

# Sustainability standards for novel macaúba value chains in Brazil for energy transition: a framework proposal

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## I. INTRODUCTION

The sustainable energy transition pursues a just transition and the decarbonization of sectors that heavily rely on fossil fuels. In the energy sector, transportation ranks second after electricity and heat in terms of greenhouse gas (GHG) emissions. Bioenergy plays a key role in the energy transition of transportation. The European Union (EU), with 3.8% to 4% of its direct emissions coming from the aviation sector, aims to achieve climate neutrality in aviation by 2045 through the use of sustainable aviation fuels (SAF). Brazil, on the other hand, aims to increase the biodiesel blend to 20%.

Given the growing demand for vegetable oils, feedstocks that fulfill sustainability requirements are essential. The macaúba palm (*Acrocomia aculeata*), a novel oil crop currently in the early stages of cultivation in Brazil, shows promising potential for biofuels due to its high productivity, multi-purpose uses, and capacity to grow in areas outside tropical rainforests.

**Aim:** The dynamic development pace of macaúba value chains (MVC) indicates an orientation toward the production of biodiesel and SAF. Therefore, to guide its entry into the bioenergy sector, it is essential to **identify sustainability policies, standards, and practices** in the biodiesel and SAF sectors of Brazil and the EU, and to **advance a sustainability standards framework** as a market-driven mechanism for macaúba-based biofuels.

## II. APPROACH

We conducted a literature review to identify the most common liquid biofuels derived from vegetable oils and their feedstocks. Then, we used these results to develop a systematic review protocol and an analytical framework.

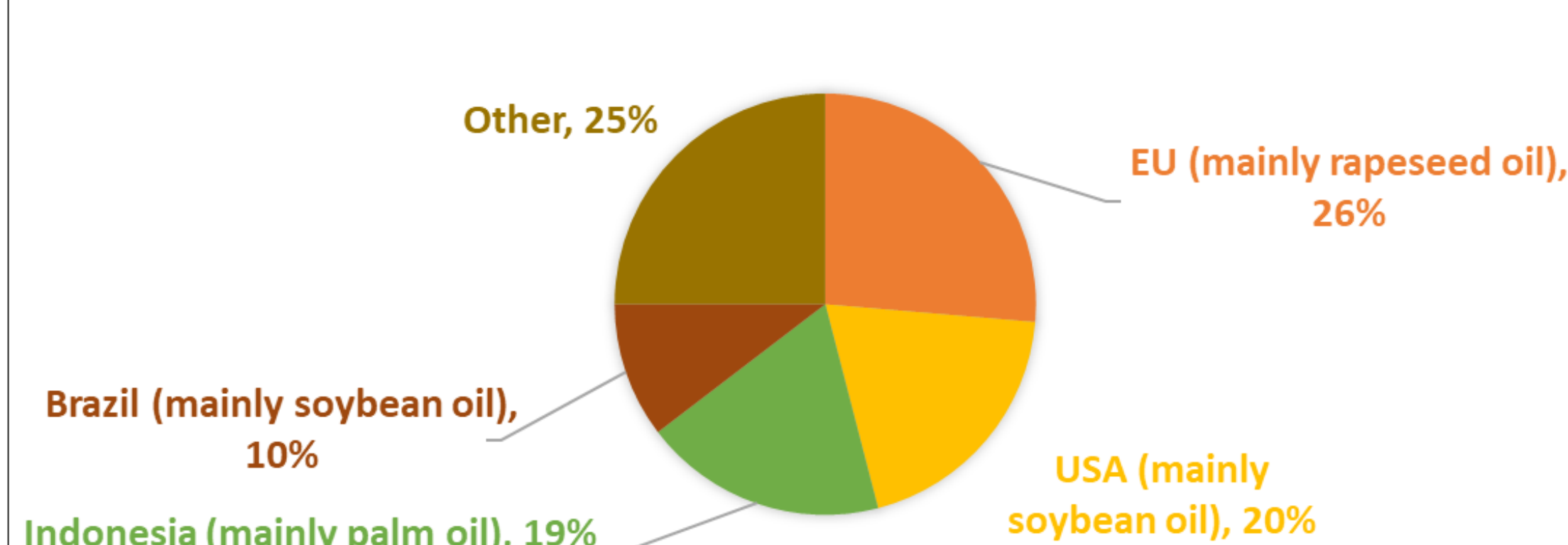


Fig. 1: Global biodiesel production and main feedstock per country/region.

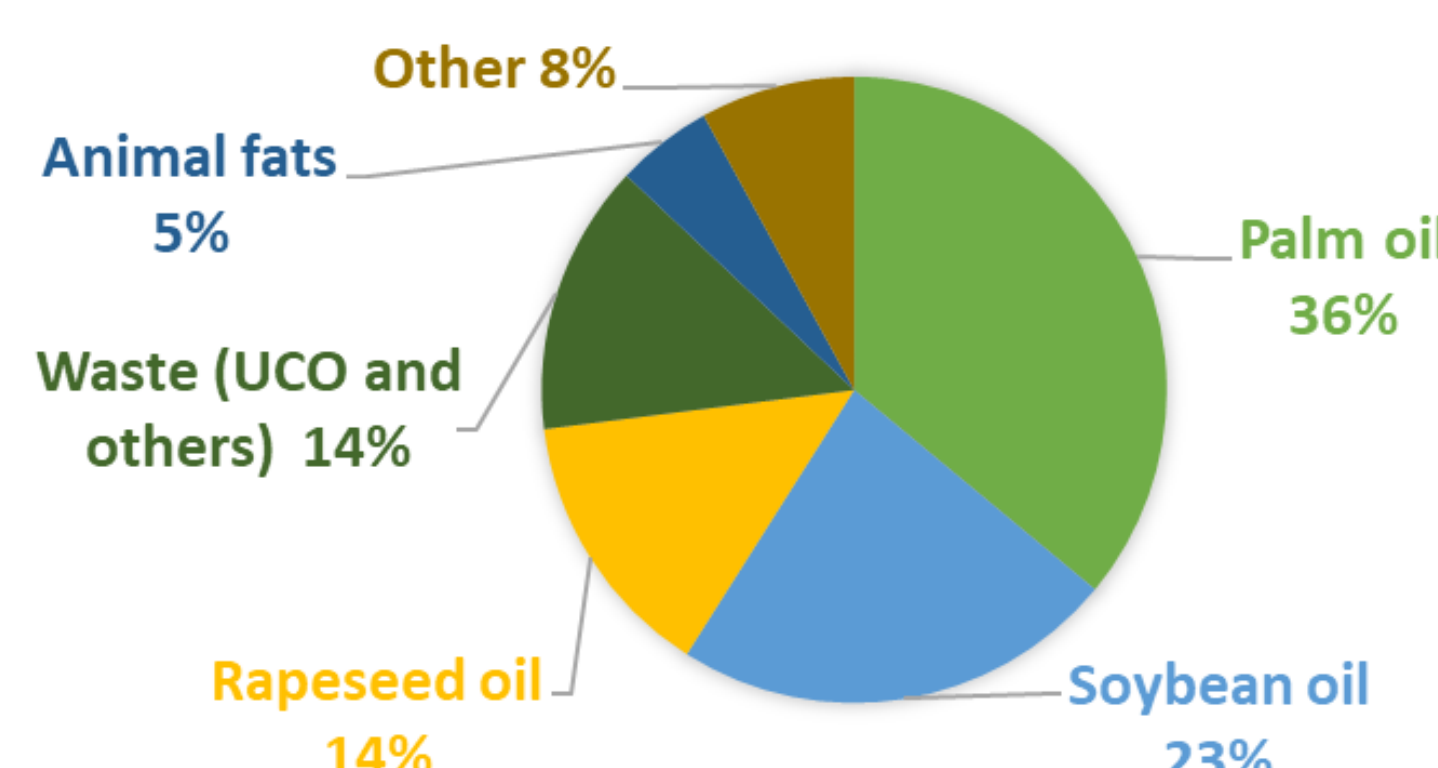


Fig. 2: Global feedstock used for biodiesel.

### Selected biofuel feedstock from vegetable crops:

- Palm oil
- Soybean oil
- Rapeseed oil

### Selected biofuels derived from vegetable oils:

#### Biodiesel

- Fatty Acid Methyl Ester (FAME)
- Hydrotreated Vegetable Oil (HVO)

#### Biojet fuel

- Hydrotreated Esters and Fatty Acids (HEFA)

P	Policy framework: directive, regulation, law Biofuels: Biodiesel, Fatty Acid Methyl Ester (FAME), Hydrotreated Vegetable Oil (HVO), Hydrotreated Esters and Fatty Acids (HEFA), Sustainable aviation fuel (SAF), biojet fuel, bio-aviation fuel (BAF), aviation biofuel Vegetable oils: palm oil, rapeseed oil, soybean oil Regional focus: EU, Brazil
O	Sustainability standards

Fig. 3: Search terms derived from the research question applying the PICO framework (P: population; I: intervention; C: comparator; O: outcome).

### Protocol for systematic literature review

We applied the PICO framework to extract from the research question the terms for our search string in the SCOPUS database as follows:

("Vegetable oil\*" OR "palm oil" OR "rapeseed oil" OR "soybean oil") AND ("Biofuels" OR "Biodiesel" OR "Fatty Acid Methyl Ester" OR FAME OR "Hydrotreated Vegetable Oil" OR HVO OR "Hydrotreated Esters and Fatty Acids" OR HEFA OR "Sustainable aviation fuel" OR SAF OR "biojet fuel" OR "bio-aviation fuel" OR BAF OR "aviation biofuel") AND ("Directive" OR polic\* OR regulat\* OR law) AND ("EU" OR "European Union" OR "Brazil") AND ("sustainability standard\*")

363 documents were found using the selected search string

### Preliminary results

Main topic categories found in the initial analysis:

- Sustainability
- Energy transition
- Value chains
- Specific for selected vegetable oil crops
- Specific for biofuels (biodiesel and biojet fuel)
- Standards, certification schemes and labels

Palm oil has the most comprehensive set of sustainability initiatives, certification schemes, and sustainability standards compared to rapeseed and soybean.

### Topics of relevance

- The EU plan of phasing out the use of palm oil for biofuels by 2030 and its challenges.
- Global sustainability governance and policy implications.

### Proposal for a sustainability standard framework

1. A general layer with relevant cross-cutting elements for agri-food value chains.
2. A specific layer with elements that address agricultural practices or technical aspects of biofuels with relevant implications for the selected crops.
3. A layer that identifies the existing sustainability standards for the selected crops.

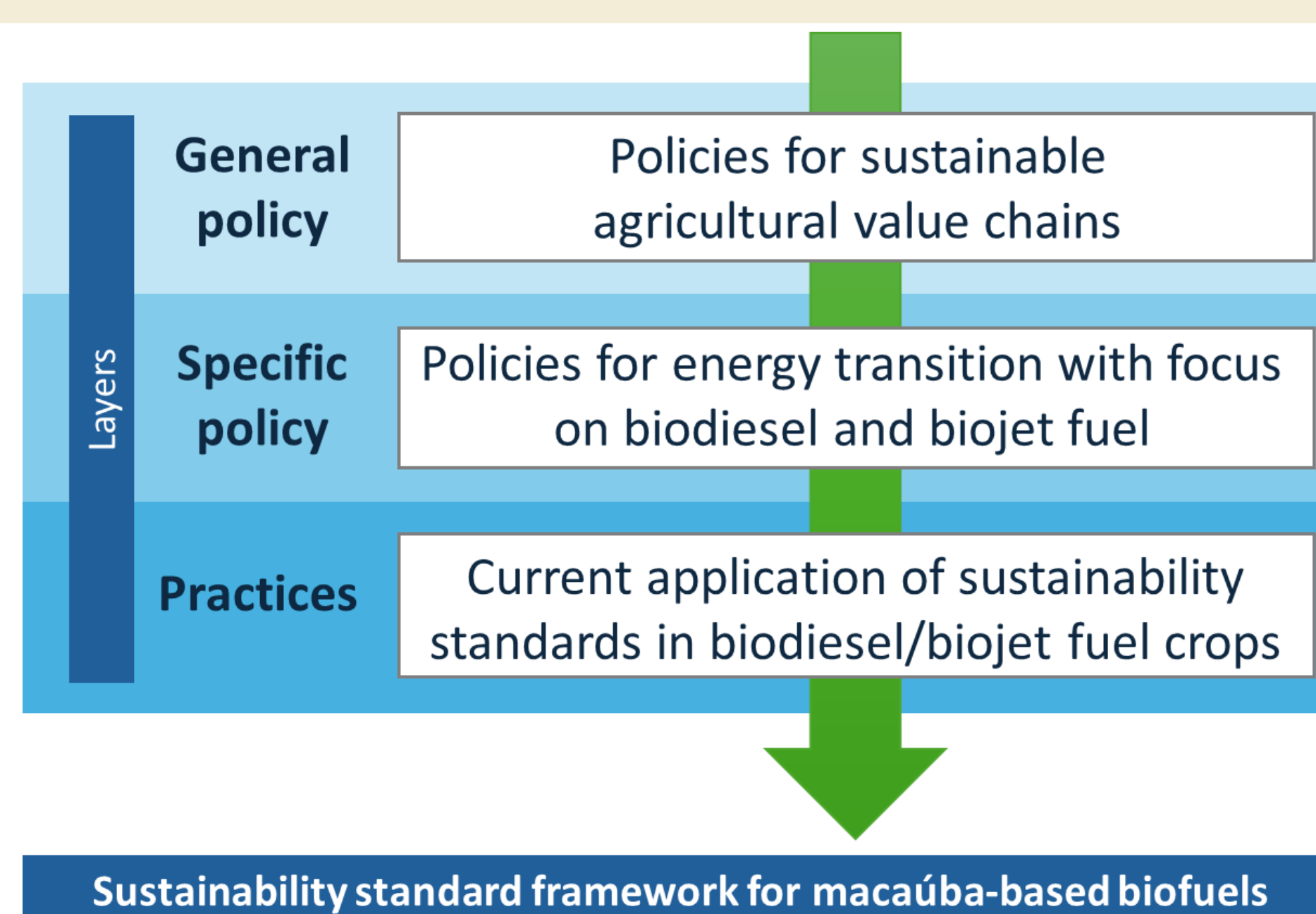


Fig. 4: Conceptual framework for the comparison of policies, standards, and practices between Brazil and the EU for macaúba value chains for liquid biofuels (MVC).

## III. OUTLOOK

- A sustainability standard framework for macaúba-based biofuels facilitates the identification of sustainability requirements for feedstock for the production of liquid biofuels.
- Its application can facilitate the identification of strenghts and hotspots to guide MVC stakeholders in current production processes.
- Next steps include: stakeholder engagement through dialogue with key actors to orient the evidence synthesis process.