Mekong Sustainable Manufacturing Alliance (The Alliance)

Development of Sustainable Biomass Guidelines and Risks Assessment Template – Multistakeholder Consultation Pre-read

Cambodia – 31st March 2023

For internal discussion only

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Introduction and Agenda

Rationale for the Development of Sustainable Biomass Guidelines and ESG Risk Assessment Tool

The **objectives of the 3rd Sustainable Supply Chain Meeting – Sustainable Biomass in Fashion Industry** is to:

- Obtain holistic insights from relevant stakeholders on drivers towards a sustainable biomass supply chain
- Obtain feedback on the current draft of the Sustainable Biomass Guidelines
- Obtain inputs on ESG risks associated with the implementation of biomass use and sourcing

Context

- The growing impact of the fashion industry (within Southeast Asia and globally), commitments towards carbon neutrality and the use of renewable energy from main apparel brands has shed light upon sustainability challenges in fuel-switching to biomass in operations.
- The development of the Sustainable Biomass Guidelines and an ESG Risk Assessment tool aims to provide understanding on the different biomass types and the necessary references and tools for key players of the **fashion industry (clothing and footwear),** such as **Tier 1 and Tier 2** factory owners, to perform a first screening when sourcing biomass for their energy use in order to assess the sustainability character of such sources through its value-chain. The two documents are developed by aligning on:
    - The United Nations Framework Convention on Climate Change (UNFCCC) or the Sustainable Development Goals (SDGs) (led with the overarching SDG 7: Affordable and Clean Energy) and consolidating on existing materials related to biomass utilization,
    - ESG criteria and reporting standards and metrics such as Roundtables for Sustainable Biofuels (RSB) or Food and Agriculture Organization (FAO).

Agenda

Time	Topic	Speaker(s)
9.30 - 9.40	Opening remarks	USAID Cambodia
9.40 - 9.55	Keynote: Textile industry, biomass and sustainability in Cambodia context	Mr. Choon Yik Thong, TAFTAC Head of Sustainability Committee
9.55 – 10.10	Sustainable Alternatives for Industrial Heat in Garment Factories in Cambodia	Lorelei Gontard, Energy Efficiency Program Officer / Geres Southeast Asia (TBC)
10.10 – 10.45	Panel: Sustainable Journey, Perspectives from Brands and Factories	▪ Richard Scotney, Global Energy Efficiency Lead, WWF, representative of H&M Group ▪ Dipjay Sanchania, Director – Climate and Energy, adidas ▪ Ben Kao, Cambodia Footwear Association ▪ Alan Chin, Senior Manager – Supply Chain Sustainability, VF Corporation ▪ Natcha Tulyasuwan, Deputy Director, Mekong Sustainable Manufacturing Alliance/ISC Mekong (moderator)
10.45-11.10	Sustainable Biomass Guidelines - Overview	Lois Sevestre, Project Manager and Decarbonization Specialist, ERM
11.10-11.15	Coffee break	
11.15-11.50	**Breakout Sessions**: Sustainability Drivers and Evaluation Approach for Biomass Categories • 2 in-person groups • 1 online group	ERM Facilitators
11.50-12.00	Closing, followed by networking lunch	Suparerk Janprasart, Director, Mekong Sustainable Manufacturing Alliance/ISC Mekong

Sustainable Biomass Guidelines & Risk Assessment (Draft)

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How to use this Guide

Objectives: The Guideline should be used to facilitate factories to:

- Screen types of sustainable biofuel that should be purchased based on their environmental, social and governance impacts
- Identify and evaluate the environmental, social and governance risks relevant to biomass sourcing and biofuel production per biomass category
- Make strategic decisions based on the risk assessment results and proposed mitigation recommendations for long-term sustainability of the fashion industry

Scope : The Guideline is applied to:

- The type of biomass: solid, liquid and gaseous biomass from all types of origin and its derived products i.e., biofuel.
- The boundary of assessment: Feedstock production (e.g cultivation) and biomass use for Tier 1 and Tier 2 of textile manufacturing. Risks and impacts related to transport of various feedstocks were excluded in the scope.
- Its Geographical coverage: Global

The Guideline does not cover assessments on specific technical aspects such as technology selection or fuel mix instruction nor economic aspects on the cost of biofuel or feedstock.

Target users: The Guideline is relevant for all enterprises operating in the textile industry and its biomass supply chain. This guideline is intended for:

- Brand/Factory decision-makers (managers), to use the results from Risk Assessment Tool (RAT) to decide on whether the biomass utilization initiative should be introduced or carried on.
- Brand/Factory technical officers and procurement officers: , to use the Guideline and RAT to assess sustainability of biomass sourcing/utilization and report the assessment results to managers.

Introduction

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Introduction – Fashion Industry

- In 2023, the fashion industry represents an important contributor of energy use and greenhouse gases (GHG) emissions; its ecological footprint is caused by high energy, water and chemical use. Due to lengthy supply chains and energy-intensive production methods, apparel and footwear industries generate **8–10%** of global carbon emissions. Today, if the industry was a country, it would be the 6th largest emitter of GHG, behind China, the United States, the European Union, India, and Russia.
- If the industry continues operating on trend, emissions from production are set to rise **60% by 2030**, reaching an estimated 2.8 billion tons of CO_2 and increasing global CO_2 contribution by 50%. With processes like textile production and the manufacturing of clothes, high levels of energy are required to satisfy the fast-paced, dynamic system.
- Many apparel brands have therefore developed commitments to reduce their GHG emissions, pledging 100% renewable energy commitments.
- Along with centralized and decentralized power generation options, the utilization of biomass bioenergy could play an important role in phasing out fossil fuels notably for the production of thermal energy (steam and/or hot water).

Figure 1 - Emissions contribution of fashion supply chain

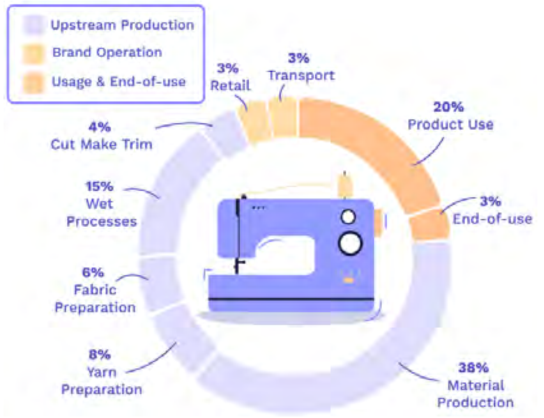
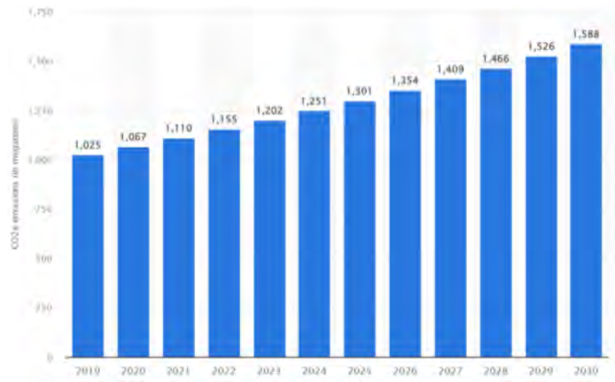


Figure 2 - Projected carbon emission of the apparel industry worldwide from 2019 to 2030



Introduction - Biomass

- Already widely produced in most parts of the globe – particularly in Southeast Asia, biomass appears to be a credible solution for energy supply, as an alternative to fossil fuels primarily for direct thermal energy requirements (production of hot water and steam generation) and electricity (notably in case of cogeneration).
- Considering the wide range of options for biomass sources and the importance of local context, defining and ensuring the sustainability of biomass sources appears to be complex and needs to be properly assessed along the supply-chain until final utilization and waste disposal.
- Indeed, its usage poses important challenges in sustainability and traceability, air quality, soil and water resources, impacting communities and environment.

Figure 3 - Feedstock-wise biomass production potential in Southeast Asia

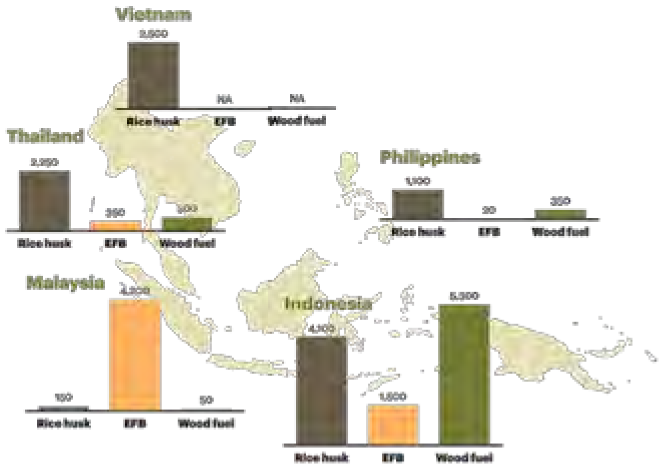
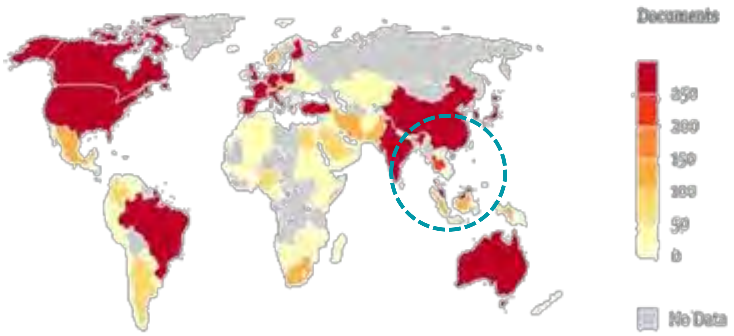


Figure 4 - Production in biomass as renewable energy by country of origin (2019)



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Introduction – Objectives and Approach

- Considering the growing impact of the **fashion industry** the variation in its value-chain, commitments towards carbon neutrality, and the use of renewable energy from main apparel brands, there lies a turning point on the objective of incorporating biomass into the industry's value-chain.
- These guidelines have therefore been prepared to provide understandings on the different types of biomass and the necessary references and tools for key players of the **fashion industry (clothing and footwear)** to perform a first screening before sourcing biomass for their energy use, with the objective of assessing the sustainability character of such sources through its value-chain, from production to utilization.
- Building on the context of Southeast Asia for the global fashion industry facing sustainability challenges in their potential usage of biomass to replace fossil fuels, these guidelines are aimed at developing a useful and user-friendly tool for **Tier 1 and Tier 2** factory owners, linked or not to the main global fashion industry groups for **global application**.
- The present document is therefore developed into several parts:
  - Section 1 describes the main processes involved in the fashion industry and the typical energy requirements;
  - Section 2 describes the different biomass options and aiming at categorizing them based on their common characteristics, sources;
  - Section 3 identifies and describes the key drivers to assess the sustainability of biomass sources on a basis of ESG criteria;
  - Section 4 explains the evaluation approach developed through a Risk Assessment Tool complementing these guidelines; and
  - Section 5 perceives the guidelines and Risk Assessment Tool into a more comprehensive project development cycle approach and outlines key principles in terms of planning, implementation and continuous improvement.
- These two key documents are developed by aligning on key frameworks such as the United Nations Framework Convention on Climate Change (UNFCCC) or the Sustainable Development Goals (SDGs) (led with the overarching SDG 7: Affordable and Clean Energy) and consolidating on existing materials related to biomass utilization, ESG criteria and reporting standards and metrics such as Roundtables for Sustainable Biofuels (RSB) or Food and Agriculture Organization (FAO).

Section 1

Processes and energy requirements of the fashion industry

Objectives:
This section presents the main processes involved in the fashion industry for Tier 1 and Tier 2 and the typical energy requirements.

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Key processes of the fashion industry

Textile and garment production is a long chain involving multiple processing steps and inputs to turn fiber into ready-to-wear products. Figure 1 below is an overview of the production process

Figure 5 – Typical Textile production process*

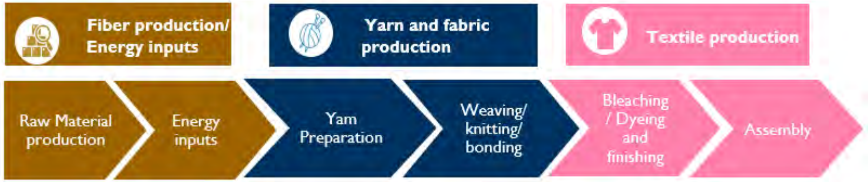
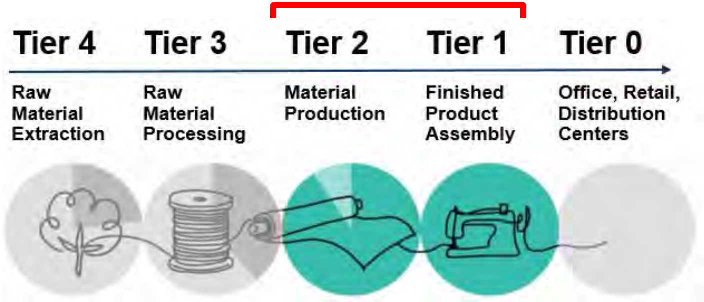


Figure 6 describes the supply chain model in the textile and apparel industry

Figure 6 – Four Tier Supply Chain Model. Source: WRI and Aii (2021)



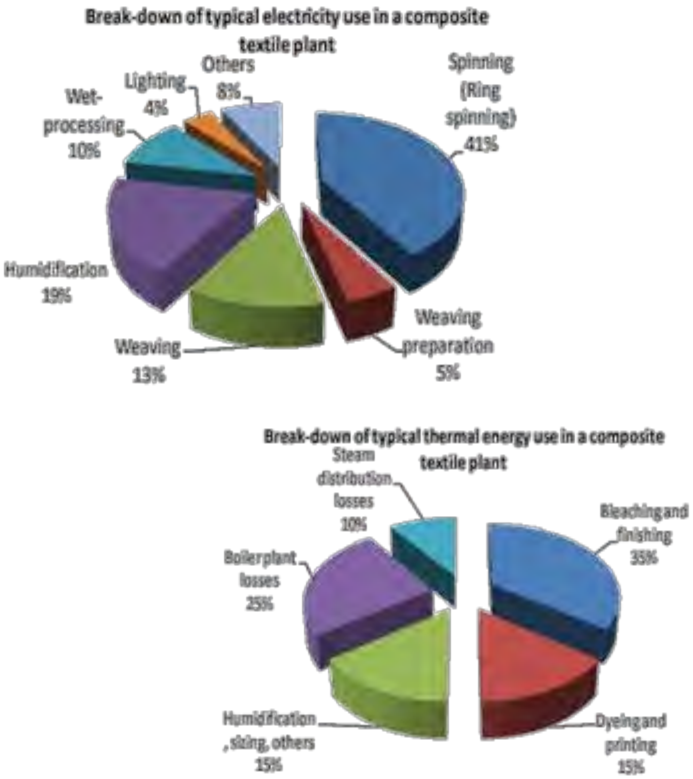
- The textile value chain starts with fiber production. This can either be sourced from natural agricultural materials and their subsequent processing to extract fiber or from crude oil extraction and the manufacture of chemicals from which synthetic fibers are made, or a combination of both. Examples include chemical fiber such as viscose rayon made by using wood pulp, synthetic fiber manufacture that manufactures polyester, nylon, and acrylic fiber from petrochemical using naphtha as raw material.
- The next stage involves spinning the fibers into yarn, and knitting, weaving or bonding fibers in other ways to become fabric.
- The fabric is then subject to chemical and/or mechanical processing (known as finishing) to produce textile with the desired properties.
- The following step involves cutting and sewing the textile into or to become the final product.

Energy use and requirements in the fashion industry

Energy use in the textile industry

- The processes involved in the textile industry differ based on the type of textile products and the fuel type used. Textile finishing requires a wide range of operations to convert input material into the final product. Such operations require energy such as electricity and/or thermal energy from hot water or steam. [1]
- The processes use large amounts of electrical and thermal energy. The share of electricity and thermal energy from the total energy consumption of the textile industry in any country depends on the structure of the industry in that country. For example, for yarn spinning, electricity is the dominant energy source, while in wet processing the main energy source is fossil fuels for producing thermal energy. Data from 2021 shows that 61% of the final energy used in the global textile industry was thermal energy and 39% was electricity [2].

Figure 7- Break-down of typical electricity and thermal energy in textile industry [3]



Sources:

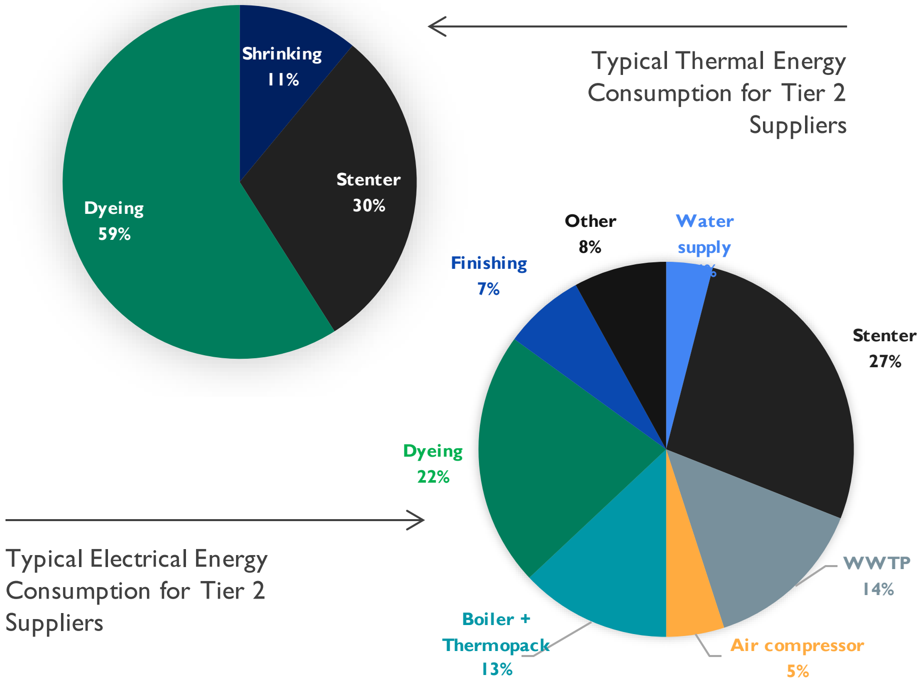
[1] Solar Thermal Energy Utilization for Medium Temperature Industrial Process Heat Applications - A Review, Raju Ramaiah and K.S. Shashi Shekar 2018

[2] Energy Efficiency in the Competitiveness of the Textile Industry - Marco Vinicio Cevallos Bravo, William Marcelo Ponce Iturralde

[3] Energy-Efficiency Improvement Opportunities for the Textile Industry - Ali Hasanbeigi

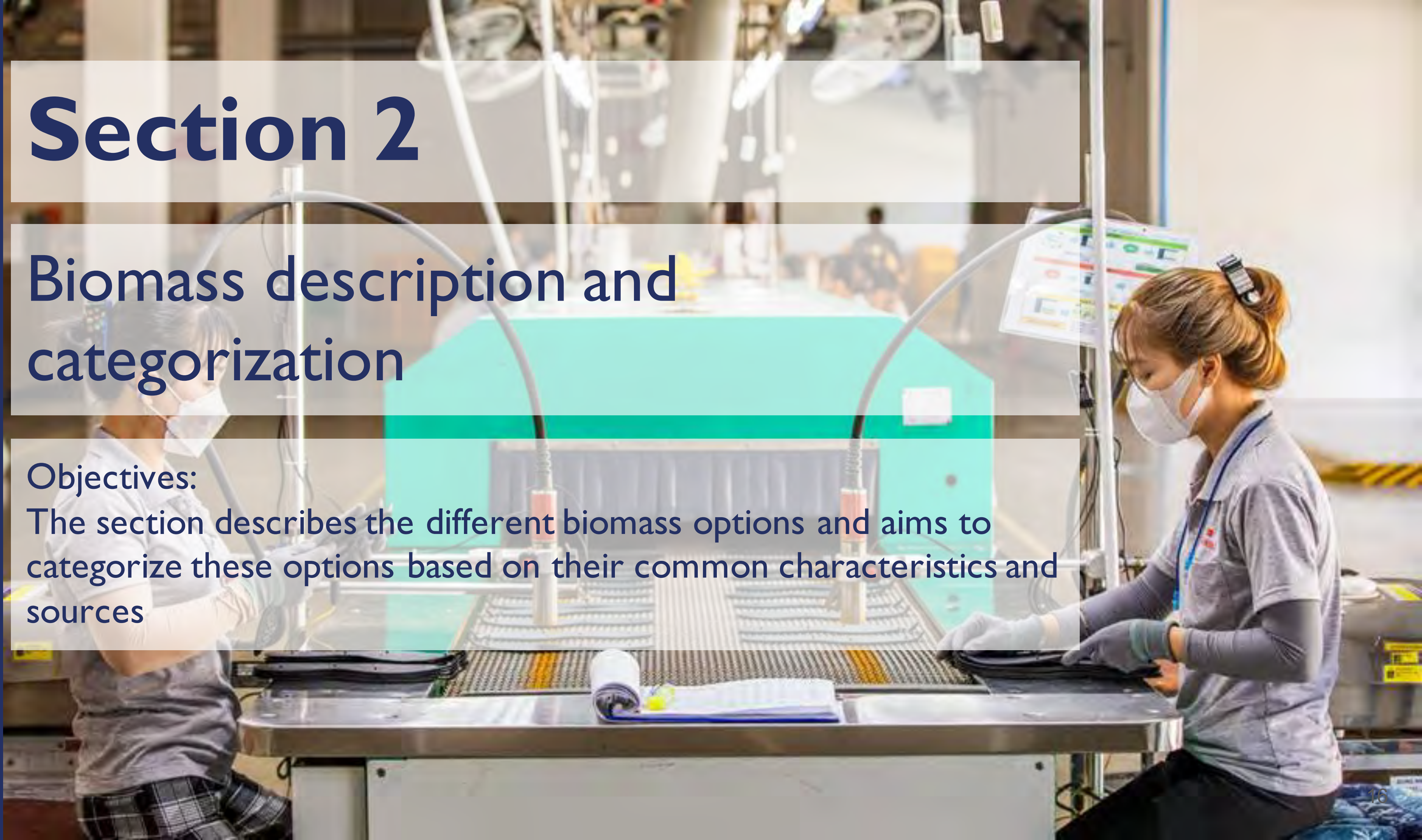
Energy use and requirements in the fashion industry

Figure 8- Break-down of typical electricity and thermal energy in apparel tier 2



Energy use in the apparel industry

- **Apparel Tier 1:** Centralized boiler systems using diesel oil, gas and coal as energy sources comprises 40% of total energy consumption while electricity consumption accounts for 60%. Sewing, air compressors and lighting accounts for majority of electricity consumption.
- **Apparel Tier 2:** About 90% of total energy usage is used for thermal processes, including heating and water removal during the drying process. The remaining 10% of total energy usage derives from electricity, majorly for dyeing and stenter and boiler utility.



Section 2

Biomass description and categorization

Objectives:

The section describes the different biomass options and aims to categorize these options based on their common characteristics and sources

What is biomass?

- Biomass is organic material originating from plants and animals. Following eventual transformation processes. Biomass can add value in:

Raw materials	Organic matter of soil amendment	Source of energy supply (bioenergy)

- Bioenergy is the energy derived from any form of biomass or biofuels. Three main families of final products can be considered as follow:

Solid biomass

- Fuels derived directly from biomass, includes feedstock derived from forestry or agricultural resources, including forestry, agricultural or agro-industrial by-products that will generally be used to produce heat from combustion with or without prior pyrolysis

Liquid Biofuels

- Liquid fuels converted from biomass
- Main liquid biofuels include bioethanol supplied from sugar or cereals crops or biodiesel from fats and oil crops to produce biodiesel respectively following fermentation/distillation and esterification.

Biogas

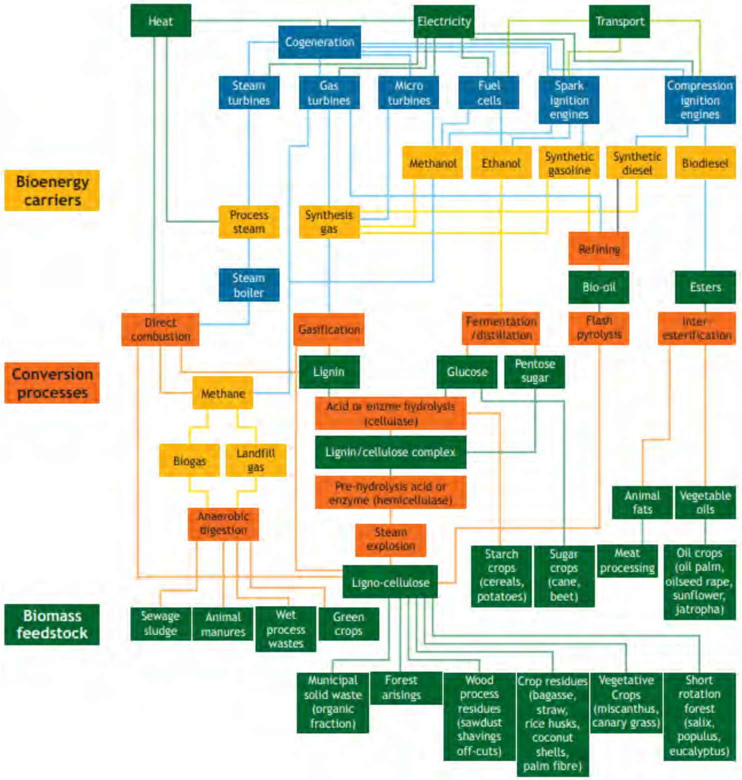
- A mixture of methane (CH_4) and carbon dioxide (CO_2) used as fuel and produced by bacterial degradation of organic matters processed from anaerobic digestion of crops, animal manures or sewage sludge
- Solid biomass can also be gasified to produce synthesis gas and use with equipment adapted to gaseous fuels

Most frequent bioenergy pathways

The following terms are described below

- **Final usage:**
  Final output for which the biomass is used. Examples: Heat, electricity, and transportation
- **Bioenergy carriers:**
  Final product or form of the fluid carrying the energy processing from the biomass. Examples: Biogas, steam, methane, biofuels, etc.
- **Conversion processes:**
  Key process treating the biomass feedstock into bioenergy product or carrier. Examples: Direct combustion, Gasification, Anaerobic digestion, Fermentation, etc.
- **Pre-treatment processes**

  Initial treatment of the biomass in order to facilitate its storage or transportation. Examples: Compaction, drying, pelletization, etc.
- **Biomass feedstock**
  Initial source of biomass following or not pre-treatment. Examples: Wood from harvested forests, corn, oil crops, organic waste, sludge, etc.



Categorization of biomass products

- Before being used as **final products** such as solid, liquid or gas biofuels to be directly used in boilers, turbines or engines, biomass needs to be transformed through various chemical, mechanical, and thermal processes from its initial form as **primary biomass**.
- Primary biomass can be obtained from multiple sources of differing locations, technical characteristics and/or from the main biomass conversion processes that apply to them.
- In this document, biomass sources have been grouped into five categories based on their key specificities as well as relevant sustainability challenges. The **five biomass categories** identified through this document are:
  1. Solid wood and residues from forest
  2. Dedicated crops including food and energy crops
  3. Residues from agricultural processes – Ligno-cellulose biomass
  4. Residues from agricultural processes – Animal manures
  5. Organic waste from factories (including wood processing factories) and municipal solid waste

Solid wood and residue from forests

Dedicated crops for food and/or energy

Residue from agricultural processes – Ligno-cellulose biomass

Residue from agricultural processes – Animal manure

Organic waste and sludge from industries and municipalities

First draft, to be further refined during consultations

Category 1: Solid wood and residue from forests

Definition

Wood products includes wood directly extracted from natural forests or harvested from cultivated forests.

Solid wood or Forest residues refers to a residue from forest harvesting such as any component of trees after timber logging or clearing land for construction. This is a major source of biomass for energy.

Main source

- Direct cutting trees from natural forests
- Wood from harvested forests
- Dead wood collected in forests

Technical characteristics

Calorific value of wood species ranges between 18.5 to 21.0MJ/kg
Moisture content between 9 to 13 % (on a basis after being oven dried at 105°C)

Source: https://www.researchgate.net/figure/Calorific-values-and-moisture-content-of-wood-waste-samples_tbl2_316435974

Bioenergy treatment process

Key processes

- Direct combustion
- Pyrolysis → Charcoal
- Gasification → Syngas

Final usage

- Wood or charcoal in boilers
- Syngas in gas turbines or gas boilers directly or mixed with natural gas

Category 2: Dedicated crops (including food and energy crops)

Definition

This category refers to crops that are grown for particular purpose such as for food and/or biomass feedstocks in biorefineries for energy. For this category, the main output of the crops is directly used as biomass products. Nevertheless, some of the crops can also be considered for human alimentation or animal feeding.

Main source

- **Edible crops**: corn, wheat, sugar crops, sorghum, starch crops, and oil crops
- **Non-edible crops**: Cassava, Switchgrass, Jatropha, miscanthus, and dedicated biomass sorghum

Technical characteristics

Calorific value of dedicated crop species ranges between 17.0 to 19.5 MJ/kg

Moisture content of the harvested product normally ranges from 40% to 50%

Source: BIOMASS CHARACTERISTICS AND ENERGY CONTENTS OF DEDICATED LIGNOCELLULOSIC CROPS

Bioenergy treatment process

Key processes

- Inter-esterification → Biodiesel
- Fermentation/Distillation → Bioethanol
- Anaerobic digestion (limited, in complement of other biomass sources) → Biogas
- Pyrolysis, Gasification (limited) → Charcoal, Syngas
- Direct combustion (limited)

Final usage

- Biodiesel and bioethanol in engines or oil boilers (in replacement of oil, gasoline, gasoil)

Category 3: Residue from agricultural processes – Ligno-cellulose biomass

Definition

Agricultural waste and residues are byproducts from crops destinated to human alimentation, animal feeding or biomass (see Category 2) and that do not directly compete with food production for land, water or with biodiversity and carbon sinks for land use.

Main source

- Rice straw, wheat straw, rice husk and corn stover mostly left in fields after harvest, and generally used fodder, landfill material or burnt.

Technical characteristics

Calorific values of crop residues ranges between 13.5 to 18.5 MJ/kg (considering LCV and HCV).

Crop Residues	MJ/Kg	
	Lower Calorific Value	Higher Calorific Value
Rice straw	13.50	14.80
Wheat straw	15.00	18.90
Rice husk	14.20	15.40
Corn stalks/stover	16.80	18.50

Converted and retrieved from Calorific-value-biomass.pdf (cfnielsen.com)

Bioenergy treatment process

Key processes

- Direct combustion
- Pyrolysis, Gasification → Charcoal, Syngas
- Anaerobic digestion (limited and in complement of other biomass sources) → Biogas

Final usage

- Solid biomass (in replacement of oil, gasoline, gasoil)
- Charcoal
- Complement for biogas

Category 4: Residue from agricultural processes –
Animal Manure

Definition

This category refers to livestock manure derived from animal feces and urine, that can be used in the production of biogas.

The biogas is produced from anaerobic digestion (methanization) and shall not be confused with biomethane that is obtained from purification of biogas or from thermal gasification and methanation from biomass (syngas).

Main source

- Main livestock manures (cows, goats,–sheep, poultry and pigs) that are used in the methanization process to produce biogas
- Producing biogas generally requires mixing manures with lignocellulose biomass (ensuring proper carbon/nitrogen content). Sludge can also be used for producing biogas.

Technical characteristics

Animal manure	CV (MJ/kg)	Biogas potential (toe/ton)
Cattle, Bull	14.9-16.3	0.008
Goat & Sheep	12.4-13.2	
Hen & Duck	22.7-23.3	0.039
Pig		
Agricultural crops		0.16-0.25
Biogas (before purification) about 60-65% CH_4	~30	
Biogas (after purification) – 90% CH_4	~45	

Source: Combustion Characteristics of Animal Manures (scirp.org) [1]
Average biogas production yield by tons of feedstock type – Charts – Data & Statistics – IEA [2]

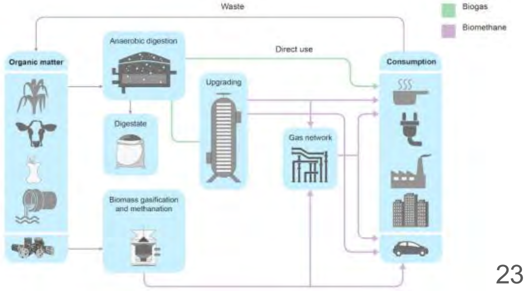
Bioenergy treatment process

Key processes

- Methanization (complementing solid agricultural residues)

Final usage

- Biogas (in gas turbines or gas boilers) complement or replacement of natural gas



Category 5: Organic waste and sludge from industries and municipalities

Definition

Biodegradable garbage, usually referred to as organic waste, is mainly the organic fraction (in opposition of mineral). It can originate from municipal waste or industrial waste.

Main source

- Food waste from restaurants, markets, organic fraction of MSW
- Non-contaminated sludges (organic fraction)
- Organic Waste from food industry including slaughterhouse waste.
- Residues from industry using wood as main feedstock (furniture, construction etc.) including wood chips, bark, sawdust, etc.

Technical characteristics

Calorific value of organic waste ranges are very wide-ranging depend on the waste types and the moisture component requiring drying before processing. After drying, calorific value is comprised between 16 and 20 MJ/kg.

Calorific value of fully dried sludge ranges between 10,900 to 13,000 MJ/kg.

No	Non Recycled MSW Components	Moisture (%)		Calorific Value (MJ/kg)		
		inherent moisture	total moisture	dry-based	air-dried	as received
1	Leaf litter	12.32	40.67	19.62	17.20	11.64
2	Food waste	8.51	65.00	18.00	16.47	6.30
3	Vegetable waste	11.46	88.25	18.25	16.16	2.14
4	Fruit waste	9.92	83.53	18.38	16.56	3.03
5	Mixed organic MSW	10.79	61.32	18.77	16.74	7.26

Retrieve from https://www.researchgate.net/figure/Physical-properties-and-calorific-value-HHV-of-raw-organic-waste-9_tbl1_329909656

Bioenergy treatment process

Key processes

- Anaerobic digestion in landfills or methanization units
- Direct Combustion in Waste-to-Energy units or coprocessing
- Thermal processes such as pyrolysis or gasification
- Pelletization for wood wastes

Final usage

- Biogas or syngas (in gas turbines or gas boilers) as a complement or replacement of natural gas
- Solid biomass, pellets or charcoal to be used in boilers

Section 3

Drivers for Sustainable Biomass

Objectives:

This section identifies and describes the key drivers to assess the sustainability of biomass sources on the basis of ESG criteria

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Sustainable Biomass Drivers

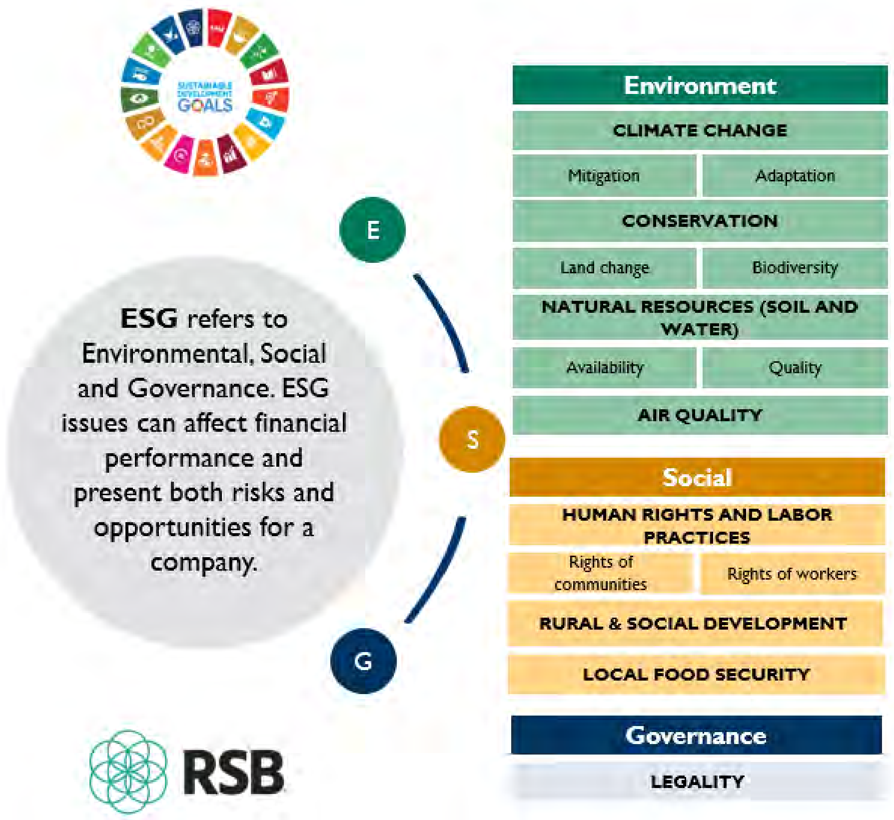
First draft, to be further refined during consultations

Following the literature review, eight key drivers have been identified define the sustainability of biomass sources and its utilization.

The eight key sustainability drivers have been identified through an approach focusing on environmental, social and governance (ESG) criteria , reviewed and cross-checked with several references including the Sustainable Development Goals and the RSB's Standards and Principles.

From the eight key drivers (Level 1), four have been divided into sub-drivers (Level 2) that lead to a more accurate evaluation in the RAT.

It should be understood that economic criteria (such as cost of biomass), or technical characteristics (such as calorific value) have not been considered as sustainability drivers. However, they should incorporated in the overall project development process as described in Section 5.



Key risk drivers for Sustainable Biomass

Environment

#	Driver – Level 1	Driver – Level 2	Potential Risk	Link with SDGs	Decision Indicators (non-exhaustive list)
1	Climate Change	Mitigation (GHG)	Production and utilization of biofuels may generate GHG (C02, CH4, N2O) that are not fully compensated by the amount of carbon stored during the life-cycle of the biomass. These emissions shall be quantified and minimized	SDG 11 - Sustainable Cities and Communities SDG 13 - Climate action	• Operations may generate GHG emission reduction from biomass/biofuel selection throughout the entire life cycle: crop production with the use of fertilizers, fuel production and use. • Select biomass from production which hasn't required the transformation of natural areas affecting carbon sinks (such as primary forests), i.e., transforming forests into agricultural land would lead in a lower capacities of carbon sinks • Ensure energy-efficient processes for biomass transformation (drying with heat recovery) and logistics (prioritize local sourcing options) • Vulnerability: biomass sources may require limited amount of inputs (water, nutrients) for its production particularly in water-stressed areas, or that are more resilient to increased and lengthy periods of droughts and/or floods in relevant areas
		Adaptation/ Vulnerability to climate change	Biofuels may be vulnerable to the impacts of climate change (physical and transition risks) and its consequences in terms of optimal conditions for production of biomass as well as in the supply-chain organization. Resilient biomass sources and supply-chain shall be prioritized		
2	Conservation	Land type change	The extraction and/or production may pose a threat on ecosystems due to land type change from natural ecosystem (forest, savanna, wetland) to agricultural, production forests or artificialized lands. Biomass generation shall minimize its impact on existing ecosystem and new production areas shall prioritize already brownfield lands.	SDG 12 - Responsible Consumption and Production SDG 14 - Life below water SDG 15 - Life on Land	• Select biomass from production which hasn't required the transformation of natural areas. • Limit the extraction of natural resources from natural areas that participate to the biomass sourcing (i.e., dead wood). • For agricultural areas, ensure cohabitation with biodiversity (ecological corridors, limit the use of chemicals affecting biodiversity, i.e., limit use of insecticides affecting insects population and the subsequent food chain)
		Biodiversity	The extraction and/or production may pose a threat to habitats and its biodiversity through change of land type but as well perturbation of biodiversity due to use of chemicals, fragmentation of habitats particularly in hot-spot biodiversity areas. Agricultural practices with limited impacts on ecosystem shall be prioritized such as agro-ecology and/or organic agriculture.		

Key risk drivers for Sustainable Biomass

Environment

#	Driver – Level 1	Driver – Level 2	Potential Risk	Link with SDGs	Decision Indicators (non-exhaustive list)
3	Impact on Natural resources (Soil & Water)	Quantity/ Availability	Biomass production may require important quantity of water and land. Low water-intensive cultures and water losses reduction as well as cultures that participate to the regeneration of soil shall be encouraged particularly in water-stress areas with potential of conflicts of usage.	SDG 3 - Good health and well-being SDG 6 - Clean water and sanitation SDG 12 - Responsible Consumption and Production	• Adopt measures to limit water consumption in the biomass production and treatment (low-water intensive biomass production and processes); Prioritize biomass options that requires low level of land area. • Limit the use of intrants that pose a risk of contamination of ecosystem (water and soil). • Prioritizing approaches limiting the degradation and desertification of soil (less chemicals, using techniques ensuring water infiltration in the soil)
		Contamination/ Quality	Biomass production may require the use of practices or species that contaminates the soil and the water resources. As well as practices or species that will affect the infiltration of water and the quality of soil and its regeneration.		
4	Air quality		Agricultural practices such as agricultural waste burning or use of chemicals at farm level as well as industrial processes for biomass treatment and combustion without appropriate contaminant control (from combustion smoke) may affect the quality of air and pose public health issues for workers and communities at local and regional level (including transboundary)	SDG 3 - Good health and well-being SDG 11 - Sustainable Cities and Communities	• Encourage the use of by-products (agricultural residues) avoiding waste burning at farm level with no combustion control. • Ensure the adoption of best available technologies for treatment of smokes in biomass treatment and energy conversion to reduce air contamination. • Risk awareness for communities and workers about air quality.

Key risk drivers for Sustainable Biomass

Social

#	Driver – Level 1	Driver – Level 2	Potential Risk	Link with SDGs	Decision Indicators (non-exhaustive list)
5	Human & Labor rights	Rights of communities/Land rights	Production and utilization of biomass may affect the rights of communities including land rights or rights to benefit from ecosystem services (particularly for minorities and indigenous people), while all stakeholders may not be granted to rights for information and participation to decision-making as stakeholders in the development of the biomass supply-chain	SDG 5 - Gender equality SDG 8 - Decent work and economic growth SDG 10 - Reduce inequality within and among countries	• Ensure that biomass production does not affect human rights such as land rights of all stakeholders and ensure appropriate compensation when necessary. • Ensure right information and participation from stakeholders
		Rights of workers	Production, logistics, utilization and waste management of biomass products shall ensure no child labor nor slavery while guaranteeing fair right for workers (remuneration, decent contracts) and safe place to work (OHS)		• Ensure that worker rights and fair labor standard compliant with national law, ILO convention norms regarding forced labor, child labor, freedom of association and fair wage.
6	Rural and Social Development		Production, logistics, utilization of biomass products may generate additional revenues and employment opportunities, though the distribution may face challenges with main portion being monopolized by a limited number of stakeholders (insider or outsider of the local communities).	SDG 5 - Gender equality SDG 8 - Decent work and economic growth SDG 10 - Reduce inequality within and among countries SDG 11 - Sustainable Cities and Communities	• Ensure decent remuneration for local farmers and biomass producers • Ensure proper distribution of employment opportunities and revenues to local communities • Ensure appropriate and equitable revenues sharing within communities with specific attention to vulnerable populations (women, children, ethnic minorities, etc.)
7	Local food safety		Production of biomass from crops that can be used for alimentation or on land that used to or could be used for food crops may impact the food safety with the risk of lower availability of food products necessary for ensuring good nutrition and/or increased price due to competition between food and energy usages	SDG 2 - Zero hunger SDG 12 - Responsible Consumption and Production	• Ensure fuel crops does not replace food crops which will result in local food insecurity

Key risk drivers for Sustainable Biomass Governance

#	Driver – Level 1	Driver – Level 2	Description / Definition	Link with SDGs	Decision indicators
8	Legality	Legal Compliance - Operations follow all applicable laws and regulations.	Compliance with main local and national laws and best practices for E&S, business activities, ethics, etc. Sustainable operations are planned, implemented, and continuously improved through an open, transparent, and consultative impact assessment and management process and an economic viability analysis.	SDG 16 - Peace, justice and strong institutions	• To check the sufficiency of Permit and License, including Business license, water use and discharge permit (if applicable) from the biomass production factories, import permits for equipment purchase and import, etc. • To have a management system and person in charge to sustain the Guideline
		Sectoral/Industrial best practices application			

Applicability of Sustainability Drivers on Biomass Categories

- As the Sustainability drivers, identified earlier in this Section, may apply differently to each biomass categories identified in Section 2, an Applicability Matrix has been prepared to determine whether each driver applies directly, indirectly or could be considered as negligible for specific biomass categories.
- The Applicability Matrix will then be used through the Risk Assessment Tool (described in Section 4) after the biomass source identification channeling the risk analysis to the key Sustainability drivers relevant for the given biomass source.

	Driver Level 1	Driver Level 2	Biomass Category				
			Solid wood/ Forestry residues	Dedicated crops	Agricultural residue (ligno-cellulose biomass)	Agricultural residus (Animal manures)	Organic waste from industries and MSW
Environmental	Climate change	Mitigation (GHG emission reduction)	Direct	Direct	Indirect	Direct	Indirect
		Adaption	Direct	Direct	Indirect	Indirect	Indirect
	Conversion	Land type change	Direct	Direct	Indirect	Indirect	Indirect
		Biodiversity	Direct	Direct	Indirect	Indirect	Indirect
	Impact on Natural resources (Soil & Water)	Quantity/ Availability	Negligible	Direct	Indirect	Indirect	Indirect
		Contamination/ Quality	Negligible	Direct	Indirect	Direct	Direct
	Air Quality		Direct	Direct	Direct	Direct	Direct
Social	Human and Labor rights	Rights of communities/Land rights	Direct	Direct	Indirect	Direct	Direct
		Worker/ Labor rights	Direct	Direct	[illegible]	[illegible]	[illegible]
	Rural and Social Development		Direct	Direct	Direct	Direct	Direct
	Food security		Negligible	Direct	Negligible	Negligible	Negligible
Governance	Legality and Regulations		Indirect	Indirect	Indirect	Indirect	Indirect

First draft, to be further refined during consultations

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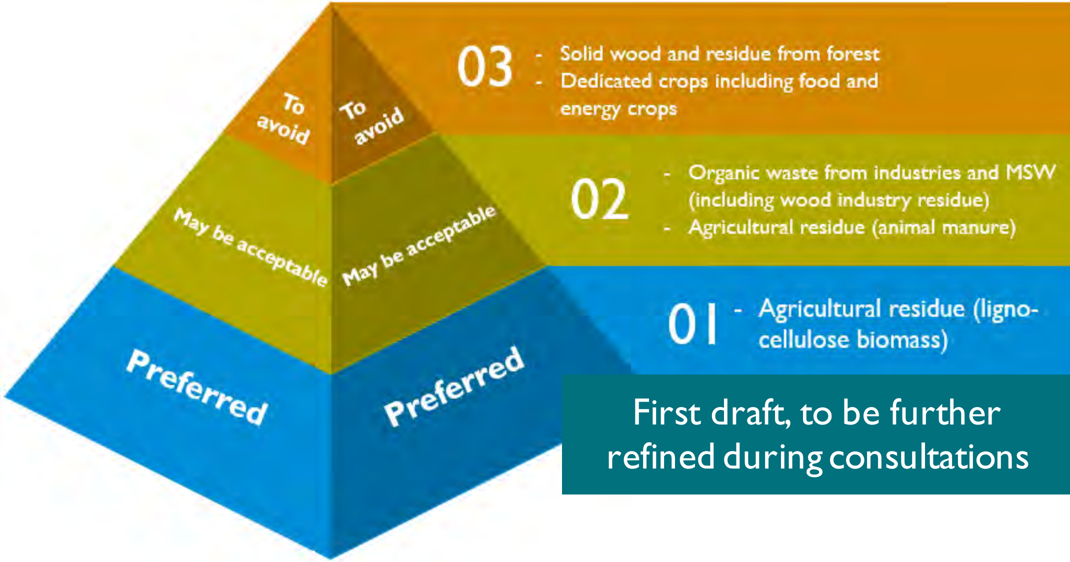
Preliminary Hierarchy For Biomass Selection

- Based on the Driver Applicability Matrix, biomass options are initially screened based on the occurrence of ESG risks.

- Biomass types with least pre-screened ESG risks occurrence may be preferred to use.

- Nevertheless, the most appropriate type of biomass for use in a region will be highly dependent on local and regional circumstances and conditions. Moreover, deeper analysis and implementation of mitigation solutions together with proper planning may allow to reduce the risk and increase the sustainability of a biomass source

- Factors influencing biomass selection include market availability, local production, technology and ESG risks consideration as described in Driver Applicability Matrix. The factory should conduct a feasibility assessment of biomass selection in a combination of technical, economic and sustainability factors.



First draft, to be further refined during consultations

Section 4

Risk Assessment for Sustainable Biomass

Objectives:
This section explains the evaluation approach developed through a Risk Assessment Tool complementing these guidelines.

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Introduction of The Risk Assessment Tool (RAT)

What is the objective of the risk assessment?

- To gain understanding of environmental, social (economics and human rights) and governance risks that occur per type of specific sourced biomass and in the biomass processing supply chain.
- To facilitate decision-makers in biomass/biofuel selection and biomass supplier screening.

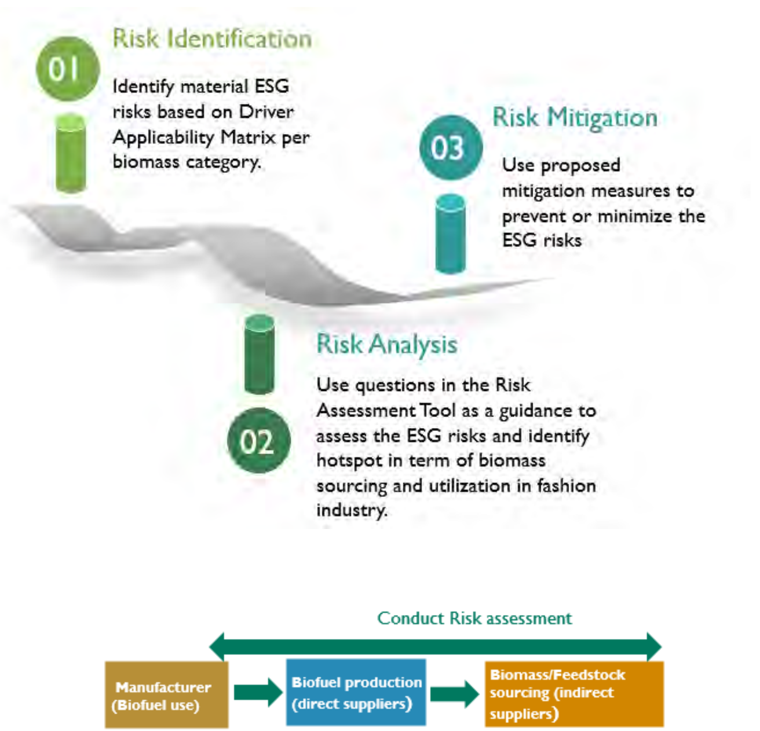
When and who should conduct the risk assessment?

- Manufacturers considering a transition to phase out fossil fuels and select a suitable and sustainable alternative such as biofuels.
- Manufacturers assessing the ESG risks of potential biomass/biofuel suppliers in the stage of supplier selection.
- Manufacturers that have already applied the use of biofuels in their operations, to verify whether purchased biofuel is produced in a sustainable manner.

Which issues should be covered in the risk assessment?

- The sustainability drivers (Level 1 and 2) as described in Section 3 are recommended for the evaluation of the sustainability of biomass production and utilization.

Figure 10 – Scope of risk assessment



How to Use The Risk Assessment Tool (RAT)?

The Risk Assessment Tool is developed on a Spreadsheet format and will be performed on a Risk assessment approach as described in previous page going through the different steps below:

1. To inform the Assessor information (company, name of assessor, date, location) for documentation control purposes
2. To provide and inform the key information about the biomass final product (i.e., wood, charcoal, bioethanol, biogas, etc.) inorder to pre-identify the key processes that the biomass has gone through during the different supply-chain steps and determine the initial biomass sources (one single final biomass product may originate from several primary biomass sources) and categories
3. To go through the sustainability drivers for each of the biomass sources and assess the related risk based on a series of questions and guided answers. The series of questions originated and are determined from the Driver Applicability matrix (see Section 3) related to the biomass-category identification. Additional specific questions may arise from the identification of conversion process involved in the fabrication of the biomass final product. Questions should be answered based on the level of information available prioritizing direct suppliers' details. In the case where no supplier is identified yet, questions may could be still be answered using local context and national and/or regional trends to estimate the level of risk. Answers will be guided with references provided to supportthe assessor in determining the risk level.
   - Questions may be asked through various form such as Checklist, Yes/No answer or Severity/Likelihood assessment depending on the biomass categories, the driver applicability and already registered answers from other drivers. For each answer it will be expected to share justifications.

4. At the end of the driver assessment, the result of the sustainability will be presented following the form of color-code heat map (see following page) addressing the risk level for each driver. Particularly for the High and Medium risk, mitigation options can be considered and added to the evaluation process with the ambitions of reducing specific risk levels to update the heat map.

Indicative List of questions to be addressed in the RAT

Driver Level 1	Driver Level 2	#	Question
Climate change	Mitigation	1	Does the use of biomass reduce the GHG emissions compared to the fuels it replaces?
		2	Does the biomass product require the use of fossil fuels during its treatment (drying, densification) and/or has been transported over long distance (>100km) from its production location ?
	Adaptation	3	Is the biomass source considered as vulnerable to consequences/hazard of weather/extreme conditions (i.e. droughts, floods, strong precipitations and storms, sea level rise, etc.) intensified by climate change?
Conservation	Ecosystem and biodiversity	4	Has biomass/biofuel producer or supplier implemented appropriate control systems and procedures to ensure that area with high conservation value is not disturbed when sourcing primary Biomass?
		5	Is the biomass source or its production done in proximity (within 10 kms) to natural areas representing important habitats for fauna and flora with a risk of expansion over natural habitat?
		6	Does the biomass processing/production require intensive use of chemicals including but not limited to fertilizer and pesticides?
Natural resource (Soil& Water)	Availability/ Quantity & Quality/ Contamination	7	Is the region from where biomass is sourced known for any water contamination or land degradation/contamination issues?
		8	Does the biomass production require initiatives to manage and minimize the use of natural resources (such as water availability), toxic materials and control pollution?
		9	Does the biomass/biofuel producer or supplier implement control measures and procedures to manage waste - hazardous waste and contaminated water (distillation, esterification, pyrolysis, methanation, methanization)?
Air Quality		10	Is the biomass production/processing associated with any practices that may lead to Air Pollution. (e.g., open burning of agricultural waste at farm level)?
		11	Does the biomass/biofuel producer or supplier implement control measures of pollutant emission from the production process (distillation, esterification, pyrolysis, methanation, methanization)?

Driver Level 1	Driver Level 2	#	Question
Human & Labor rights	Right of communities	12	Is the region from where biomass is sourced inhabited by ethnic minorities/and or indigenous people?
		13	Is the biomass produced on land that has led to population resettlement?
	Right of Workers	14	Does the factory have policy and control mechanisms to check employment contract, payment records, grievances log for all workers, including biomass suppliers to assess associated labor risks?
		15	Does the biomass producer or supplier provide decent remuneration and maintains labor rights based on local and national regulations?
		16	Does the biomass/biofuel producer or supplier have adopted appropriate health and safety safeguards for its employees and workers?
		17	Does the biomass/biofuel producer or supplier regularly provide occupational health & safety or safety management training to its employees and workers?
		18	Does the biomass/biofuel producer or supplier have the Human Rights Policy/no Child & Forced Labor Policy?
		19	Has the biomass/biofuel producer or supplier implemented control systems and procedures to verify that feedstock is not supplied using practices leading to violation of Labor and Human Rights?
		20	Is the biomass/biofuel producer or supplier been legally notified about any violation of Human Rights/Child Labor in the last 5 years?
Rural Social development		21	Does the production of biomass engage with agricultural cooperatives or other form of local businesses ensuring decent employment for local population?
		22	Does the biomass resource that you are sourcing has a competitive use in the area of biomass origin?
Local food safety		23	Is the main biomass source (excluding agricultural waste) an important part of the local alimentation chain? In case of non-edible crop, can the land be used for food agriculture?
		24	Is the country/region considered at risk in terms of Food safety (as per definition of UNFCCD)?
Legality		25	Is there a valid legal environmental license available with the supplier/producer?
		26	Does the biomass producer have a permit or authorization approval for sourcing/processing the feedstock?
		27	Has the biomass producer implemented appropriated control systems and procedures to ensure that feedstock is legally harvested and supplied and follows national legal requirements?

Risk Assessment Output

Following the completion of the risk analysis, output will be provided in the form of a heat map where risk can easily be identified being evaluated for each driver from Low (Green), Medium (Orange) and High (Red) – see example below.

Following this initial assessment, it is recommended to proceed with a risk mitigation analysis and evaluate the residual risk before decision-making. In order to select one biomass source, it is recommended that High Risk should be mitigated, Medium should be mitigated while Low Risk mitigation may be considered. Following the evaluation considering mitigation option, one or several biomass sources may be prioritized.

Indicative mitigation options (non-exhaustive list) are listed in the following page.

Biomass source 1 to be prioritized

Driver Level 1	Driver Level 2	Before mitigation			After mitigation		
		Biomass Category 1		Biomass Category 2	Biomass Category 1		Biomass Category 2
		Biomass Source 1	Biomass Source 2	Biomass Source 2	Biomass Source 1	Biomass Source 2	Biomass Source 2
Legality	Compliance	Low	Low	Low	Low	Low	Low
Climate Change	Mitigation (GHG)	Medium	Medium	Medium	Medium	Medium	Medium
	Adaptation/Vulnerability to climate change	Low	Low	Low	Low	Low	Low
Human & Labor rights	Rights of communities/Land rights	High	Medium	Medium	Low	Medium	Medium
	Rights of workers	High	Medium	Medium	Low	Low	Medium
Rural and Social Development	Providing sufficient and equitably shared revenues/employment for communities	Low	Low	Medium	Low	Low	Low
Food security	Affordable Price & availability	Low	Low	Low	Low	Low	Low
Conservation	Change of land type	High	High	Low	Medium	Medium	Low
	Biodiversity	High	High	[illegible]	Medium	Medium	Low
Natural resources (Soil & Water)	Quantity/ Availability	Low	Low	[illegible]	Low	Low	Low
	Contamination/ Quality	Low	Low	[illegible]	Low	Low	Low
Air quality	Emission of pollutants affecting public health	Medium	Medium	[illegible]	Low	Low	Medium

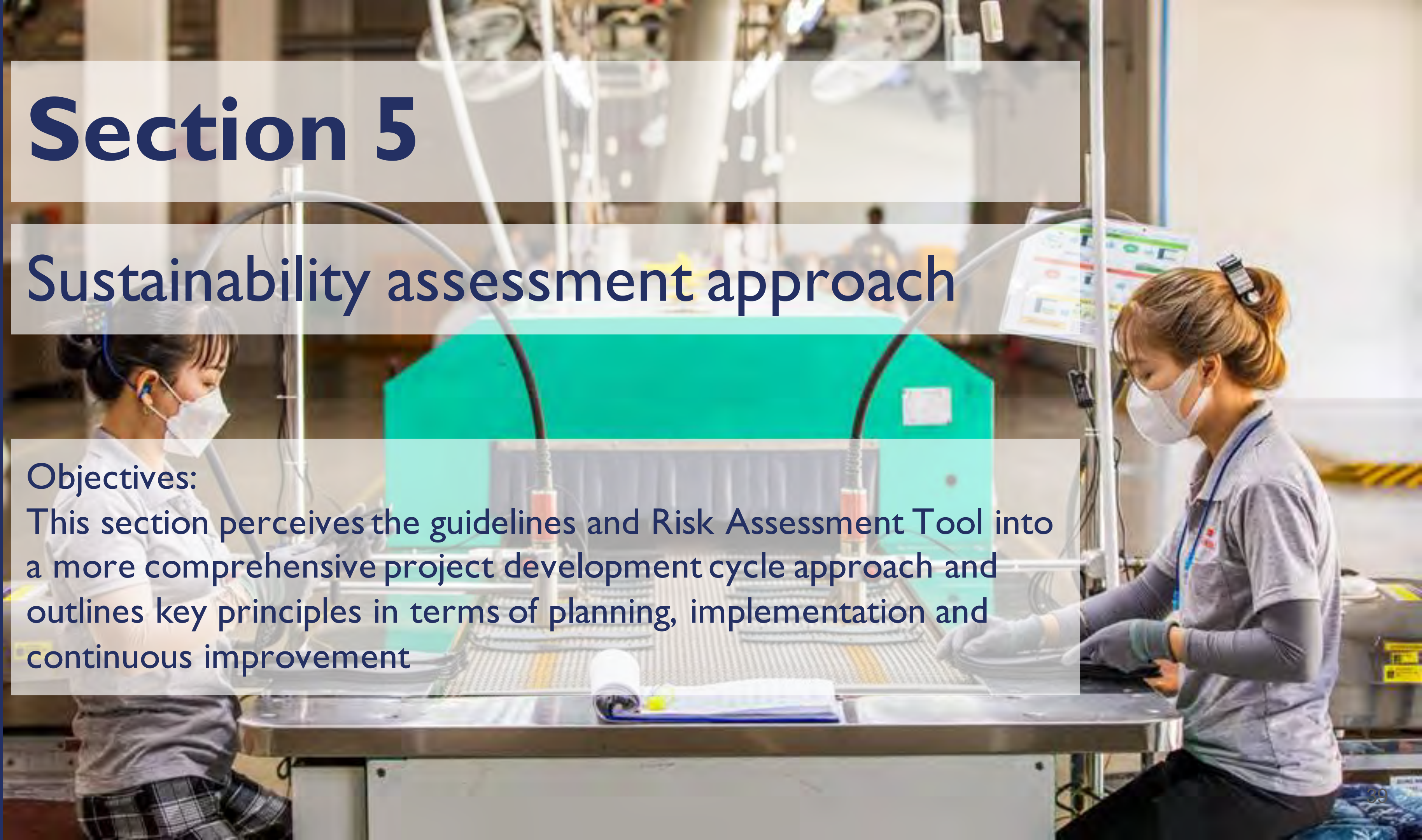
Sample

Indicative List of Mitigation Options

Following the first assessment, several drivers may be evaluated as Low, Medium or High risk. For these last two categories, a No-Go may be decided or mitigation options shall be discussed.

The table on the right is provided for information purposes and aims at listing general mitigation solutions for each driver that may be applicable to the biomass source.

	Driver: Level 1	Driver: Level 2	Possible mitigation options (non-exhaustive list)
Environmental	Climate change	Mitigation (GHG emission reduction)	▪ Prioritize local feedstock to reduce GHG emissions related to transportation ▪ Avoid fossil fuels and ensure highest energy efficiency standards for pre-treatment processes and combustion processes with appropriate Energy Management System implemented (ISO 50001)
		Adaption	▪ Select biomass sources the most resilient to the risks related to climate change for the selected area (occurrence of floods, droughts, extreme temperature and natural hazards)
	Conversion	Land use change	▪ Select biomass sources with the highest calorific value to limit the occupation of the land
		Biodiversity	▪ Prioritize traditional and agroecological practices reducing the destruction of biodiversity areas and limiting the use pesticides
	Natural resources (Soil& Water)	Availability	▪ Select biomass sources with the lower water consumption, especially in region with a risk of usages conflicts. The seasonality of the water consumption may also be considered in line with the other water usages (industry, residential). ▪ Certified biomass sources from organizations such as FSC (Forest Stewardship) should be prioritized.
		Quality	▪ Limit the use of chemical in the agricultural processes and implement appropriate control and storage for chemicals, highly concentrated substance (e.g., digestate from methanization) and waste management to avoid contamination of natural environment
	Air Quality		▪ Valorise the by-products (agricultural residues) from the agricultural processes to prevent open burning at farm level ▪ Ensure appropriate smoke and gas effluents control and treatment from biomass conversion processes (e.g., combustion, pyrolysis)
Social	Human and Labor rights	Land use rights	▪ Audits on suppliers and biomass sources may be performed to ensure that communities have not been affected by the development of the biomass supply chain
		Labor rights	▪ Implement at factory level and Prioritize/Encourage suppliers with appropriate Occupational, Health and Safety policies and protective equipment (when required). Audits on suppliers may be performed
	Rural and Social Development		▪ Audits on suppliers and biomass sources may be performed to ensure that communities are benefitting from the development of the biomass supply chain in terms employment and revenues
	Food security		▪ Prioritize non-edible crops and agricultural residues that don't fall into competition with food practices of the communities.
Governance	Legality and Regulations		▪ Perform ethics and compliance audits on suppliers and ensure that all required permits are approved and valid. Prioritize supplier with traceability of the feedstock



Section 5

Sustainability assessment approach

Objectives:

This section perceives the guidelines and Risk Assessment Tool into a more comprehensive project development cycle approach and outlines key principles in terms of planning, implementation and continuous improvement

Planning, Monitoring, & Continuous Improvement

At the stage of exploring, analyzing and implementing projects and operations related to biomass, as for any new project, sustainable operations shall be planned, implemented, and continuously improved through an open, transparent, and consultative impact assessment and management process and an economic viability analysis.

For example, the Management of Change – Plan/Do/Check/Act approach can be considered to ensure appropriate, efficient implementation of project while shifting from fossil fuels to biomass fuels.

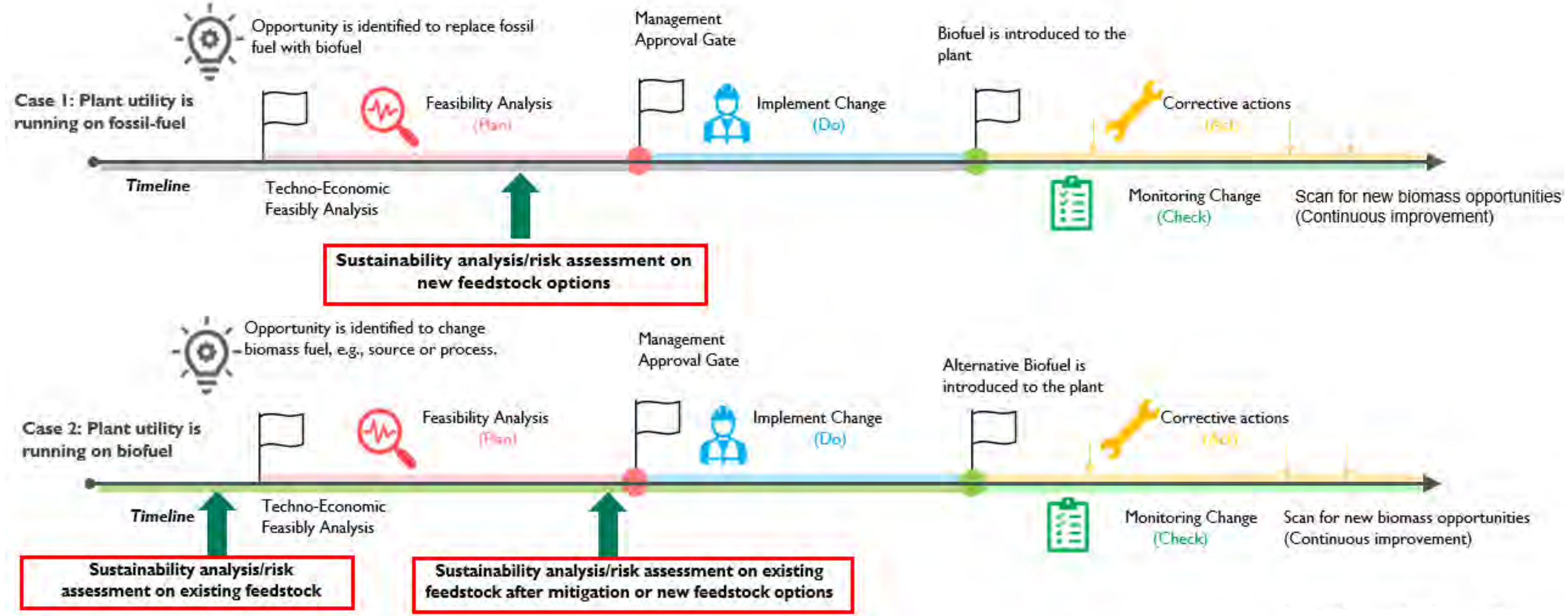
Management of Change (MOC)

- Identify Potential Change
- Plan: Feasibility Analysis
  Techno-Economic Analysis → Technical, Commercial, Legality, Sustainability Analysis)
- Management Decision → Approve/Reject, Revisit Feasibility Analysis
- Do: Implement Change → Verify Risk Mitigations are being carried out
- Check: Monitoring Change → Verify Risk Mitigations are being carried out
- Act: Corrective Actions → If actual operations differ than those expected, implement correction actions
- Continuous improvement

Element	Description of element	Good Practice Expectations
Identify Potential Change	Introducing or Changing Biomass Source Category, Conversion Process, or Supply Chain.	1. If already using a biomass source, apply this guideline and risk assessment methodology to establish a baseline, and identify any unacceptable sustainability risks. 2. If introducing or changing a biomass source, conversion process or a change to a biomass supply chain, apply this guideline. Evaluating a potential change requires resources and time, approval to feasibility analysis stage 2 should be granted by factory management.
Feasibility Analysis	Assessment of Techno-Economic Feasibility Assessment of Sustainability Feasibility	The first step is to determine if the potential change of biomass source, process, biofuel, or supply chain is feasible from a Techno-Economic perspective. If the potential Biomass related change, e.g., biomass source, process, biofuel, or supply chain is feasible from a Techno-Economic perspective, proceed to the Sustainability Assessment described in this guideline. Note: Feasibly analysis should cover the full lifecycle of the biomass source, including energy conservation and waste management (e.g., ash, smoke, digestate)
Approval	Management Approval at an appropriate level is required to implement the biomass related change.	
Implement Change	Execution of the Biomass related change via approved company practices, e.g., project management etc.	It is important to implement the change that was approved by management, not a variation of that change. Ensure that the change is implemented in proper manner in accordance with company practices. Risk mitigations generated during the feasibility analysis should be embedded in the scope of work of the change. Biomass related changes may require training of plant personnel, modification of standard operating procedures or changes to plant equipment.
Monitoring Change	Performance of the Biomass related change is monitored to ensure it is delivering the benefits expected and does not result in unanticipated results.	Despite the best intentions and rigorous planning, Biomass related changes may have unanticipated results. It's important to monitor the change to ensure that the change provides the benefits expected in terms of technical, economic and sustainability.
Corrective actions	If the Biomass related change results in unforeseen negative consequences, corrective actions are to be implemented.	Unanticipated results related to the Biomass change may require corrective actions to ensure that the original expectations are achieved, or that unintended consequences are addressed.
Continuous improvement	In accordance with best practices, plant should stive to continuously improve operations.	Continuous improvement may result in the introduction of biomass sourced fuel or the replacement of a biomass derived fuel with a better performing biomass derived fuel, in terms of the biomass source and conversion process. Improvements may be to any of Techno-Economic Performance measures, or to the Sustainability Drivers. Changes require application of the management of change process discussed in this guideline.

Timeline of Implementation

The figure below shows an indicative recommendation of when to apply the guidelines and the RAT during the project development cycle in the case of the plant/factory considering to use biomass instead of fossil fuels (Case 1) or in the case whereby it is already using biomass and wants to assess its sustainability.



Use of Technology, Inputs, and Management of Waste

The use of technologies shall seek to maximize production efficiency and social and environmental performance and minimize the risk of damages and impact to the environment and people. As all biomass types have an impact even after considering all mitigation options, it is important to consider the following principles for the sustainable use of energy and biomass.

- Proper assessment of the rationale for energy use and consider it within the scope of Responsible Production and Consumption principle (SDG 12).
- Use of best practices and technologies of the highest standards in terms of energy savings and energy efficiency for the biomass conversion equipment as well as the manufacturing of machines in order to limit the amount of energy and biomass input for one unit of the final product. Indicators such as Energy intensity (i.e., MJ/unit or MJ/kg of product) may be used. Proper Energy Management Systems could also be implemented to monitor the energy use and lead to energy savings (using protocols and standards such as ISO 50001).
- Waste management should also be-well-considered at all steps of the supply chain in order to recover most of the organic fractions that can be considered as secondary products, therefore increasing the efficiency of the whole system. For remaining waste products, proper storage and treatment should be ensured to limit environmental and social risks (including combustion ash or smoke treatment residue) as well as material and/or energy recovery before proceeding as landfill waste (such as agricultural residue).

References & Bibliography

To note that references, bibliography, and additional notes will be consolidated upon finalization of the Guidelines and the Tool. Literary research has been cited throughout the Guidelines draft.

Public Consultation Questionnaire

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Public Consultation Questionnaire

- We are seeking to hear feedback from the wider public and relevant stakeholders to input on the overall approach of the guidelines.
- Please note that data points presented as part of this consultation are exploratory and are indicated as such. We will incorporate and modify the Guidelines and Tool upon consideration of the feedback received.
- The consultation will close on April 10th 2023.
- For those wishing to provide feedback, please kindly click this link or scan the **QR code** below. All feedback will be confidential.

Thank you.