restoring degraded lands?
- What are the most promising species to achieve efficient bioenergy production from degraded land, in terms of species characters, productivity and additional environmental values?
- What are the socio-economic and environmental benefits and challenges of bioenergy plantations on degraded land?

Trees which are native to the region have high potential to contribute to land restoration, biodiversity improvement and diversification of farm products. In climate-smart agroforestry setup they have the potential to be combined with agricultural crops. Some examples for Indonesia are Tamanu trees, bamboo and Pongamia. They are easy to grow, multifunctional, native to the region and have the potential for land restoration and to produce a local source of energy. The principles for successful tree planting are '*the right tree on the right place and for the right purpose while respecting local rights*'.

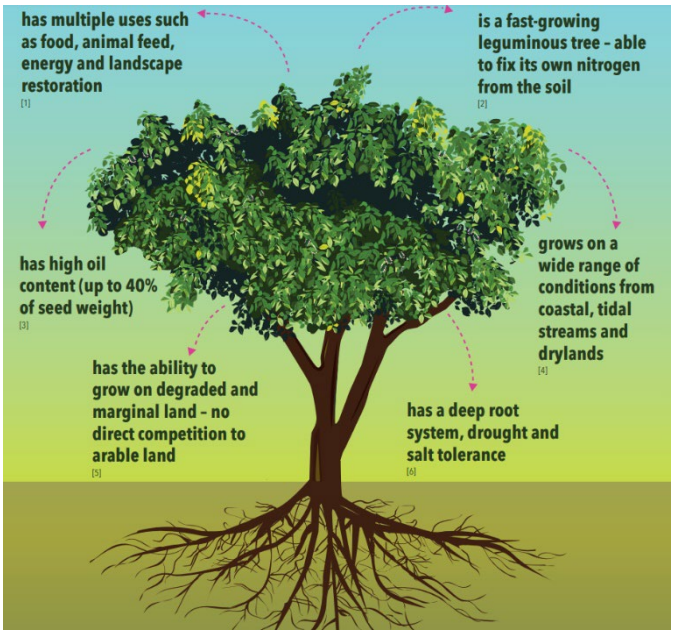


Figure 11: assets of the Pongamia tree.
Source: CIFOR-ICRAF[7]

Main lessons of CIFOR-ICRAF's work in this field:

- Large areas of degraded and underutilized land are available in Indonesia (and globally). The **degraded land can be restored with climate-smart agroforestry systems that support food, energy, and environmental conservation goals.**
- Bioenergy plantations on degraded land are a promising approach for land restoration and to enhance native biodiversity.
- Bioenergy and food production, including rice, pineapple and fish can be combined at plot and landscape scale - increasing the value of the land, enhancing food security, and supporting rural livelihoods.

[7] CIFOR-OCRAF (2022). Bioenergy for landscape restoration and livelihoods: Re-creating energy-smart ecosystems on degraded landscapes https://www.cifor.org/knowledge/publication/8500

It is important to disseminate best practices and identify the potential for scaling up and improving existing models, through public, private partnerships.

Opportunities of bioenergy and biomass supply in South Africa

William Stafford, Council for Scientific and Industrial Research (CSIR), South Africa

Urban organic waste, harvested invasive alien plants (IAP) and residues from agriculture and forestry provide the highest potential for biomass feedstocks in South Africa. The potential for dedicated energy crops is overall limited considering the need to avoid food-fuel conflicts, protect conservation areas and ensure agro-ecological suitability (including water availability). Nevertheless, there could be substantial potential to grow non-food crops such as solaris (tobacco seed) to produce plant oils which could be used to produce sustainable aviation fuel (SAF).

Invasive alien plants (IAPs) provide an important biomass resource potential in South Africa, with up to 215 million oven-dry tonnes available. Currently large areas of the country are covered by (often woody) invasive species on unmanaged and often difficult to access areas, causing significant impacts to water resources and to productive land. The South African government is providing support to remove these IAPs.

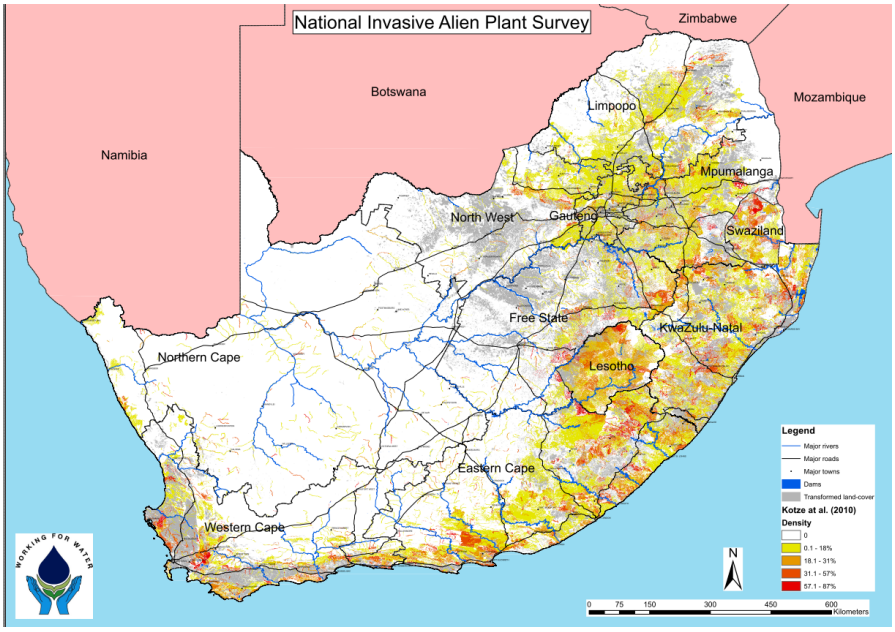


Figure 12: Average density of Invasive Alien Plants in South Africa. Source: 2010 National Invasive Alien Plant Survey

The suitability of biomass for products, the available conversion technologies and value-adding opportunities will determine the optimal use of biomass. While silviculture is mainly aimed at high value products – with some residues available for energy – **harvested invasive plants and bush encroachments have greater potential to utilize them for lower-value but higher-volume products, such as fuel and electricity, because of their mixed nature and low density.**

Bioenergy opportunities are to consider environmental impacts, economic viability, and social protection. Multi-stakeholder engagement and community participation is needed to balance local market opportunities (and sustainable development) and international market opportunities. Project and socio-economic risks can be reduced through supply chain management - aggregating supply and securing biomass supply and long-term off-take agreements.

Rice Straw Energy in the Philippines

Craig Jamieson, Straw Innovations

Around 750 million tonnes of rice straw are produced in Asia each year. In the Punjab, India, these are often burned on the field to make way for the wheat crop that follows (see earlier presentation of Morese); in the Philippines, the straw is also burned but to reduce this, some government bodies are encouraging farmers to leave the straw to decompose and recycle the nutrients. Unfortunately, **in flooded rice fields, this anaerobic degradation leads to massive spikes in methane emissions**. The climate impacts are dramatic: rice production today is responsible for as much greenhouse gas (GHG) emissions as all the other crops in the world combined. Its carbon footprint is greater than the entire global aviation industry.

Harvesting above-ground residues could halve these methane emissions; moreover, it provides a vast resource of energy. It is also demonstrated across 30 years that the removal of the above ground straw does not lead to reduced soil organic matter in flooded rice systems – the roots that remain in the ground are enough to maintain the soil organic carbon. The nutrients from the straw – after energy conversion - can be returned to the soil.

However, this straw is very difficult to harvest through raping and baling, as can be done in drier regions. Straw Innovations – a spinout company from research in the field - has developed a co-harvester for rice and straw which even works in wet rice fields and only leaves behind ankle high stubble.

Figure 13: rice and straw co-harvester developed by Straw Innovations. Source: Straw Innovations Ltd

A pilot – supported by UKaid – has been developed in the Philippines and is currently being scaled-up as a whole system, from collecting the rice straw, and processing it for energy (biogas, gasification, pyrolysis) with the energy used to dry rice and power a bioenergy hub.

Application of GBEP bioenergy sustainability indicators in developing countries

Tiziana Pirelli, Global Bioenergy Partnership (GBEP)

The Global Bioenergy Partnership (GBEP) is an international initiative established to implement the commitments taken by the G8 in 2005 to support "biomass and biofuels deployment, particularly in developing countries where biomass use is prevalent". GBEP has been receiving renewed mandates from G7 and G20 since its establishment. It has developed a set of indicators for the assessment and monitoring of bioenergy sustainability. Aim is to facilitate the harmonization of sustainability assessments and to support policy formulation.

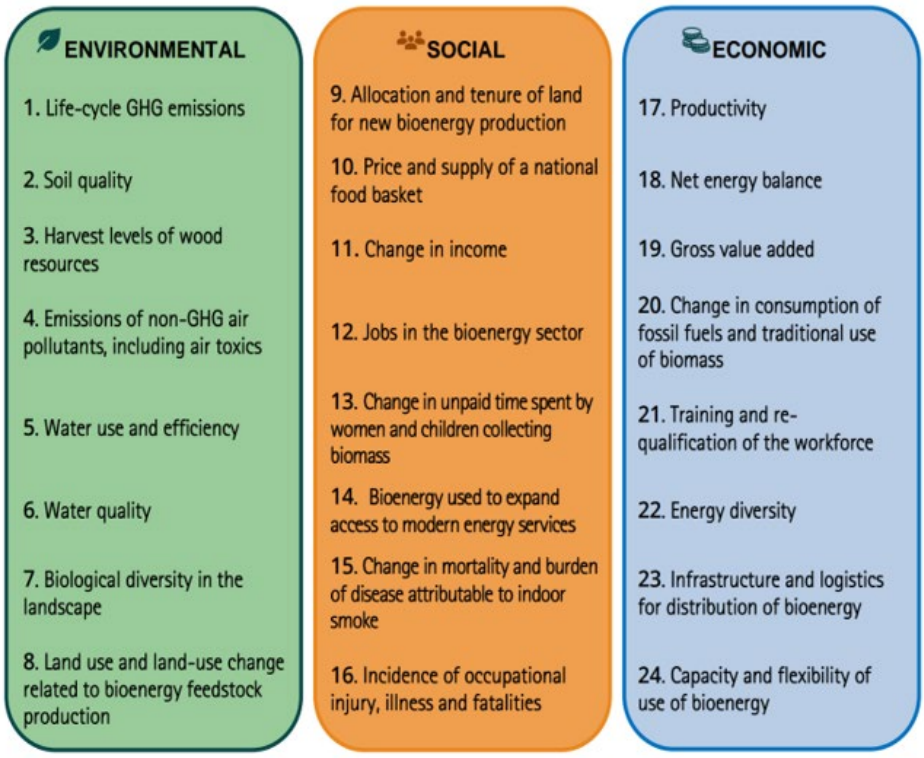
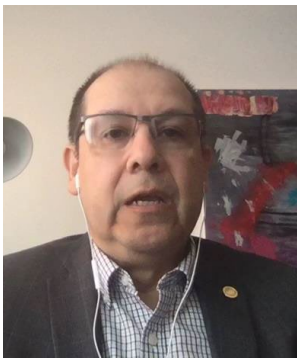


Figure 14: Overview of the 24 GBEP sustainability indicators. Source: GBEP[8]

Measured over time, the GBEP indicators show progress towards or away from a sustainable development path as determined nationally. All indicators from the environmental and social pillars and the majority from the economic pillar are linked to the UN Sustainable Development Goals (SDGs) and their targets and indicators. So far, 14 countries have implemented the GBEP indicators, among which Paraguay and Viet Nam.

[8] GBEP (2011). The Global Bioenergy Partnership Sustainability Indicators for Bioenergy. Available at: https://www.globalbioenergy.org/fileadmin/user_upload/gbep/docs/Indicators/Report_HYPERLINK_updated_CM_25-05-2017.pdf

Guillermo Parra Romero of DIPACAR gave a presentation on the implementation of the GBEP bioenergy sustainability indicators for bioenergy (GSIs) in Paraguay[9], with a focus on ethanol from sugarcane/corn (2016-2018) and biodiesel from soybean (2021). In September 2022, authorities learned first-hand the importance of GBEP Sustainability indicators, and the work done in that matter so far in Paraguay. They got acquainted with the reality and potential of bioenergy production and use in Paraguay.



The current (2022) biofuels situation in Paraguay is that ethanol is blended at 25 to 27% levels in gasoline; 86% of the ethanol is derived from corn, 12% from sugarcane and 2% from molasses. From June 2023, the blending percentage of biodiesel into diesel will be increased from 1 % to 2%.

Nguyen Thi Anh Tuyet of Hanoi University of Science and Technology gave a presentation on the outcomes of the implementation of the GSIs in Viet Nam, with a focus on Indicator #1 on biogas pathways in Vietnam[10]. The main ways to help reducing GHG emissions in Vietnam have been defined as:

- Anaerobic wastewater treatment & biogas boiler
- Bagasse for power generation (CHP)
- Installing biogas plants, to change manure management practices, generate biogas for cooking, and replace chemical fertilizers with the use of biogas by-products.

Using biogas for cooking achieves GHG emission savings of around 75% in comparison to the reference scenario in which cooking is done by commercial natural gas or LPG cook stoves.

The application of biogas technology to treat livestock (pig) waste at household and farm scale currently faces some difficulties:

- Biogas construction cost is high and the technical process of tunnel operation is complicated.
- Many biogas digesters put into use have not been designed and installed to suit the livestock needs of households and have not been operated according to technical requirements.
- The types of generators on the market are not popular and have not met the needs of consumers. H_2S concentrations (> 2,000 ppm) are an important topic, leading to wear and smell.
- The utilization of sewage sludge and treated wastewater from biogas digesters for fertilizer and animal feed purposes has not been guided for effective use.

[9] Background: GBEP (2018). Sostenibilidad de la Biomasa Forestal para Energía y del Etanol de Maíz y Caña de Azúcar en Paraguay. Resultados y recomendaciones de la implementación de los indicadores de la Asociación Global de Bioenergía. Available at: https://www.fao.org/3/i9576es/I9576ES.pdf

[10] Background: GBEP (2018). Sustainability of biogas and cassava-based ethanol value chains in Vietnam. Results and recommendations from the implementation of the Global Bioenergy Partnership indicators. Available at: https://www.fao.org/3/i9181en/i9181en.pdf

Before the panel discussion a second poll was shared with the audience on how sustainable biomass supply can be stimulated in developing economies.

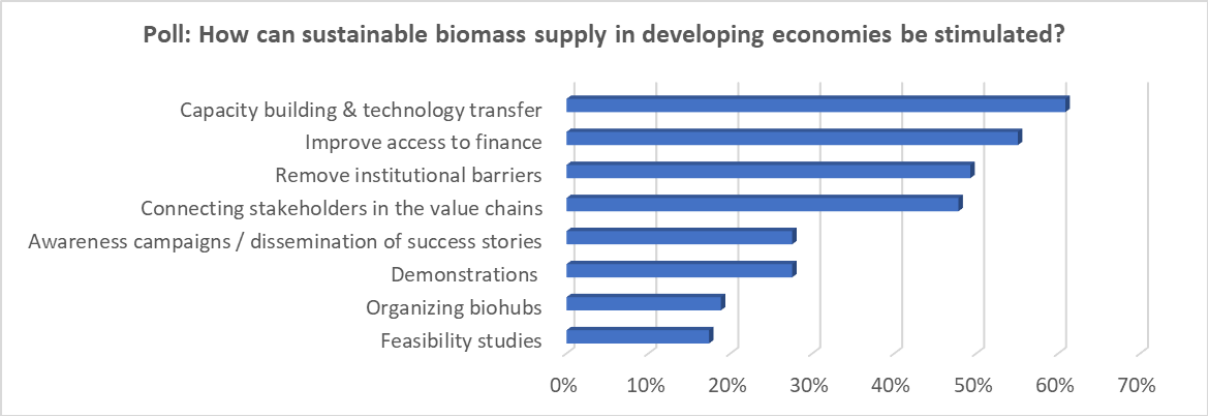
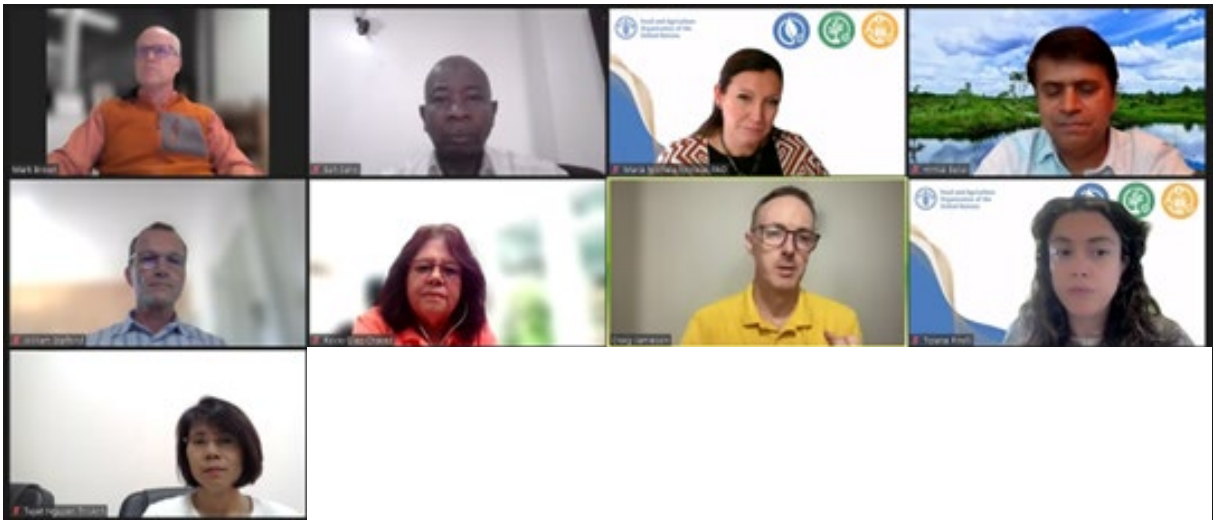


Figure 15: result of audience poll on how sustainable biomass supply can be stimulated in developing economies (max 3 selections per participant – 69 participants answered).

For this poll, participants could indicate their preferences from a list of eight options. As in the second poll in session 1, capacity building and technology transfer come out as most important tool. Next to that, access to finance, the removal of institutional barriers and connecting stakeholders in the value chains also came out as key approaches.

Panel discussion

The panel discussion was moderated by Mark Brown and Bah Saho; all speakers participated. They were also joined by *Rocio Diaz-Chavez of Imperial College London*.



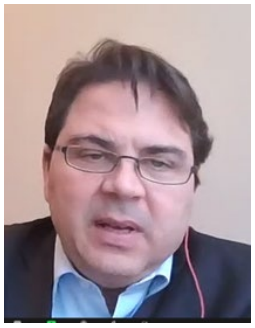
The panel discussion was focused on how sustainable supply chains can be facilitated in developing economies. Main conclusions:

- It is key to consider co-benefits and win-win opportunities of setting up biomass supply chains in a **context specific approach**, considering the local/regional/national situation, and connected to the biomass feedstock itself and existing value chains. We need to focus on improving current systems and use existing feedstocks which have proven to be efficient in production and utilization. Some new feedstocks – such as bamboo - can also be considered in certain countries. The first real action should be to look at the country context and organise a dialogue with all

relevant stakeholders to get multistakeholder engagement. Thereby gaps and barriers can be identified which need to be overcome to realize local potentials and concrete measures proposed, such as capacity building and raising awareness on the opportunities to improve local livelihoods.

- New methods and frameworks are necessary such as landscape governance to better **integrate different uses of biomass resources** in agreement with stakeholders and communities. There is a **nexus between energy, food, and ecosystems**. Energy plays an important role in agricultural landscapes. If there is a lack of (clean) energy, this is also problematic for the food chain - cold chain energy is needed to avoid food losses and wastes.
- Biomass can be made available as a residue from food or wood processing (in cascading approaches), through the cultivation or restoration of marginal or abandoned lands, via crop rotations, the combined production via agroforestry, or the valorisation of waste and residue streams. Moreover, the by-products of bioenergy systems (such as digestate as a co-product from biogas) can play an important role in local developments. Overall, biomass supply is to be considered in the context of the wider bioeconomy, not just energy.
- **Sustainability is key** in a wider sense. It is important to get things right before scaling which requires a rigorous analysis of sustainability (greenhouse gas profile; energy needs, …), and have third party verification of the sustainability of biomass supply chains. The different dimensions of sustainability need to be considered and are equally important: environmental, social, and economic. Particularly in rural areas in developing countries the social dimension is very important. Clear benefits should lead to a 'green premium', which internalizes social and environmental aspects in market prices.
- The financial system and the **demonstration of real business cases** needs more attention in the Global South. Many research and feasibility projects need to move into demonstration projects with efficient supply chains, so people can get a feel of the practice. It is also important to review past examples and assess which were the benefits, challenges, and mistakes so we can turn these into positive solutions. Support is needed to invest in logistics, storage, and aggregation hubs and to optimize supply chains. Incentivizing farmers cooperatives can be a much more effective approach than bans on residue burning.

Session 3: Sustainable biofuel production in developing economies



This session was moderated by **Gerard Ostheimer**, Manager of the Clean Energy Ministerial Biofuture Campaign, and **Ricardo Gorini**, Senior Programme Officer at the International Renewable Energy Agency (IRENA).

Gerard Ostheimer emphasized that workshops such as these are serving a very important role in getting more people to think more deeply about expanding the bioeconomy in the global South. These webinars will mark a taking-off point for more active international engagement in this field. Ricardo Gorini added that scaling up of bioenergy production is crucial for the decarbonisation of the energy system - for the outlook for 2030 and 2050 we need to double or triple the use of sustainable biofuels.

As a warmup, the session started with a first poll to the audience on what they considered as biofuels with most potential in developing economies.

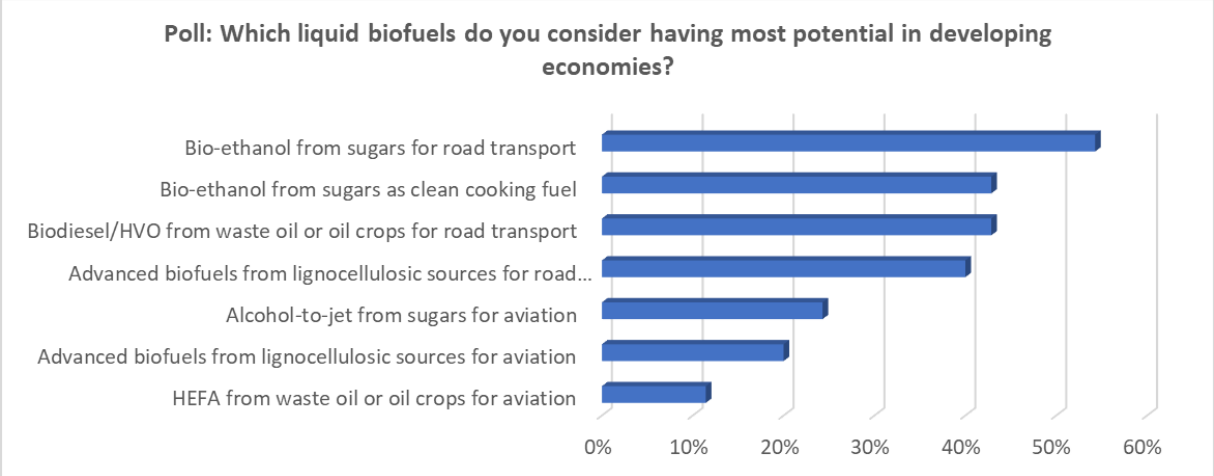


Figure 16: result of audience poll on what people considered as biofuels with most potential in developing economies (max 3 selections per participant – 70 participants answered).

Road transport biofuels (in different forms) and clean cooking fuels were considered to have most potential in developing economies. The potential for sustainable aviation fuel was considered somewhat less relevant.

Unlocking the Bioethanol Economy: A pathway to inclusive and sustainable industrial development in developing countries

Rainer Janssen, WIP Renewable Energies (Germany)

Bio-ethanol is a global commodity and is widely used as a blending component in gasoline. In Brazil, the ethanol programmes have lead to substantial greenhouse gas savings in the transport sector. Moreover, Brazil has reduced its dependency on petroleum imports (which was 80% in 1980) to below zero since 2005, now being a net fuel exporter.

Bio-ethanol is also increasingly applied as a clean cooking fuel in developing countries. This replaces traditional biomass use, thereby leading to substantial improvements in indoor air pollution, reducing deforestation and providing broader access to clean cooking.

The application of ethanol as cooking fuel happens at much smaller scale than in the transport market, but it is important to reserve a certain share of produced bio-ethanol as cooking fuel. UNIDO is rolling out programmes to support ethanol cooking in developing countries, particularly setting up distribution chains.

Figure 17: Benefits of bioethanol as a renewable energy source for transport and clean cooking. Source: UNIDO 2022[11]

The deployment of bioethanol production and application (both in transport and as cooking fuel) comes with various challenges and strategies. Impacts on food security, land use changes, biodiversity or inefficient land use need to be managed. Moreover, the local population needs to receive a fair share of the added value created.

The bioethanol industry needs an enabling framework, which is defined by (1) a clear government framework, (2) private sector engagement and access to finance, and (3) market development. An integrated policy framework covers strategic priority, policy clarity and certainty, market access, financial support, sustainability governance and innovation support. Countries can learn from each other in collaboration platforms, but also due attention is needed for country-specific aspects, such as specific drivers, risk and barriers.

[11] UNIDO 2022. Unlocking the bioethanol economy: A pathway to inclusive and sustainable industrial development in developing countries. Available at: https://www.unido.org/sites/default/files/files/2022-08/UNIDO_Ethanol_Summary_Report_screen.pdf

Biofuels in Emerging Markets: Potential for sustainable production and consumption in Argentina, Brazil, Colombia, and Guatemala

Glaucia Mendes Souza, FAPESP BIOEN / University of São Paulo (Brazil)

A great potential exists for biofuels in emerging economies of Latin America, the Caribbean, Africa, and Asia as these regions have a growing demand for sustainable energy, plentiful local resources, and land availability to produce biofuels. In a new initiative, IEA Bioenergy Task 39 (transport biofuels) evaluates policy frameworks and biofuel mandates across the global south. Policy environments were classified into three categories: fully implemented biofuels market, partially implemented biofuel blending mandates, and a positive policy environment where a legal framework is in place. In a first phase, Argentina, Brazil, Colombia, and Guatemala were considered, with biofuels markets fully implemented.[12] Together, these countries provide 29% of global bioethanol and 24% of global biodiesel production; through their biofuel implementation, these four countries together are annually avoiding 68 million tons of $CO2_{eq}$.

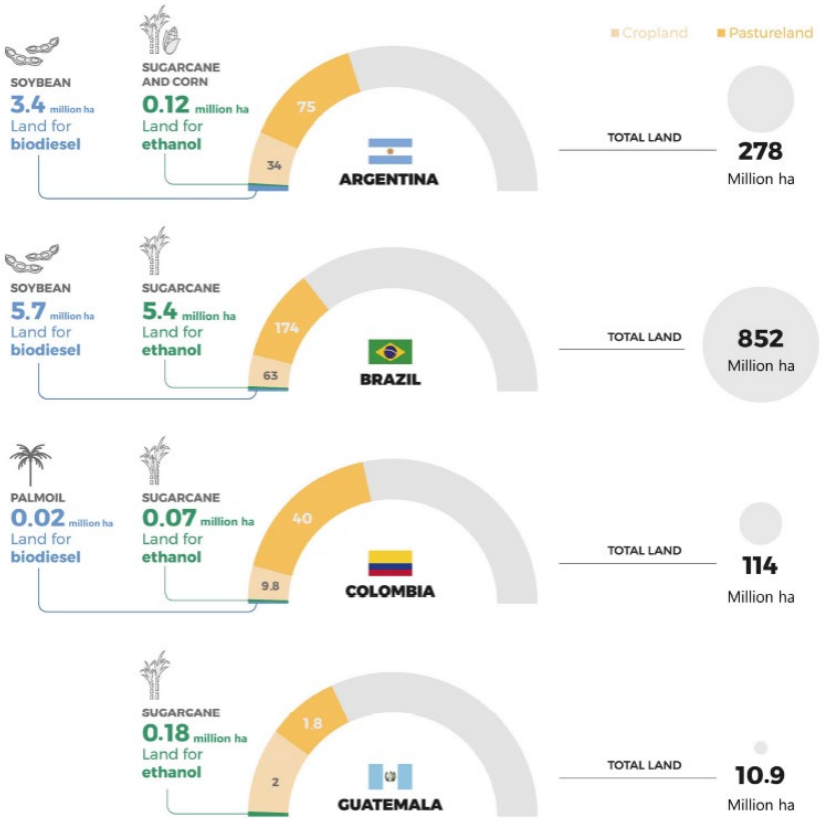


Figure 18: Current land used (in Million hectares) for biofuels, food crops and pastures in Argentina, Brazil, Colombia, and Guatemala. Source: IEA Bioenergy 2023

Land use for biofuel crops, food crops, and pastures was evaluated as well as the potential land needed to duplicate biofuels production in these countries. The total land used in Argentina, Brazil, Colombia, and Guatemala for biofuels production corresponds to 4.6%, 6.3%, 0.2%, and 10%, respectively, of the land used for pastures. **Conversion of small portions of extensively managed pastureland (from 0.1% to 10%) could add significant land for biomass feedstocks and double**

[12] IEA Bioenergy (2023). Biofuels in Emerging Markets – Potential for sustainable production and consumption in Argentina, Brazil, Colombia, and Guatemala. Available at: https://www.ieabioenergy.com/blog/publications/biofuels-in-emerging-markets-potential-for-sustainable-production-and-consumption-in-argentina-brazil-colombia-and-guatemala/

biofuel production. The payback time for soil carbon stocks of the pasture to sugarcane transition is around 2 to 3 years, while there are important positive impacts in terms of job creation, local economic development, and a reduction of greenhouse gas emissions through the replacement of fossil fuels.

SAF production challenges and opportunities in developing countries

Robert Malina, Hasselt University (Belgium) & Megersa Abate, World Bank

Sustainable Aviation Fuels (SAF) are an umbrella term for biomass, waste, or power derived jet fuels. At the moment, nine SAF pathways are ASTM certified for use in jet engines, usually up to a 50% blend. **SAF will need to play a major role in the decarbonization mix for air travel as it is the only option that can generate significant greenhouse gas (GHG) emission reductions for the sector in the medium-term already.** Their benefits are feedstock and conversion pathway specific.

SAF production can reduce up to 58% of aviation CO_2 emissions compared to business as usual in 2050 – this will require significant policy support, even more so in developing countries. Required investment for the scale-up of SAF is high, but comparable to current and historical investments in other energy sectors. Abatement costs of SAF in 2030 can be below 100 USD per ton $CO2_{eq}$ for some highly mature and GHG-beneficial pathways. By 2050, and under the assumption of aggressive policies for mitigating climate change, large volumes of SAF could be provided at below zero, or close to zero abatement costs.[13]

Very few airports in developing countries distribute SAF at the moment and current SAF production plans are dominated by OECD locations, with less than 10% of SAF expected to be produced in developing countries (mainly South America and Asia) in 2025. This implies that developing countries are currently missing out on significant economic, environmental, and social benefits of SAF production. Nevertheless, significant feedstock potential exists in non-OECD countries (of which about 2/3 from non-food sources), from which over 500 million tonnes of SAF per year could be produced.

One of the key barriers for SAF production in (most) non-OECD countries is the need to find new sources of financing and leverage existing ones. **High risk premiums for financing drive up SAF costs in developing countries, leading to 15-40% higher costs compared to OECD countries.** Driving down risk premiums for SAF production would be a major factor in reducing the costs of producing SAF in these countries. Even if risk premiums are down to OECD levels, there is still a cost gap with conventional jet fuel to make up for (the "green premium").

[13] R. Malina, M. Abate, C. Schlumberger, F. Navarro Pineda. 2022. The Role of Sustainable Aviation Fuels in Decarbonizing Air Transport. World Bank. http://hdl.handle.net/10986/38171

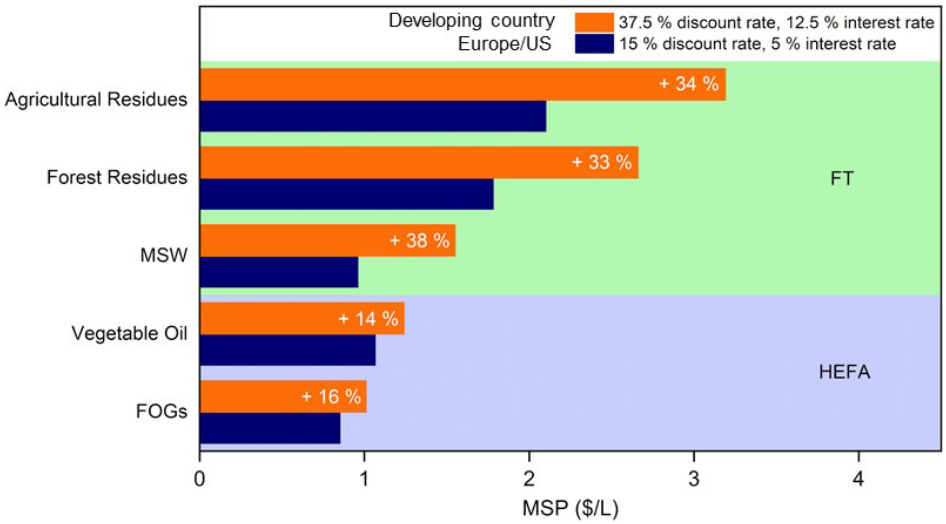


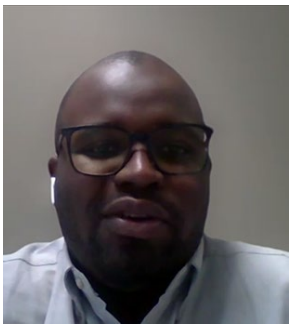
Figure 19: estimation of SAF production costs from different resources, indicating the difference related to higher financing costs in developing countries. For comparison: the conventional jet fuel price in April 2023 was 0.6 $/litre. Source: World Bank (2022)

Coalitions will be needed to drive down risk premiums and distribute the green premium – for each specific SAF investment case. This includes financing agreements with international development banks; offtake agreements from (international) airlines; Scope 3 credit purchases by corporates; and government commitments (expertise, regulation).

The World Bank has set up the 'Global Facility to Decarbonize Transport (GFDT). The GFDT will support low carbon mobility and resilient transport solutions in three ways: project design and implementation, research and data, and capacity building. The ambition is to raise $200 million over a 10-year period to invest in low-carbon transport solutions. They are yet to raise aviation specific funding.

Opportunities for SAF production in South Africa

Farai Chireshe, WWF South Africa



In South Africa, civil aviation related emissions account for more than 8% of total transport CO_2 emissions. Moreover, consciousness of climate impacts of aviation could reduce tourism and the competitiveness of South African exports could be impacted by carbon border adjustment mechanisms. Sustainable aviation fuel (SAF) can play a key role in the decarbonisation of aviation, also impacting the international competitiveness of South Africa.

South Africa has an excellent resource base, a long-standing experience with SAF production technologies and it can provide important export opportunities. The main SAF resource potential lies in (1) oil seeds, (2) A-molasses, (3) industrial off-gases, and (4) cleared invasive alien plants (IAP) and garden waste. IAP and garden waste represents between 50 and 66% of SAF production potential. **Invasive Alien Plants are an ideal feedstock for South Africa as they are mandated by law to be cleared for reasons of biodiversity, fire risk suppression, water security, land use productivity and ecological functions of ecosystems.**

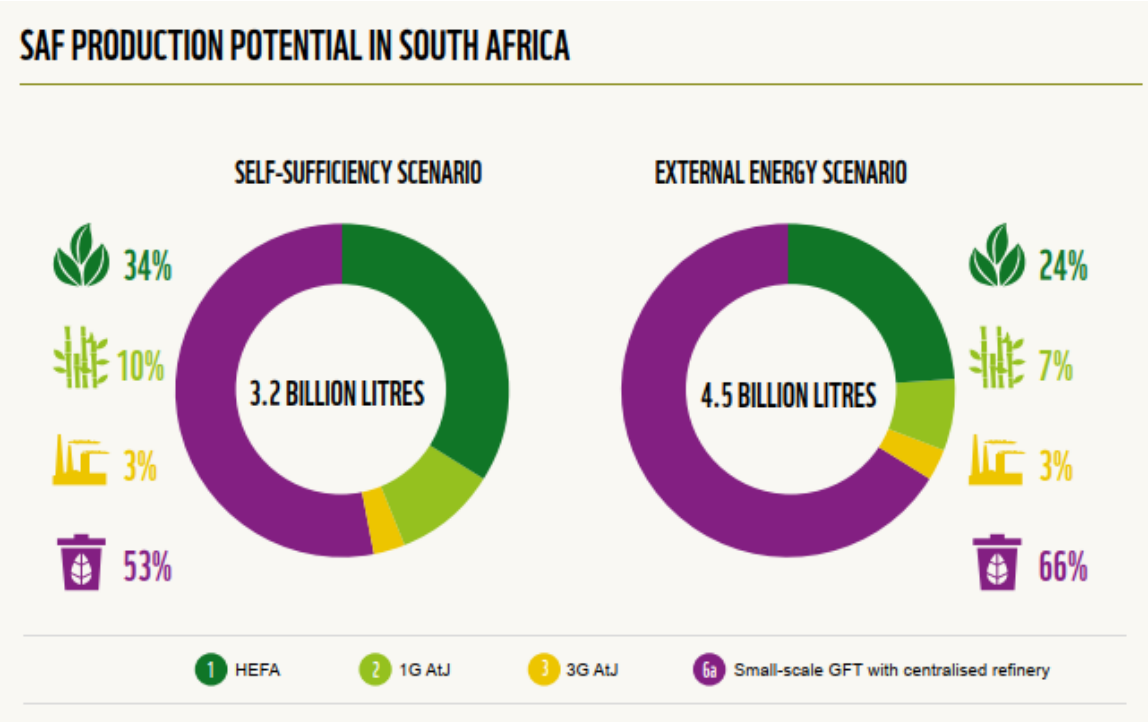


Figure 20: SAF production potential in South Africa. The 'external energy' scenario includes the addition of green hydrogen in biobased processes to boost the yields. Source: WWF (2022)[14]

Recommendations to facilitate SAF development in South Africa:

- Policy certainty will be key to develop a SAF industry in South Africa. Developing a roadmap for SAF production in the country is a critical step towards this. Various stakeholders (e.g., government departments, feedstock producers, fuel producers, airlines, airports, aircraft manufacturers, civil society, tourism bodies) will need to work together on this.
- Some of the assessed pathways in South Africa are already cost competitive with international SAF prices; several more could become competitive with relatively minor policy support, such as farmer support mechanisms to lower feedstock costs and measures to lower the cost of capital.
- Strict sustainability principles are to be applied to ensure environmental benefits are realised.
- It is important to demonstrate the feasibility of complex invasive alien plant-to-SAF supply chains, and link existing alien clearing activities to SAF value chains.
- Facilities can be placed in high biomass density regions to convert the resource to intermediate (transportable) products; the final refining can be done in existing refineries.
- Synergies of the bioeconomy alongside with green hydrogen can lead to higher yields and reduced production costs.

[14] WWF (2022). Blueprint for Sustainable Aviation Fuel (SAF) Production Potential in South Africa. Available at: https://wwfafrica.awsassets.panda.org/downloads/saf_technical_report.pdf

As a starter for the panel discussion a second poll was shared with the audience on how sustainable biofuel production can be stimulated in developing economies.

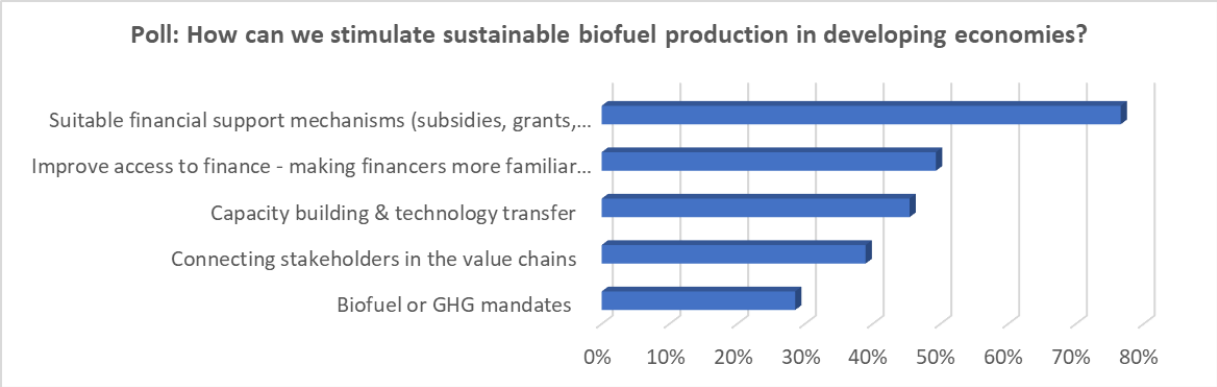


Figure 21: result of audience poll on how to stimulate sustainable biofuel production in developing economies (max 3 selections per participant – 77 participants answered).

Providing suitable financial support mechanisms and improving access to finance were considered as the most important options, followed by capacity building, and setting up value chains.

Panel discussion

The panel discussion was moderated by Gerard Ostheimer and Ricardo Gorini; all speakers participated. They were also joined by Jossy Thomas of UNIDO (who presented in Session 1).

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

Greatest challenges to develop biofuel production pathways in developing economies

- One of the biggest challenges is to find financing for biofuel projects. **To motivate private finance, viable business models, stable policies, de-risking and creating multiple revenue streams from the biomass processing is needed.** The cost of capital is higher in developing countries, because of an additional risk premium; on the other hand, biomass yields tend to be higher, and cost of labour is lower. The World Bank supports developments in emerging economies, and - in terms of biofuels - currently puts priority on difficult to abate sectors, such as aviation and marine biofuels; the focus is on rather big projects which provide substantial GHG benefits.

- Policy certainty is key to attract investments; a **clear long-term vision and a supportive policy framework is often lacking**. Blending mandates are the most straightforward approach to obtain certain market shares with biofuels. But mandates need to be within reach (not put too early) and penalties are needed for when mandates are not reached.
- Most non-OECD countries have a reasonable framework for renewable energy, but they only scratch the surface for biofuels because of fear that this would affect food security. Unnuanced messages related to food versus fuel, carbon debt or biodiversity loss and orchestrated opposition have created a negative image in Europe and North America for biofuels and bioenergy. This also contaminates the prospects of promising projects in emerging economies. Some climate funding mechanisms are very wary to include biofuel projects in their portfolio.
- Setting up the whole biomass value chain is a big challenge and needs to be demonstrated at scale. For other renewables - particularly for power production - this is less of a challenge.

Prospects of sustainable aviation fuels (SAF)

- Aviation is an international market, and for the roll-out of SAF it is necessary to attract private capital in these international markets. Because of the SAF mandates and incentives in Europe and North America, markets will put priority there. As financial resources of airlines are limited, this will probably limit their efforts elsewhere, also because investments are riskier in some developing regions - this may be different in the medium to long term. On the other hand, fast investments and learnings in developed countries can benefit emerging economies in the longer term.
- The Climate Finance department of the World Bank finances projects based on significant emission reductions, and SAF is clearly on their radar. This is a result-based climate financing instrument to support developing countries. As it is result-based there is a requirement for MRV systems (Monitoring, Reporting and Verification), which can also align with the CORSIA scheme for international aviation. The key prerequisite for support is having long term off-take agreements. The policy environment in Europe and the US would facilitate such off-take agreements, but there are certainly options to derive feedstock supply from developing countries.
- South Africa is an early mover on SAF feasibility studies, but it needs good off-takers in the local market and a good policy environment to take off. African airlines are shorter in cash, nevertheless, many international carriers fly to South Africa. Uptake of SAF in South Africa can also help to fulfil mandates elsewhere through certificate systems.

Role of the international community

- The international community can help in risk mitigation. There is a need to share experiences from different countries; this can be facilitated through international organisations such as IEA Bioenergy, the Biofuture Platform, UNIDO, the Council on Clean Cooking, GBEP, IRENA and others who can provide a platform to share experiences. South-south cooperation can be stimulated so technologies can be more contextual.
- International organizations can also have an important role to show opportunities and alleviate misunderstandings on food versus fuel and other concerns, and show that biofuel production can be synergetic, providing opportunities to stimulate the agricultural sector and stimulate the economic environment in rural areas. Through biorefinery approaches multiple products can be produced: food, fuels, bioproducts, fertilizers, etc. The biogenic CO_2 which can be captured from biomass conversion processes can open other venues in future.
- Multinational forums are important. International agencies working in the biofuel/bioeconomy field are now routinely in touch, but we need to put more effort in leveraging our convening power and engage with outside players to remove barriers between different policy fields (energy, agriculture, environment, climate, …). We need to pull together people from the business side, social and environmental organisations, experts, and intergovernmental agencies to make broader coalitions.

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