DISCUSSION PAPER

WOOD for GLOBE

Global stock-taking and review of Sustainable Wood Policies

Gary Bull & Erica Di Girolami

May 2024

DISCUSSION PAPER

WOOD for GLOBE

Global stock-taking and review of Sustainable Wood Policies

Gary Bull & Erica Di Girolami

MAY 2024

TABLE OF CONTENTS

TABLES

BOXES

Acknowledgements

We wish to acknowledge and thank our colleagues at BOKU University, IUFRO, the FAO Forest Products and Bioeconomy team lead by Sven Walter, Mr. Olman Serrano, and the FAO leader of the project, Thais Linhares Juvenal. This was a challenging and complex assignment and the forest community pulled together to get these preliminary results.

Executive Summary

The outcomes of the XV World Forestry Congress in Seoul, Korea, held on 2-6 May 2022, highlighted the importance of sustainable wood value chains in tackling developmental challenges. The Seoul Forest Declaration affirms that wood should be used to transform economic sectors towards a circular bioeconomy and climate neutrality. The Ministerial Call for Sustainable Wood invites countries to consider scaling up sustainable wood-based pathways, including increasing sustainable wood-based solutions in their Nationally Determined Contributions to address climate change. Such calls for considering the role of sustainable wood as part of the global response to developmental challenges stem from the increased knowledge and evidence on the potential of sustainable wood products to provide cost-effective and innovative contributions at scale to carbon neutrality while building synergies with broader aims for economic recovery, growth of rural areas and circular economy innovation.

In 2022, FAO in collaboration with the International Union of Forest Research Organizations (IUFRO) and the Centre for Bioeconomy at the University of Natural Resources and Life Sciences, Vienna (BOKU), engaged with the WOOD for GLOBE project, funded through the Forest Fund, Republic of Austria, an initiative by the Austrian Federal Ministry of Agriculture, Forestry, Regions and Water Management (BML). The project's primary goal is to strengthen global dialogue and networking to support the increased use of sustainable wood with a view to create a carbon-neutral bioeconomy worldwide. To achieve this, the project will pilot the concept of the global wood policy platform through three key activities: i) Exchanging technical knowledge and policy experiences (WP1), ii) Sharing scientific knowledge and experiences (WP2), and iii) Facilitating global and regional policy dialogues (WP3).

As part of the technical knowledge and policy exchange (WP1), the goals of this discussion paper are:

1. Undertake a global stock-taking and review of sustainable wood policies, practices, initiatives and programs.
2. Expand the scope of the discussion for the development of sustainable wood policies;
3. Identify issues preventing the full development of sustainable wood policies and point out opportunities available to address them.
4. Provide priorities for action.

The methodology employed to achieve these four goals involved a comprehensive approach, combining the review of both scientific and grey literature, engagement with networks of contacts specializing in sustainable wood topics, and leveraging the expertise of the authors of this paper in the field.

Key Issues and Opportunities

The lack of a consensus definition for sustainable wood policy, inadequate data collection, enforcement challenges, weak partnerships, poorly functioning supply chains, and a lack of integration with sustainable forest management and nature-based solutions emerge as critical issues. To advance sustainable wood policies effectively, there are several opportunities. First, we need a clear definition of terms like 'sustainable wood policy' to guide our discussions. We also need a way to collect data on how these policies are evolving, so we can share information and make better decisions. Using new technologies can help us spread information and ensure everyone follows the rules. It is important to make sure our policies work well with other efforts to manage forests sustainably and protect nature. Working closely with NGOs, Indigenous Communities, and Smallholders can make our policies more inclusive and effective. We must also make it easier for smallholders to access markets and manage their supply chains. Creating more global policies and platforms can help us coordinate our efforts and learn from each other. We should connect our policies with efforts to tackle climate change and promote sustainable economic growth. Educating consumers about the benefits of sustainable wood products can increase demand and support responsible choices. Lastly, working with forest investment managers can help fund initiatives that promote sustainability.

Priority Actions

We propose that the priority actions respond to the issues and opportunities identified in this report. The emerging ***circular*** **forest bioeconomic sector** will require an action list. We begin with following priorities for action:

1. Invest in Monitoring and **Data** Infrastructure

2. Develop and Promote **Sustainable Wood-Based Products**

3. Establish and Strengthen **Partnerships**

4. Promote Certification, Standards, **Global Frameworks, and a Global Wood Policy Platform**

5. Engage in Policy Forums to integrate **Sustainable Wood Policies**

6. Enhance Education, **Communication** and Awareness

Seizing opportunities and taking these priority actions, significant progress can be made to addressing the gaps and issues outlined in the earlier text and work towards more sustainable wood production, consumption, and forest management practices.

The challenge for the global community now is to find the time and resources required to develop a more cohesive and compelling set of policies (with its proxies of practices, initiatives, and programs) so that the vision of sustainable wood for a sustainable world can be better realized.

To further develop the use of sustainable wood will require that governments, industries, indigenous peoples, NGOs, and consumers collaborate to develop and implement policies, processes, and programs.

1. Introduction

Forests and trees are essential for the planet's health and human well-being, offering a wide range of goods and services. Wood and non-wood forest products (NWFP) play an important role in ensuring sustainable consumption and production, enhancing livelihoods, creating healthy landscapes and cities, and minimizing global carbon and material footprints. Solid wood products sequester carbon, allowing the extension of forest carbon benefits beyond conservation and restoration. They also contribute to other climate and health benefits, such as temperature regulation and well-being, while their lower carbon footprint promotes sustainable and green urban areas.

The outcomes of the XV World Forestry Congress in Seoul, Korea, held on 2-6 May 2022, highlighted the importance of sustainable wood value chains in tackling developmental challenges. The Seoul Forest Declaration affirms that wood should be used to transform economic sectors towards a circular bioeconomy and climate neutrality. The Ministerial Call for Sustainable Wood invites countries to consider scaling up sustainable wood-based pathways, including increasing sustainable wood-based solutions in their Nationally Determined Contributions to address climate change. Such calls for considering the role of sustainable wood as part of the global response to developmental challenges stem from the increased knowledge and evidence on the potential of sustainable wood products to provide cost-effective and innovative contributions at scale to carbon neutrality while building synergies with broader aims for economic recovery, growth of rural areas and circular economy innovation.

The shift towards more carbon-neutral circular economies with a stronger contribution of forest products will not happen without targeted policies and incentives, on both production and consumption. With regard to sustainable consumption, for instance, policies oriented to consumer markets such as wood encouragement policies and awareness-raising campaigns can help to shift markets from fossil-fuel and mineral-based products to sustainable wood products. Platforms for national and international policy and technical dialogues are one potential means to enable exchange of experiences and learning with a view to scale up a transformation towards resilient economies and climate neutrality. Awareness of the potential of the sustainable use of forest pathways, in particular the potential of wood, also needs to be scaled up. FAO, together with the members of the CPF joint-initiative Sustainable Wood for a Sustainable World (SW4SW) and the Forest Communicators Network, launched a global “Grow the Solution” communication campaign at the 19th Session of the UN Forum on Forests, with the objective of accelerating the uptake of benefits from sustainable wood in policy, investment, and consumption decisions. However, efforts need to be further scaled up to address the challenges of improving rural livelihoods and contributing to resilient economies and climate neutrality with the urgency required.

In 2022, FAO in collaboration with the International Union of Forest Research Organizations (IUFRO) and the Centre for Bioeconomy at the University of Natural Resources and Life Sciences, Vienna (BOKU), engaged with the WOOD for GLOBE project, funded through the Forest Fund, Republic of Austria, an

initiative by the Austrian Federal Ministry of Agriculture, Forestry, Regions and Water Management (BML). The project's primary goal is to strengthen global dialogue and networking to support the increased use of sustainable wood with a view to create a carbon-neutral bioeconomy worldwide. To achieve this, the project will pilot the concept of the global wood policy platform through three key activities: i) Exchanging technical knowledge and policy experiences (WP1), ii) Sharing scientific knowledge and experiences (WP2), and iii) Facilitating global and regional policy dialogues (WP3). As part of the technical knowledge and policy exchange (WP1), the goals of this discussion paper are:

5. Undertake a global stock-taking and review of sustainable wood policies, practices, initiatives and programs;
6. Expand the scope of the discussion for the development of sustainable wood policies;
7. Identify issues preventing the full development of sustainable wood policies and point out opportunities available to address them;
8. Provide priorities for action.

This is important since sustainable wood policies could have positive impacts on many aspects of our environment and society. In particular, they can:

Decarbonize Material Use: Sustainable wood is sourced from well-managed forests where trees are replanted after harvesting. This helps to sequester carbon and reduce the net carbon emissions associated with wood products.

Meet UN Sustainable Development Goals (SDGs):

a. **SDG 7 (Affordable and Clean Energy):** Sustainable wood can be used as a renewable source of energy, such as in biomass power generation, contributing to clean energy goals.
b. **SDG 13 (Climate Action):** By sequestering carbon, using sustainable wood products can help combat climate change, which aligns with SDG 13.
c. **SDG 15 (Life on Land):** Sustainable forestry practices promote healthy ecosystems and biodiversity, which is directly linked to SDG 15.
d.

Improve Forest Health and Abundance: Sustainable forestry practices, like selective harvesting and reforestation, help maintain the health and abundance of forests. This ensures that forests continue to provide ecosystem services and resources.

Improve Livelihoods: Sustainable forestry practices often involve local communities and indigenous peoples, providing them with livelihood opportunities. This can include jobs in forest management, timber harvesting, and non-timber forest product collection.

Respond to Biodiversity Loss: Sustainable Forest management prioritizes biodiversity conservation by protecting habitats, maintaining diverse tree species, and preserving wildlife corridors. This helps counteract biodiversity loss.

Encourage Innovation and Entrepreneurship: The shift towards sustainable wood encourages innovation in forestry practices, wood processing, and product development. Entrepreneurs can explore new technologies and business models that align with sustainability principles.

Address Deforestation and Forest Degradation: There are preliminary signs that deforestation is being reduced, but forest degradation, induced by both human and natural disturbances remains a concern.

The remainder of this discussion paper is organized as follows: Chapter 2 describes and analyzes critical concepts that would support the development of a sustainable wood policy and proposes a working definition to foster discussion. Chapter 3 explains how we need to move beyond product focussed policies, to the development of a broad set of sustainable wood policies to encompass a very wide range of existing, new, and emerging products. Chapter 4 introduces the methodology used to collect data for the literature review. Chapter 5 presents a global overview of policies, practices, initiatives, and programs concerning sustainable wood, as well as the results that emerged from the literature review, compared with expert assessment. Chapter 6 elucidates on specific issues that hamper the development of appropriate policies, and it points out opportunities to address each of these issues. Chapter 7 identifies priorities for action and, finally, chapter 8 concludes the discussion paper.

2. Key Definitions

To develop new policies, such as sustainable wood policy, it is important to build consensus around the language used. This chapter provides a description of existing definitions that can be used to negotiate policies related to sustainable wood, followed by a proposed definition of sustainable wood policies.

There are two main reasons definitions matter:

1. *To create the basis for discussion and negotiations for policy development.*
2. *To serve as the basis for information assembly, processing, and reporting over time.*

The key definitions developed so far that are particularly relevant to the discussion of sustainable wood policy are: sustainable forest management, sustainable forest bioeconomy[1], sustainable production and consumption of wood and sustainable wood policies. Note that the word 'sustainable' features in all the definitions and it is acknowledged that reaching agreement on what it means is a great challenge, in and of itself.

2.1 Sustainable Forest Management

In its broadest sense, SFM encompasses the administrative, legal, technical, economic, social, and environmental aspects of the conservation and use of forests. It implies various degrees of human intervention, ranging from actions aimed at safeguarding and maintaining forest ecosystems and their functions to those favouring specific socially or economically valuable species or groups of species for the improved production of goods and services. In addition to forest products (comprising both wood and non-wood forest products), sustainably managed forests provide important ecosystem services, such as carbon sequestration, biodiversity conservation, and the protection of water resources. Source: htts://www.fao.org/sustainable-forests-management/en/

Sustainable Forest Management (SFM) is a comprehensive approach to managing forests. It aims to strike a balance between the conservation and utilization of forests, ensuring their long-term health and viability.

[1] It has been argued that the word 'circular' should be included but there is currently no consensus on its inclusion.

Box 1

Sustainable Forest Management Components

The seven thematic elements of sustainable forest management are derived from ongoing regional and international processes on criteria and indicators for sustainable forest management. These elements have gained recognition from FAO member countries and the UNFF. They include:

1. **Extent of forest resources:** Ensuring adequate forest cover and stocking to support social, economic, and environmental dimensions of forestry, including efforts to reduce deforestation and restore degraded landscapes.
2. **Biological diversity**: Conservation and management of biodiversity at ecosystem, species, and genetic levels, with a focus on protecting fragile ecosystems and fostering genetic improvement for increased productivity.
3. **Forest health and vitality:** Managing forests to minimize risks and impacts of disturbances like wildfires, pollution, invasive species, and pests, which affect social, economic, and environmental aspects.
4. **Productive functions of forest resources:** Sustaining a valuable supply of wood and non-wood forest products while ensuring sustainable production and harvesting practices.
5. **Protective functions of forest resources:** Addressing the role of forests in moderating soil, hydrological, and aquatic systems, and reducing risks of natural disasters like floods, avalanches, erosion, and drought.
6. **Socio-economic functions:** Recognizing the contributions of forest resources to the economy through employment, processing, and marketing, as well as their cultural and recreational value, and ensuring fair and equitable use and management.
7. **Legal, policy, and institutional framework:** Establishing necessary arrangements for supporting sustainable forest management, including participatory decision-making, governance, law enforcement, monitoring, research, education, and technology transfer.

Source: FAO. 2005a. Global Forest Resources Assessment 2005 – progress towards sustainable forest management. FAO Forestry Paper No. 147. Rome. www.fao.org/docrep/008/a0400e/a0400e00.htm.

2.2. Sustainable Forest Bioeconomy

The [sustainable forest] bioeconomy can be defined as the **production**, **utilization**, **conservation**, and **regeneration** of biological [forest] resources, including related knowledge, science, technology, and innovation, to provide sustainable solutions (information, products, processes, and services) within and across all economic sectors and enable a transformation to a sustainable [forest] economy" (International Advisory Council on Global Bioeconomy, 2020). Source: https://www.fao.org/3/cb7445en/cb7445en.pdf

A sustainable forest bioeconomy could be considered as an economic and ecological concept that revolves around sustainable and regenerative forest management practices to harness the full potential of forests while minimizing waste and environmental impact. It integrates the principles of a circular economy with the utilization of forest resources, emphasizing a holistic approach to maximize the value derived from forests while preserving their health and biodiversity.

A sustainable circular forest bioeconomy aims to create a sustainable, regenerative, and environmentally responsible economic model that leverages forest resources efficiently while minimizing negative ecological impacts.

Box 2

Sustainable Forest Bioeconomy Components

- **Sustainable Forest Management:** The foundation of a circular forest bioeconomy is sustainable forest management.
- **Biomass Utilization:** Forest biomass, including wood, can be used in various industries, such as construction, furniture, paper, and energy production. In a circular forest bioeconomy, the focus is on efficient utilization of biomass resources to minimize waste and maximize value.
- **Recycling and Reuse:** Products made from forest resources should be designed for recyclability and reusability whenever possible.
- **Bioenergy:** Forest biomass can be used as a renewable energy source, such as biofuels and biomass-based power generation. This reduces reliance on fossil fuels and lowers greenhouse gas emissions.
- **Forest Ecosystem Services**: Recognizing the broader benefits of forests beyond timber and biomass, a circular forest bioeconomy values the ecosystem services provided by forests, including carbon sequestration, water purification, and habitat preservation.
- **Circular Supply Chains:** Circular forest bio-economies promote closed-loop supply chains where materials and products are efficiently recovered, recycled, or repurposed, reducing waste and environmental impact**.**
- **Innovation and Technology**: Advances in technology, such as precision forestry and sustainable harvesting techniques, plays a crucial role.
- **Research and Education**: Ongoing research and education are essential to continuously improve forest management practices.
- **Stakeholder Collaboration:** Collaboration among governments, businesses, communities, and environmental organizations is vital to achieving the goals of a circular forest bioeconomy.
- **Biodiversity Conservation:** Protecting and enhancing biodiversity within forests is a core principle of circular forest bioeconomy.

Source: Authors' elaboration

2.3 Sustainable Production and Consumption of Wood

Sustainable production and consumption of wood refers to the balance between the extraction of wood resources and the regeneration of forests, ensuring the long-term health and viability of forest ecosystems while meeting human demands for wood-based products. It directly contributes to the achievement of SDG12.

“Sustainable production and consumption of wood promotes forest conservation, enhances the value of forests and mitigates climate change. Building and living with wood responds to an increased demand for renewable materials and provides impetus for green recovery. Sustainable wood offers solutions across multiple value chains, including construction, furniture, packaging, renewable energy, biomaterials for clothing and biochemical”. Source: https://www.fao.org/3/cc0247en/cc0247en.pdf

Box 3

Sustainable Production and Consumption of Wood Principles

- **Forest Management**: Sustainable forestry practices involve carefully planning and managing forests to ensure their health and productivity.
- **Legal and Regulatory Frameworks**: Governments and organizations develop and enforce laws and regulations that govern forest management, logging activities, and the trade of wood products to prevent illegal logging.
- **Certification**: Certification systems like the Forest Stewardship Council (FSC) and the Programme for the Endorsement of Forest Certification (PEFC) help consumers identify wood products that come from sustainably managed forests.
- **Reduced Waste:** Minimizing waste in the production and consumption of wood products involves efficient processing techniques and recycling or repurposing wood products.
- **Responsible Consumption:** Encouraging responsible consumption means using wood products efficiently, choosing sustainable alternatives when possible, and considering the environmental impact of wood choices in construction, furniture, and other applications.
- **Sustainable Harvesting**: Practicing selective and responsible logging techniques to ensure that the rate of wood extraction does not exceed the rate of forest regeneration.
- **Protection of Ecosystems:** Preserving critical ecosystems, habitats, and biodiversity within forests is a fundamental aspect of sustainable wood production.
- **Carbon Storage and Sequestration:** Recognizing the role of forests in capturing and storing carbon dioxide (CO2) from the atmosphere.
- **Social and Economic Benefits:** Ensuring that communities and workers involved in the wood industry benefit from sustainable practices and respect for indigenous rights and local traditions.

Source: Authors' elaboration

2.4 Sustainable Wood Policies (working definition)

Based on the definitions of wood encouragement policies, sustainable circular forest bioeconomy, and sustainable production and consumption of wood, a working definition of sustainable wood policy is proposed:

Sustainable wood policies are those based on the premise of sustainable forest management as a supplier of raw material, since it can both expand the sustained use of wood into a wide array of products (solid wood, traditional commodities, bioproducts and bioenergy), and substitute for fossil fuel-based products.

Sustainable wood policies could be a set of policies, programs, initiatives, and practices designed to promote the responsible management of forests to produce wood and wood products.

Box 4

Sustainable Wood Policies Components

- **Forest Management Practices**: Encouraging sustainable forest management practices that prioritize biodiversity conservation, carbon sequestration, and the protection of ecosystem services. This includes practices such as selective logging, reforestation, and minimizing habitat disruption.

- **Legal Compliance:** Enforcing laws and regulations related to forestry and timber harvesting to prevent illegal logging and trade in wood products. Sustainable wood policies often involve strengthening legal frameworks and improving enforcement mechanisms.

- **Certification Programs:** Supporting and promoting forest certification schemes such as the Forest Stewardship Council (FSC) and the Programme for the Endorsement of Forest Certification (PEFC). These programs provide third-party verification of sustainable forest management practices.

- **Sustainable Harvesting and Processing**: Setting limits on the volume and rate of wood extraction to ensure that it does not exceed the forest's capacity for regeneration, while also setting up productivity standards This may involve implementing logging quotas, rotation cycles, and norms regarding technology and use of residues.

- **Biodiversity Conservation:** Protecting and enhancing the biodiversity of forests through measures like the establishment of protected areas, buffer zones, and the preservation of critical habitats.

- **Community Engagement:** Involving local communities, indigenous peoples, and stakeholders in decision-making processes related to forest management to ensure their rights are respected, and their livelihoods are considered.

- **Monitoring and Reporting:** Establishing systems for monitoring and reporting on the state of forests, including the assessment of deforestation rates, habitat destruction, and compliance with sustainable wood policies.

- **Research and Innovation**: Promoting research and innovation in sustainable forestry practices, including the development of technologies and techniques that reduce the environmental impact of wood production, and maximum utilization of harvested tree.

- **Market Incentives**: Creating incentives for businesses and consumers to choose sustainably sourced wood and wood products through mechanisms such as green procurement policies, tax incentives, or consumer education.

- **International Collaboration:** Engaging in international partnerships and agreements to address global challenges related to deforestation, illegal logging, and the trade in illegal timber.

Source: Authors' elaboration

3. Scope

For the purposes of this discussion paper, the focus is placed on four key wood-related sectors, following consultation. The current status and regional analysis for each sector are examined. In summary, these sectors are:

1. Solid wood – building materials, furniture
2. Additional traditional commodities - Pulp – paper, packaging, first generation of biofuels and energy
3. Bioproducts – emphasis on new product development in bio-composites, biochemicals, Next-Gen wood products.
4. Bioenergy – second generation of energy and biofuels.

3.1 Solid Wood - Building Materials and Furniture

Current Status: The solid wood sector is crucial for construction and furniture industries. Sustainable forestry practices, such as certification programs (e.g., FSC - Forest Stewardship Council), have gained prominence. Many regions have adopted sustainable forestry management practices to ensure a steady supply.

Regional Analysis: The approach to solid wood policy and practices can vary significantly by region. Some countries, for example, have strong sustainability commitments, while some regions might face challenges related to illegal logging and unsustainable harvesting.

3.2 Additional Traditional Commodities

Current Status: In the pulp and paper sector, there has been a growing focus on recycling, reducing waste, and increasing energy efficiency. Many regions have also invested in research and development for the production of textiles, and first-generation biofuels and bioenergy from wood by-products.

Regional Analysis: The pulp and paper industry often faces challenges from digitalization, impacting traditional paper consumption. In response, some regions, such as Europe, are diversifying into specialty papers and packaging materials. The development of first-generation biofuels and energy varies widely, with some regions investing heavily in biofuel production while others prioritize other renewable energy sources.

3.3 Bioproducts

Current Status: The bioproducts sector has seen significant innovation in recent years. This includes the development of bio-composites, biochemicals, and next-generation wood products like engineered wood and cross-laminated timber. These innovations aim to replace traditional materials with more sustainable alternatives.

Regional Analysis: Regions with strong R&D capabilities and a focus on sustainability, such as Scandinavia and parts of North America, have been leaders in bioproduct innovation. Government incentives and funding for research play a crucial role in promoting this sector.

3.4. Bioenergy - Second Generation of Energy and Biofuels

Current Status: Bioenergy, including second-generation biofuels, has gained traction as a renewable energy source. Second-generation biofuels are produced from wood residues and non-food crops. This sector is driven by environmental concerns and the need to reduce carbon emissions.

Regional Analysis: The development of bioenergy depends on regional policies and incentives. Some regions, such as the UK, Sweden and Denmark, have invested in bioenergy infrastructure, while others may prioritize other renewable energy sources like wind and solar.

In some regions, wood related industries are leading in sustainability and innovation while others face challenges related to resource management and market demands. Policies, practices, initiatives, and programs continue to evolve to address environmental concerns, promote sustainable practices, and support the growth of these key wood sectors.

So, what is civil society doing as seen through the eyes of the academic community? We decided to undertake a global literature review with a focus on regions that are typically underrepresented in the dialogues on sustainable wood policies. This is discussed in the next section of the report.

4. METHODOLOGY

In August 2023, a literature review was conducted to explore the existing body of knowledge on sustainable wood policies and practices in selected regions across the globe.

The search strategy involved electronic database searches using Science Direct, Scopus, Google Scholar, and Google, employing a combination of keywords and Boolean operators relevant to sustainable wood policies, renewable energy, and the construction sector.

The geographic focus encompassed a diverse set of regions (i.e., Africa, Latin America, Europe, North America, Asia, Oceania) and countries, providing a global perspective on sustainable wood policies and practices. Countries included Argentina, Australia, Austria, Bhutan, Brazil, Canada, Chile, Congo Basin, Costa Rica, Finland, France, Gabon, Germany, Ghana, India, Indonesia, Japan, Kenya, Korea, Malaysia, Malawi, Mexico, Mozambique, New Zealand, Nicaragua, Paraguay, South Africa, Sweden, Uganda, and the United States.

To avoid language bias, the review aimed to include publications in English, French, and Spanish. Both scientific papers and grey literature were considered, with a specific focus on case studies in developing countries.

The review focused on several key sectors within the realm of sustainable wood policies, including solid wood applications (e.g., construction materials and furniture manufacturing), traditional commodities (e.g., pulp, paper, and packaging), and the initial generation of biofuels and energy derived from wood resources. Additionally, the investigation extended to bioproducts, emphasizing the development of innovative products in areas such as biocomposites, biochemicals, and the next generation of wood-based products. Bioenergy sector was also explored, particularly the second generation of energy and biofuels originating from wood resources.

The research questions that guided the literature review were the following:

1. What are the main sustainable wood policies in the country/region?
2. What are the issues and gaps for sustainable wood policies/investments/education/technology transfer in the country/region?
3. What are the opportunities and priorities for fostering sustainable wood policies/investments/education/technology transfer in the country/region?

During the literature review a list of policies, initiatives, practices, and programs have been collected in an Excel file. Examples of relevant policies are those considered 'soft' power such as forest management certification, and 'hard' power such as national legislation and international agreements. Examples of initiatives, programs, and practices are land-based activities such as harvesting timber, silvicultural practices, and types of forest governance.

5. Results

This chapter is organized as follows: First, various policies, initiatives, practices, and programs at the global level will be presented. *The list is not exhaustive,* and the primary objective is to take stock of what has been done at the policy level regarding sustainable wood use, to support discussions on how to advance the sustainable wood agenda in response to global challenges. To provide a clearer overview, the different categories of policies, initiatives, practices, and programs have been classified based on whether these are public, private, or stemming from NGOs. Subsequently, the main findings of the literature review will be presented.

5.1 Review of Policies, Practices, Initiatives and Programs

5.1.1 Public Policies, Legislation and Agreements

Examples of relevant policies are those considered as 'hard' power such as national legislation and regulations, and international agreements, and 'soft' power such as forest management certifications.

National Legislation and Regulations

Africa

2016. Forestry Development Master Plan. Ghana

The National Forestry Development Master Plan follows a sectoral approach and spans 20 years from 2016 to 2036. Its primary aim is to promote sustainable forest management, preserve ecosystems, conserve biodiversity, protect wildlife, safeguard the environment, promote soil conservation, plan land use, sustainably utilize forest resources, encourage afforestation, rehabilitate degraded landscapes, and cultivate plants, all while ensuring social equity.

To enhance the productivity and sustainability of forestry, several key actions will be taken: (i) implementing measures to protect forests, wildlife, wetlands, and savannah ecosystems, (ii) enhancing management systems for protected areas, (iii) supporting climate-smart agriculture, and (iv) developing forest management certification.

Efforts will be made to modernize forest enterprises, aiming to create job opportunities for both rural and urban populations, while promoting equitable benefit sharing and public participation in forest and wildlife resource management.

Capacity building of forestry institutions and the public will be strengthened through training, research, and technology-led initiatives focusing on sustainable forest and wildlife management. This will increase public awareness about the value and various benefits of forests.

Fiscal measures will support natural forest and wildlife management, timber plantation development, plant and machinery acquisition, tertiary processing activities, woodfuel processing, and micro/small forest-based enterprises. Forest and wildlife-based industries will be developed to meet both domestic and international demand for competitively priced quality products. Furthermore, **efforts will be made to develop wood marketing, expand exports, promote trade, and ensure a sustainable supply of timber and woodfuels for the domestic market.**

The Master Plan aims to contribute to reducing Greenhouse Gas (GHG) emissions by addressing deforestation and forest degradation, as well as regulating climate and temperature.

2016. National Forest Programme 2016-2030. Kenya

The National Forest Framework outlines a strategic roadmap for the period 2016-2030, aimed at promoting sustainable forest management. Its overarching objective is to develop, manage, conserve, restore, and utilize forests and related resources to foster socio-economic growth and climate resilience. The strategic objectives encompass:

a) Expanding tree cover and halting forest degradation through sustainable forest management.

b) Maximizing the economic, social, and environmental benefits derived from forests, including improving the livelihoods of forest-dependent communities.

c) Strengthening capacity development, research, and technology adoption to enhance the value-added to forest products.

d) Establishing an enabling environment to attract resources and investment for forest development.

e) Promoting good forest governance by integrating national values and governance principles into forest development.

Furthermore, the National Forest Framework aims to strengthen the productivity and sustainability of forestry. It provides a long-term framework based on the principles of Sustainable Forest Management, focusing on enhancing forest value chains **(including wood and non-wood forest products value chains),** competitiveness, job creation, and market expansion. Key objectives include promoting sustainable forest management and increasing forest cover to a minimum of 10%.

1974. Wood Industries Corporation Act 1974 (Ch 334). Uganda

This Act sets up the Wood Industries Corporation with the primary mandate of advancing wood industries in Uganda. The Corporation is empowered to undertake various activities, including: establishing forest industries and wood processing facilities, acquiring shares in relevant forest and wood processing enterprises, overseeing the management and personnel of designated companies listed in the Act's Schedule, and engaging in the trading of timber and other forest products.

Additionally, the Minister is authorized to enact Regulations aimed at preventing timber and processed wood shortages within Uganda and mandating that the export and marketing of timber and processed wood outside Uganda are exclusively managed through or by the Corporation.

Asia Pacific

2010. Act on the Promotion of the Use of Wood in Public Buildings (Act No.36), Japan

In June 2010, Japan's Ministry of Agriculture, Forestry, and Fisheries (MAFF) proposed a bill aimed at encouraging the utilization of wood in public buildings. This bill was later enacted into law on May 26, 2010, known as the Law Concerning Promotion of Use of Wood Materials for Public Buildings (Law No. 36 of 2010).

The purpose of this law is to advocate for the use of timber as a means to combat global warming, foster a recycling-oriented society, preserve forested areas, replenish water sources, and fulfill other multifaceted functions, while also stimulating the economies of mountainous villages and other regions.

Specifically, the legislation aims to boost the adoption of domestically sourced Japanese wood by mandating that all government construction projects (limited to buildings with up to three stories and less than 3,000 square meters in floor area) incorporate wood materials, either for construction purposes or in the form of flooring, wall panels, and windows for interior use.

2016. Clean Wood Act. Japan

In May 2016, the Government of Japan enacted the Act on Promotion of Use and Distribution of Legally-Harvested Wood and Wood Products, commonly referred to as the Clean Wood Act (CWA). This legislation encompasses various timber product categories imported into Japan, applying broadly to both processed and unprocessed wood products, ranging from logs and sawnwood to fuelwood, wood chips, plywood, and furniture.

The primary objective of the CWA is to encourage businesses involved in the wood products trade to prioritize legal timber. Unlike imposing penalties for non-registration or knowingly dealing in illegal timber, the Act focuses on promoting legal practices by establishing provisions for companies to register as a "Registered Wood-related Business Entity." To qualify for registration, companies must furnish documentation verifying the legal status of the wood utilized across their supply chain.

Despite the Act's implementation in May 2016, and up until April 2020, only 397 out of an estimated 20,000 eligible businesses had voluntarily registered under its provisions.

2021. Act on the Sustainable Use of Timbers. Republic of Korea

The objective of this Act is to address climate change and enhance the quality of life for individuals, as well as to foster the sustainable development of the national economy by augmenting the carbon sequestration function and other diverse functionalities of timber, while ensuring its sustainable utilization.

The underlying principle of this Act acknowledges that creating a pleasant living environment and increasing carbon storage through timber utilization are fundamental elements in promoting national well-being, cultivating cultural lifestyles, and mitigating climate change. It aims to achieve the sustainable use of timber and pass on timber usage to future generations through the promotion of timber culture and the enhancement of timber education.

Both the State and local governments are committed to promoting the sustainable utilization of timber by implementing measures essential for advancing timber culture, enriching timber education, and ensuring a systematic and steady supply of timber products.

To facilitate the sustainable utilization of timber, the Minister of the Korea Forest Service is mandated to develop and execute a comprehensive plan for timber sustainability every five years. This plan encompasses various aspects, including assessing the current status and future prospects of timber supply and distribution, strategies for promoting timber culture and enhancing timber education, short- and long-term plans for timber supply and demand, investment plans for nurturing the timber market and industry, initiatives for promoting sustainable timber use, research and development projects to boost the competitiveness of the timber industry, training programs for technical expertise in the timber sector, and strategies for promoting the utilization of domestic timber resources, among others.

Furthermore, to promote the sustainable use of timber, a committee on sustainable timber utilization shall be established.

2017. The Tasmanian Wood Encouragement Policy

The Tasmanian Wood Encouragement Policy ensures that sustainably sourced wood is given full consideration, where feasible, in Tasmanian Government procurement, especially for new construction and refurbishment endeavors. Rather than mandating the use of wood, the policy aims to integrate wood as a significant design element under specific conditions:

• When it offers value for money,
• When it meets appropriate quality and functionality standards,
• When it aligns with the Buy Local Policy,
• When there are no technical or performance barriers to considering wood, and
• When it adheres to relevant Australian Standards.

Specifically, the Tasmanian Wood Encouragement Policy aims at:

• Foster sustainable economic growth within the Tasmanian forest and wood products industry, encouraging investments in wood processing innovations and technology.
• Support government initiatives aimed at mitigating climate change.
• Promote the utilization of materials that sequester carbon within building structures.
• Reduce carbon emissions associated with the building and construction sector.
• Cultivate a culture that values wood.
• Showcase leadership at both local and national levels.
• Urge government agencies to explore wood usage, particularly in construction, fit-out, heating, and energy needs for building projects.
• Highlight the benefits of wood to government agencies.
• Promote information sharing and educational efforts on the advantages of using wood in construction and building infrastructure.
• Encourage the consideration of wood in demonstration projects.
• Complement the Buy Local Policy and related Treasurer's Instructions.

2015 – Rotorua Lakes Council, New Zealand: Wood First Policy and Action Plan

The Rotorua Lakes Council's Wood First Policy and Action Plan, designed to promote the utilization of wood products and strengthen the district's crucial wood industry, revolves around three main objectives:

• Promoting and facilitating the adoption of wood as the preferred, sustainable building material for all projects within the district.
• Mandating the use of wood in all council building projects.
• Actively endorsing and advocating for wood and the wood industry, both locally and regionally, as well as on a national scale.

2019 – Western Australia: Wood Encouragement Policy

The Wood Encouragement Policy (WEP) for Western Australia is intended to support the forestry industry by promoting the use of responsibly sourced wood in the construction and outfitting of buildings across the region. Primarily targeting State Government procurement, particularly agencies engaged in construction and infrastructure projects such as office buildings, public transportation facilities, housing developments, and schools, the WEP extends its reach to encourage adoption by other entities like Local Governments and private companies.

Unlike mandating or showing preference for wood usage, the WEP instead aims to foster the utilization of responsibly sourced wood in construction projects where:

• It offers value for money.
• It meets standards of quality and functionality.
• It aligns with other pertinent legislation, policies, and guidelines.

Europe

2021. Switzerland. Wood Resource Policy

The Wood Resource Policy plays a crucial role in Switzerland's sustainable development strategy, contributing significantly to forest, climate, energy, regional, and other sectoral policies. Spearheaded by the Federal Office for the Environment (FOEN), this policy is primarily implemented in collaboration with relevant partners through the Wood Action Plan, focusing on two key priority areas: enhancing Swiss wood value added and promoting Climate-Appropriate Buildings.

Specifically, the Wood Resource Policy aims to achieve three main objectives:

1. Increase the utilization of Swiss wood and wood-based products.
2. Ensure sustainable supply, processing, and utilization of wood and wood-based products from Switzerland, meeting demand at all stages.
3. Enhance the competitiveness of the forestry, timber, and energy wood industry through innovation.

2011. Construction Products Regulation (CPR) - Regulation (EU) No 305/2011 of the European Parliament and of the Council of the European Union, laying down harmonised conditions for the marketing of construction products and repealing Council Directive 89/106/EEC

The regulation outlines the guidelines for the marketing of construction products, establishing methods and criteria for evaluating and expressing their performance, as well as the conditions for implementing CE marking. While Member States retain responsibility for aspects like fire safety, mechanical resistance and stability, environmental considerations, energy requirements, and other applicable regulations concerning buildings and construction works, the regulation does not mandate the usage of wood. However, it does include two provisions that encourage wood utilization.

One requirement focuses on the greenhouse gas emissions of construction products, while another stipulates the use of "environmentally compatible materials." The metric employed is the carbon footprint, calculated according to EU-level standards, covering the entire life cycle of a building and all construction materials involved.

Latin America and the Caribbean

2023. Reglas de Operación 2023 del Programa Desarrollo Forestal Sustentable para el Bienestar. Mexico

The overarching goal of this Program is to provide support to forest area owners, legitimate possessors, and inhabitants, enabling them to undertake actions that contribute to the protection, conservation, restoration, and integration into sustainable forest management of suitable lands. Additionally, the Program aims to strengthen the value chains within the forestry sector, thereby aiding in climate change adaptation and mitigation efforts and ensuring the right to a healthy environment. This is achieved through the implementation of various components, concepts, and support modalities outlined in the Program's rules.

The specific objective of this instrument is to establish the rules and procedures applicable to the operation, allocation, and execution of federal resources within the Sustainable Forest Development for Wellbeing Program.

Five distinct components are delineated within the Program, each with its specific objectives and eligible beneficiaries. These components include:

1. Community forest management and value chains, aiming to strengthen governance and the development of social, technical, and cultural aspects, along with technology transfer. It also supports activities related to the management, cultivation, use, and certification of both timber and non-timber forest resources, as well as enhancing supply, transformation, and market processes of raw materials and forest products.

2. Commercial Forestry and Agroforestry Plantations, which seeks to assist eligible individuals in establishing and developing competitive and sustainable Commercial Forestry and Agroforestry Plantations. The objective is to enhance productive diversification and increase forest production.

3. Forest Restoration of Microwatersheds and Strategic Regions, with the goal of supporting eligible individuals in implementing comprehensive forest restoration projects in microwatersheds and strategic regions. These projects aim to restore the productivity of degraded forest ecosystems.

4. Environmental services (ES), aimed at supporting eligible individuals in actively conserving forest ecosystems through economic incentives. It also aims to promote collaboration between economic and operational resources with users of environmental services and interested parties to conserve, protect, and sustainably utilize ecosystems while maintaining the provision of environmental services.

5. Forest protection (FP), which aims to support eligible individuals in undertaking activities to prevent, combat, and control pests and forest fires. This component also aims to reduce the deterioration of various forest ecosystems nationally through the provision of support for phytosanitary treatments, forest sanitation brigades, and rural fire management brigades.

2006. Law No. 11.284 on public forests management for sustainable production and other provisions. Brazil

This Law comprises 86 articles organized into five Chapters. Its primary focus is the regulation of public forest management with the aim of ensuring sustainable timber production. It places particular emphasis on aspects such as local community management, forest concessions, environmental licensing, and forestry pricing.

2018. Ley Nº 57-18 - Ley Sectorial Forestal. República Dominicana.

The purpose of this Forest Sector Law, which consists of 76 articles divided into thirteen Chapters, is to regulate and promote sustainable forest management of forests, seeking their conservation, use, production, industrialization and commercialization, as well as the protection of other natural resources that are part of their ecosystems, maintaining their biodiversity and capacity for regeneration. The foundations of this law are: 1) Establish legal mechanisms that guarantee sustainability in the use of forest resources; 2) Ensure the organization, conservation and sustainable management of forests to obtain the multiple goods and services that these ecosystems provide, including the regulation of the water regime, protection of biodiversity, soil conservation, adaptation and carbon sequestration, and energy production, among others; 3) Promote the reforestation of forest areas currently without forest, to provide the forestry products and services that are required; 4) Guarantee the protection of forest ecosystems against fires, indiscriminate logging, loss of biological diversity, genetic degradation, diseases and pests; 5) Value and compensate the environmental services provided by forests and forest plantations, as an incentive for their conservation and improvement; 6) Promote and strengthen the development of the forestry industry in all stages of the productive chain, under the criteria of competitiveness, efficiency and rationality; 7) Promote social participation in forest management.

Forest Management Certification Systems

Global

a. Forest Stewardship Council (FSC): FSC is one of the most recognized forest certification systems globally. It sets rigorous standards for responsible forest management, including sustainable harvesting, protection of biodiversity, and respect for indigenous rights. It operates in over 89 countries, with 160,021,382 certified hectares around the globe (FSC, Facts and Figures, 2024).

b. Programme for the Endorsement of Forest Certification (PEFC): PEFC is another major certification system that endorses national forest certification schemes. It operates in more than 50 countries and emphasizes sustainable forestry practices, legal compliance, and community engagement. Currently, over 280 million hectares of forest area (or 690 million acres) are managed in compliance with PEFC's internationally accepted Sustainability

Benchmarks - Nearly three-quarters (71%) of all certified forests globally are certified to PEFC (PEFC, Facts and Figures, 2024).

Multilateral Agreements

Global

International agreements like the International Tropical Timber Agreement, the United Nations Framework Convention on Climate Change (UNFCCC), the Convention on International Trade in Endangered Species of Wild Fauna and Flora, and the Convention on Biological Diversity (CBD) address forest conservation and sustainable management at the global level, influencing national policies. Some agreements are ratified and therefore often reflected in national legislation and others are not ratified and are therefore more aspirational

5.1.2 Public Initiatives and Programs

Examples of practices, initiatives and programs illustrated in this section indicate that land-based activities such as harvesting timber, silvicultural practices, governance, and soft laws are widespread as illustrated below.

Initiatives

Europe

2020. Wood4Bauhaus

The European wood-based sector has launched the Wood Sector Alliance for the New European Bauhaus (Wood4Bauhaus), establishing an inclusive platform that unites its diverse stakeholders. Wood, renowned for its versatility across various products, embodies the essence of circularity. Long-lasting wood products have the capacity to sequester carbon for extended periods, contributing to the sustainability of buildings and living spaces. Moreover, they can be reused, remanufactured, and recycled, further extending their carbon storage potential.

This alliance aims to raise awareness about the transformative potential of the Circular Economy, showcasing the versatility of innovative wood products and building systems. It also seeks to facilitate collaborative partnerships with the wood sector for the New European Bauhaus, emphasizing co-creation and innovation.

The European Commission's New European Bauhaus initiative advocates for a creative, interdisciplinary movement embedded within society, aimed at envisioning a sustainable future and embarking on a transformative journey towards affordable and aesthetically pleasing living spaces in both urban and rural settings. A crucial aspect of this work involves transitioning the building sector towards a circular model, which can play a key role in mitigating climate change.

The alliance has been initiated by several umbrella organisations: the InnovaWood EU network for wood research, innovation and education, the European Panel Federation (EPF), the European Confederation of Woodworking Industries (CEI-Bois), the European Federation of Building and Woodworkers (EFBWW), the European Organisation of the Sawmill Industry (EOS). It has also the support of the Horizon 2020 project consortia BASAJAUN and WoodCircus. The ambition is to grow the network of supporters and contribute to forming a major hub of the sector for the New European Bauhaus.

2022. European Wood Policy Platform (WoodPoP)

To facilitate the transition to an advanced wood-based bioeconomy, the European Wood Policy Platform (woodPoP) serves as a dedicated forum for multilateral policy discussions, knowledge sharing, and experience exchange among public and private actors within the wood sector at both national and regional levels. This platform aims to promote best practices and coordinated approaches in developing policy solutions.

The European Wood Policy Platform (woodPoP) is guided by the following objectives:

• Encouraging and facilitating policy dialogue and dynamic exchange on sustainable wood production and consumption, emphasizing its role in fostering an innovative, circular bioeconomy that supports energy transition and climate objectives.

• Fostering interdisciplinary exchange of technical and scientific knowledge, as well as policy experiences, to cultivate a shared understanding of efficient, forward-looking wood-based pathways and to promote innovation by integrating existing European and national resources.

• Promoting cooperation and collaborative activities on wood-related matters, as well as effective wood policy development and implementation across the pan-European region. This includes supporting the harmonization of regulations and the standardization of wood products.

• Enhancing the visibility and promoting the added value of an enhanced utilization of wood, wood-based materials, and particularly long-lived wood products derived from sustainable forest management. These are recognized as key drivers for inclusive green growth, contributing to climate protection and mitigation efforts by reducing greenhouse gas emissions.

Box 5

FAO Initiatives and Reports Related to Sustainable Wood and Forestry

- **2022 Seoul Forest Declaration:** The Seoul Forest Declaration, adopted during the 16th World Forestry Congress in Seoul, South Korea in 2022, is a significant global commitment to promote sustainable forest management. It emphasizes the importance of forests in achieving various sustainable development goals and calls for global collaboration to address forest-related challenges.

- **Ministerial Call for Sustainable Wood:** Ministerial declarations and calls for sustainable wood often underscore the commitment of governments to promote responsible and sustainable forestry practices. Such calls can lead to the development of policies and initiatives aimed at achieving sustainable wood production and consumption.

- **2022 SOFO Report:** The State of the World's Forests (SOFO) report is released periodically by FAO. The 2022 SOFO report provides an overview of global forest resources, their role in addressing climate change, and their importance for achieving sustainable development goals. It often highlights the need for sustainable wood management as a key component of global forest stewardship.

- **FAO's Regional Forest Communicators Networks:** First established in Europe 30 years ago and now counting seven networks in six regions, the Regional Forest Communicators Networks promote understanding of topical forestry issues in order to strengthen sustainable forest management in policy and practice. They share best practices and tools to implement effective communication campaigns on a regional level, promote learning among their members, and exchange up-to-date information on topical forest issues. The networks have been instrumental in promoting the ongoing Grow the Solution communications initiative, which seeks to influence public perceptions about sustainable wood.

- **FAO Strategic Framework 2022-2031:** FAO's strategic framework for 2022-2031 outlines its goals and priorities for addressing global challenges, including those related to forests and sustainable wood production. It guides FAO's efforts in promoting sustainable forest management, conserving biodiversity, transitioning to a bioeconomy, and mitigating climate change through forest-related initiatives.

- **Regional Commissions in Latin America and the Carribean and Asia Pacific:** Regional commissions often play a vital role in addressing forestry and environmental issues specific to their regions. In Latin America and Asia, these commissions are working on strategies and policies to promote sustainable wood production, conserve forests, and support local communities.

These are some of the many initiatives and reports that reflect the importance of forests and wood products in achieving broader sustainability goals, including climate change mitigation, biodiversity conservation, and poverty alleviation.

Europe

2019. Build-in-Wood

To tackle the global and European challenges of reducing greenhouse gas (GHG) emissions in the construction sector, Build-in-Wood aims to foster a sustainable and innovative wood value chain tailored for multi-storey wood buildings. Coordinated by the Teknologisk Institut of Denmark and backed by funding from the European Union, the project aims to mainstream optimized and cost-effective wood construction methods across the European construction landscape.

Between 2019 and 2024, Build-in-Wood will confront this challenge head-on by pioneering the development of materials, components, structural systems, and façade elements specifically designed for multi-storey wood buildings, catering to both new construction and retrofitting. These innovations will undergo rigorous testing, piloting, and comprehensive documentation to ensure swift adoption in the market. Furthermore, the project will actively involve selected cities to strengthen urban-rural connections.

Build-in-Wood seeks to establish a solid foundation for the solutions developed to be readily applicable in full-scale construction projects upon completion. Specific objectives include:

• Promoting wood as the preferred material for multi-storey building construction.
• Reducing GHG emissions within the European building sector.
• Establishing an innovative and sustainable European value chain for multi-storey wood buildings.
• Enhancing connectivity between rural and urban areas and contributing to sustainable urbanization efforts.
• Boosting productivity within the European building sector.

2016. The Wood Building Programme. Finland

The Wood Building Programme (2016-2023) coordinated by the Ministry of the Environment aimed at increasing the use of wood in urban development, public buildings as well as large constructions such as bridges and halls. The programme also aims to diversify and expand different applications for wood while creating as much value added as possible.

It promotes the use of wood by strengthening the skills base in the industry, updating legislation and building regulations relevant to wood construction and by providing evidence-based information on wood construction. The goal of the programme is that in the 2020s the use of wood is a natural part of construction in Finland. The programme’s objectives are to promote and develop the skills base to take wood construction onto an internationally competitive level and to support industrial wood material manufacturing in Finland to

boost exports and to support Finnish Bioeconomy Strategy by increasing the use of wood in construction and thereby increase the long-term storage of carbon.

It has five focus areas: Increasing the use of wood in urban development; Promoting the use of wood in public buildings; Increasing the building of large wood constructions; Strengthening of regional skills bases; Promoting exports.

North America

2017. Green Construction through Wood (GCWood) Program. Canada

The Green Construction through Wood (GCWood) program champions the integration of innovative wood-based building technologies into construction initiatives. This initiative is aligned with Canada's commitment to meeting its emissions reduction targets for 2030 and 2050 as outlined in the Paris Agreement, while also advancing long-term priorities related to reducing greenhouse gas (GHG) emissions.

GCWood focuses on investing in wood construction projects that offer numerous benefits, including:

• Reduction of GHG emissions through the utilization of renewable and sustainable resources, thereby contributing to the decarbonization of the built environment. • Acceleration of the adoption of cutting-edge building technologies and systems. • Updating of building codes to accommodate taller and larger wood structures. • Provision of affordable housing and community infrastructure.

Since its inception in 2017 until 2023, the program has successfully funded 16 demonstration projects aimed at mitigating risks and promoting broader adoption and commercialization of wood-based products. These projects encompass the construction of both tall and low-rise wood buildings, as well as timber bridges. As of March 2023, the program has funded 4 tall wood building projects, 10 low-rise non-residential building projects, and 2 timber bridge projects.

5.1.3 Private Sector Initiatives

It is worth noting that several critical private sector initiatives are currently underway. This is by no means an exhaustive list, but it illustrates the breadth of the current discussion across each of the four major wood products categories described in chapter 3 of this paper. The list below covers a range of subjects, from sustainable forestry practices to innovative packaging solutions, all of which relate to the development of a sustainable wood policy. It is important to clarify that most private sector initiatives require support from industrial policies implemented by governments.

Global

International Sustainable Forestry Coalition

The global forestry sector is interested to play a greater role in the policy processes related to our transition to a sustainable society. The intention of the International Sustainable Forestry Coalition is to contribute positively to the debates by bringing the global expertise, scientific knowledge, and practical perspectives of our sector to support policy outcomes that benefit both people and the planet.

Forestry, along with agriculture and other land uses, needs to contribute more to the thinking about solutions to the global challenges of climate change, deforestation and biodiversity loss, and the need for a transition to a circular bioeconomy.

The key challenge, as so many have identified, is how we move at the speed and scale that can help address these challenges in the near term, rather than decades into the future?

How can the forestry sector contribute to keeping the 1.5-degree objective alive, increase global timber and fibre supplies at the rate needed to pivot to the bioeconomy, while halting deforestation, reversing biodiversity loss, and enhancing the lives and livelihoods of small holders, Indigenous Peoples, and rural communities?

The Coalition thinks that the forestry sector has considerable expertise to contribute to these challenges.

Sustainable Biomass Program

The Sustainable Biomass Program (SBP) is a certification scheme designed for woody biomass used in industrial, large-scale energy production. SBP has developed a certification scheme to provide assurance that woody biomass is sourced both legally and sustainably allowing companies in the biomass sector to demonstrate compliance with regulatory requirements, as a minimum. This certification scheme is designed as a clear statement of standards and processes necessary to demonstrate such compliance.

For over three decades, certification systems addressing environmental, social, and human rights issues have been in existence. Today, there are over 200 certification standards used in global supply chains, with over half of them related to forestry and logging, biomass, and biofuels.

SBP seeks to avoid duplication and to be consistent with standards that have overlapping scopes, while not limiting innovation and improvement. The key certification systems that operate within the forest/biomass sector are identified below. The SBP certification system draws heavily on well-

proven forest-level certification systems, such as, the Forest Stewardship Council (FSC), the Programme for Endorsement of Forest Certification (PEFC), and the Sustainable Forestry Initiative (SFI).

It is not the intention to compete with or replicate what others do, but to fill the gap between those systems and the need to demonstrate that biomass is sustainable and can contribute to achieving climate goals. For example, there is limited uptake of certification in some key forest source areas and many systems do not cover all the key requirements faced by biomass end users, such as the provision of data on the energy used in the production and transport of the biomass.

Africa

Africa's Forestry Impact Platform

In 2021, FAO released a report saying that Africa's forests and landscapes needed restoration of the degraded lands and urged a ramping up efforts for climate action. The assessment found that in Africa, four million hectares of forests are disappearing yearly – conservation and restoration are crucial for inclusive adaptation and building resilient and sustainable ecosystems.

Later in 2021, a public announcement at COP26, by a group of investment partners, said they would to develop strategies designed to scale and transform the sustainable forestry sector in Sub-Saharan Africa.

In 2022, as a partial response, the first investors in the African Forestry Impact Platform was announced in order to scale sustainable forestry in Sub-Saharan Africa. The intent is to deliver sustainable financial returns, forest restoration and management, and climate, community, and biodiversity benefits.

New Forests, along with its investment partners British International Investment (BII), Norfund and Finnfund, have signed subscription agreements for their investment in a dedicated African fund, the African Forestry Impact Platform (AFIP), for US$200 million, and announced AFIP's first acquisition, Green Resources, East Africa's largest forest development and wood processing company.

AFIP will continue to raise long term institutional capital to support the sustainability and development of Africa's growing forestry sector, with the aim of raising US$500 million for the Platform in the next two to three years. AFIP will invest in a portfolio of plantation forestry operating companies and related assets in Sub-Saharan Africa, primarily targeting established assets that can be expected to provide stable and predictable cash flows across a diversified set of markets. AFIP will focus on four key areas of impact: climate change mitigation, biodiversity conservation,

gender and diversity, and community and livelihoods. As an open-ended investment vehicle AFIP will help to create and perpetuate sustainable landscapes that can balance conservation and production systems.

Latin America and the Caribbean

Sustainable Forestry - Project Alpha

Project Alpha is located in the Brazilian state of Mato Grosso do Sul, it aims to protect and restore nature to an area roughly twice the size of Manhattan — and find new ways to pay for it. Designed by BTG Pactual Timberland Investment Group (TIG) with help from Conservation International, the project has brought together two groups often seen as natural adversaries: conservationists and timber operators.

“It’s easy to form a snap judgment about planting non-native plantations anywhere outside their range, like eucalyptus from Australia,” said Turner, a scientist at Conservation International. “But snap judgment isn’t how we’re going to solve climate change and save biodiversity. We need to test what really works. This is a very serious commitment to improve the way we manage nature within private properties.”

Over the next five years, TIG plans to secure US$ 1 billion from investors to plant, conserve and restore nearly 275,000 hectares (741,000 acres) of degraded land in Brazil, Uruguay, and Chile. In doing so, they plan to capture some 32 million metric tons of climate-warming carbon over a 15-year period, the equivalent of taking 470,000 cars off the road.

Half of the land acquired by TIG will be protected or restored back to its natural state and set aside for conservation, while the other half will be planted with commercial species, like eucalyptus. Not merely a trade-off, where commercial activities fund conservation, the plan represents a unified system where restoring nature provides added value to investors through the sale of carbon credits, while sustainably certified timber revenue helps fund ongoing monitoring and protection of the native forest.

5.1.4 NGOs Initiatives

It is important to highlight that several NGOs have been engaged in numerous projects with industry and government partners in sustainable forest management and the implementation of sustainable wood policies. A few examples related to sustainable wood use are presented below, with additional examples provided in Annex 1.

Initiatives

Global

The Global Forest and Trade Network (GFTN)

The Global Forest and Trade Network (GFTN), an initiative by WWF, aims to establish connections among companies committed to implementing best practices in forest management. It serves as a platform for engagement between transformation industries and forest product-consuming companies that have pledged to adhere to a Responsible Purchase Policy for forest products in major global markets.

With over 350 member companies globally, the GFTN encompasses a diverse range of stakeholders, including forest owners, wood transformation industries, importers, traders, construction firms, suppliers, and investors. These companies are further organized into national and regional Forest and Trade Networks (FTNs) across 30 producer and consumer countries spanning Europe, America, Africa, Oceania, and Asia.

Asia Pacific

Sustainable Wood Factory Development

The initiative to develop a sustainable wood processing and raw material support chain model is driven by the need to tackle issues such as stranded timbers and the prevention of log and timber exports. It also aims to foster vocational skills development and enhance the value of Lao wood products, all while ensuring the optimal utilization of wood resources, as directed by Prime Minister’s Order No. 15.

Furthermore, this project endeavors to bolster anti-deforestation efforts within the country by encouraging local communities to cultivate industrial trees for commercial purposes, thereby creating employment opportunities.

Latin America and the Caribbean

Impact-oriented reforestation investment strategy

In 2021, Conservation International announced that would have worked as an impact adviser to BTG Pactual Timberland Investment Group's (TIG) new impact-oriented reforestation investment strategy in Latin America. The strategic collaboration endeavors to mobilize US$ 1 billion over five years to achieve significant climate, environmental, and social benefits on a large scale, while also generating financial returns. The strategy is designed to safeguard and rehabilitate hundreds of thousands of acres of natural forests in degraded landscapes across Latin America, as well as to plant hundreds of millions of trees in sustainably managed, independently certified commercial forests. This initiative aims to provide tens of millions of tons of carbon benefit and promote inclusive and equitable community development.

Additionally, the collaboration will invest in the development of processing facilities focused on producing climate-positive forest products, such as solid wood capable of storing carbon sequestered from the atmosphere for decades or longer and substitute for more carbon-intensive, non-renewable materials.

North America

Sustainable Wood Sourcing

LEVER has designed 10 mass timber projects to date, utilizing regional timber sourced from the Northwest and California. This includes wood products certified by the Forest Stewardship Council (FSC). LEVER collaborates closely with clients to ensure the sourcing of sustainable building materials, landscape elements, and native plantings in a responsible manner.

The Oregon Conservation Center stands as one of the pioneering buildings in the country to incorporate domestically-fabricated CLT that is FSC certified. Its construction underscores the potential of next-generation wood construction to be sustainably sourced through responsible forestry practices. The Nature Conservancy is one key partner.

5.2 Literature Review Results

This section presents a summary of the main findings from the key research papers reviewed for this discussion paper compared with expert assessment of the issues and opportunities for advancing sustainable wood policies (Tables 1 and 2*). More detailed information from the scientific literature is provided in Annex 2.*

The focus of the search was on Africa and Latin America and the Caribbean to illustrate how these regions in global policy discussions are looking at the development of sustainable wood policies.

Specifically, attention was directed to these regions because they often receive less attention in such debates compared to the Global North and Asia Pacific. It is acknowledged that further research is needed to expand this analysis at the global scale.

Table 1. Mapping of Literature Review Results and Expert Review of the Issues for Sustainable Wood Policies

	Literature Review Results (Africa and Latin America and the Caribbean)	***Expert Review***
Issues	Governance challenges	Weak Partnerships and Collaboration
"	Inadequate funding Informal practices Unequal distribution of benefits	Weak Market Info, Supply Chains and Finance for Smallholders
"	Lack of reliable data	Lack of a consensus definition for sustainable wood policy Inadequate data collection and information sharing
"	Lack of sustained political commitment to develop and implement effective policies and strategies crucial for ensuring sustainable wood production and use;	Weak global policy frameworks and wood policy platforms
"	Poor forest management and rising demands	Absence of direct linkages to sustainable forest management and nature-based solutions

“	Notable gaps in the literature are climate change linkages and communication	Lack of integration with forest bioeconomy Need for improved climate change linkages Need for ongoing efforts to communicate the merits of wood products

Table 2. Mapping of Literature Review Results and Expert Review of the Opportunities for Sustainable Wood Policies

	Literature Review Results (Africa and Latin America and the Caribbean)	***Expert Review***
Opportunities	Adopt improved and efficient technologies	Embrace and advance newer technologies for information dissemination and ensuring compliance
“	Enact and implement appropriate policies	Create a consensus definition of critical words such as sustainable wood policy
“	Develop and maintain credible and reliable database	Develop a method to collect data that describes how sustainable wood policies are developing for information sharing
“	Educational reforms	Engage in co-ordinated education campaigns to communicate and increase consumer awareness
“	Encourage interagency collaboration and coordination Public-private collaboration	Engage in partnerships and collaboration with NGOs, Indigenous communities, and smallholders
“	Improve resource planning and coordination Support research and innovation	Create compatibility with sustainable forest management and nature-based solutions initiatives
“	Increase access to finance Increase infrastructure investments	Engage with forest investment managers who are making a strong contribution to the transition to a sustainable society

“	Increase the supply of woody biomass Promote alternative energy sources Regulatory and intellectual property enhancement	Integrate sustainable wood policies with the forest bioeconomy and climate change
“	International engagement	Create additional global wood policy frameworks and a platform

Both Tables 1 and 2 summarize Annex 3 and compare results from the scientific literature with the views of expert, aiming to highlight both the significant differences and the areas of overlap. The comparison allows to gauge the state of knowledge on specific topics.

Table 1 focuses on the issues related to sustainable wood policies. Both the research and the experts point out that the common challenges are inadequate funding for policy development, the reliance on informal markets, the unequal distribution of benefits affecting particularly farmers and smallholders with poor information, the lack of reliable data and importantly, the lack of ongoing political commitments to create and enforce effective policies for sustainable wood. Addressing these challenges is made more complex by continued poor forest management practices in some regions, and the growing demand for wood to replace fossil fuels in a wide array of products.

It is also noteworthy that in comparison with the expert views, the literature review results do not discuss the linkages of sustainable wood policies, in its many forms, with climate change or the serious communication challenges. Finally, the literature does not report on the importance of having a consensus definition for sustainable wood policy.

Table 2 presents an outline of opportunities for sustainable wood policies. Both the scientific literature and expert opinions converge on the necessary conditions for moving forward. It is worth noting that both agree it is important to establish and maintain trustworthy databases, engage in coordinated education/communication campaigns to enhance consumer awareness, and embrace and advancing newer technologies for information dissemination and ensure compliance by the appropriate validation and verification procedures. Additionally, sustainable wood policies development has to be integrated with both forest bioeconomy/bioproducts discussions and the climate change initiatives, such as climate smart forestry. The creation of a coherent sustainable wood policy framework is critical for forest, for industry and for people.

6. Issues and Opportunities

The discussion encompassing the definitions, the review of policies, initiative, practices and programs, and the academic literature review, has laid the groundwork for delving into the crucial facets associated with sustainable wood policy, forest management, and the wider scope of a circular forest bioeconomy. While not comprehensive, the ensuing list serves as a discussion catalyst, drawing from literature surveys, policy evaluations, and the extensive experience of the authors entrenched in this field over several decades. Out of these discussions on pertinent issues emerge a broad spectrum of opportunities and priority actions.

Table 3. Issues and Opportunities

Issues	Opportunities
Lack of a Consensus **Definition** for Sustainable Wood Policy There is no universally agreed-upon definition of what constitutes a sustainable wood policy for both production and consumption. This lack of clarity can lead to inconsistent practices and hinder progress in sustainable forestry.	Create a consensus **definition** of critical words such as sustainable wood policy Words matter. Despite years of discussion no definition of sustainable wood policy has emerged. To provide more direction a definition will need to be developed.
Inadequate **Data** Collection and **Information** Sharing There is no systematic framework in place to collect and share data and information related to wood production and consumption. This information gap can	Develop a method to collect **data** that describes how sustainable wood policies are developing for **information** sharing The third industrial revolution is the digital revolution. We are aware of the power of data and information in shaping our world.

hinder informed decision-making and policy development. Need for Enforcement. Ensuring compliance with information tools remains a challenge particularly in regions with limited governance and resources. Despite decades of effort, activities, such as illegal logging and trade, persist in various parts of the world.	Embrace and advance newer technologies for **information** dissemination and ensuring compliance Technology is continuously improving our ability to measure and monitor the impacts of forestry practices on forests. This includes the use of satellite imagery, blockchain, remote sensing, and data analytics. Such advancements can provide a robust basis for tracking and verifying sustainable practices, increasing transparency, and building trust among stakeholders. They can also be used to monitor and trace the origin of wood products, reducing the risk of illegal logging. As we move into the fourth industrial revolution, it is critical that, at a global scale, the sector has tools to be an information powerhouse for manufacturing, for communication, and building trust
Absence of Direct Linkages to **Sustainable Forest Management** and **Nature Based Solutions** Sustainable wood policies often lack direct connections to sustainable forest management practices. To ensure long-term wood resource sustainability, policies should align closely with practices that promote responsible harvesting and regeneration of forests.	Create compatibility with **sustainable forest management** and **nature-based solutions** initiatives There is an opportunity to align sustainable wood production and consumption with emerging markets for nature-based solutions. This compatibility can promote sustainable forest management and support biodiversity conservation.
Weak **Partnerships** and **Collaboration**	

Weak or non-existent partnerships between stakeholders, including governments, industry, NGOs, and communities, can impede progress in achieving sustainable wood policy goals. Collaboration is essential to address complex issues in the forestry sector.	Engage in **partnerships** and **collaboration** with NGOs, Indigenous Communities, and Smallholders Partnerships and collaboration with non-governmental organizations (NGOs), indigenous communities, and smallholders can play a pivotal role in advancing sustainable wood policies. The stakeholders and indigenous peoples have valuable local knowledge and can contribute to responsible forest management and conservation efforts.
Poorly Functioning **Supply Chains**, Especially with **Smallholders** Smallholders need more access to market information, assistance with logistics and access to finance. It is imperative to ensure that smallholders improve their livelihoods in sustainable forestry and sustainable wood utilization sectors.	Improve **Market Access** and **Supply Chain Logistics** for Smallholders There are many smallholders participating in both forest land management, and in the production and utilization of wood products. There is an opportunity to use information technology to provide better market information, better land management options to improve incomes and wealth, better ways to bring goods to markets, and better ways to bring educational tools to the land guardians. In short IT tools can help address a serious information asymmetry challenge for the smallholders.
Weak Global **Policy Frameworks and Wood Policy Platforms**	Create Additional **Global Wood Policy Frameworks and a Platform**

Weak policy frameworks prevent the strengthening of the linkages between sustainable wood policies and national forest policies. Weak policy platforms prevent the development of a globally coherent response.	Create more collaborative efforts between countries and organizations that are enhancing the effectiveness of sustainable wood policies and practices. There is an opportunity to draft and adopt links between sustainable wood policies and national forest policies at global policy fora such as COFO (Committee on Forestry) and UNFF (United Nations Forum on Forests).
Lack of Integration with **Forest Bioeconomy** The absence of direct linkages between sustainable wood policies and the forest bioeconomy can hinder efforts to maximize the value of forest resources while minimizing waste. Need for Improved **Climate Change** Linkages There is room for improvement in connecting sustainable wood policies to climate change discussions and greenhouse gas (GHG) reporting frameworks. Recognizing the role of forests in sequestering carbon and mitigating climate change is crucial. Increasing the use of wood fiber is seen as critical to the development of a carbon-neutral bioeconomy. Sustainable wood policies should support practices that	Integrate **Sustainable Wood Policies** with the **Forest Bioeconomy** and **Climate Change** Sustainable wood policy has to be directly linked to the emerging forest bioeconomy and climate change discussion. Wood is a renewable resource, it is used to create a wide suite of relatively benign products ecologically, particularly in comparison to products created from fossil fuels and it is the basis of a sustainable livelihood for tens of millions of people. The methods to describe this are still underdeveloped.

harness the carbon-storing potential of forests while promoting responsible wood utilization.	
Need for Ongoing Efforts to **Communicate** the Merits of Wood Products Despite decades of effort, civil society remains deeply suspicious of the sustainable connection of harvesting trees and the many products and services that a harvested tree provides to society.	Engage in Co-ordinated **Education** Campaigns to **Communicate** and Increase Consumer **Awareness** Continue to work with educators and communications specialists to create more demand for sustainable renewable products that are sourced in a sustainable manner.
Need to **improve linkages to the financial services**, pension funds and insurance industries who manage a great deal of the institutional investments.	Engage with **Forest Investment Managers** who are making a strong contribution to the transition to a sustainable society. There is an opportunity to support the role of sustainable forest management in the climate, nature, social justice and forest bioeconomy transitions.

7. Priority for Action

Based on the issues and opportunities identified in the previous chapter, the following priorities for action are identified:

1. Invest in Monitoring and **Data** Infrastructure:

Investing in technology and data infrastructure for monitoring forest impacts is essential. Governments and organizations should work together to ensure that accurate and up-to-date information is available to support evidence-based policy decisions.

2. Develop and Promote **Sustainable Wood-Based Products**:

Encouraging the development and use of sustainable wood-based products in various industries can create economic incentives for responsible forest management. Governments and industry can collaborate to support research and innovation in this regard.

3. Establish and Strengthen **Partnerships**:

Governments, industry stakeholders, and NGOs should actively engage with indigenous communities and smallholders to build strong partnerships. These partnerships can facilitate knowledge sharing, capacity building, and inclusive decision-making processes.

4. Promote Certification, Standards, **Global Frameworks, and a Global Wood Policy Platform**:

Encouraging the adoption of forest certification schemes and sustainability standards can help promote responsible wood production and consumption. These systems provide a framework for assessing and verifying sustainable practices. The promotion of a global policy platform for all of civil society will also improve coherence and linkage to locally relevant challenges.

5. Engage in Policy Forums to integrate **Sustainable Wood Policies**:

Engaging in global policy forums, as suggested throughout this discussion paper, can facilitate the alignment of sustainable wood policies with national and international forest policies. This can help establish and align common goals and standards.

6. Enhance Education, **Communication** and Awareness:

Public awareness and education campaigns can play a vital role in promoting sustainable wood policies. Informing consumers about the environmental and social benefits of choosing sustainably sourced wood products can drive demand for responsible forestry practices.

Seizing opportunities and taking these priority actions, significant progress can be made to addressing the gaps and issues outlined in the earlier text and work towards more sustainable wood production, consumption, and forest management practices.

8. Conclusions

This discussion paper was meant to provide background material for continued dialogue and negotiations on sustainable wood policies. Specific objectives were:

1. Undertake a global stock-taking and review of sustainable wood policies, practices, initiatives and programs;
2. Expand the scope of the discussion for the development of sustainable wood policies;
3. Identify issues preventing the full development of sustainable wood policies and point out opportunities available to address them;
4. Provide priorities for action.

The methodology employed to achieve these four goals involved a comprehensive approach, combining the review of both scientific and grey literature, engagement with networks of contacts specializing in sustainable wood topics, and leveraging the expertise of the authors of this paper in the field.

More research is needed for a comprehensive review and global stock take of sustainable wood policies, practices, initiatives and programs. For the time being the hope is to have provided enough information to encourage a discussion on the critical topic of sustainable wood policy and the associated terms of sustainable forest management, sustainable forest bioeconomy and the sustainable production and consumption of wood products.

Critical issues/opportunities emerging from the review have been highlighted , followed by a proposed list of priorities for action to be taken by the international community in the next few years.

The challenge for the global community now is to find the time and resources required to develop a more cohesive and compelling set of policies (with its proxies of practices, initiatives, and programs) so that the vision of sustainable wood for a sustainable world can be better realized.

ANNEX 1 - NON-GOVERNMENTAL ORGANIZATION INITIATIVES

Name of the Initiative	Lead Organization	Partners	Country	Aim
Generally defined as "Restoration project''	Conservation International	The Brazilian Ministry of Environment, the Global Environment Facility (GEF), the World Bank, the Brazilian Biodiversity Fund (Funbio) and Rock in Rio's environmental arm "Amazonia Live."	Brazil	Regrow 73 million trees in the Brazilian Amazon by 2023
Central Highlands Restoration Project (CHiRP)	The Nature Conservancy	IKEA Foundation, Commonland, Samerth Charitable Trust, Global Business Inroads, and United Designers	India	Launched in 2019, CHiRP aims to conserve and restore forested landscapes while improving the livelihoods of forest-dependent communities. It seeks to balance economic development with sustainable resource management by providing science-based win-win solutions, thereby enabling communities and nature to thrive together. By 2025, the project aims to have 2,000 hectares of land restored and protected, with sustainable income sources based on robust market linkages developed for 1,000 smallholder families while creating biodiversity and climatic benefits.

Name of the Initiative	Lead Organization	Partners	Country	Aim
The Cacau Mais Sustentável (More Sustainable Cocoa) project	The Nature Conservancy	The Brazilian Ministry of Agriculture, CAPPRU (the Alternative Cooperative of Smallholders and Urban Farmers of São Félix do Xingu), Cargill Cocoa & Chocolate	Brazil	The Nature Conservancy is working with farmers like Benício to plant sustainable agro-forests of cocoa trees, banana trees and a mix of native hardwood trees to help restore the rainforest while providing a better livelihood. Additionally, the Conservancy is teaching farmers practices that improve soil conditions for cattle ranching and in turn stop the deforestation cycle. The goal is to reduce deforestation by 97 percent and remove São Félix do Xingu from the environmental black list.
Sustainable Rattan and Bamboo	WWF Laos	IKEA and Sida (the Swedish International Development Cooperation Agency), and National Agriculture	Laos Cambodia Vietnam	WWF's sustainable rattan project operates in Bolikhamxay, Xekong and Saravan provinces. The objective of the project in Laos – which also runs in Cambodia and Vietnam – is to secure credible forest certification, establish a more sustainable rattan production supply chain, and develop sustainable financing for small

Name of the Initiative	Lead Organization	Partners	Country	Aim
		and Forestry Research Institute (NAFRI)		and medium sized enterprises to invest in it.
Sustainable Bamboo, Acacia and Rattan Project	WWF Vietnam	Hoa Loc cooperative	Vietnam	WWF-supported projects and local partners are helping communities significantly boost their incomes from products like rattan, acacia, rubber and bamboo while scaling up efforts to prevent illegal and unsustainable logging. At the same time, they have nurtured robust, forest-friendly and profitable local industries, creating success stories that can be used to inspire others.
Sustainable Forest Programme	WWF International	WWF Finland, WWF Sweden, and WWF UK	Tanzania, Uganda, Kenya, Madagascar, Mozambique	To address illegal trade in timber and embrace regional collaboration among countries, the WWF East Africa Regional Forest programme is among initiatives as Non Governmental Organization that seek to strengthen regional coordination and collaboration and scale-up regional interventions to improve forest governance in the region. The programme works in 5 countries (Tanzania, Uganda, Kenya, Madagascar, Mozambique) and engage closely with Regional Economic Commissions (RECs) such as COMESA, EAC and SADC

Name of the Initiative	Lead Organization	Partners	Country	Aim
Sustainable Forestry	WWF South Africa	Mondi and Sappi	South Africa	To strengthen industry self-governance and improve collective water stewardship practices, WWF convenes partnerships with forestry companies who have plantations in strategic water source areas which support important wetlands and catchments.
Forests Forward	WWF International	27 participants	Global	Forests Forward is a signature WWF programme for corporate action in support of nature, climate and people. WWF's local and global experts support companies committing to ambitious goals by helping them prioritise the forest-related activities that will yield the greatest impact, and integrating new activities into initiatives they already have in place. Then, WWF helps companies take action. Sourcing more responsibly to reduce a company's forest footprint. Investing in forest landscapes to protect and restore the world's most threatened and ecologically important ones. Improving the management of forests, to boost each forest's ability to sustain biodiversity, benefit climate, and support local communities
Union 4 forest restoration	The Nature Conservancy (TNC Brazil)	Conservation International (CI-Brazil) World Resources Institute (WRI) Brazil WWF-Brazil	Brazil	The alliance that aims to restore 4 million hectares of forests and landscapes in the Amazon, Cerrado, and Atlantic Forest by 2030. The total area to be restored is approximately the size of Denmark.

Name of the Initiative	Lead Organization	Partners	Country	Aim
Trillion Trees	BirdLife International, Wildlife Conservation Society WWF	1t.org Aga Khan Development Network Coalition for Private Investment in Conservation (CPIC) Food and Agriculture Organisation of the United Nations Global Returns Project Nature4Climate Starling Bank	Global South	The Trillion Trees partners focus on three imperatives that have been determined to have the highest impact on increasing global forest cover: • Protecting standing forests • Ending the causes of deforestation • Restoring forests

ANNEX 2 - LITERATURE REVIEW SUMMARY

The reviewed scientific literature does not provide a clear definition of sustainable wood policy. For this reason and based on the proposed working definition[1], we are going to present the results of the literature review based on (some of) the key wood related sectors investigated, namely: i) Solid wood ii) Bioenergy and iii) Bioeconomy. We mainly reviewed the literature for the African and Latin American region, since they are often underrepresented in this policy discussions. When possible, we have highlighted the main issues and opportunities for improvement.

Africa

Solid Wood

In the management of forest and the production of solid wood, Africa is very much influenced by sustainable wood policy development in other countries. Therefore it is useful to review this global context briefly.

Timber serves as a fundamental construction material used worldwide, with forests playing a crucial role in the supply chain for both softwood and hardwood timbers employed in the construction industry. Each major construction material (e.g., steel, concrete, brick, timber, cement, sand, and aggregate) has its distinct supply chain. However, the timber supply chain is unique (Ramage et al., 2017) and timber is the only widely used building material that can be truly considered sustainable (Ibidem).

Developed regions have established various regional and national policy frameworks, such as the European Forest Strategy, to safeguard forests and enhance the long-term competitiveness of the forest sector. Long-term measures in sustainable forest management are especially critical in developing regions, where weak governance in the forest sector has failed to curb illegal deforestation and has, in some instances, promoted the corrupt undervaluation of forest land and the under-pricing of forest products, leading to government-complicit deforestation, both for conversion to agricultural land and illegal logging (FAO, 2014; FAO, 2012; Palo et al., 2012).

Given the substantial global trade in forest and agricultural products, a significant portion of deforestation associated with these products enters the international market for consumption. For example, 33% of deforestation linked to crops and 8% of deforestation associated with livestock products enter the global trade market. Additionally, up to 40% of global roundwood production originates from illegal logging (UNECE/FAO, 2014; WWF, 2014). Acknowledging this, for instance, EU is actively and increasingly implementing measures on both the supply and demand

sides to regulate traded products. This is done to promote sustainable forest management practices in developing regions. Complementing these efforts are bilateral agreements and regulations, such as the EU Forest Law Enforcement, Governance and Trade (FLEGT) Action Plan, which ensure standardized third-party audits (e.g., from the FSC/PEFC) of wood products. These audits certify that the products originate from responsibly managed forests and enable systematic tracking of wood from certified forests to the final product. Currently, only about 10% of global forests are certified, with the majority in North America and Western Europe. An estimated 30% of global roundwood production originates from these certified forests (UNECE/FAO, 2014).

In addition to international and national efforts in forest management, promoting the use of sustainable wood products as alternatives to non-renewable or high-embodied energy materials can bolster environmental conservation endeavors (Oliver et al., 2014). In the EU building sector, the EU Construction Products Regulation mandates that construction must follow principles that ensure the sustainable use of natural resources from design and construction to demolition and recycling. This regulation specifically requires the use of life-cycle analysis (LCA)-based Environmental Product Declarations (EPDs) to assess the sustainable use of resources in all construction products. Consequently, efforts are underway to compile comprehensive LCA data for wood and wood products, as seen in initiatives like the UK's Wood First Plus Initiative.

A study conducted by Baiden et al. (2005) investigated the use and potential of timber for housing construction in Ghana, and the barriers it faces. Results showed that the use of timber for the construction of buildings encounters two main barriers, one psychological and the other technical. In Africa, as elsewhere, psychologically, there is a perception that timber would be consumed by fire if used in building construction. Additionally, timber is perceived as always being susceptible to insect attack and decay, and timber-constructed houses are often viewed as old-fashioned and for those with lower economic status. Consequently, those who lived in timber houses are shifting to sandcrete block buildings because they are perceived as modern buildings.

Technically, the large number of timber species in the country is not well reflected in the availability of timber products on the local market. This is partly because a majority of the logs and timber products are exported to foreign countries, leaving a small amount for the local market, which is insufficient for full timber buildings for the Ghanaian population. The local market cannot, therefore, meet the demand should there be an intensive shift from the construction of sandcrete block buildings to the construction of timber buildings.

Timber constructed households have not adopted any maintenance policies aimed at keeping the buildings in good conditions for long periods. Common problems often encountered during the lifespan of the structures are decay of timber due to contact with water and wearing of floor boarding. All these are avoidable with a good maintenance culture. Additionally, there is a lack of knowledge of the principles of design in the use of timber for structural performance, economy, and

aesthetics in house construction by architects. Expert tradesmen in timber housing construction are not available. Technical data, such as durability and strength properties, as well as seasoning characteristics on a large number of readily available secondary species, are not available, thus limiting their use in construction. The standard of timber engineering is inadequate as timber receives little attention in the training of architects and engineers, and there is a lack of extensive carpentry training in the timber industry.

So we can see for Africa, there is a huge challenge to increase the use of solid wood as a building material and very few studies have been undertaken to explore how to resolve the many issues.

Bioenergy

Wood serves as the primary energy source in sub-Saharan Africa, with approximately 80% of the population, roughly 780 million people, relying on wood-based fuels for cooking (IEA, 2017). This percentage has only decreased by three points since 2000. In rural areas, firewood is the predominant cooking fuel, while urban areas often favor charcoal. Wood-based fuels are popular due to their widespread availability, ease of use, and affordability. They also offer an essential source of income, particularly for poor households (Hoffmann et al., 2018; Mwampamba et al., 2013; Sedano et al., 2016; Vollmer et al., 2017; Zorrilla-Miras et al., 2018). The charcoal sector, for instance, generates jobs and cash income for hundreds of thousands of individuals, with values reaching several hundred million USD in countries like Tanzania (Sander, 2009) and Kenya (Mwampamba et al., 2013). Moreover, wood-based cooking fuels are renewable and, if managed, harvested, and used sustainably, they possess a relatively low carbon footprint (Berndes et al., 2016), making them potentially valuable in reducing global CO2 emissions.

Nonetheless, the use of wood-based cooking fuels can result in detrimental environmental and health consequences. Various studies have indicated that the harvesting of these fuels can lead to environmental degradation (Ahrends et al., 2010; Bensel, 2008; Mwampamba, 2007; Sassen et al., 2015; Specht et al., 2015; Sulaiman et al., 2017). However, the extent of this impact remains a subject of debate (Chidumayo and Gumbo, 2013; Ghilardi et al., 2018; Iiyama et al., 2014) and varies depending on the geographical context (Bailis et al., 2015).

Moreover, unsustainable wood-based fuel harvesting contributes approximately 2% to the global carbon footprint (Bailis et al., 2015; Okoko et al., 2017), and the improper use of these fuels results in millions of premature deaths annually due to exposure to carbon monoxide and fine particles (Langbein, 2017; Legros et al., 2009; WHO, 2018). Although the percentage of the population using wood-based fuels has declined in recent years and is expected to continue declining (Bonjour et al., 2013), the absolute number of wood-based biomass energy consumers will rise in the coming decades (UNECA, 2014), with projections nearing 900 million in sub-Saharan Africa by 2030 (IEA, 2017). The growth in demand for wood-based cooking fuels is mainly driven by rapid population

growth (IEA, 2017; World Bank, 2014) and the slow pace of energy transition from "traditional" biomass fuel (e.g. firewood, charcoal) to modern cleaner alternatives (e.g. liquefied petroleum gas, electricity) (Zulu and Richardson, 2013). Additionally, increased urbanization is anticipated to lead to greater charcoal consumption (Felix, 2015; Hosier et al., 1993; Sander et al., 2011), further increasing the demand for wood. The continued expansion of woodfuel demand has raised concerns regarding its environmental impact. However, the connection between woodfuel consumption and tree loss is intricate. Woodfuel extraction is closely linked to agricultural production. As the population expands and more land is cultivated, greater wood is generated from land clearance. Timber harvesting, wildfires, mining, and urban expansion also reduce tree cover. Effective policymaking for energy supply, agricultural development, and sustainable environmental management necessitates a better understanding of the intricate interplay among these drivers of land cover change (World Bank, 2022). These findings align with those of Namaswa et al. (2022).

The key issues identified in the academic literature for Africa (Bar et al., 2021; Namaswa et al., 2022; Taron et al., 2023) for this sector are as follows:

- The sector faces inadequate funding, governance challenges, and a lack of sustained political commitment to develop and implement effective policies and strategies crucial for ensuring sustainable production and use. Poor governance has led to the under-pricing of biomass energy, particularly woodfuel, due to competition from illegally harvested woodfuel.
- Most African countries lack reliable data on biomass energy supply and demand. The data available is often characterized by high uncertainty, making it difficult to undertake effective wood energy planning and policy formulation (Miyuki et al., 2014). This scarcity and uncertainty in wood energy data hinder the integration of wood energy into national-level planning exercises, which are essential for formulating national policies, resource allocation, and prioritizing development objectives and targets (Githiomi, 2010). Biomass energy, in contrast to alternatives like LPG, kerosene, and electricity, largely operates in the informal sector and does not pass through a monetized economy.
- The woodfuel value chain exhibits complexity due to numerous stakeholders, informal practices, and unequal distribution of benefits. This situation provides little incentive for sustainable woodfuel extraction, and it often leaves the poorest communities marginalized. In many African countries, woodfuel prices do not account for replacement costs, as fuelwood/charcoal producers are not required to replace or compensate for the trees they extract. This has resulted in unsustainable harvesting of this resource.
- Current energy consumption patterns in Africa have led to deforestation and forest degradation, posing a significant environmental challenge. The negative environmental impacts of cooking with wood-based fuels are increasing in many African nations. Poor forest management and rising demands are contributing to elevated levels of deforestation, making the resource less accessible. This is evident in the increased daily trips that rural

women make to gather fuelwood, extended gathering times, and higher household expenditures on woodfuel (Namaswa et al., 2016). Furthermore, it can lead to reduced profits for woodfuel producers and vendors due to increased transportation costs from production sites.

In Africa there are still opportunities in the sector, and the consistent message across studies (Bar et al., 2021; Hazelton et al., 2013; Namaswa et al., 2022; World Bank, 2022; Bowd et al., 2018; Shackleton et al., 2022; Amezaga et al.; 2013) are summarized below:

- Enact and implement appropriate biomass energy policies;
- Develop and maintain of credible and reliable biomass energy database;
- Adopt improved and efficient production and utilisation technologies;
- Increase the supply of woody biomass (e.g., on-farm tree planting and out-grower schemes Assisted natural regeneration; Agroforestry, etc);
- Improve resource planning and coordination;
- Encourage interagency collaboration and coordination;
- Increase access to finance; and,
- Promote alternative energy sources.

Bioproducts and Bioenergy

In Africa, some of the key drivers that shape the bioeconomy include the availability of resources, advancements in biotechnology through research and development, demographic factors, and various policies and regulations (Wesseler et al., 2017). Government measures, such as policies, strategies, and legislation, as well as investments in research, intellectual property rights, and public acceptance, are also considered significant forces that propel innovation within the bioeconomy (Kardung et al., 2021).

In Africa, an analysis by Oguntuase and Adu (2021) on the state of bioeconomy development revealed that Kenya is ahead of other African countries in terms of people in research and development (R&D). Tunisia is next to Kenya in this category and performed better than South Africa. Mauritania, Lesotho, Liberia, Chad, and Congo are the least performers in this group.

With respect to biomass production, Gambia occupies the top spot. Other countries in the top ten are Rwanda, Sierra Leone, Malawi, Democratic Republic of Congo, and Tanzania. The least performers in this categorization are Algeria, Mauritania, Egypt and Chad. South Africa leads Kenya, Mauritius, Rwanda and Morocco in investments in research and technology. Chad, Lesotho, Liberia, and Congo followed Mauritania in terms of least investment in R&D.

African countries performed poorly under the institutional arrangements category. Mauritania, Chad, Lesotho, and Liberia occupied the bottom position in institutional arrangements, production determinants, people in R&D and investment in R&D.

In terms of preparedness to adopt the bioproducts and bioenergy, South Africa, Kenya, Mauritius, Rwanda, and Morocco occupy the top spot. A number of African countries possess abundant biomass resources, but are poorly equipped to adopt bioproducts and bioenergy, when compared with countries from Asia, Europe and America. This is primarily attributed to poor government funding of R&D, shortage of technicians and researchers in R&D, inadequate or absence of cutting-edge technologies, lethargic industrial production processes, poor industry-university partnership, and weak institutional arrangements, particularly in the quality of infrastructure and rule of law.

Strategies for promoting Africa's bioproducts and bioenergy must focus on targeted spending to assist R&D initiatives, establishment of an effective innovation system, improved education, and developing markets to boost competitiveness. Increasing foreign investment in the bioeconomy sector will also enhance general governance, infrastructure quality, and the rule of law (Oguntuase and Adu, 2021). Incomplete datasets and nonavailability of comparable data remain major limitations in Africa. In the absence of quality data, it is difficult to formulate good strategies and scale up innovations for sustainable bioeconomy on the continent (Oguntuase and Adu, 2021). These recommendations are consistent with the findings by Virgin et al.(2022).

In Africa, the opportunities identified in the academic literature arevas follows:

1. Biotechnology Promotion:
    - Focused awareness strategies concerning biotechnology's potential benefits in the context of a bioeconomy.
2. Educational Reforms:
    - Revisiting the policy framework for education to stimulate interest in science and technology at primary and secondary levels.
    - Redesigning tertiary-level curricula to incorporate biotechnology courses.
3. Infrastructure Development:
    - Establishing infrastructures for low- and high-end biotechnology techniques, such as genome editing, tissue culture, and genome sequencing.
    - Increasing funding for bioeconomy research, development, and innovation (R&D/I).
4. Research and Innovation Support:
    - Promoting basic and applied research on key enabling technologies.

- Strengthening links between science and business through interdisciplinary cooperation between universities, research institutes, and industries.

5. Manpower Development:
    - Providing motivation and incentives to retain highly skilled manpower.
    - Establishing centers of excellence and promoting multidisciplinary approaches in workforce development.
6. Information Technology Investment:
    - Massive investment in broadband information technology infrastructure to enhance knowledge transfer and applications.
7. Capacity Building:
    - Establishing specialized biotechnology centers of excellence for capacity building in priority areas.
8. Public-Private Collaboration:
    - Establishing collaborative technology parks, ventures, and incubators with the private sector to facilitate the market entry of biotech products.
9. International Engagement:
    - Fostering international linkages and partnerships.
    - Attracting foreign investments, contingent on the presence of functional basic facilities.
10. Regulatory and Intellectual Property Enhancement:
    - Establishing and consolidating regulatory, biosafety, and intellectual property bodies.
    - Developing more effective biotechnology guidelines and policies.
    - Setting up certification and testing facilities.
11. Infrastructure Investments:
    - Investments in critical infrastructure elements like potable water, reliable power supply, roads, and biomass storage and processing facilities, all of which are essential for the bioeconomy's success.

Latin America

Bioproducts and Additional Traditional Commodities

For Latin America, the literature review yielded research results with a specific focus on Brazil (Maximo et al., 2022). Brazil possesses the world's second-largest forest area, with more than 485 million hectares naturally regenerating forests, while approximately 10.5 million hectares are planted

forests (FAO, 2020; IBGE, 2020). Despite the prevalence of natural forests, the forest industry primarily sources around 78% of its wood from planted forests owned by the industry (IBGE, 2020).

These planted forests are predominantly composed of exotic Eucalyptus spp. plantations, making up roughly 76% of the total, and they are primarily situated in the southwest and midwest regions. Additionally, Pinus spp. plantations, constituting nearly 20% of the planted forest area, are mainly found in the southern region (IBÁ 2019, 2020). Notably, the southwest and southern regions of Brazil are home to the majority of pulp and paper companies, with Eucalyptus and pine serving as the primary raw materials (IBÁ 2020, IBGE, 2020).

The wood products value chain associated with the Brazilian tree industry (IBÁ) plays a significant role in Brazil's economy, contributing 1% to the national gross domestic product and generating 1.5 million direct jobs (IBÁ, 2021). The key products in the Brazilian forest industry, with regard to the relative share of generated taxes, include pulp and paper (61%), wood panels and engineered wood flooring (25%), solid wood products (8%), and other products (6%) (IBÁ, 2019).

Furthermore, Brazil's planted tree industry ranks as the second-largest global producer of wood pulp. This sector has consistently produced an annual average of 20 million tons between 2017 and 2020, with approximately 75% of the output earmarked for export (FAO, 2020; IBÁ, 2019). Wood pulp and other traditional forest products, such as sawnwood and wood chips, are commodities traded on the international market, heavily reliant on global supply and demand dynamics. Due to intense competition primarily based on pricing, market fluctuations in this sector could pose risks for suppliers (Sathre et al., 2019; Page et al., 2001).

The current forest economy in Brazil encompasses a wide array of economic activities rooted in innovation within the field of biological sciences. These efforts ultimately lead to the creation of more sustainable products, processes, and services through biotechnology. In addition to the economic benefits realized through the implementation of a bioeconomy strategy, Brazil's engagement in the bioeconomy is viewed as a means of aligning with international agreements. This includes commitments related to the United Nations' 2030 agenda and the Paris Agreement. If Brazil remains steadfast in its commitment to land restoration and the reduction of greenhouse gas emissions, it can further fortify its forest sector while addressing environmental concerns, progressing toward a circular bioeconomy.

In 2018, the Action Plan for Technology and Innovation in the Bioeconomy was established to execute the National Strategy for Science, Technology, and Innovation (MCTIC, 2018). This initiative also aimed to foster the development of a national bioeconomy, involving the creation of specific governmental bodies for this purpose. The Action Plan had the overarching objective of promoting social, economic, and environmental benefits, filling knowledge gaps, encouraging innovation, and facilitating the strategic integration of the Brazilian bioeconomy into the global landscape (Ibidem).

The Action Plan was structured into three primary action areas: i) Advancement in scientific and technological development for the sustainable production of biomass, including the utilization of residues, as well as the genetic enhancement of native species for bioproducts; ii) Progress in innovation within bioindustries through scientific and technological advances in biomass processing, iii) The development and manufacture of high-value bioproducts, particularly chemicals derived from biomass, with the aim of solidifying the circular bioeconomy (Ibidem).

Similar to many other nations, Brazil's forest economy strategy is grounded in the promotion of sustainable development. The specific value chains explored in this context include the familiar themes of solid wood products, bio-based products, the pulp and paper industry, and panels industry, and biorefineries.

- Solid Wood Products and Panels Industry: Brazil is seeing the emergence of engineered wood products, such as glued laminated timber (glulam), cross-laminated timber (CLT), and laminated veneer lumber (LVL).
- Bio-Based Products: Companies in Brazil are investing in innovative bio-based products as sustainable alternatives to traditional ones. These innovations aim to add value to forest products and make better use of industrial side streams. Examples include biofuels, bio-oils, nanofibers, and wood-based textiles.
- Pulp and Paper Industry: Brazil has been investing in innovative products within the pulp and paper sector, such as eucalypt kraft fluff pulp and dissolving pulp. Potential products for the future include nanocrystalline cellulose (NCC), wood-based textile fibers, lignin-based products, and chemical derivatives from tall oil.
- Biorefineries: The pulp and paper sector produces biochemicals, but there is potential for extracting chemical compounds like resins and tannins from non-wood forest products. These compounds can be used in various industries, including food, beauty products, and pharmaceuticals. Expanding the product portfolio to include higher value-added bio-chemicals and bio-based polymers is an opportunity for companies.

REFERENCES

Aguilar, A.; Patermann, C. Biodiplomacy, the New Frontier for Bioeconomy. New Biotechnol. 2020, 59, 20–26.

Ahrends, A., Burgess, N.D., Milledge, S. a H., Bulling, M.T., Fisher, B., Smart, J.C.R., Clarke, G.P., Mhoro, B.E., Lewis, S.L., 2010. Predictable waves of sequential forest degradation and biodiversity loss spreading from an African city. Proc. Natl. Acad. Sci. U. S. A 107, 14556–14561

Amezaga, J. M., Bird, D. N., & Hazelton, J. A. (2013). The future of bioenergy and rural development policies in Africa and Asia. *biomass and bioenergy*, *59*, 137-141.

Aznar-Sánchez, J.A.; Belmonte-Ureña, L.J.; López-Serrano, M.J.; Velasco-Muñoz, J.F. Forest Ecosystem Services: An Analysis of Worldwide Research. Forests 2018, 9, 453

Bailis, R., Drigo, R., Ghilardi, A., Masera, O., 2015. The carbon footprint of traditional woodfuels. Nat. Clim. Change 5, 266–272

Bär, R., Reinhard, J., Ehrensperger, A., Kiteme, B., Mkunda, T., & von Dach, S. W. (2021). The future of charcoal, firewood, and biogas in Kitui County and Kilimanjaro Region: Scenario development for policy support. Energy policy, 150, 112067.

Bensel, T., 2008. Fuelwood, deforestation, and land degradation: 10 years of evidence from cebu province, the Philippines. Land Degrad. Dev. 19, 587–605

Berndes, G., Abt, B., Asikainen, A., Cowie, A., Dale, V., Egnell, G., Lindner, M., Marelli, L., Par´e, D., Pingoud, K., Yeh, S., 2016. Forest biomass, Carbon Neutrality and Climate Change Mitigation (From Science to Policy), from Science to Policy. European Forest Institute

Bonjour, S., Adair-Rohani, H., Wolf, J., Bruce, N.G., Mehta, S., Prüss-Ustün, A., Lahiff, M., Rehfuess, E.A., Mishra, V., Smith, K.R., 2013. Solid fuel use for household cooking: country and regional estimates for 1980-2010. Environ. Health Perspect. 121, 784–790

Bowd, R., Quinn, N. W., Kotze, D. C., & Guilfoyle, M. J. (2018). A systems approach to risk and resilience analysis in the woody-biomass sector: A case study of the failure of the South African wood pellet industry. Biomass and Bioenergy, 108, 126-137.

Chidumayo, E.N., Gumbo, D.J., 2013. The environmental impacts of charcoal production in tropical ecosystems of the world: a synthesis. Energy Sustain. Develop. 17, 86–94

EA, 2017. Energy Access Report 2017: from Poverty to Prosperity (World Energy Outlook Special Report). International Energy Agency (IEA), Paris, France

European Commission. A new EU forest strategy: for forests and the forest-based sector. Report, European Commission; 2013

FAO. FAOSTAT dataset. Food and Agriculture Organization of the United Nations; 2015.

FAO. Global Forest Assessment Resources 2020 Main Report; FAO: Rome, Italy, 2020.

FAO. Global forest resources assessment 2010. Report, Food and Agriculture Organization of the United Nations; 2010

FAO. State of the world's forests. Report, Food and Agriculture Organization of the United Nations; 2012.

FAO. State of the world's forests: enhancing the socioeconomic benefits from forests. Report, Food and Agriculture Organization of the United Nations; 2014

FCPF. Forest carbon partnership facility – 2015 annual report. Report, The World Bank; 2015.

Felix, M., 2015. Future prospect and sustainability of wood fuel resources in Tanzania. Renew. Sustain. Energy Rev. 51, 856–862

German Bioeconomy Council. A Report from the German Bioeconomy Council Bioeconomy Policy (Part III) Update Report of National Strategies around the World; German Bioeconomy Council: Berlin, Germany, 2018

Ghilardi, A., Tarter, A., Bailis, R., 2018. Potential environmental benefits from woodfuel transitions in Haiti: geospatial scenarios to 2027. Environ. Res. Lett. 13, 035007

Githiomi J (2010). Micro-level wood energy planning for Kiambu, Thika and Maragwa districts; a case study for decentralized wood energy plan in Kenya. PhD Thesis, Department of Environmental Studies, Kenyatta University.

Hassegawa, M.; Karlberg, A.; Hertzberg, M.; Verkerk, P.J. Innovative Forest Products in the Circular Bioeconomy. Open Res. Eur. 2022, 2, 19.

Hassegawa, M.; Karlberg, A.; Hertzberg, M.; Verkerk, P.J. Innovative Forest Products in the Circular Bioeconomy. Open Res. Eur. 2022, 2, 19

Hazelton, J. A., Windhorst, K., & Amezaga, J. M. (2013). Forest based biomass for energy in Uganda: Stakeholder dynamics in feedstock production. Biomass and Bioenergy, 59, 100-115.

Hoffmann, H., Uckert, G., Rybak, C., Graef, F., Sander, K., Sieber, S., 2018. Efficiency scenarios of charcoal production and consumption – a village case study from Western Tanzania. Food Sec. 1–14.

Hosier, R.H., Mwandosya, M.J., Luhanga, M.L., 1993. Future energy development in Tanzania: the energy costs of urbanization. Energy Pol., Urban Energy Environ. Afr. 21, 524–542

Hurmekoski, E.; Jonsson, R.; Korhonen, J.; Jänis, J.; Mäkinen, M.; Leskinen, P.; Hetemäki, L. Diversification of the Forest Industries: Role of New Wood-Based Products. Can. J. For. Res. 2018, 48, 1417–1432.

IBÁ. Relatório Anual 2019; IBÁ: Brasília, Brazil, 2019

IBÁ. Relatório Anual 2020; IBÁ: Brasília, Brazil, 2020

IBÁ. Relatório Anual 2021, Indústria Brasileira de Árvores; IBÁ: Brasília, Brazil, 2021.

IBGE. Instituto Brasileiro de Geografia e Estatística—Produção da Extração Vegetal e da Silvicultura 2019; IBGE: Rio de Janeiro, Brazil, 2020

Iiyama, M., Neufeldt, H., Dobie, P., Njenga, M., Ndegwa, G., Jamnadass, R., 2014. The potential of agroforestry in the provision of sustainable woodfuel in sub-Saharan Africa. Curr. Opin. Environ. Sustain., Sustain. Challenges 6, 138–147.

IPCC. Land use, land-use change, and forestry: summary for policymakers. Report, Intergovernmental Panel on Climate Change (IPCC); 2000

Jonsson, R.; Rinaldi, F.; Pilli, R.; Fiorese, G.; Hurmekoski, E.; Cazzaniga, N.; Robert, N.; Camia, A. Boosting the EU Forest-Based Bioeconomy: Market, Climate, and Employment Impacts. Technol. Forecast. Soc. Chang. 2021, 163, 120478.

Kardung, M.; Cingiz, K.; Costenoble, O.; Delahaye, R.; Heijman, W.; Lovri´c, M.; van Leeuwen, M.; M'barek, R.; van Meijl, H.; Piotrowski, S.; et al. Development of the Circular Bioeconomy: Drivers and Indicators. Sustainability 2021, 13, 413

Karvonen, J.; Halder, P.; Kangas, J.; Leskinen, P. Indicators and Tools for Assessing Sustainability Impacts of the Forest Bioeconomy. For. Ecosyst. 2017, 4, 1–20.

Langbein, J., 2017. Firewood, smoke and respiratory diseases in developing countries—the neglected role of outdoor cooking. PloS One 12, e0178631

Legros, G., Havet, I., Bruce, N., Bonjour, S., Rijal, K., Takada, M., & Dora, C. (2009). The energy access situation in developing countries: a review focusing on the least developed countries and Sub-Saharan Africa. *World Health Organization*, *142*, 32-1.

Leskinen, P.; Cardellini, G.; González García, S.; Hurmekoski, E.; Sathre, R.; Seppälä, J.; Smyth, C.E.; Stern, T.; Verkerk, H. Substitution Effects of Wood-Based Products in Climate Change Mitigation. Sci. Policy 2018, 7, 28.

MCTIC. Plano de Ação em Ciência, Tecnologia e Inovação em Bioeconomi; Ministério da Ciência, Tecnologia, Inovações e Comunicações and Centro de Gestão e Estudos Estratégicos: Brasília, Brazil, 2018; ISBN 978-85-5569-150-8

Miyuki L, Neufeldt H, Dobie P, Njenga M, Ndegwa G, Jamnadass R (2014). The potential of agroforestry on the revision of sustainable woodfuel in sub-Saharan Africa. Current Opinion in Environmental Sustainability 6:138-147

Mwampamba, T.H., 2007. Has the woodfuel crisis returned? Urban charcoal consumption in Tanzania and its implications to present and future forest availability. Energy Pol. 35, 4221–4234

Mwampamba, T.H., Ghilardi, A., Sander, K., Chaix, K.J., 2013. Dispelling common misconceptions to improve attitudes and policy outlook on charcoal in developing countries. Energy Sustain. Develop. 17, 75–85

Mwampamba, T.H., Ghilardi, A., Sander, K., Chaix, K.J., 2013. Dispelling common misconceptions to improve attitudes and policy outlook on charcoal in developing countries. Energy Sustain. Develop. 17, 75–85

Nabuurs GJ, Masera O, Andrasko K, et al. Chapter 9. Forestry. Cambridge University Press, Cambridge, UK; 2007. p. 541–84

Namaswa, T., Githiomi, J., Oduor, N., & Kitheka, E. (2022). Sustainable biomass energy production and utilization in sub-Saharan Africa: A case study of Kenya. Journal of Horticulture and Forestry, 14(4), 56-67.

Oguntuase, O.J., Adu, O.B., 2021. Bioeconomy as climate action: How ready are african countries?. In: Oguge, N., Ayal, D., Adeleke, L., da Silva, I. (Eds.), African Handbook of Climate Change Adaptation. Springer, Cham, pp. 1–15.

Okoko, A., Reinhard, J., Wymann von Dach, S., Zah, R., Kiteme, B., Owuor, S., Ehrensperger, A., 2017. The carbon footprints of alternative value chains for biomass energy for cooking in Kenya and Tanzania. Sustain. Energy Technol. Assess. 22, 124–133

Oliver CD, Nassar NT, Lippke BR, McCarter JB. Carbon, fossil fuel, and biodiversity mitigation with wood and forests. J Sustain For 2014; 33:248–75

Page, S.; Hewitt, A. World Commodity Prices: Still a Problem for Developing Countries? Overseas Development Institute: London, UK, 2001; ISBN 0-85003-521.

Palo M, Lehto E. Private or socialistic forestry? Forest transition in finland vs. deforestation in the tropics. London, UK: Springer Science+Business Media; 2012.

Ramage, M. H., Burridge, H., Busse-Wicher, M., Fereday, G., Reynolds, T., Shah, D. U., ... & Scherman, O. (2017). The wood from the trees: The use of timber in construction. Renewable and Sustainable Energy Reviews, 68, 333-359.

Sander, K., 2009. Environmental Crisis or Sustainable Development Opportunity? Transforming the Charcoal Sector in Tanzania (No. 50207). The World Bank, Washington DC, USA.

Sander, K., Haider, S.W., Hyseni, B., 2011. Wood-based biomass Energy Development for Sub-saharan Africa: Issues and Approaches. The World Bank, Washington DC, USA.

Sassen, M., Sheil, D., Giller, K.E., 2015. Fuelwood collection and its impacts on a protected tropical mountain forest in Uganda. For. Ecol. Manag. 354, 56–67

Sathre, R.; Gustavsson, L. Process-Based Analysis of Added Value in Forest Product Industries. Forest Policy and Economics 2009, 11, 65–75.

Schier, F.; Morland, C.; Dieter, M.; Weimar, H. Estimating Supply and Demand Elasticities of Dissolving Pulp, Lignocellulose Based Chemical Derivatives and Textile Fibres in an Emerging Forest-Based Bioeconomy. For. Policy Econ. 2021, 126, 1024

Sedano, F., Silva, J.A., Machoco, R., Meque, C.H., Sitoe, A., Ribeiro, N., Anderson, K., Ombe, Z.A., Baule, S.H., Tucker, C.J., 2016. The impact of charcoal production on forest degradation: a case study in Tete, Mozambique. Environ. Res. Lett. 11, 094020

Shackleton, C., Sinasson, G., Adeyemi, O., & Martins, V. (2022). Fuelwood in South Africa Revisited: Widespread Use in a Policy Vacuum. *Sustainability*, *14*(17), 11018.

Specht, M.J., Pinto, S.R.R., Albuqueque, U.P., Tabarelli, M., Melo, F.P.L., 2015. Burning biodiversity: fuelwood harvesting causes forest degradation in human-dominated tropical landscapes. Glob. Ecol. Conserv. 3, 200–209.

Staffas, L.; Gustavsson, M.; McCormick, K. Strategies and Policies for the Bioeconomy and Bio-Based Economy: An Analysis of Official National Approaches. Sustainability 2013, 5, 2751–2769.

Sulaiman, C., Abdul-Rahim, A.S., Mohd-Shahwahid, H.O., Chin, L., 2017. Wood fuel consumption, institutional quality, and forest degradation in sub-Saharan Africa: evidence from a dynamic panel framework. Ecol. Indicat. 74, 414–419.

Taron, A., Majumder, A., Bodach, S., & Agbefu, D. (2023). Public-private partnerships for the circular bioeconomy in the Global South: lessons learned. *Resource Recovery and Reuse Series 22*.

UNECA, 2014. Energy Access and Security in Eastern Africa: Status and Enhancement Pathways. United Nations Economic Commission for Africa (UNECA), Addis Ababa

UNECE/FAO. Forest products: Annual market review 2013–2014. Report, United Nations Economic Commission for Europe, and Food and Agriculture Organization of the United Nations, 2014.

Virgin, I., Diaz-Chavez, R., Morris, E.J., Haileselassie, T., Tesfaye, K., De Cliff, S., Njau, K., Munganyinka, E., Muyambi, F., Otim, M.O. 2022. The State of the Bioeconomy in Eastern Africa:

2022. Stockholm Environment Institute, The East African Science and Technology Commission and BioInnovate Africa

Vollmer, F., Zorrilla-Miras, P., Baumert, S., Luz, A.C., Woollen, E., Grundy, I., Artur, L., Ribeiro, N., Mahamane, M., Patenaude, G., 2017. Charcoal income as a means to a valuable end: scope and limitations of income from rural charcoal production to alleviate acute multidimensional poverty in Mabalane district, southern Mozambique. World Develop. Perspect. 7 (8), 43–60

Wesseler, J.; von Braun, J. Measuring the Bioeconomy: Economics and Policies. Annu. Rev. Resour. Econ. 2017, 9, 275–298.

WHO, 2018. Global Health Observatory Data Repository [WWW Document]. World Health Organization. URL. http://apps.who.int/gho/data/node.home. accessed 12.12.18

World Bank, 2014. Population growth [WWW Document]. URL. http://data.worldbank. org/indicator/. accessed 11.27.14.

World Bank, 2022. Analysis of the Woodfuels Sector in Ghana: With options for demand reduction, supply-side measures, fuel switching and governance changes. © World Bank.

WWF. Forensic methods used to verify the declared species and origin of wood. Report, World Wide Fund for Nature, 2014

Zorrilla-Miras, P., Mahamane, M., Metzger, M.J., Baumert, S., Vollmer, F., Luz, A.C., Woollen, E., Sitoe, A.A., Patenaude, G., Nhantumbo, I., Ryan, C.M., Paterson, J., Matediane, M.J., Ribeiro, N.S., Grundy, I.M., 2018. Environmental conservation and social benefits of charcoal production in Mozambique. Ecol. Econ. 144, 100–111.

Zulu, L.C., Richardson, R.B., 2013. Charcoal, livelihoods, and poverty reduction: evidence from sub-Saharan Africa. Energy Sustain. Develop. 17, 127–137.