SMEP

Sustainable Manufacturing and Environmental Pollution Programme

# PLASTICS MANAGEMENT AND RECYCLING AMID GLOBAL GOVERNANCE CHANGE

## Insights from the SMEP plastics projects

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Partnership | Progress | Prosperity

This report was written by Katja Spur, in the context of the Sustainable Manufacturing and Environmental Pollution (SMEP) programme funded by the Foreign, Commonwealth and Development Office of the United Kingdom (UK-FCDO) and is implemented in partnership with UN Trade and Development (UNCTAD). This study was prepared in collaboration with the UNCTAD Oceans Economy Programme. Comments and insights were provided by Henrique Pacini, Glen Wilson, David Vivas Eugui and Maria Durleva under the guidance of Chantal Line Carpentier from the UNCTAD Secretariat.

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Lia Tostes designed the report, and Lana Barcellos illustrated the cover art.

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# Acronyms and abbreviations

| | |
|---|---|
| **ALDFG** | abandoned, lost or otherwise discarded fishing gear |
| **EIP-AGRI** | European Innovation Partnership for Agricultural Productivity and Sustainability |
| **FAO** | Food and Agriculture Organization of the United Nations |
| **HS** | Harmonized System |
| **LDPE** | low-density polyethylene |
| **PBS** | polybutylene succinate |
| **PET** | polyethylene terephthalate |
| **PP** | polypropylene |
| **R&D** | research and development |
| **SMEP** | Sustainable Manufacturing and Environmental Pollution |
| **SPS** | Sanitary and Phytosanitary (measures) |
| **TBT** | Technical Barriers to Trade |

# 1.

# Introduction

Facts

SURGE IN OCEAN PLASTIC WASTE BY 2040

## 11 mmt per year

## Triple in 16 years

▶ With about 11 million metric tons of plastics entering the ocean annually, and this figure may triple by 2040 without intervention, plastic pollution harms ecosystems and poses risks to human health.

**Plastic pollution today has reached alarming levels and there is a strong worldwide consensus around its negative environmental, social and economic implications.** Countries and communities most vulnerable to the negative effects of plastic pollution are often those with less regulatory tools and financial means to adopt and enforce policies and measures for safe and adequate plastic waste management (UNCTAD, 2023). Furthermore, the current rate of plastic waste generated exceeds efforts to prevent it, thus increasing the already elevated pressure on the environment. The Organisation for Economic Co-operation and Development (OECD) estimates that global plastic waste is to almost triple by 2060 with half of it still going to landfill and less than a fifth being recycled (OECD, 2023). OECD member countries estimate they will double their plastic consumption, while economies in sub-Saharan Africa and Asia might see even larger increases. Despite recycled plastics seeming to be growing faster than virgin plastics, they will only constitute 12 per cent of total plastic use by 2060.

With about 11 million metric tons of plastics entering the ocean annually, and this figure may triple by 2040 without intervention (UNEP, 2023; The Pew Charitable Trust and Systemiq, 2020), plastic pollution harms ecosystems and poses risks to human health. The presence of microplastics in food and water sources can accumulate in organs and potentially lead to serious health issues, including obesity, diabetes and cancer (SAPEA, 2019; OECD, 2023). The burning of plastic waste further exacerbates health risks and environmental damage (UNCTAD, 2022a). The study, "Impacts of Plastic Pollution on Human Health", brings insights from the Sustainable Manufacturing and Environmental Pollution (SMEP) programme (SMEP, 2024) emphasizes the necessity of enhancing plastic recycling and collection services to support efforts eliminating plastic leakage into the environment. Low recycling rates in SMEP programme countries in Sub-Saharan Africa and South Asia call for investment in recycling infrastructure to protect not only the environment but also public health. The findings of this study (SMEP, 2024) support global efforts in improving recycling practices and aligning these with public health objectives.

← Image 1. Plastic waste in waterways in Kpeshie Lagoon, Accra, during a visit to the Ghana Clean-up project

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Facts

**PLASTIC POLLUTION IN MANUFACTURING HUBS**

▶ The focus on specific geographic regions in the SMEP intervention responds to recent scientific findings revealing that a substantial portion of global ocean plastic pollution originates from Asian and African countries facing challenges with insufficient or absence of waste collection systems.

The SMEP programme, financed by the Foreign, Commonwealth and Development Office of the United Kingdom (UK-FCDO) and implemented in partnership with UN Trade and Development (UNCTAD), focuses on mitigating environmental challenges associated with the manufacturing sector in developing countries. While the manufacturing industry plays an important role in creating productive capacities, value addition, exports and overall economic development, it often contributes to high pollution levels and environmental degradation, particularly in sectors dominated by micro-, small-, and medium-sized enterprises (MSMEs). Factors such as limited capacity for investment, lack of access to resources and technological know-how contribute to poor pollution management. To address pollution at its source and to shift trends of pollution footprints from manufacturing away from business as usual, UK-FCDO and UNCTAD entered into a partnership in 2018 to reduce the environmental and social impacts of manufacturing in developing countries in Sub-Saharan Africa (SSA) and South Asia (SA). This collaboration marked the start of the SMEP programme, which seeks to develop evidence and technical solutions that will help reduce the levels of pollution and environmental degradation generated by industrial/manufacturing processes, including plastic pollution (FCDO, 2019). The focus on specific geographic regions in the SMEP intervention responds to recent scientific findings revealing that a substantial portion of global ocean plastic pollution originates from Asian and African countries facing challenges with insufficient or absence of waste collection systems, leading to the widespread dispersal and accumulation of plastics in the environment (FCDO, 2019).

As part of the activities under the SMEP programme aimed at addressing plastic pollution, analysis and field projects were competitively selected to receive support, and to provide scientific evidence that enhances understanding of the environmental, health and socio-economic impacts within specific trade-exposed manufacturing sectors in Sub-Saharan Africa and South Asia. For this, the programme supports activities that include the development and testing of technology-based solutions, identification of policies and business models for uptake and generating evidence to combat plastic pollution. This report analyses empirical lessons from a sample of those projects aimed at understanding how measures being considered at the international level to reform the plastics economy could affect operators on the ground.

## 1.1 Objective and methodological approach

The objective of this report is to examine the plastic portfolio intervention projects, identify lessons learned from the contextual and policy environment in which they operate as well as document their business ecosystems, through which their social and environmental impact can be better understood. This study intends to provide practical insights to policymakers with potential solutions to address plastic pollution. This is not an impact evaluation or progress report. The analysis draws on a combination of externally verifiable quantitative and qualitative sources to provide information about the structure and future of projects' businesses that received grant funding from the SMEP programme. Many of these projects are yet to pass piloting or testing phase as of 2024, which further emphasizes their changing nature. Thus, the findings showcased in the report aim to provide a snapshot of the projects' evolving nature, which could further develop, fail or adapt to deliver on their value proposition in the future.

The design of this report follows a mixed method approach where quarterly and annual project reports submitted to the SMEP programme were analyzed for each project. These were then combined with insights from secondary literature, survey and semi-structured individual interviews with representatives of the projects' key personnel, and in some cases sub-projects within a project, involving the following components:

1. An online survey sent to the projects' teams to collect data on project performance and identify and measure its progress in the following areas: i) regulatory framework, ii) stakeholders involved (clients and suppliers), iii) technology and innovation, iv) environmental impact, v) social and health impact, vi) finance, vii) scale and value proposition and viii) constraints and drivers. The qualitative data was converted into semi-quantitative data to estimate: i) social impact, ii) technology and innovation and iii) financial sustainability for each project. For each of the three areas of project impact, relevant questions from the survey were selected and evaluated on a scale from 0 to 1. The average for each was calculated based on this.

2. The survey was followed by semi-structured interviews with the project teams to further clarify qualitative inputs needed to substantiate the projects' business models and efforts influencing plastic pollution-related policies and regulations.

↑ Image 2. Modular plastic shredding station by the GIVO-Warwick project in Lagos, Nigeria, 2023

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## 2.

# SMEP programme: Plastic portfolio

**Even though there is conflicting information as to how much plastic waste gets recycled and what type of plastic can be safely recycled, the demand for recycled products continues to grow.** Global plastic recycling rates are expected to increase from 9 per cent in 2019 to 17 per cent in 2060. However, it would still represent a smaller share of waste management compared to incineration (18 per cent) and sanitary landfilling (50 per cent) (OECD, 2022). These realities along with increasing environmental awareness spur public and private efforts to develop solutions for mitigation and prevention of plastic pollution. A growing number of companies are now using secondary (recycled) plastics in their production processes, sourced from waste that was either recovered from the environment or collected from organized or informal waste streams. On the other hand, some initiatives focus on prevention of plastic waste by upscaling or developing materials that can substitute plastic (UNCTAD, 2023). All these initiatives bring into spotlight a different type of business model, often called a sustainable business model (SBM), one that is centered around its value proposition and environmental objectives, while also ensuring financial sustainability (Dijkstra et al, 2020). However, for many small, local or early-stage companies, the costs of starting a viable business are often too high, no matter how environmentally or socially relevant these activities are.

To address these gaps the SMEP programme started a Plastics Intervention stream of work aiming to finance research and research-related services to develop solutions that would reduce plastic pollution in Sub-Saharan Africa and South Asia. A call for proposals was put out in 2021 to support projects seeking to:

- Significantly reduce plastics waste in the environment through innovative solutions within the plastics value chain;
- Achieve market adoption and scalability, requiring solutions to be technically and economically viable;
- Advance rapidly through technology readiness levels and overcome technical and other barriers; and
- Implement solutions in SMEP focus countries or demonstrate scalability in these regions.

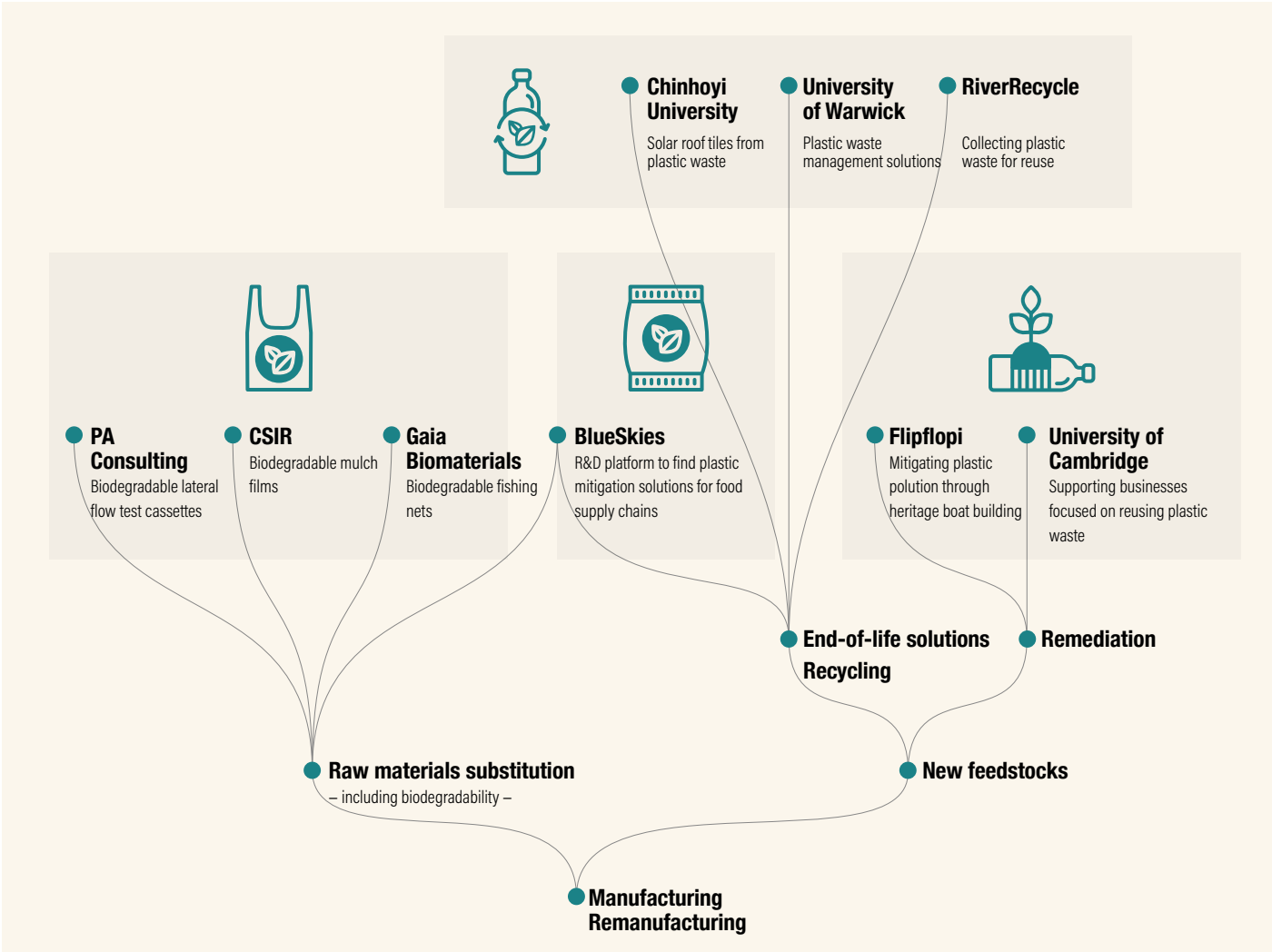
Ten projects were selected and provided with grant funding under SMEP. Projects are completing three phases of implementation with eight projects currently active (2024) in Phase 2:

**Phase 1** Project preliminary research and investigation (3 months). Two projects didn't advance into the next phase, thus eight currently active projects.

**Phase 2** Project implementation and development (up to 12 months), which is the phase projects were in at the time of this research.

**Phase 3** Project development and embedding (up to 15 months).

↓ Figure 1. Projects under the plastic portfolio of the SMEP programme



As seen in Figure 1, projects can be divided in two major groupings: i) end-of-life solutions, which include upcycling and recycling of plastics waste and ii) material substitution, which essentially focuses on developing biodegradable materials for substituting or reducing the usage of conventional plastics.

Five out of eight SMEP plastic portfolio projects are dedicated to end-of-life solutions:

RiverRecycle in Ghana: recycling plastics collected in communities, beach clean-ups and from rivers;

GIVO-Warwick project in Nigeria: recycling plastics collected from urban neighborhoods of Lagos and Abuja;

Flipflopi in Kenya: upcycling plastics collected in the Lamu archipelago into heritage furniture and boats;

Plastic-to-Ghar in Nepal: upcycling plastics into construction and insulation materials, some in isolated mountain communities; and

Chinhoyi University project in Zimbabwe: upcycling plastics into roof tiles.

International efforts to address plastic pollution often focus on downstream strategies but an increasing number of initiatives aim to create circular economies by transforming the entire plastic life cycle. Lately, many efforts have been dedicated to developing new materials that could replace plastics, however, these processes demand significant financial support due to extensive development and testing timeframes. Of the eight projects currently supported under the plastic portfolio three aim to develop new materials as alternatives to plastics.

These three projects are embarking on or supporting the development of new material alternatives and applications, which could replace conventional plastics in important economic activities:

Catchgreen project in South Africa, Kenya and The United Republic of Tanzania, developing biodegradable fishing nets and ropes for seaweed production;

CSIR project in South Africa and Nigeria, trialing biodegradable polymers to replace conventional agricultural mulch films; and

FreshPPact Impact Hub in Ghana, procuring development of solutions to shift away from plastics in mulch films, food packaging and workers' personal protective equipment (PPEs).

Plastic mulch, widely used in agriculture for moisture retention and weed control, poses environmental challenges as its plastic residues accumulate in the soil after crops are harvested. Substitutes and organic mulch methods, including paper mulch, bio-based spray-on mulch, straw and woodchips, offer similar benefits to plastic mulch but may not be suitable for all crops. The CSIR project funded by the SMEP program is developing biodegradable mulch films using locally available materials. Specifically tailored for African climate crop cycles, these films have the potential to address the challenge of microplastic accumulation in soil and water systems, contributing to improved human and ecological health.

The deadliest marine debris are abandoned, lost, or discarded fishing gear (ALDFG), commonly known as "ghost gear", consists of fishing equipment and plastic waste from aquaculture, drifting on water bodies or accumulating on the ocean floor. Predominantly made from polymers such as rayon, dacron and nylon, approximately 2 per cent of all fishing gear is lost annually. Ghost gear can make up to 70 per cent of macroplastics in the ocean by weight. Yet, little has been achieved to reduce this type of pollution, thus SMEP funding for testing and development of biodegradable fishing gear is of significant importance.

Facts

**MACROPLASTICS IN THE OCEAN BY WEIGHT**

# 70% ALDFG

▶ ALDFG, or "ghost gear", can make up to 70 per cent of macroplastics in the ocean by weight, yet little has been achieved to reduce this type of pollution.

↑ Image 3. Projects under the plastic portfolio of the SMEP programme

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## 2.1 Policy and regulatory measures to reduce plastic pollution

Research, testing and innovative production processes pose challenges to the reduction of plastics in use and in the environment. In addition, there are also current market conditions such as lower unit prices for plastics, trade policies, tariffs and non-tariff measures that hinder these efforts. Hence reducing plastic pollution, recovering plastics from the environment giving them a 'second life' and incentivizing plastic substitution should be viewed from a perspective of economic development, benefiting developing economies by fostering new capacities, increasing exports and creating employment opportunities (UNCTAD, 2023).

Economically, plastic pollution impacts sectors such as tourism and fisheries, resulting in estimated annual costs of $2.2 trillion (SMEP, 2022a). The urgency to address this crisis has led policymakers to set up negotiations that could, if successful, reduce future plastic pollution drastically. The ongoing International Negotiating Committee (INC) discussions aim to adopt internationally binding instruments to combat this environmental crisis. The treaty aims to introduce measures along the full life cycle of plastics (sourcing, processing, disposing and recovery), incentivize non-plastic substitutes and be ready for adoption by 2025 (UNEA, 2022). The commitment to combat plastic pollution is evident in the growing momentum of global environmental multilateralism and collaboration on this issue is crucial. The current negotiations offer hope for a landmark treaty to effectively address the challenges posed by plastic pollution, with concrete commitments such as control measures.

An illustrative list of border and internal market measures could make for a dramatic change in how plastics are deployed and traded (see Table 1 below). Such control measures could guide economies toward alternatives that are less harmful than single-use plastics while simultaneously promoting the adoption of sustainable material substitutes and alternatives (UNCTAD, 2023b).

Table 1. **Trade and border control/mitigation measures across each stage of the plastics value chain**

Control measures applicable to plastics are being discussed as one of the main tools for a legally binding instrument on plastic pollution, including in the marine environment. This table summarizes several options, covering both trade / border measures and internal market measures, which can be adopted by countries. Control measures can help steer economies away from harmful, problematic, single-use plastics and at the same time help to promote more sustainable material substitutes and alternatives.

| Trade and Border measures | RAW MATERIALS<br>Hydrocarbons | UPSTREAM<br>Polymer pellets | MIDSTREAM<br>Products and parts | DOWNSTREAM<br>Plastic wasted residues | RECOVERY<br>From land and water bodies |
|---|---|---|---|---|---|
| **Tariffs**<br>• Preferential or higher tariffs on certain goods. | × | × | × | × | |
| **Import ban (quantitative restriction/QR)**<br>• Import ban on imports of SUPs causing persistant pollution. | | | × | × | |

Table 1 cont. Trade and border control/mitigation measures across each stage of the plastics value chain

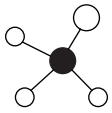
| Trade and Border measures | RAW MATERIALS  Hydrocarbons | UPSTREAM  Polymer pellets | MIDSTREAM  Products and parts | DOWNSTREAM  Plastic wasted residues | RECOVERY  From land and water bodies |
|---|---|---|---|---|---|
| **Import quota (QR)**<br>• Limitations on imports of single-use plastics. | × | × | × | × | |
| **Import licensing procedures**<br>• Import licenses for recyclable plastic waste;<br>• Import licenses for plastic bag components to avoid circumventing. | | × | × | × | |
| **Export ban**<br>• Export ban of polymers, products or scrap material to destinations with limited capacity to process end-of-life materials. | | × | × | × | |
| **Export quotas**<br>• Limits on specific polymer or scrap material exports. | | × | | × | |
| **Export licenses**<br>• Adherence to Basel plastic waste ammendments / Prior Informed Consent procedure. | | | | × | |
| **Export taxes**<br>• Preferential or higher tariffs on certain goods. | | | | × | |
| **Trade defense tools**<br>• AD/CVD applied to plastics;<br>• Peace clause so not to apply Antidumping and countervailing duties (AD/CVD) on material substitutes. | × | × | × | × | |

Table 2. Internal market control/mitigation measures across each stage of the plastics value chain

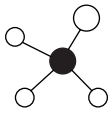
| Internal market measures | RAW MATERIALS  Hydrocarbons | UPSTREAM  Polymer pellets | MIDSTREAM  Products and parts | DOWNSTREAM  Plastic waste and residues | RECOVERY  From land and water bodies |
|---|---|---|---|---|---|
| **Monetary and economic instruments**<br>• Environmental or chemical taxes applicable to plastics;<br>• Packaging and recycling fees;<br>• Preferential tax treatment to alternatives/substitutes. | × | × | × | × | × |

Table 2 cont. Internal market control/mitigation measures across each stage of the plastics value chain

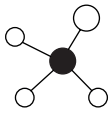
| Internal market measures | RAW MATERIALS<br>  <br>Hydrocarbons | UPSTREAM<br>  <br>Polymer pellets | MIDSTREAM<br>  <br>Products and parts | DOWNSTREAM<br>  <br>Plastic waste and residues | RECOVERY<br>  <br>From land and water bodies |
|---|---|---|---|---|---|
| **Public procurement**<br>*–not including public hydrocarbon enterprises–*<br>• Government procurement favouring goods with recycled content;<br>• Procurement of plastic depollution services. | | | × | | × |
| **Subsidies to services**<br>• Direct grants to R&D;<br>• Subsidies for recycling or decontamination services imports. | × | × | | | |
| **Reduction of subsidies to goods**<br>• Removal of subsidies to fossil fuels;<br>• Remove subsidies from polymer pellets. | × | × | | | |
| **Operation licenses**<br>• Authorize operation for polymer production or recycling/recovery services of sufficient quality. | × | × | × | × | × |
| **Labelling (technical barrier to trade/TBT)**<br>• Labelling requirements clearly indicating polymer and recycled content;<br>• Proper labelling requirements of recycled plastic scrap trimmings or pellets. | | × | × | × | |
| **Investment regulations**<br>• Authorize operation for polymer production or recycling/recovery services of sufficient quality. | × | × | | × | × |
| **Services liberalization & regulation**<br>• Plastics decontamination services liberalization;<br>• National plastic waste management frameworks. | | | | | × |
| **Extended producer responsibility (EPR)**<br>• Deposit schemes;<br>• Take-back programmes. | | | | × | |
| **Design and Quality standards (TBT)**<br>• Exclusion of any hazardous chemicals;<br>• Minimum thickness, reusability, mono-material requirements;<br>• Durability. | × | × | × | × | |

Table 2 cont. Internal market control/mitigation measures across each stage of the plastics value chain

| Internal market measures | RAW MATERIALS<br>  <br>Hydrocarbons | UPSTREAM<br>  <br>Polymer pellets | MIDSTREAM<br>  <br>Products and parts | DOWNSTREAM<br>  <br>Plastic waste and residues | RECOVERY<br>  <br>From land and water bodies |
|---|---|---|---|---|---|
| **Internal production and commercialization bans of plastic products** | | | × | × | |
| **Certification and conformity assessment (Sanitary and phytosanitary/SPS) (TBT)** | | × | × | | |
| **Recycling targets (ADM)** | | | | × | × |
| **Measuring, monitoring and mapping of plastic litter (ADM)** | | | | × | × |

↑ *Source: UNCTAD (2023)*

Not only would these measures have a substantial impact on reducing plastic trading and thus pollution but would also impact project operations of many market operators (recyclers, upcyclers, material substitute and alternative developers) whose operations reduce plastic pollution in the environment. For this report, the survey was sent to all 10 projects initially supported under the SMEP plastic portfolio and received responses from nine of them, even though only eight are currently being financed by SMEP as of 2024. Table 3 on the next page shows how projects' leaderships perceive actual as well as potential new control measures impact if introduced.

The projects' perception is that currently **not many measures are either in place or enforced to have a substantial impact**. This is especially relevant for the two projects solely focused on developing alternative material to plastics (namely Catchgreen and CSIR). **Border measures to address plastic pollution are almost non-existent**, while internal market measures have more effect in some countries (e.g., Ghana and Kenya). However, when projects were asked about the potential impact of these same control measures if approved and enforced, the picture is quite different. All projects would be affected and mostly in a positive way. The impact of border-related control measures is mainly related to supply and demand dependency. For example, if there is an export ban on plastics, more feedstocks would be available for domestic (re)use where tariffs on plastics would be seen positively by projects developing alternatives to plastics. Understandably, a complete future ban on internal production and commercialization of plastics would have a direct negative impact on the recycling/upcycling business models. However, **all projects would welcome a more robust policy on: i) measuring, monitoring and mapping of plastic litter, ii) design and quality standards, iii) services regulation, iv) subsidies and v) public procurement that would benefit either alternatives to plastics, or recycled material content.**

Table 3. Perceived regulatory measures' impact – today and potentially in the future – on SMEP programme plastic portfolio projects

| Trade and Border measures | | Ghana Clean-up | Uni. Cambridge | FreshPPact | Catchgreen | CSIR | UoW GIVO | FlipFlopi | Chinhoyi Uni. |
|---|---|---|---|---|---|---|---|---|---|
| Import ban and prohibition | PRE | | | | | | | | |
| | FUT | | | | | | | | |
| Import quotas | PRE | | | | | | | | |
| | FUT | | | | | | | | |
| Import licenses | PRE | | | | | | | | |
| | FUT | | | | | | | | |
| Export bans | PRE | | | | | | | | |
| | FUT | | | | | | | | |
| Export quotas | PRE | | | | | | | | |
| | FUT | | | | | | | | |
| Export licenses | PRE | | | | | | | | |
| | FUT | | | | | | | | |
| Export taxes | PRE | | | | | | | | |
| | FUT | | | | | | | | |
| **Internal market measures** | | **Ghana Clean-up** | **Uni. Cambridge** | **FreshPPact** | **Catchgreen** | **CSIR** | **UoW GIVO** | **FlipFlopi** | **Chinhoyi Uni.** |
| Monetary and economic instruments | PRE | | | | | | | | |
| | FUT | | | | | | | | |
| Public procurement | PRE | | | | | | | | |
| | FUT | | | | | | | | |
| Subsidies to services | PRE | | | | | | | | |
| | FUT | | | | | | | | |
| Reduction of subsidies to goods | PRE | | | | | | | | |
| | FUT | | | | | | | | |
| Operation licenses | PRE | | | | | | | | |
| | FUT | | | | | | | | |
| Labelling (TBT) | PRE | | | | | | | | |
| | FUT | | | | | | | | |

↑ *Source*
*Survey with project developers and focal points of SMEP Plastics portfolio*

*Notes*
*Light pink stands for negative, light green for positive and grey signifies no impact*

PRE *at present (2024)*
FUT *in case control measures are adopted in the future*

Table 3 cont. Perceived regulatory measures' impact – today and potentially in the future – on SMEP programme plastic portfolio projects

| Internal market measures | | Ghana Clean-up | Uni. Cambridge | FreshPPact | Catchgreen | CSIR | UoW GIVO | FlipFlopi | Chinhoyi Uni. |
|---|---|---|---|---|---|---|---|---|---|
| Investment regulations | PRE | | | | | | | | |
| | FUT | | | | | | | | |
| Services liberalization and regulation | PRE | | | | | | | | |
| | FUT | | | | | | | | |
| Extended producer responsibility (EPR) | PRE | | | | | | | | |
| | FUT | | | | | | | | |
| Design and quality standards | PRE | | | | | | | | |
| | FUT | | | | | | | | |
| Plastic production and sales bans | PRE | | | | | | | | |
| | FUT | | | | | | | | |
| Certification and conformity assessment | PRE | | | | | | | | |
| | FUT | | | | | | | | |
| Recycling targets | PRE | | | | | | | | |
| | FUT | | | | | | | | |

↑ *Source*
*Survey with project developers and focal points of SMEP Plastics portfolio*

*Note*
*Light pink stands for negative, light green for positive and grey signifies no impact*

PRE *at present (2024)*
FUT *in case control measures are adopted in the future*

## 2.2 Surveyed projects' growth potential

SMEP plastic portfolio projects are essentially showcasing how various business models can be organized to emphasize long-term social, environmental and financial sustainability. The plastic portfolio offers practical insights into how sustainable business ecosystems operate, what drives their operations and what elements inhibit their growth. Projects are innovative in their consideration of environmental, social and economic factors. In this context, SMEP plastic portfolio shows different approaches to creating value from waste or for the development of biodegradable, compostable materials. More importantly, however, it stresses that **all projects are creating positive or reducing negative impacts on the environment and on society by improving livelihoods. It means changing the way businesses and their stakeholders define value proposition, how they generate, deliver and capture value**. These could include maximizing efficiency, utilizing waste, adopting renewables, focusing on functionality over ownership, embracing stewardship, promoting self-sufficiency, serving societal/environmental needs, preserving cultural heritage (e.g.,, Flipflopi project) and scaling up solutions (Dijkstra et al., 2020). **Considering that adapting a business model to changing conditions usually takes between three to five years, which proves difficult for new projects to progress from prototyping to establishing a minimum viable product and securing financial sustainability (IDB, 2023), the plastic portfolio projects are in the early stages and might need additional support and time to succeed.**

In understanding factors influencing business ecosystems used by projects under the SMEP plastic portfolio, projects were surveyed and analyzed for how certain policies, market dynamics and business operations drive or hinder the projects' growth. On a scale from zero to five, where zero had no effect at all, project teams rated the extent of influence as a factor affecting their businesses. Findings were interpreted either as drivers or barriers (Dijkstra et al., 2020). There are some similarities between the two main groups of projects (e.g., end-of-life and material substitution). For example, **all projects indicated that their value proposition and projects' leaderships were highly motivated, and the majority are convinced that they are creating a highly sustainable product**, potentially benefiting from higher price margins for green products. Some of the most common challenges reported are access to finance, availability of R&D funding and resource scarcity. **Projects working with material substitution indicated that costs of material inputs are very high, which could drive end-product prices higher and thus impact business negatively**. Furthermore, **deployment of plastic substitutes also demands establishing a whole new supply chain, rather than just tapping into already existing ones. Inevitably this means investing in new partnerships, logistics and meeting regulatory requirements**. On the other hand, projects working with plastic waste struggle with often inadequate national policies on plastic and lack of enforcement, particularly on **waste segregation, which directly impacts the quality of feedstock used in project operations**. Nevertheless, these products are rewarded on the market due to the growing global demand for recycled and sustainable products.

Table 4. Top drivers for SMEP programme plastic portfolio projects' operations addressing plastic pollution

| Material shift | End-of-life solutions |
|---|---|
| Sustainable product | Motivated leadership |
| Motivated leadership | Sustainable product (durability) |
| First mover advantage | First mover advantage |
| Customer demand for plastic substitutes and alternatives | Customer demand for plastic substitutes and alternatives |
| Customer and client acceptance of the product | Niche market |

*Source → Survey with project developers and focal points of SMEP Plastics portfolio*

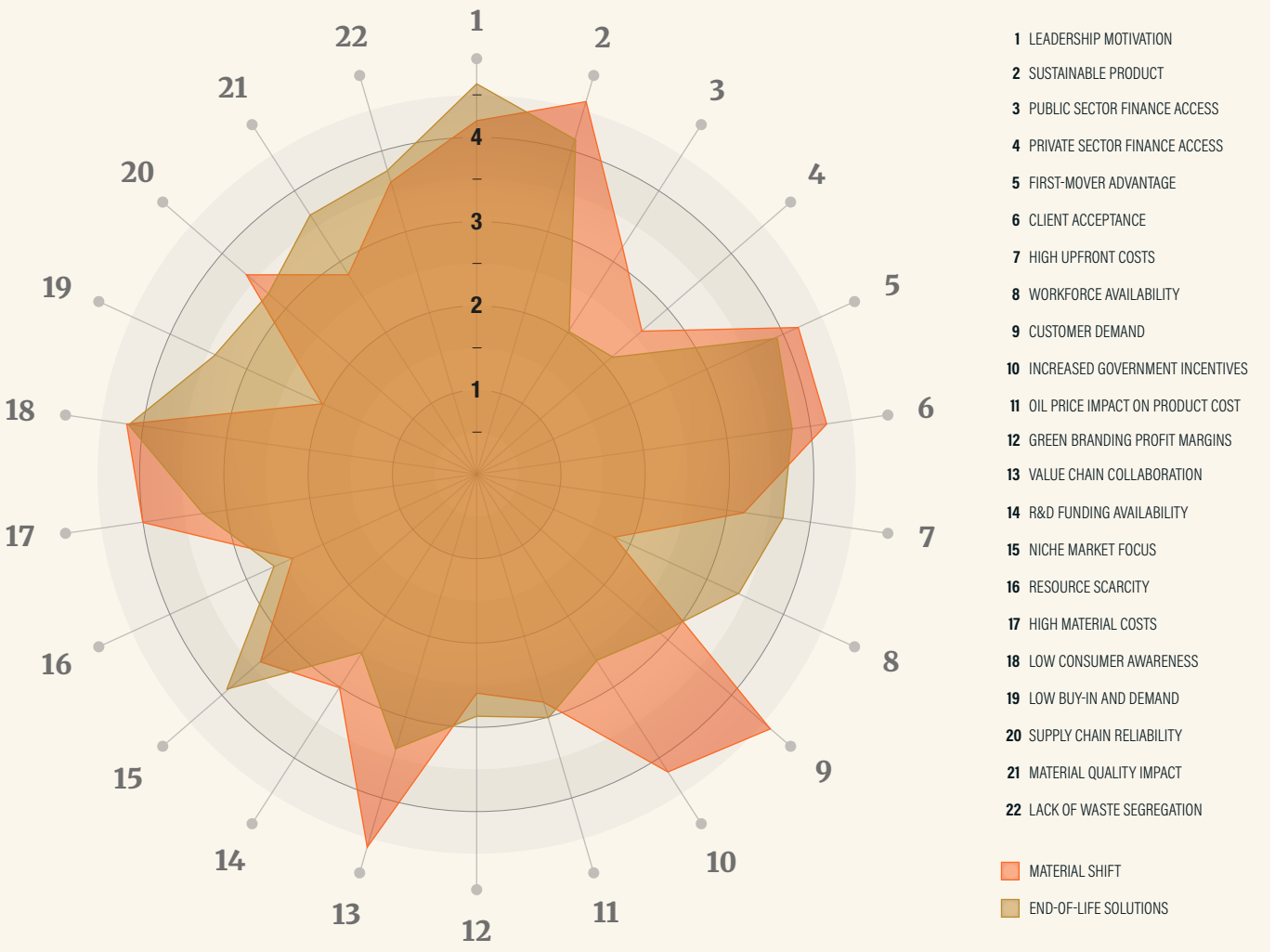
Table 5. Top barriers for SMEP programme plastic portfolio projects' operations addressing plastic pollution

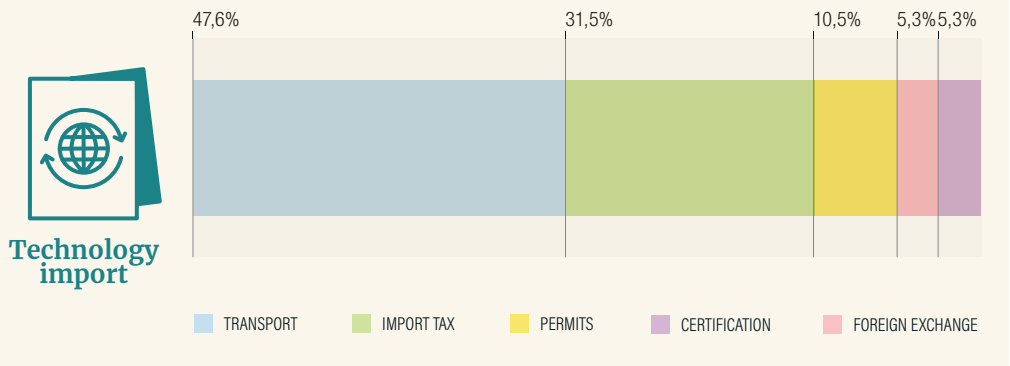
| Material shift | End-of-life solutions |
|---|---|
| Low consumer awareness | Product is negatively affected by material quality differences |
| High costs of material inputs | Lack of waste segregation by waste generators |
| High upfront capital needs | Resource scarcity |
| Access to private sector financing | Limited qualified workforce |
| Product is negatively affected by material quality differences compared to virgin / fossil-based plastics | High upfront capital needs |

*Source → Survey with project developers and focal points of SMEP Plastics portfolio*

For this report, referencing to technology encompasses either machines projects purchased and (often) imported to set up their production processes or could also refer to new material, an innovation that prevents plastics and enables a material shift, such as in the case of biodegradable fishing gear. Findings show that **whenever technology was imported, transport was listed as the most challenging factor, followed by import tax and then documentation related to permits**. These results indicate that there might be a positive correlation between the business enabling environment and the growth of sustainable businesses; if ease of conducting a business should be increased (e.g., simplified procedures for import, permits, etc.) **there might be broader private sector benefits, and regulatory framework and public services could specifically target, even prioritize, sustainable businesses with environmental objectives (e.g., reducing import taxes, introducing subsidies)**.

↓ Figure 2. Barriers and drivers that influence SMEP programme plastic portfolio projects' goals and business sustainability




← Figure 3. Most mentioned challenges in technology imports for SMEP plastic projects (e.g., machines, inputs, capital, all related to production process)

↑ *Source*
*Survey with project developers and focal points of SMEP Plastics portfolio*

## 2.3 Scalability of surveyed projects

The support from the Government of the United Kingdom for research and development (R&D) and innovation forges connections between businesses and academia to leverage scientific advancements for industrial purposes and over time, this support might include assistance for university spin outs and small business start-ups (UKRI, 2016). For traditional private sector companies, The Scale-up Report on UK Economic Growth outlines common challenges faced by scaling companies and while finance is often seen as a primary challenge, the report highlights a broader spectrum of obstacles hindering the scale up process including difficulties in recruiting skilled personnel, leadership, accessing new markets, policies and regulations, access to capital and finance and adequate facilities. However, within the development community, interest in scaling up was encouraged by technological advancements and global initiatives such as the Millennium Development Goals (MDGs) and the Sustainable Development Goals (SDGs) (IDB, 2023).

↓ Box 1. Terminology of scale and scalability in international development

**SCALE**

A systematic process leading to sustainable impact affecting a large and increasing proportion of the relevant need.

Scale is a relative concept: it needs to be defined in relation to the magnitude of the problem being addressed.

**SCALABILITY**

Potential of an intervention or project refers to its ability to grow and expand effectively without significantly increasing unit costs.

It also refers to the possibility for revenue growth to increase exponentially rather than just incrementally, through effective scaling.

Thus, three approaches could be identified when discussing scaling up a project and projects might choose one or more approaches, depending on the needs and capacity of the project (IDB, 2023):

1. Expansion, which involves increasing the organizational size, operational or geographical scope. It requires significant time, effort and resources but provides control over product, quality, and branding (e.g., vast majority of projects, including the Ghana Clean-up, FlipFlopi, Gaia BioMaterials AB, etc.).
2. Replication occurs when an organization transfers an innovation, procedure or model from a different organization, needing guidelines, capacity-building and skills training and uniform procedures (e.g., Plastic-to-Ghar, GIVO-Warwick and CSIR).
3. Collaboration happens when organizations or stakeholders join forces in achieving their objectives. Success depends on the alignment around shared priorities and best practices (e.g., many surveyed projects indicated collaboration as a way of achieving scalability, which might be the result of their ongoing environmental efforts where leadership prioritizes plastic pollution leveraging the strengths and resources of multiple partners before their individual profit or brand name such as BlueSkies and their subprojects).

According to the survey results, Table 6 on the next page shows all plastic portfolio projects indicate potential for scalability, although by using different approaches and considering different factors impacting the process.

Table 6. Type of scalability and factors impacting the SMEP programme plastic portfolio projects' scale

| Material shift | | CSIR | Gaia Biomaterials | BlueSkies Biodegradable mulch | BlueSkies Bioplastic packaging | BlueSkies Plastic mulch lifiting solution |
|---|---|---|---|---|---|---|
| Approach to scalability | Expansion | × | × | × | × | × |
| | Replication | × | | | | × |
| | Collaboration | × | × | × | × | × |
| Limiting factors | Feedstock availability | | | | | |
| | Market demand | × | × | | × | × |
| | Marketing | | | | | |
| | Technology | | | | × | |
| | Capacity | | | | | × |
| Scalability challenges | Location | × | × | × | | |
| | Understanding local needs | × | × | × | | × |
| | Technology | × | × | | × | |
| | Policy and regulation | × | × | | | × |

| End-of-life solutions | | Plastic-to-Ghar | Ghana Clean-up | FlipFlopi | GIVO / Warwick | Chinhoyi University |
|---|---|---|---|---|---|---|
| Approach to scalability | Expansion | | × | × | | × |
| | Replication | × | × | × | × | |
| | Collaboration | × | × | × | × | |
| Limiting factors | Feedstock availability | × | | | | |
| | Market demand | × | × | | × | |
| | Marketing | | × | | × | × |
| | Technology | | | | | × |
| | Capacity | | × | × | × | |
| Scalability challenges | Location | × | × | × | | × |
| | Understanding local needs | × | | | | × |
| | Technology | × | | × | × | × |
| | Policy and regulation | | | × | × | × |

↑ *Source*
*Survey with project developers and focal points of SMEP Plastics portfolio*

# 3.
# Projects deep dive


**MATERIAL SHIFT**

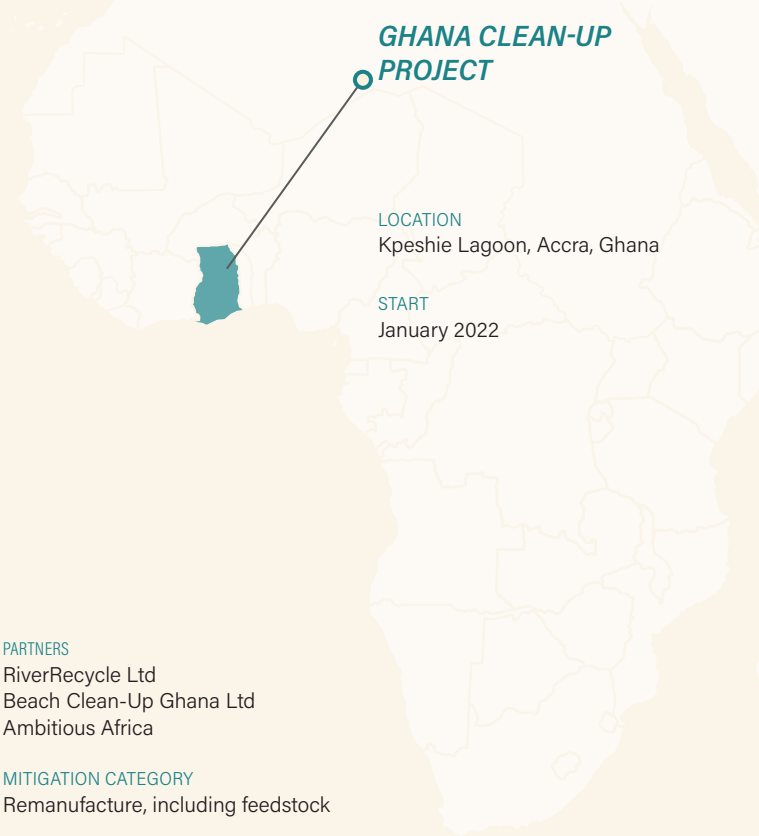
1 Ghana Clean-up
2 Catchgreen
4 CSIR
7 FreshPpact

**END-OF-LIFE SOLUTIONS**

3 Chinhoyi University
5 Flipflopi
6 GIVO-Warwick
8 Plastic-to-Ghar

↑ **Figure 4.** World map highlighting SMEP Plastic Portfolio projects in Sub-Saharan Africa and South Asia by country

*Source*
*Survey with project developers and focal points of SMEP Plastics portfolio*




LOCATION
Kpeshie Lagoon, Accra, Ghana

START
January 2022

PARTNERS
RiverRecycle Ltd
Beach Clean-Up Ghana Ltd
Ambitious Africa

MITIGATION CATEGORY
Remanufacture, including feedstock

## 3.1 Ghana Clean-up Project

↑ Image 4. RiverRecycle's river cleaning technology

© RiverRecycle Oy

**The project's lead organization, RiverRecycle, aims to address oceanic plastic pollution by establishing river cleaning and plastic recycling points along the banks of the world's most polluted rivers and intercept plastic waste before it reaches the ocean**. Hence, the Ghana Clean-up project focuses on plastic waste collection and recycling while at the same time significantly reducing the flow of plastic into the ocean in Ghana. Captured plastic material is then turned into valuable products for business viability. The project not only aims to clean rivers and prevent ocean pollution but also focuses on community engagement, incentivizing recycling and leveraging innovative technology to improve the economics of plastic waste reprocessing operations.

Municipalities in Accra are facing pollution issues, specifically plastic pollution caused by insufficient waste management system. Beach Clean-up Ghana Ltd. was established with the permission and assistance of the Ministry of Sanitation and Water Resources of Ghana to clean their beaches of mainly plastic waste by using traditional and mechanical raking methods. At the same time, there was no mainstream solution available in Ghana to remove and treat plastic waste present in rivers, hence RiverRecycle and Beach Clean-up set up the Ghana Clean-up project, choosing Kpeshie Lagoon located in the La Dade Kotopon Municipal District with the support from authorities.

▶ Material shift project

The local community in Kpeshie Lagoon, Accra has experienced challenges with plastic pollution. In the past, environmental clean-up efforts addressed the issue but lacked a follow-up plan, leading to the waste being disposed of in landfills without further processing, such as at a factory or designated collection site. Additionally, some organizations attempted to tackle the problem but struggled to achieve financial sustainability, making it difficult to continue their clean-up activities. However, Ghana Clean-up has successfully transformed plastic waste management in the area. They have established a business model centered around plastic collection, ensuring the ongoing

removal of plastics from the environment. Moreover, the project has played a vital role in raising awareness about plastic pollution, its detrimental effects on the environment and public health. Importantly, it has engaged the entire community in these efforts. While the most vulnerable members of the community are primarily motivated by earning income through collecting and delivering plastic waste, their actions contribute significantly to the elimination of plastic waste hazards in the area.

The project became operational in early 2022. It aims to capture plastic waste in the water bodies, especially in river-ocean outflows but also captures litter in the inverse route when the ocean's tides are high and bring in plastic litter in the opposite direction. Captured materials are fed into recycling process to turn them into valuable materials. The project is collecting polyethylene terephthalate (PET) bottles and low-density polyethylene (LDPE) material (especially bags) floating as aquatic litter in Accra from other (land) sources, including from beaches. Collected plastic material is flaked, bagged and/or compressed into bales, primarily for foreign markets. The project is also testing the production of plastic boards, which can be used to replace plywood in the construction and furniture industries.

### 3.1.1 Business ecosystem

One of the key aspects of their business model is the establishment of new incentives for the collection and segregation of flexible packaging. By doing so, they not only increase the overall rate of plastic collection for recycling but also generate new income streams for waste workers and local communities. The project recognizes that one of the most pressing challenges in plastic waste management is the disposal of low-value flexible plastic packaging. According to a project team member's experience, these materials often end up in landfills, open dumpsites or the natural environment due to lack of recycling solutions. RiverRecycle seeks to reverse this trend by creating recycling solutions specifically for low-value plastics such as hot-pressed plastic boards from LDPE material.

The implementation of the project has been phased-in, beginning with the installation of the river cleaning systems to prevent plastic from flowing into the ocean. This service did not receive subsidies from local communities and municipalities, signaling a great potential for future

↓ Image 5. Booms installed in Kpeshie Lagoon, Accra

policy measures to encourage other similar projects. Once demand for low-value plastics is established, they move on to establishing land-based waste collection systems. This community engagement further contributes to the segregation of plastics, important for material intake into their operations and for lowering leakage into the environment. Finally, the project implements recycling technology capable of increasing the value of flexible plastic packaging and other plastics that are not traditionally recycled. This technology plays a vital role in creating a circular economy that avoids the practices that lead to plastic entering rivers and ultimately, the ocean.

Three main sources of feedstock keep the Ghana Clean-up project running: i) waterways, ii) land collection by community and waste pickers and iii) from industry waste. The most innovative approach is the instalment of booms on the lagoon to capture plastics coming down the river. However, due to dry/rainy season fluctuations, the volume of plastics captured is unpredictable and insufficient for the production needs, thus the project's main source of feedstock is land plastic waste. Community outreach with Ambitious Africa provides for a more stable land-based collection stream, which seems, for now, the most suitable source of generating feedstock and collecting plastics for recycling facilities. The project invests substantially in teaching coastal communities about the importance of plastic waste separation from the rest of the municipal solid waste, explaining the impacts of dumping waste into the environment, and showcasing the project's product samples (particularly in schools) as to what value plastic brings if collected/ recovered from the environment. Recycling technology spurs industrial symbiosis by receiving feedstock from other sources of waste such as tourism and farms (e.g., mechanically recaptured mulch used at farms).

Most of the plastic waste collected is clear blue or transparent PET bottles as those have the most material value locally so the aggregators and pickers tend to prioritize these. Such bottles are often baled, and the rest of the plastics received, especially LDPE, are used for making boards. The project operations in Accra require transportation from plastics collection points (where material is dirty) to the processing site. Plastic material then goes through a mechanical recycling process. They use machinery (mostly imported from Viet Nam) such as a baler (used for compacting PET bottles), washing line (for low- value plastics to be cleaned), water system (cleans the dirty water before it is discharged), hot press (heats up the low-value plastics), cold press (cools down the processed plastics into a board) and cutting table to shape the final product (plastic boards). Both hot and cold press machines were purchased from a local board manufacturing company in Ghana. The Ghana Clean-up team is setting up an operation procedure to better implement the monitoring plan on the feedstock quantities, qualities and sourcing.

Facts

**FROM PLASTIC WASTE TO PRODUCT**

▶ Ghana Clean-up Project captures plastic waste from the environment and repurposes it into valuable products.

The project's primary focus has shifted due to challenges in the declining market for plastic two distinct product lines:  compressed bales, made from PET plastic and plastic boards, made from PET plastic and plastic boards. These plastic boards are created using low-value plastics and have found applications in construction, schools, furniture and more. Some boards were donated to schools. They are gaining recognition for their durability, surpassing traditional materials such as plywood, and for their environmental significance as they repurpose plastics collected from the environment into valuable products. The project is collaborating with local carpenters to incorporate these recycled plastic boards into furniture such as chairs, tables and wardrobes. This represents a significant departure from the conventional materials typically used by carpenters, thus requiring value chain innovation.

↑ **Image 6.** Plastic boards produced from plastic collected from the Kpeshie Lagoon

© RiverRecycle Oy

In encouraging clients to experiment and familiarize themselves with this novel material, the project has adopted an innovative approach. They offer plastic boards through a lease agreement, with payment only due when the furniture incorporating these boards are sold. This approach has a dual purpose. First, it alleviates the financial burden of pre-financing or credit on small businesses, such as carpenters, allowing them to experiment with the new material without upfront financial constraints. This not only supports local artisans but also fosters trust along the value chain, making it more likely for these carpenters to become long-term partners or clients of the project. Second, it introduces an element of risk-sharing between the project and the carpenters, aligning incentives for successful product development and sale. In essence, this

innovative approach promotes sustainability and environmental responsibility through the use of recycled plastics and supports the growth and resilience of local businesses. Recognizing the importance of expanding the impact of the Ghana Clean-up project, RiverRecycle has developed an internal toolkit for standard operating procedures to support scalability of the business model. These tools encapsulate the lessons learned from all RiverRecycle's implementing projects (such as in the Philippines, India, Indonesia, Bangladesh and Ghana) and facilitate the replication of their operation model in other countries. Location seems to be the key factor in determining the scalability, which is especially helpful when planning to replicate the model and implement similar designs in other locations in Accra, Ghana, or other sites of RiverRecycle. Their boom system designs have also been improved over time with every challenge encountered (heavy rain, debris damage, and dry season).

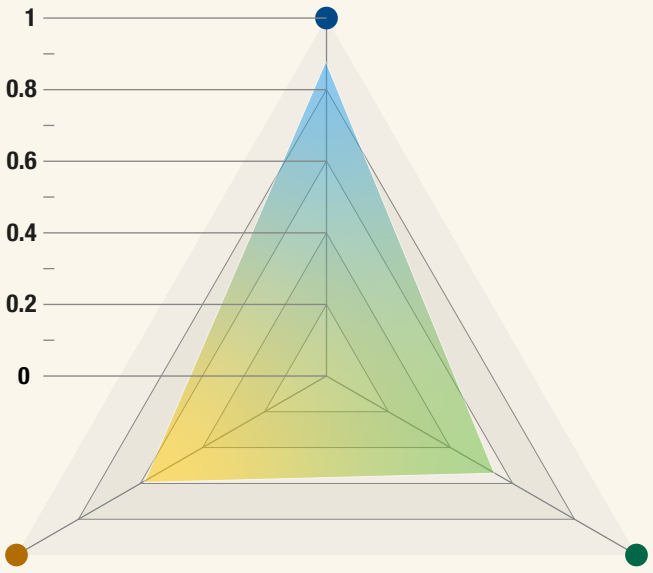
### 3.1.2 Evidence of sustainability and impact

The project aims to stimulate economic empowerment within the communities by collaborating with local carpenters, introducing new product opportunities and offering pre-financing, thereby strengthening the local economy. Moreover, the project took actions to increase awareness about the economic value of plastics among community members, which resulted in individuals starting their own buy-back businesses, further contributing to local economic growth. Additionally, the Ghana Clean-up project has forged partnerships with the local community to produce branded boards suitable for various purposes, including beach bars and schools.

The Ghana Clean-up project has actively engaged with women within their communities, with half of their workforce being female. Training programs have ensured that all employees, including women, have become proficient in operating the equipment safely and effectively. Furthermore, the project team has been proactive in collaborating with women's associations, fostering awareness about plastic recycling and collection and encouraging women to organize themselves as aggregators, thereby promoting gender inclusivity and empowerment. These collaborations not only generate economic opportunities but also promote a sense of shared responsibility.

↓ Figure 5. Ghana Clean-up project's estimated social impact, financial sustainability, and technology readiness

*Source*
*Survey with project developers and focal points of SMEP Plastics portfolio*




**Social Impact**

- Capacity building and skills trainings provided for women
- Capacity building and skills developed for socially disadvantaged groups
- Capacity building and skills trainings provided for community
- Positive impact to livelihood of immediate community
- Positive impact outside the value chain and immediate community
- Positive impact on improved living conditions
- Positive impact on gender inclusion
- Positive impact on social inclusioN
- Full-time jobs created

**Business Sustainability**

- Long-term sustainability of revenues
- Manageability of costs
- How many sources of revenue can the project generate
- Current profitability
- Revenues matching initial plans

**Technology & Innovation**

- Capacity building for using the technology needed
- Ease of maintenance
- Ease of importing technology
- Ease of usage of this technology for the project
- Ease of technology transfer
- Technology transfer needs
- Technology developed nationally or imported

↑ Image 7. Plastic boards produced from plastic collected from the Kpeshie Lagoon

© RiverRecycle Oy

Based on the data gathered, the Ghana Clean-up project has created up to 20 long-term jobs, conducted training activities specialized for women and disadvantaged groups, and the community at large. Furthermore, livelihoods seem to be improved for an immediate local community and along the project's value chain. Since the project started 146.2 tons of plastic waste have been recovered from the environment. The project's planned processing capacity is 660 tons/year with 1 ton/day for the plastic board production line and 1 ton/day for PET bales.

The key factor to replicate the project is location as installing booms requires certain characteristics of a water basin to collect plastic waste. Other factors that might affect the project's ability to scale are production capacity, qualified workforce, market demand and marketing knowledge.

The project has invested a substantial amount of funds to set up booms on the lake to capture plastics floating in the water and this was only made possible with the grant support under the SMEP programme. Local fabricators were used, which stimulated local innovation capacities. Upfront costs are high due to the specific design of the booms for the location and purchasing and maintenance of all machinery needed to start the production of plastic boards. One of their challenges is in the sorting process as plastic waste comes in batches, thus needs to be sorted and ready for processing. With the low cost of feedstock (recovered from the environment) combined with higher profit margins for products classified as "green or recycled", the project can offset some of the challenges confronted early on. With training completed on waste separation for local aggregators and the local community, the project plans to prioritize production and client relationships.

## Collaboration with policymakers and shapers

The Ghana Clean-up project is actively engaging with the World Economic Forum's Ghana National Plastics Alliance Partnership (NPAP) to provide policy recommendations. They are also collaborating with the national government and the Intergovernmental Negotiating Committee (INC) focal point to emphasize the importance of transparency in gathering and providing data related to plastics in Ghana to the public.

## Enabling environment for companies tackling plastic pollution

### Permits

The project needed to acquire a permit from the Ghana Maritime Authority to install a trash boom system for stopping and capturing the floating debris at the Kpeshie Lagoon in Accra, Ghana. They have also received letters of support from the municipalities and approval from the community leaders for local project implementation

### Electricity

There is a limited availability of high-amperage electrical installations on-site. The amount of energy the hot press machine consumes may exceed the capacity of on-site connections on-site. The project is actively trying to resolve the issue with the electric company for more potent transformers and cabling to be installed, a process which takes time. Two solutions are under consideration: a) obtaining a new meter, which requires the electric company to come in, prepare and install it, but the local power utility company has been difficult to reach or, b) renting a generator to expedite the making of board samples, which would enable them to start the approval process with the Ghana Standards Authority (GSA). There is also an opportunity to install a solar power system on-site to reduce reliance on grid power and reduce emissions.

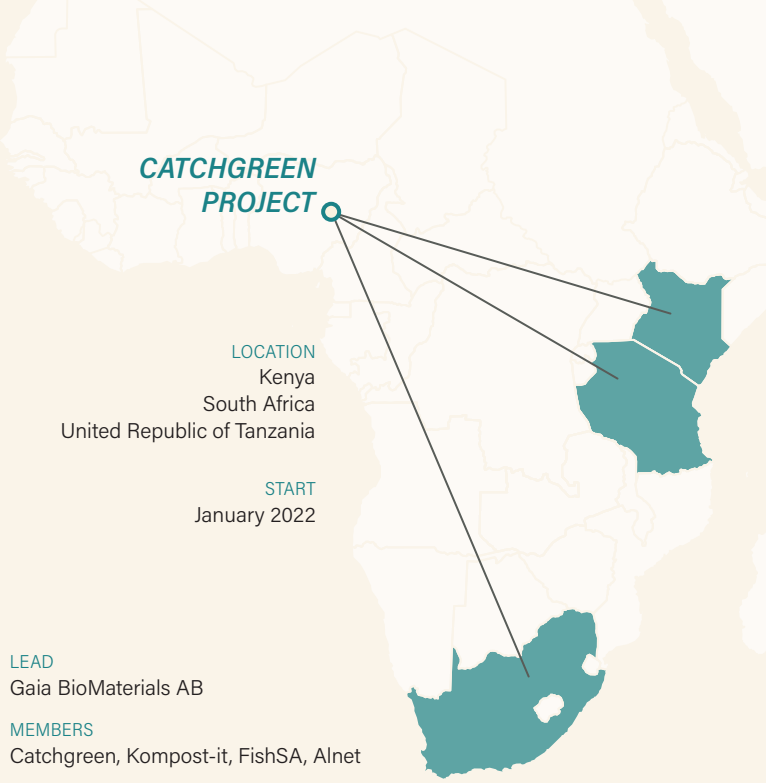
### Registration

Products (boards) need to be registered with the GSA. For this, the project needs to produce samples and have them tested with the GSA for strength and other characteristics. Lacking electricity, the project has not been able to produce these samples so the GSA process to get the product approved for the market is delayed.

### Data

To design the equipment (e.g. the floating solution installed to capture the plastic waste in the water bodies), data such as as the river's depth was needed. Public authorities did not have any such data collected or available thus the team needed to gather those by themselves. It took time and effort as well as costs to get the information needed. Due to the lack of detailed environmental information about the river, heavy rain often damages the equipment and takes time, effort and costs to repair. This results in missed business opportunity where the team cannot receive the feedstock or advance the core work of processing plastics, but instead they need to dedicate time and spend funds on repairs. Leveraging from lessons learned from the Bangladesh operation with similar equipment and challenges, the team is confident they will be able to adjust the equipment to withstand the pressure of water that is coming down with debris.

↑ Box 2. Policy and regulatory measures: insights from Ghana Clean-up project implementation




LOCATION
Kenya
South Africa
United Republic of Tanzania

START
January 2022

LEAD
Gaia BioMaterials AB

MEMBERS
Catchgreen, Kompost-it, FishSA, Alnet

RESEARCH AND PILOTING PARTNERS
Green House, Kenya Marine and Fisheries Research Institute (KMFRI), Stiftelsen for industriell og teknisk forskning (SINTEF), and Irvin & Johnson

MITIGATION CATEGORY
Substitution, biomaterials / alternative plastics

## 3.2 Catchgreen Project

↑ Image 8. Woman separating entangled ALDFG from algae

© H. Pacini, UNCTAD

**The Catchgreen project aims to mitigate marine pollution caused by ALDFG.** The project focuses on responsible disposal practices, enhancing the overall sustainability of the fishing industry and supporting the longevity of livelihoods tied to the fisheries sector. Its value proposition is in the development of Biodolomer®Ocean, a biodegradable polymer based on polybutylene succinate (PBS) specially designed for fishing gear. Gaia BioMaterials AB has thus designed a new polymer for the project, aiming to replace conventional materials such as high-density polyethylene (HDPE) fishing nets for marine applications, including nets. HDPE has long been a preferred material in the manufacturing of fishing gear due to its properties – high strength, flexibility, resilience and toughness. Therefore, the new material developed by the project is to emulate these properties but to be completely metabolized into harmless biomass at its end-of-life. The new material is biodegradable in marine environments, with zero microplastics or toxins, and can be composted as a waste management solution. The Catchgreen project received funding from the SMEP programme for the development, testing and refining of the biodegradable material, which will be commercially available to support the fisheries sector in joint efforts to reduce future marine pollution.

The project will offer technical insights by conducting piloting to prove efficiency in various applications, laboratory biodegradability testing to demonstrate degradation in ocean water over time and a life cycle analysis (LCA) of the environmental impacts, measuring benefits of biodegradable fishing nets compared with conventional fishing nets. The findings will be used to drive applications in the industry (e.g., sustainable fishery certification programs) and inform government policies (e.g., standards, regulations, and potential financial incentives for biodegradable fishing nets).

▸ Material shift project

### 3.2.1 Business ecosystem

The project's business ecosystem involves the use of biodegradable polymer, marketed as Biodolomer®Ocean by Gaia BioMaterials AB, in fishing nets to eliminate the long-term impact of ghost fishing nets, reduce the accumulation of microplastics from the use of HDPE fishing gear and provide an end-of-life solution for old and discarded fishing gear. The project targets specific products for different markets, focusing on commercial and small-scale fishing contexts, with commercial model that aims to subsidize nets for poorer fishing communities with a blended financing. Gaia BioMaterials AB, a Swedish company, supplies materials to Catchgreen's project partner, Alnet, in South Africa. Gaia produces over 10,000 tons of Biodolomer annually, experiencing growth with a global customer base in 50 countries. Their main production line is primary plastics (pellets) containing bioplastics or bioplastic mixes (including minerals and vegetable fibers). Currently, the polymers are produced at their headquarters in Sweden with plans for expansion to other locations and using local resources. Gaia's innovation is in its machinery and manufacturing process.

The new polymer developed by Gaia is PBS-based and demonstrates significant potential as an aliphatic polymer capable of undergoing natural biodegradation through different processes, including microbial digestion in marine environments. The polymer's characteristics suit its intended application, which are thermal stability, flexibility, ductility and excellent processability over a broad temperature range. PBS was chosen as the binding agent and has undergone copolymerization with polybutylene adipate terephthalate (PBAT), a biodegradable polymer akin to fossil-based polyethylene (PE) known for its commendable flexibility and resilience. The inclusion of calcium carbonate has been implemented to enhance the material's rigidity.

The biodegradable material is designed to sink to the ocean floor, where microbial activity catalyzes a degradation process estimated to take approximately five years. By transitioning to biodegradable fishing nets, the project aims to eliminate the long-term impact of ghost fishing nets, potentially reducing 10 million tons of fishing nets in the ocean over a 10- to 15-year period. The Biodolomer®Ocean is expected to degrade into biomass, addressing concerns of marine life entanglement and ingestion.

↓ **Image 9.** Partial view of Gaia BioMaterials factory premises in Sweden (4,000–6,000 $m^2$ total area)


↑ Image 10. Biodegradable ropes for seaweed farming produced through SMEP project work

© E. Algotsson, Gaia BioMaterials AB / Catchgreen project

← Image 11. Fisherman with Biodegradable Net from Catchgreen Project

© E. Algotsson, Gaia BioMaterials AB / Catchgreen project

Gaia produced three tons of a specialized polymer for their project partner Alnet in South Africa, which has used the polymer to create threads and spin a prototype fishing net, initially focusing on smaller nets for trials rather than large trawler-sized ones. There is a market potential for conventional fishing nets, particularly in segments less prone to mechanical strain. Subsequently, the project also produced biodegradable ropes for seaweed farming.

Key targeted products include:

- Trawl nets (South Africa and international markets)
- Gillnets (Southern African small-scale fisheries markets)
- Ropes (for seaweed, kelp, mussel farms, Southern African and international markets)
- Lobster and crab pots (South Africa and international markets)

Laboratory testing of Biodolomer®Ocean is currently underway with SINTEF in Norway. Although these have only been running for 6 months, preliminary results seem promising and indicate early stages of degradation and small losses of tensile strength. Given the heterogeneity of oceanic temperatures across different locations, comprehensive pilots involve various countries (e.g., South Africa and Kenya). In the context of supplying ropes (e.g., seaweed farming), where sustained functionality over a certain period is crucial, the product will be subjected to testing in similar conditions within the intended operational timeframe. This evaluation aims to prove the product's degradability, suitability and efficacy, which is important not only for the time intended but also for the costs related to material replacement. The project also aims to undertake experimental at-sea deployment of the nets (outside of the SMEP funding) to test the behavior and long-term biodegradability of the nets in real-life conditions.

Additional refinement of the material is scheduled prior to expanding production scales, with a primary focus on enhancing the material's toughness, stress resistance, flaw sensitivity and elevating its melt viscosity. The material being tested for strength and suitability in different applications (e.g., future products offered on the market), including trawl nets, gillnets, ropes and lobster pots. The upcoming manufacturing trials are scheduled for March 2024 at Alnet in South Africa.

Biodegradable ropes are expected to be available on the market in a couple of years. While the product is not yet officially on the market, there seems to be increased demand due to increased awareness of marine pollution. The project is actively engaging different stakeholders, potential investors and clients as there is a growing demand for biodegradable fishing gear, especially for seaweed and kelp farmers.

The project's business includes three sales approaches for Biodolomer®Ocean: i) direct sales under the Catchgreen brand, ii) exclusive sales to a large fishnet manufacturer and iii) non-exclusive sales to various manufacturers for different applications. The commercial model aims to subsidize nets for poorer fishing communities in Tanzania and Kenya, with larger fishing companies in South Africa contributing due to their environmental impact. These large-scale fisheries, which rely on Marine Stewardship Council (MSC) certification, can afford more expensive nets, prioritizing factors such as petrol, staff and fishing efficiency over net cost. Smaller commercial fisheries in Tanzania and Kenya may need subsidies, funded possibly through blended mechanisms such as plastic-free deployment indicators to offset plastic footprints. Plastic offsets are intended for companies unable to reduce plastic pollution to finance biodegradable fishing nets such as carbon emissions neutralization. Blended financing could therefore help attract commercial funds to sectors and regions with significant development finance needs, ensuring the additionality of biodegradable nets for small-scale fisheries where commercial financing is lacking.

### 3.2.2 Evidence of sustainability and impact

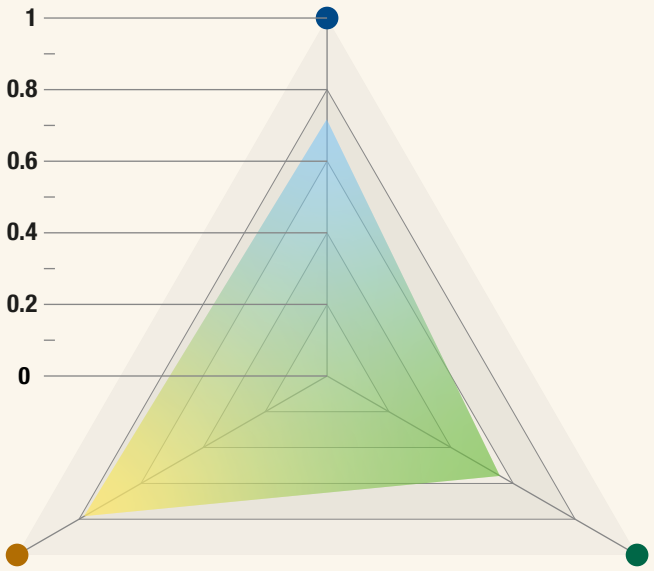
The project aims to secure livelihoods linked to the fisheries sector, crucial for food security, economic growth and the viability of marine ecosystems by strategically identifying market opportunities, emphasizing small-scale fisheries and securing external funding for subsidized nets in target counties. At the core of the project's focus on repairable biodegradable fishing nets and sustaining the fishing net repair industry is a gender component as the industry is dominated by women.

Since its kick-off, the project has created up to 10 full-time jobs and provided training for women and the local community specifically. Due to the project's trial phase, it is too early to measure the direct impact on the livelihoods of their immediate local community outside the value chain. Technology, which in this case is the development of an innovative biodegradable and compostable polymer, has been developed in Sweden and exported to South Africa, where it was processed, adapted and subsequently exported to Kenya and Tanzania for trials. Importing the granulates from Sweden to South Africa does not have regulatory restraints and there is no import duty on biodegradable compounds. However, there are no specific Harmonized System (HS) codes for biodegradable ropes as finished products and the export of ropes from South Africa to Kenya required the payment of 15 per cent import duties.

After the project's successful pilot phase, the expectation is to have three products available for market release, thus creating three sources of income. Pricing for these products depends mainly on the feedstock prices. In mitigating a potentially negative effect of the more expensive biodegradable feedstock, compared to conventional materials which could increase final product prices, policy and regulation could play a crucial role alongside scaling capacity, market readiness, and demand. The project, with its multiple partnerships and proactive efforts to obtain public and private (co)financing, is financially sound and performing according to the plan. However, since products are not yet on the market, it is difficult to estimate long-term financial sustainability.

↓ Figure 6. Catchgreen project's estimated social impact, financial sustainability, and technology readiness

*Source*
*Survey with project developers and focal points of SMEP Plastics portfolio*




**Social Impact**

- Capacity building and skills trainings provided for women
- Capacity building and skills developed for socially disadvantaged groups
- Capacity building and skills trainings provided for community
- Positive impact to livelihood of immediate community
- Positive impact outside the value chain and immediate community
- Positive impact on improved living conditions
- Positive impact on gender inclusion
- Positive impact on social inclusioN
- Full-time jobs created

**Business Sustainability**

- Long-term sustainability of revenues
- Manageability of costs
- How many sources of revenue can the project generate
- Current profitability
- Revenues matching initial plans

**Technology & Innovation**

- Capacity building for using the technology needed
- Ease of maintenance
- Ease of importing technology
- Ease of usage of this technology for the project
- Ease of technology transfer
- Technology transfer needs
- Technology developed nationally or imported

↓ Box 3. Policy and regulatory measures: insights from the project implementation of Catchgreen

The pilot phase in Kenya, led by the Kenya Marine Fisheries and Research Institute (KMFRI) in collaboration with Beach Management Units (BMUs), aims to promote gender inclusiveness and social equity in the fisheries sector by jointly managing resources and enabling livelihoods dependent on fishing. Women already play a dominant role in coral restoration and seaweed harvesting, and these activities could empower women along the seaweed value chain to create and market products such as soaps, body lotions and cosmetics.

### Policy influence and advocacy

Policy changes could significantly impact the project and its supplier, Gaia BioMaterials AB. Therefore, the project actively seeks to influence international policies and leads engagements with governments, NGOs and international organizations to gain support for the uptake of biodegradable fishing nets. Catchgreen advocates for an enabling environment favoring the shift towards sustainable materials and the use of biodegradable fishing nets at the global level by promoting discussions on blended financing as a transition tool and as part of a wider range of activities to tackle plastic pollution. For these purposes, the Catchgreen project focuses on influencing:

i. international policy and monitoring of the use and disposal of fishing nets;

ii. possible (voluntary) producer responsibility for fishing nets;

iii. policy differentiation between biodegradable and non-biodegradable fishing nets; and

iv. policy support for biodegradable fishing nets as an environmentally sustainable alternative to traditional fishing nets.

### Trade and tariff policy

Catchgreen has provided evidence to the World Trade Organization on the high tariffs applied to the Biodolomer®Ocean when it crosses borders, as there are no HS codes that allow for targeted tariff reduction. As it is up to the discretion of individual Customs Authorities to decide how to classify the materials, this often results in higher costs, consequently making the material uncompetitive with petroleum-based plastics. Catchgreen advocates for this to be taken into consideration when new HS codes are created at the next five-year update of codes.

### Legislation and environmental regulations

The SMEP project has successfully engaged with a number of governments and national and international organizations such as the national departments of fisheries in South Africa, Tanzania and Kenya, the Oceans and Marine Wildlife Conservation Initiatives at WWF-US, MSC, the Food and Agriculture Organization of the United Nations (FAO) and the Global Ghost Gear Initiative to gain support for the uptake of biodegradable fishing nets. The project, together with FishSA and Bureo, a Brazilian fishnet recycling company, is engaging with the Department of Forestry, Fisheries and the Environment of South Africa to revise current fisheries legislation to include guidelines on the loss and the disposal of nets, including the possible prohibition of discard nets in the ocean, compulsory reporting on losses, and extended producer responsibility (EPR).

### Subsidies and economic support for developing nations

In Mombasa, Kenya, the project has a partnership with the Kenya Marine Fisheries and Research Institute (KMFRI) and Kenya Fisheries Services (KFS). Simultaneously, Catchgreen participates in discussions with FAO, which is acting as the implementing agency for Article 7 of the draft Agreement on Fisheries, on targeted technical assistance to developing countries for implementing disciplines under the Fisheries Subsidies Agreement. This could create opportunities to subsidize biodegradable fishing nets for Kenyan fishermen. Collaboration prospects with KMFRI also involve integrating some of the Catchgreen products and replacing gillnet ropes in their ongoing experimental initiative.

The project collaborates with KMFRI for trials of biodegradable ropes in gillnets as part of the FAO-funded Gillnet Modification Project. Additional pilots include the use of biodegradable ropes in seaweed rafts, coral reef restoration and six-month trials of biodegradable trawl nets for the hake fishing industry by Irvin & Johnson. SINTEF, a Norwegian-based company, is contracted to assess biodegradability in seawater.

### Standards and certifications

Catchgreen is also in talks with MSC to include biodegradable fishing nets as a requirement in their Fisheries standard. An impact study is being developed under the MSC Ocean Stewardship Program, examining the consequences of lost Biodolomer®Ocean nets, assuming a lower ghost fishing rate due to their higher density and anticipated degradation within two years.

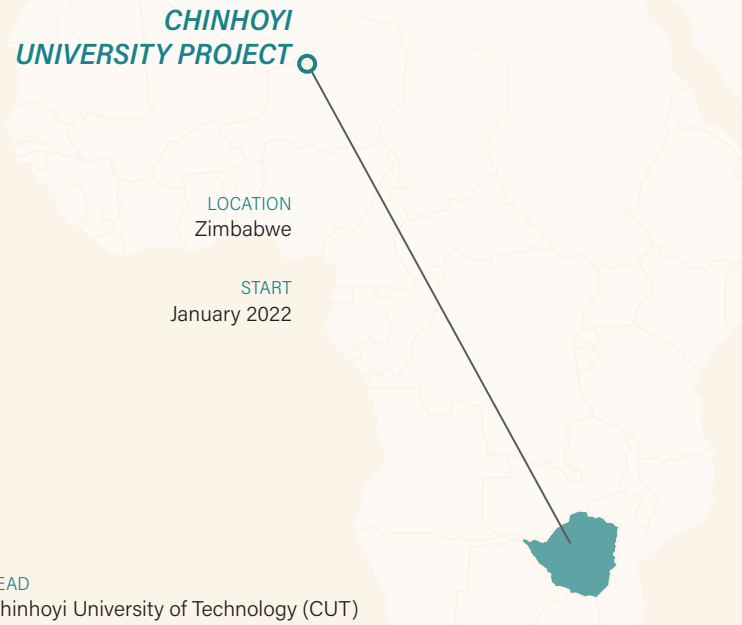
### Plastic waste reduction standards

Additionally, the project has engaged Verra to expand the scope of Verra's Plastic Waste Reduction Standard. This involves displacing petroleum-based plastics with bioplastics and compostable plastics. The project's stakeholder registration with Verra and participation in the revision survey for the Displacement of Virgin Petroleum-Based Production methodology highlight its commitment to sustainable plastic waste reduction.

### Biodegradability and toxicity testing

Catchgreen's partner, Gaia BioMaterials AB collaborates with SINTEF, the Norwegian Seafood Research Fund, Dsolve, and Norsus in securing financial support for long-term trials of Biodolomer®Ocean fishing nets. Trials include different parts of trawl nets and crab pots. Funding also supports ongoing biodegradability testing at SINTEF, providing insights into microbial changes over time and additional toxicity information.

↑ Box 3 cont. Policy and regulatory measures: insights from the project implementation of Catchgreen project


LOCATION
Zimbabwe

START
January 2022

LEAD
Chinhoyi University of Technology (CUT)

MEMBER
Kudiwa Waste and Energy Solutions

MITIGATION CATEGORY
Remanufacture

## 3.3 Chinhoyi University Project

↑ Image 12. Fabrication of roof tiles made from upcycled SUP waste

© Kudiwa Waste and Energy Solutions

**The Chinhoyi University of Technology (CUT) in Zimbabwe is developing solar roofing tiles made from plastic waste composite material.** This initiative aims to use plastic waste as raw material for roof tiles, supporting increased waste collection, reducing plastic pollution, and providing income for waste collectors. The project is addressing plastic pollution, especially in underserved areas, diverting plastics from dumpsites and offering a sustainable energy solution through solar photovoltaic tiles. Despite challenges with an unstable national power supply, the team has produced several prototypes, constructed a model roof for exhibitions, and engaged with platinum mining companies, among others, for plastic waste collection. The project has organized activities to promote waste separation and thus directly and indirectly supports livelihoods in the local community, in particular waste pickers.

### 3.3.1 Business ecosystem

The project's main product is a roof tile made from plastic waste using different types of single-use plastic waste in the category of polypropylene (PP), HDPE, LDPE, and PET. Two types of tiles are explored: a regular tile made from plastic waste and another with a solar panel installed on top. The composite solar roof tiles are planned to be lighter in comparison to traditional ceramic roofing; durable, with low heat or thermal conductivity, and low-cost manufacturing. The solar component is produced based on the project's specifications and imported from China, benefiting from zero duty, no value added tax (VAT) or any other taxes on solar equipment under the current regulation in Zimbabwe. The product's characteristics such as reducing breakages during transportation or in the event of accidents, should outperform common ceramic tiles.

▸ End-of-life solutions

↑ Image 13. Composite solar roof tile made from upcycled SUP waste

© Kudiwa Waste and Energy Solutions

Their target markets are primarily households as direct clients and construction companies (hardware stores) but could also reach scale if they partner with public and private institutions that support housing projects. The project's value proposition is to offer roofing tiles that are affordable, environmentally friendly, lightweight, durable, and feature an appealing and unique design. The product is a low-cost solution that eliminates the need for a separate solar system installation as the solar roof tiles seamlessly integrate into the roof structure, providing clean energy. This not only enhances building aesthetics but also allows customers to choose the size of the solar system that aligns with their specific needs and budgets. Assumptions include the availability of raw materials such as plastic and sand and a readily available market for solar roof tiles due to the numerous environmental and budgetary benefits they offer.

In the rainy season, there is a decline in the demand for tiles as the local population tends to favor pavements for their driveways. This creates an opportunity for a new product, specifically pavements, to address the seasonal fluctuations in demand. The focus shifts to promoting pavements during the rainy season and tiles during the dry (summer) season.

Operations can be expanded substantially and would depend on the availability of feedstock. Even though the project works with local waste pickers who collect plastics from local dumpsites, and local organizations to whom the project provides cages for storing plastic waste and collects them weekly, they plan to make their main source of feedstock local retailers and the mining industry, which produce about five tons of plastic waste every two to three weeks, and this latter source would be free of charge. Understanding that some of the plastic waste is now exported (e.g., South Africa) and could instead be used locally, this would ensure an adequate raw material supply meet expansion needs. Additionally, with the right policy enforcement, such as plastic ban and waste separation, plastic pickers would be able to collect plastic feedstock more easily and faster. The project operates with sufficient machinery to produce test tiles and some for local demonstration. However, once the product is market ready, licensed, and accepted by clients, expanding production will require more machinery along with additional funding.

### 3.3.2 Evidence of sustainability and impact

The project relies on already established technology, which creates a high social impact. It could be financially sustainable once production is underway, certification obtained, and a stable distribution channel secured. The project aims to address the ongoing issue of plastic waste and other raw materials present locally such as fly ash and construction waste. With the consistent demand for housing and roofing materials, the project's financial sustainability could be achieved. The initial funding from the SMEP programme will kick-start the project and the projected revenue from selling solar roof tiles could be reinvested to guarantee its continuity. The project is expected to become self-sufficient, however, the timing depends on the public administrative and regulatory procedures as well as customer acceptance of the product and the effectiveness of its marketing strategies.

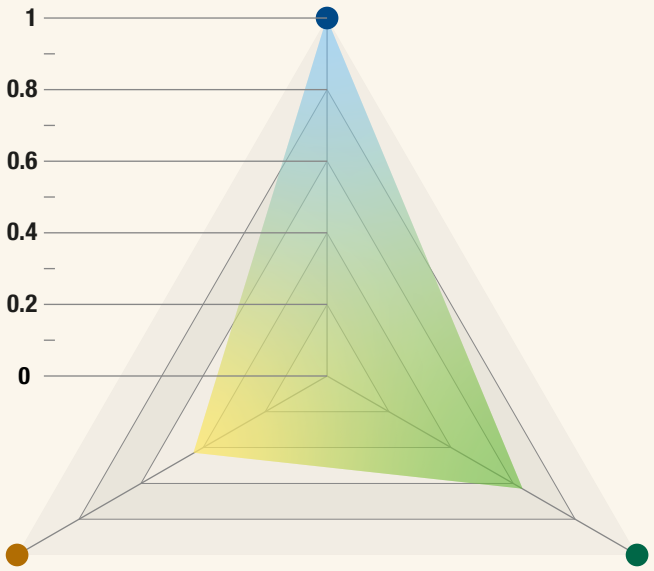
Following optimization, the project aims to utilize 50 tons of plastic waste monthly. Zimbabwe currently generates approximately 18,000 tons of plastic waste each month, with existing recycling efforts and exports addressing only 10 per cent of this volume. In its initial stages, the project's intervention will address 0.3 per cent of the total plastic waste, remediating a portion of this environmental concern. However, as demand rises and new markets for the product emerge, the project could grow significantly.

Currently, the project's primary focus is on increasing the production target to 150 roofing tiles per 8-hour shift while monitoring costs to achieve the targeted unit cost. Simultaneously, they have started marketing activities for the roof tiles. Roofing at least one show house was important for this project to achieve their market entry and demonstration of their product. However, the unavailability of the ridge mould delayed the project in roofing their first show house. In addressing this, the project needs to import a ridge mould from Botswana, inevitably increasing costs, delaying the production time and market entry. Also, their production output has not significantly increased over time, currently averaging 110 tiles per shift but aiming for at least 175 tiles per 8-hour shift, although the unit cost has already been reduced. The latter has been achieved by using new, more affordable formulations consisting of different types of plastic waste.

The project has created up to 10 full-time jobs and has indirectly impacted many more by providing payments for plastic waste collected. It has proactively organized capacity-building activities for women, socially disadvantaged groups and larger community. By providing regular payments to waste pickers and their families the project has been creating backward improvements, improving living conditions locally and impacted those throughout the newly established value chain. The Chinhoyi project had some challenges securing qualified labor force due to its remote location, but it was resolved when it opened to women and men, often from the same household. The project holds quarterly meetings with women plastic pickers to address issues such as safety, health, council by-laws, financial literacy, sustainable entrepreneurship and business registration in the plastics value chain.

↓ Figure 7. Chinhoyi University project's estimated social impact, financial sustainability, and technology readiness

*Source*
*Survey with project developers and focal points of SMEP Plastics portfolio*




**Social Impact**

- Capacity building and skills trainings provided for women
- Capacity building and skills developed for socially disadvantaged groups
- Capacity building and skills trainings provided for community
- Positive impact to livelihood of immediate community
- Positive impact outside the value chain and immediate community
- Positive impact on improved living conditions
- Positive impact on gender inclusion
- Positive impact on social inclusioN
- Full-time jobs created

**Business Sustainability**

- Long-term sustainability of revenues
- Manageability of costs
- How many sources of revenue can the project generate
- Current profitability
- Revenues matching initial plans

**Technology & Innovation**

- Capacity building for using the technology needed
- Ease of maintenance
- Ease of importing technology
- Ease of usage of this technology for the project
- Ease of technology transfer
- Technology transfer needs
- Technology developed nationally or imported


LOCATION
Nigeria, South Africa

START
January 2022

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

PARTNERS
Elizade University, Nigeria

MITIGATION CATEGORY
Substitution, biomaterial

## 3.4 CSIR

↑ Image 14. Biodegradable mulch film rolls produced by CSIR

© V. Ojijo, CSIR (SA)

**The industry's shift towards more sustainable production methods, driven by the need for eco-friendly solutions, is motivated by factors such as consumer environmental awareness, and demands for organically produced food.** Unlike conventional plastic mulches, biodegradable mulch should not result in microplastics, therefore addressing important concerns about soil structure alteration and potential harm to crop productivity. Currently bioplastic mulches are sold at higher prices compared to traditional plastic mulch films. The SMEP programme supported the project to develop biodegradable mulch, which would offer a more environmentally friendly solution with the potential for cost mitigation over the life cycle.

The Council for Scientific and Industrial Research (CSIR) in South Africa is collaborating with Elizade University in Nigeria to address pollution from conventional plastic mulch film used in agriculture. The current non-biodegradable plastic mulch poses recycling challenges, leading to significant waste, and potentially impacting human health through microplastics contamination of soil. The project aims to develop biodegradable mulch films (BDM) using locally available natural polymers such as starch to replace PE mulch films. The initiative is responding to the growing African market's need for sustainable solutions to enhance crop productivity.

### 3.4.1 Business ecosystem

▸ Material shift project

The project has developed different BDM formulations for various crop life cycles, optimized film production, and performance evaluations and is focused on reducing formulation costs to compete with commercial PE mulch films by conducting industrial optimization. One of their goals is to design and produce at least three formulations to address various crop life cycles: short (1 - 3 months), medium (up to 12 months) and long-term (24 months, relevant for crops such as pineapple). Film production optimization entails assessing film performances and refining the

starch modification process. By refining formulations, costs can be reduced and biodegradability improved. In addition to the project's six original formulations, the team has developed new, more cost-effective formulations, which come with a lower price tag than the base commercial bioplastic currently in use. To tailor performance, these formulations will be integrated into multilayer film constructions. Initial tests indicate that these multi-layer constructions could be cost-effective, exhibit good processability, and deliver customized performances.

As the project is in a pilot phase, products are not yet readily available on the market. Although stakeholders' engagement is ongoing, clients need to be identified at a later stage. Potential distribution channels are also already being explored to raise awareness about biodegradable mulch and its benefits. For example, advocacy activities aimed at raising awareness of BDMs as part of the ongoing project efforts in Nigeria are gaining momentum. The project envisions that the technology, once ready, to be licensed to commercial partners. The BDM technology will be put into operation by compounders, who typically handle the formulation and production of intermediate pellets for subsequent processes. Additionally, converters, utilizing pellets from compounders or resin suppliers, will manufacture product intermediates or final products like BDMs. The intended recipients of the produced BDMs are usually retail suppliers serving as intermediaries before reaching the ultimate users, who, in this case, are the farmers. In certain situations, the end-users themselves may be the target customers for the produced BDMs. The project aims to target vulnerable, female farmers and/or small farmers, who might be impacted by the development of a new regulation in the European Union to reduce plastics throughout the agriculture value chain.

↓ Image 15. Trial laying of biodegradable mulch film in South Africa

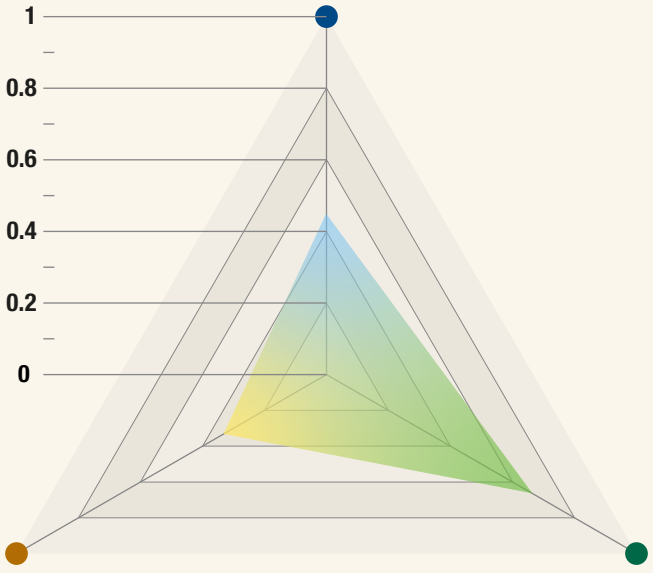


### 3.4.2 Evidence of sustainability and impact

The project estimates that it could prevent 1,050 tons of plastic waste per year, assuming it would secure one per cent of the African market in five years after project competition. Hence, similar to other projects developing new materials (e.g., Gaia BioMaterials, FreshPPact Impact Hub - Biodegradable mulch) whose core innovation is undergoing trials and not yet deployed, it seems challenging to estimate impacts or provide evidence at this stage. However, the project has created jobs and provided capacity-building and skills training to the community, which means a certain positive impact on livelihoods has been made and the potential impact on the environment is estimated to be high as it would effectively eliminate plastics from farming.

↓ Figure 8. CSIR project's estimated social impact, financial sustainability, and technology readiness

*Source*
*Survey with project developers and focal points of SMEP Plastics portfolio*




**Social Impact**

- Capacity building and skills trainings provided for women
- Capacity building and skills developed for socially disadvantaged groups
- Capacity building and skills trainings provided for community
- Positive impact to livelihood of immediate community
- Positive impact outside the value chain and immediate community
- Positive impact on improved living conditions
- Positive impact on gender inclusion
- Positive impact on social inclusioN
- Full-time jobs created

**Business Sustainability**

- Long-term sustainability of revenues
- Manageability of costs
- How many sources of revenue can the project generate
- Current profitability
- Revenues matching initial plans

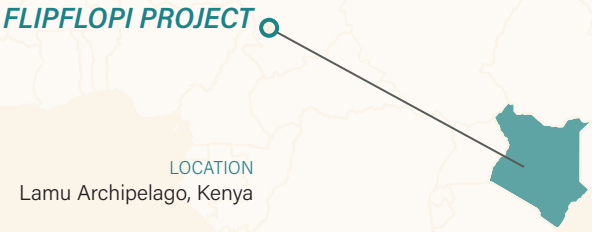
**Technology & Innovation**

- Capacity building for using the technology needed
- Ease of maintenance
- Ease of importing technology
- Ease of usage of this technology for the project
- Ease of technology transfer
- Technology transfer needs
- Technology developed nationally or imported

## Policies and regulatory measures

To promote the adoption of biodegradable mulch films, the CSIR project engages with government entities and enterprises to incentivize farmers. This includes advocating for a compulsory extended producer responsibility (EPR) scheme, green procurement, special economic zones for green technologies, and tax rebates. The stakeholder engagement strategy emphasizes the impact on Nigeria's gross domestic product (GDP) and food security, leveraging existing activities aligned with BDM solutions. Collaboration with FAO and its partner networks is planned to garner support for the technology's implementation in Nigeria and potentially other regions.

← Box 4. Policy and regulatory measures: insights from the project implementation of CSIR


LOCATION
Lamu Archipelago, Kenya

START
January 2022

LEAD
Flipflopi Project

PARTNERS
CORDIO East Africa, University of Northumbria, University of Portsmouth

MITIGATION CATEGORY
Remanufacture

## 3.5 Flipflopi Project

↑ Image 16. UNCTAD visit to the Flipflopi Project

© M. Durleva, UNCTAD

**The Flipflopi project, in collaboration with CORDIO East Africa, the University of Northumbria and University of Portsmouth, aims to address marine ecosystem health and sustainability challenges in Lamu, Kenya.** Titled "Mitigating Plastic Pollution through Heritage Boat Building", the project combines indigenous knowledge with modern innovation by constructing traditional sailing, motorized vessels and heritage furniture from plastic waste. Collaborating with communities in the Lamu archipelago, the project demonstrated the feasibility of bringing remote island communities into a circular economy, expanding heritage plastic boatbuilding and preventing plastic pollution. The closed-loop model of recycling plastics for artisanal vessel and furniture construction is seen as replicable in coastal communities worldwide.

The project aims to address plastic pollution by advocating for the reduction in consumption, increased reuse, waste collection and recycling and innovation in the plastics value chain. The ultimate mission is to create a world without single-use plastic. Advocacy efforts, led by partners at ALN, aim to bring political and legal representation from the East African Community (EAC) to support a regional bill for a complete ban on unnecessary single-use plastics in EAC partner states. Since 2022, the Flipflopi project recovered and recycled over 257,500 kilograms of plastics. They have established a 12-week locally accredited vocational training course, locally manufactured high-grade plastic lumber and developed over 40 different prototypes for marketable products, including traditional Lamu furniture, doors, hand carts and new plastic boats. Offering courses for students and organizing training sessions for trainers could eventually transform into a more structured business and become a source of revenue.

▸ End-of-life solutions

### 3.5.1 Business ecosystem

The project is making lumber out of plastic waste, which is then used to make traditional Lamu furniture and custom designed outdoor furniture as well as boats (Image 16 and 17). The project

↓ Image 17. Heritage chair made from plastic waste

© M. Durleva, UNCTAD

is prioritizing their furniture production, which has a ready demand from clients such as safari camps, boutique hotels, restaurants and private homes in Kenya and beyond, thereby contributing towards the organization's financial sustainability.

Feedstock (e.g., plastic waste) for the production is provided by the local community or, often, from other environmental groups. The individual plastic collectors are part of the local community, and some organize themselves and deliver feedstock collectively while Flipflopi also has a tractor and trailer that picks up plastics directly from the neighborhoods. Flipflopi has trained collectors to do basic sorting at source which saves significant time at the Material Recovery Centre. Further sorting into types and colors is done manually by the team at the facility.

For boatmaking, Flipflopi only uses HDPE plastics collected, while for the making of furniture PP plastics and LDPE are also being used and trialed. PP type of plastics can also be used to produce sheets that could be used as tabletops, lining for doors or boats but for that the project would need to purchase a press machine. Softer plastics are challenging to convert into high quality products, hence more suitable for construction materials (e.g., fencing poles, building blocks) where design aesthetics of the product might not be a priority. An increasing proportion (from around 50 to 60 per cent) of the plastics received cannot be fully recycled locally yet (mainly PET and PVC) so it is shredded and sent to Mombasa or Nairobi as flakes to be recycled there at a selling price that currently does not cover Cost of Goods. The hope is that PET can be reduced by advocacy and replaced by public water dispensers, glass bottles and other plastic substitutes.

↓ Image 18. UNCTAD visit to the Flipflopi Project

© FlipFlopi Project

The Flipflopi project aims to establish a strategic partnership to expand their offering of recycled plastic furniture businesses and artisanal boat markets. Efforts are put into refining their data collection systems to assess the viability of using carbon credit/plastic credit markets to support and scale operations (Flipflopi, 2023).

← Image 19. Flipflopi's neighborhood tractor: direct plastic collection

© M. Durleva, UNCTAD

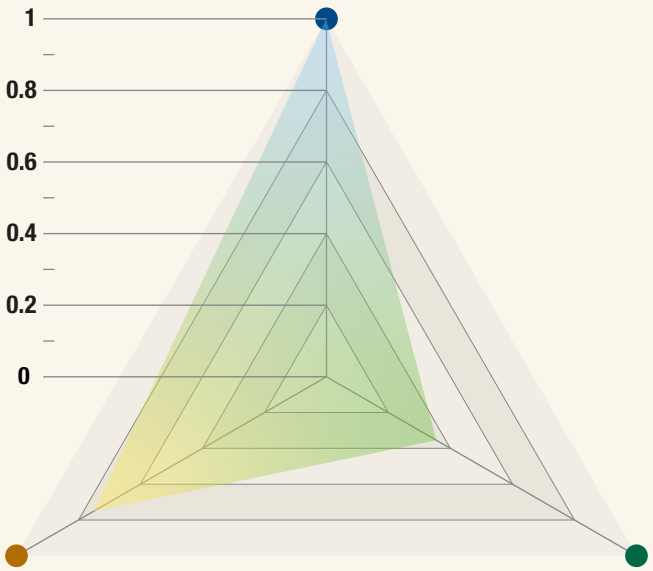
### 3.5.2 Evidence of sustainability and impact

Working with multiple island communities, the project has established regular monthly collections. Since 2022, the Flipflopi project is estimated to have processed over 32 tons of HDPE and PP plastic into "green" lumber at their facility, prevented over 80 tons of PET bottles from ending up in ocean and land and recovered 258 tons of plastic waste from the environment.

The project has created 26 full-time employments and monthly contract work for 8 to 10 artisans, of which 43 per cent are women bringing direct positive impact to local community livelihoods. Dhow-building and sailing have long been male-dominated fields. Lamu Polytechnic took the lead by enrolling women in their Vessel Repair and Maintenance Course, with three of them joining Flipflopi's heritage boat building course as part of the first pilot course. Flipflopi has currently over 500 community members (approximately 65 per cent are female) involved in their collection network receiving direct cash transfers and is actively recruiting more women to join the project (Flipflopi, 2023).

↓ Figure 9. Flipflopi project's estimated social impact, financial sustainability, and technology readiness

*Source*
*Survey with project developers and focal points of SMEP Plastics portfolio*




**Social Impact**

- Capacity building and skills trainings provided for women
- Capacity building and skills developed for socially disadvantaged groups
- Capacity building and skills trainings provided for community
- Positive impact to livelihood of immediate community
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- Positive impact on improved living conditions
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- Full-time jobs created

**Business Sustainability**

- Long-term sustainability of revenues
- Manageability of costs
- How many sources of revenue can the project generate
- Current profitability
- Revenues matching initial plans

**Technology & Innovation**

- Capacity building for using the technology needed
- Ease of maintenance
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- Ease of usage of this technology for the project
- Ease of technology transfer
- Technology transfer needs
- Technology developed nationally or imported

| | |
|---|---|
| **Local solid waste management policy** | Lamu Municipality Solid Waste Management policy – advocating for the removal of burning of plastic waste from the policy. The Flipflopi project has been formally recognized as a key stakeholder in waste management by Lamu County and consequently contributed to the first solid waste management policy for Lamu Municipality.<br><br>The first organization in Lamu County to be approached by government-approved EPR Associations to determine practical pathways to establishing EPR schemes in Lamu County. |
| **National policymakers** | Advocacy for transport subsidies to be included in the upcoming EPR law currently being debated in Kenya. Transport is expensive for bringing PET and other waste into Nairobi to be recycled from the rest of the country. |
| **Regional and international policymakers** | A draft bill submitted for tabling at the East Africa Legislative Assembly, aimed at eliminating unnecessary single-use plastics across East African Community countries in partnership with Africa Legal Network.<br><br>Recognition of work done at the national level by the National Environmental Management Authority with a case study included in the National Marine Litter Policy.<br><br>Engagement with the INC focal point for Kenya and their efforts as part of the ongoing international negotiations on a legally binding plastics treaty.<br><br>Engagement with several members of the East African Legislative Assembly (EALA), instrumental in initiating the drafting of a bill to ban single-use plastics in East Africa that has been refined by the African Legal Network and is set to be voted on in November 2024. |

↑ Box 5. Policy and regulatory measures: insights from the project implementation of Flipflopi



LOCATION
Nigeria

START
January 2022

LEAD
University of Warwick

PARTNERS
GIVO Africa, Chatham House, De Montfort University, Environmental Sustainability Associates Ltd, Zero Waste Goods

MITIGATION CATEGORY
Municipal waste collection, plastic sorting, mechanical recycling

↑ Image 20. GIVO Centre, Maryland, Ikeja, Lagos.

© H. Pacini, UNCTAD

## | 3.6 GIVO-Warwick Project

**The University of Warwick and GIVO Africa have collaborated to address plastic waste issues in Nigeria through a scalable, sustainable and digitally-enabled waste management solution.** The GIVO project aims to create digital tools for efficient GIVO center operations, serving as hubs for collecting, sorting, and processing post-consumer plastic into recyclates. The project includes digital systems to identify, track, and report plastic flow, promoting transparency and reducing environmental pollution.

The initiative also seeks to improve livelihoods by offering financial incentives for recyclables, encouraging material substitution, enhancing manufacturing, remanufacturing products, and promoting recycling solutions. GIVO aims to formalize employment for waste pickers and create skilled jobs, with the Information Technology (IT) system serving as a crucial legacy product. The project has reduced greenhouse gas emissions by establishing fully off-grid centers and using renewable solar energy to feed 100 per cent of their operations. The use of clean energy, optimization of IT infrastructure, smart operation and maintenance of GIVO centers are part of the project's goals.

### 3.6.1 Business ecosystem

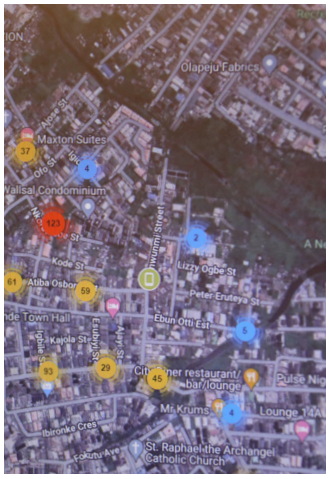
▸ End-of-life solutions

The center operates out of a 40-foot container, and all processes within the center are solar powered, resulting in carbon-neutral operations. They make use of the Internet of Things (IoT) devices to measure and track the collection of recyclables from their depositors. GIVO uses a back-end platform to understand processes, issues, and develop solutions to enhance productivity and efficiency of their system. This information is available on the GIVO Web Platform for access as needed.

The project currently runs two plastic waste centers in Abuja and Lagos. Leveraging electric bikes, they engage local communities within a 2-km radius to collect plastic waste. Initially conceived as a community engagement strategy, this approach evolved into a practical staffing solution due to its feasibility and the project's zero carbon objective. Community leaders teach locals how to participate in plastic collection, resulting in significant quantities of plastic waste being gathered, securing the production of the centers. It should be noted that plastic waste is collected directly from depositors before it enters the environment, meaning the project has collected 122 tons from depositors between January 2022 and June 2023. The project puts a lot of emphasis onfeedstock sourcing. In other words, it matters to their business model how many journeys are involved to get the plastic waste from the environment to the GIVO center because it affects the project's carbon footprint and the cost of feedstock transportation. Thus, strategic center locations are chosen to ensure a steady inflow of feedstock and maximize revenue potential. However, challenges such as permit delays and fuel shortages impede the timely expansion of operations.

↓ Image 21. The project uses data to track locations, record type and quantity of plastic waste collected

© H. Pacini, UNCTAD




Upon arrival at the centers, plastic waste undergoes manual sorting, a process considered for automation in the future, then shredding and finally ready to be sold mostly as flakes to off-takers. The key to resolving feedstock challenges is in choosing the right location to secure a permanent inflow of feedstock production. Some of the plastics processed are currently is about 20 to 30 per cent shredded, and the rest is either granulated or loose, differentiated by material. This operational model operates on a methodology centered around collecting data for optimizing operation processes, serving as a learning platform aimed at developing a sustainable business ecosystem for future scalability. The project has the capacity to process 180 tons of plastic waste per year (90 tons per center).

The revenue streams of the project are projected to include: i) commodity trading (e.g., selling of shredded, granulated or loose plastic waste materials, of which shredded is currently the project's most profitable source of revenue), ii) subscription services (e.g., licensing the technology, tracking payments and employee management along with a platform for waste management and recycling companies), iii) data commercialization (e.g., data related to business processes dealing with plastic waste, optimizing production and operational efficiency within the centers) and iv) carbon credit potential. Plans that include licensing the project's technology and franchising centers would enable scaling of the technology and model, particularly targeting low- and middle-income countries with limited waste management infrastructure. In the long run, the GIVO-Warwick project would earn income from plastic and carbon credits, licenses and franchising centers.

← Image 22. Waste collector digitally recording and weighing plastic waste upon delivery to GIVO center

© H. Pacini, UNCTAD


↑ Image 23. GIVO container with solar roof panels

© H. Pacini, UNCTAD


← Image 24. Electric bike for plastic waste collection

© H. Pacini, UNCTAD

### 3.6.2 Evidence of sustainability and impact

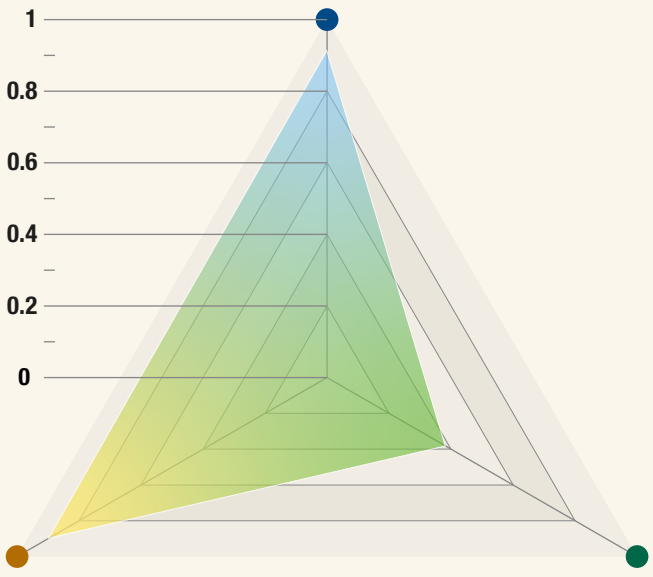
The project places a strong emphasis on environmental sustainability and circularity, focusing on producing high-quality recycled materials and forging strategic partnerships with clients who prioritize these values. As a result, the project has secured clients due to their competitive advantage of producing high-quality shredded or granulated plastic consistently. Furthermore, with the circularity and carbon footprint in mind, the project prioritizes environmental elements over the lucrative ones. It also selects clients who pick up shredded plastics from their location to make fibers for clothes or fiberglass, closing the loop in a local product. As mentioned, the project focuses on shredding, simultaneously using the two machines in the centers to maximize efficiency. In addressing the shredders' repair challenges, the project focuses on R&D for machinery set up to ensure a zero carbon approach to everything the project does. The University of Warwick has thus initiated a collaboration with a start-up from the Netherlands to develop a specialized shredder due to the challenges related to existing equipment maintenance.

The project actively works with the local community aiming to provide a positive and long-lasting impact on livelihoods. GIVO recruits its staff from marginalized communities and focuses on training for female staff, particularly with leadership roles. They also provide community-based training and use social media channels to engage with and train younger generations within their target communities and beyond. They have created over 20 full-time jobs with extended social security, organized capacity-building and skills development for women, socially disadvantaged groups, and the broader community that would not have the kind of opportunity if it were not for the GIVO center.

All partners in the project engage extensively with local and national governments such as the Ministry of Environment as well as international organizations such as the World Bank and the United Nations Industrial Development Organization (UNIDO) to advocate for supportive regulatory frameworks for plastic waste in Nigeria and help in the transition towards a circular plastic economy. The project is also actively engaged with policymakers and has helped them shape locally appropriate policymaking strategies for EPR.

↓ Figure 10. GIVO/Warwick project's estimated social impact, financial sustainability, and technology readiness

*Source*
*Survey with project developers and focal points of SMEP Plastics portfolio*




**Social Impact**

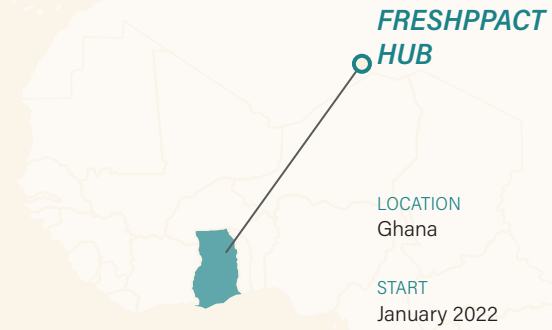
- Capacity building and skills trainings provided for women
- Capacity building and skills developed for socially disadvantaged groups
- Capacity building and skills trainings provided for community
- Positive impact to livelihood of immediate community
- Positive impact outside the value chain and immediate community
- Positive impact on improved living conditions
- Positive impact on gender inclusion
- Positive impact on social inclusioN
- Full-time jobs created

**Business Sustainability**

- Long-term sustainability of revenues
- Manageability of costs
- How many sources of revenue can the project generate
- Current profitability
- Revenues matching initial plans

**Technology & Innovation**

- Capacity building for using the technology needed
- Ease of maintenance
- Ease of importing technology
- Ease of usage of this technology for the project
- Ease of technology transfer
- Technology transfer needs
- Technology developed nationally or imported




LOCATION
Ghana

START
January 2022

LEAD
BlueSkies Pvt Ltd

MEMBERS & PARTNERS
University of Northampton's Centre of Sustainable Business Practices, Waitrose and Partners

MITIGATION CATEGORY
Material substitution, including biomaterial

## 3.7 FreshPPact Hub

↑ Image 25. A plantation supported by FreshPPact, utilizes biodegradable mulch film

© FreshPPact

**The Fresh Produce Impact Hub - FreshPPact aims to address environmental pollution in the fresh produce industry.** It is a partnership among the University of Northampton's Centre for Sustainable Business Practices, Blue Skies, and Waitrose and Partners, whose primary focus is plastics pollution mitigation, specifically in Ghana where Blue Skies have set up a production of fresh fruit for export. FreshPPact's approach to date included scoping out "Challenge Funds", identifying the needs for relevant innovation along the fresh produce supply chain, engaging with over 150 stakeholders, calling for proposals to source pertinent solutions, project shortlisting and collaborating with key partners to implement the selected solutions. Accordingly, the following solution providers and solutions have been selected:

1. **COCO360** A Ghana-based solution provider that utilizes coconut husk waste for mulch sheets aimed at reducing plastic use in agriculture;
2. **Data Solutions Hub (DSH)** Based in Scotland, UK and is currently developing equipment for efficient plastic mulch removal aimed at promoting circularity and reducing plastic waste from agricultural mulching; and
3. **Kelpi** Based in England, UK and is transforming seaweed into sustainable packaging films and pouches.

▸ Material shift project

The FreshPPact team is also undertaking a comparative agricultural experiment to holistically compare alternative solutions to existing plastic mulching.

These solution providers are supported by FreshPPact with access to facilities and farms to implement commercial trials/pilots, and once proven successful, Hub partners are assisting with communication and visibility, promoting wider uptake of solutions in the sector.

There is an important policy component to this project, which aims to support the government plastic pollution-related policy efforts. Data produced by the project, research papers focusing on infrastructure to strengthen plastic pollution enforcement, collection faciility infrastructure, access to collection services, and trainings on how to turn plastic waste collection and management into a business opportunity are all part of the project's activities and engagement with policymakers in Ghana. For example, the University of Northampton has conducted research on food waste upcycling, potentially creating value from fruit waste by creating new products (SMEP programme's Chequered Flag project in Kenya plans to use pineapple waste for the recovery of fibers in the textiles value chain3), enhancing sustainability credentials and effectively minimizing waste, whether it is mango peels, coconut shells, pineapple leaves, or similar by-products. The University team has also prepared a research article focusing on the macro impacts of plastics pollution on the communities in Ghana, which is currently under review in a relevant journal.

### 3.7.1 COCO360: biodegradable agricultural mulch

The use of plastic mulch in the global fresh produce industry presents a significant environmental challenge due to the growing issue of plastic pollution, especially in regions with inadequate waste management infrastructure such as Sub-Saharan Africa and East Asia. Ghana, home to major fresh produce manufacturers and exporters, faces concerns about the environmental impact of single-use plastic mulch, notably in pineapple farms. Plastic mulch is employed in agriculture to suppress weeds, conserve water, and enhance crop production but its reusability and disposal often carry significant environmental and human health risks. The scale of the issue is substantial, with global agricultural value chains using millions of tons of plastic annually. Blue Skies, a fruit manufacturer in Ghana, alone uses around 14 tons of non-recyclable plastic agricultural mulch each year.

COCO360 uses a new method of producing biodegradable mulch from coconut fiber/coir (waste) and is part of the larger holistic mulch project the FRESHPPACT team is undertaking to eliminate the use of plastics on farms sourcing fruits for their production and export. Coconut waste is in abundance thus a reliable and cheap source of feedstock for the COCO360 project. The coir would be purchased from local farmers and processed by automated equipment installed on the farms. Target customers are low-income pineapple farmers who would benefit from using organic mulch in a move towards building sustainable value chains. Potentially, larger farms could also obtain this organic mulching material, thereby contributing to the commercialization of this innovative product.

← Image 26. Coconut waste during Blue Skies production processes

© H. Pacini, UNCTAD

← Image 27. COCO360 biodegradable agricultural mulch

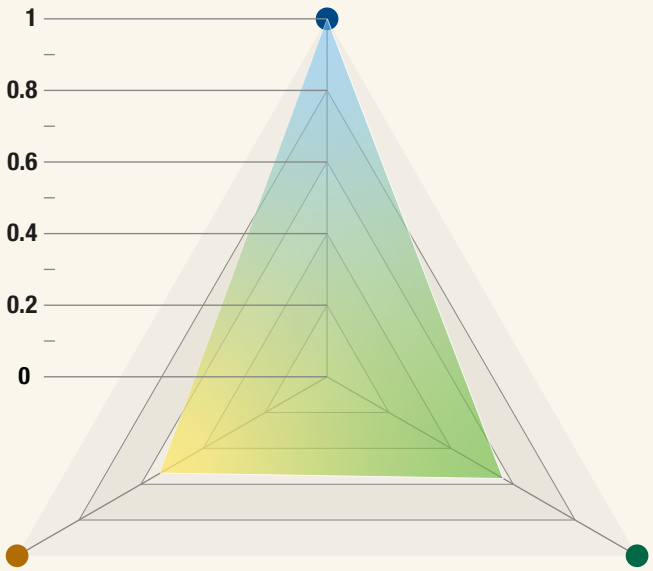
© M. MacGillivray, BlueSkies

In addition, there are other organic waste available such as pineapple leaves that could be turned into mulch as well. The FreshPPact Hub is looking into ways to utilize organic waste produced by Blue Skies fresh fruit production process, for example, they are exploring whether they can use any other organic waste as feedstock to develop new substitute materials for plastics in plastic packaging.

COCO360 has been offering employment to over 20 people, and has provided capacity-building and skills development to women, socially disadvantaged groups, and general local community. In their estimation over 10 tons of plastic waste over 100 acres of land have been prevented using biodegradable mulch.

↓ Figure 11. COCO360's estimated social impact, financial sustainability, and technology readiness

*Source*
*Survey with project developers and focal points of SMEP Plastics portfolio*




**Social Impact**

- Capacity building and skills trainings provided for women
- Capacity building and skills developed for socially disadvantaged groups
- Capacity building and skills trainings provided for community
- Positive impact to livelihood of immediate community
- Positive impact outside the value chain and immediate community
- Positive impact on improved living conditions
- Positive impact on gender inclusion
- Positive impact on social inclusioN
- Full-time jobs created

**Business Sustainability**

- Long-term sustainability of revenues
- Manageability of costs
- How many sources of revenue can the project generate
- Current profitability
- Revenues matching initial plans

**Technology & Innovation**

- Capacity building for using the technology needed
- Ease of maintenance
- Ease of importing technology
- Ease of usage of this technology for the project
- Ease of technology transfer
- Technology transfer needs
- Technology developed nationally or imported

↑ Image 28. BlueSkies' product featuring PET packaging film

© H. Pacini, UNCTAD

### 3.7.2 Kelpi, biodegradable packaging

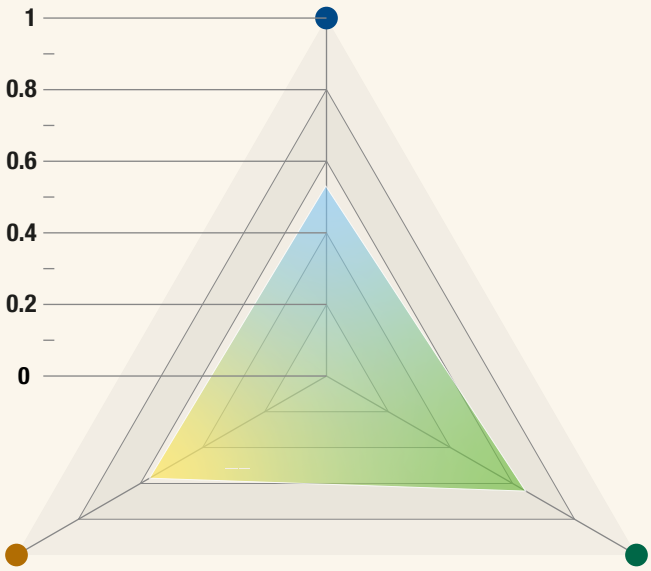
Plastic packaging contributes significantly to the escalating issue of plastic pollution, as it is a common material used for preserving food safety and extending shelf life. Blue Skies' products, especially fresh-cut fruit, are packed in PET trays with film lids. With either paper or plastic labels, they are placed in cardboard cases for transportation from Ghana to Europe. Freshly squeezed juice, constituting less than 5 per cent of sales, is packaged in PET bottles sealed with LDPE caps and distributed mainly in the local markets in Ghana. Ice cream, sold locally or exported, is packed in plastic-lined paper tubs within cardboard cases. All packaging materials are manufactured in Europe and imported into Ghana.

Kelpi is a company addressing plastic pollution by developing alternative biodegradable packaging options (e.g., compostable, marine-degradable, and recyclable). This solution provider uses carbohydrates from seaweed to create biopolymers and produce biodegradable material with superior barrier properties to substitute plastic packaging. Currently, the project is gathering material and technical requirements for products. The product prototyping phase will likely require a variety of prototypes available for testing as the material needs to be resilient enough to sustain the whole supply chain proces – from the factory in Ghana to the stores of Waitrose and Partners (e.g., Waitrose and Partners would be an initial client for their products in collaboration with Blue Skies, although plans are to expand further) and to end consumers. In the future, it might be important to test the production scale to match clients' needs.

↓ Figure 12. Kelpi's estimated social impact, financial sustainability, and technology readiness

*Source*
*Survey with project developers and focal points of SMEP Plastics portfolio*

The leading supermarket chains in the United Kingdom alone sold 900,000 tons of plastic packaging in 2019, a 1.2 per cent increase since 2017, despite having reduction targets. Blue Skies contributes to this issue, using over 400 tons of single-use plastic packaging annually in Ghana and 643 tons across all sites. While a significant portion is recyclable and includes recycled content, the films, totaling 36 tons in Ghana and 78 tons across all sites are non-recyclable virgin plastics. The lack of recycling infrastructure, coupled with a lack of waste mapping, poses challenges to effective recycling and the growth of a circular economy. Therefore, the extent to which Blue Skies' packaging is actually recycled remains debatable, raising concerns about potential pollution through landfill disposal, incineration or littering.




**Social Impact**

- Capacity building and skills trainings provided for women
- Capacity building and skills developed for socially disadvantaged groups
- Capacity building and skills trainings provided for community
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- Positive impact outside the value chain and immediate community
- Positive impact on improved living conditions
- Positive impact on gender inclusion
- Positive impact on social inclusioN
- Full-time jobs created

**Business Sustainability**

- Long-term sustainability of revenues
- Manageability of costs
- How many sources of revenue can the project generate
- Current profitability
- Revenues matching initial plans

**Technology & Innovation**

- Capacity building for using the technology needed
- Ease of maintenance
- Ease of importing technology
- Ease of usage of this technology for the project
- Ease of technology transfer
- Technology transfer needs
- Technology developed nationally or imported

← Image 29. BlueSkies project site in Ghana using plastic mulch

© H. Pacini, UNCTAD

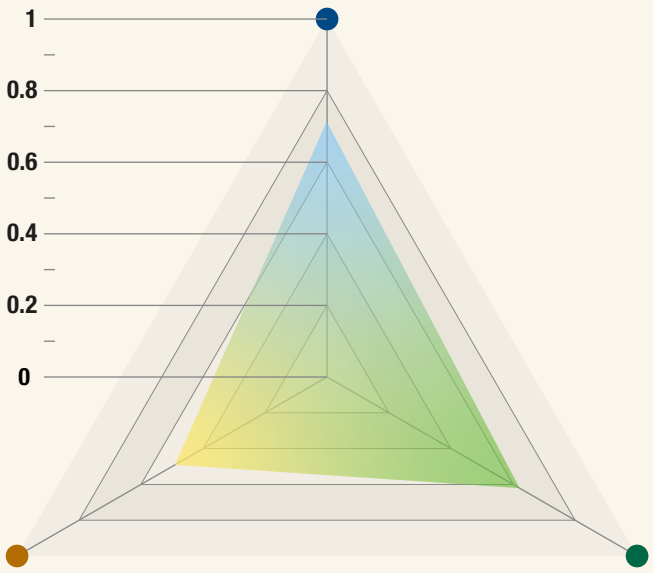
### 3.7.3 Data Solution Hub, plastic mulch lifting solution

Data Solution Hub was selected to develop a mulch lifting solution made specifically for pineapple farming (targeting to recover 140 tons of plastic waste per 380 acres) to support Blue Skies' supply chain farmers. This steel-based modular machinery would be attached to a tractor and help farmers who use plastic mulch to discard it after the harvesting period. They plan to develop two alternative designs for testing in different conditions. The final product would be flat-packed and shipped to be assembled on the farm directly. This solution would be designed to pick up small pieces of plastic mulch, as small as the size of one square centimeter but not smaller than that. Discussions with a manufacturing facility in the United Kingdom were progressing with plans to transfer manufacturing to Ghana in the future. If proved effective, the project might be expanded to other similar farming sites such as in India and Bangladesh.

The service provider has thus far extended up to 10 employment opportunities and plans to provide training for women, disadvantaged groups, and local communities.

↓ Figure 13. Data Solution Hub's estimated social impact, financial sustainability, and technology readiness

*Source*
*Survey with project developers and focal points of SMEP Plastics portfolio*




**Social Impact**

- Capacity building and skills trainings provided for women
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- Positive impact to livelihood of immediate community
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**Business Sustainability**

- Long-term sustainability of revenues
- Manageability of costs
- How many sources of revenue can the project generate
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- Revenues matching initial plans

**Technology & Innovation**

- Capacity building for using the technology needed
- Ease of maintenance
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PLASTIC-TO-GHAR PROJECT

LOCATION
Nepal

START
January 2022

LEAD
University of Cambridge

MEMBERS & PARTNERS
Impact Hub Kathmandu, Field Ready UK, Polyfloss Factory, Recosolution, Clean Up Nepal, Doko Recycler

MITIGATION CATEGORY
Remanufacture

↑ Image 30. Elderly woman sitting beside a discarded plastic bottle in Ree village, Nepal

© H. Pacini, UNCTAD

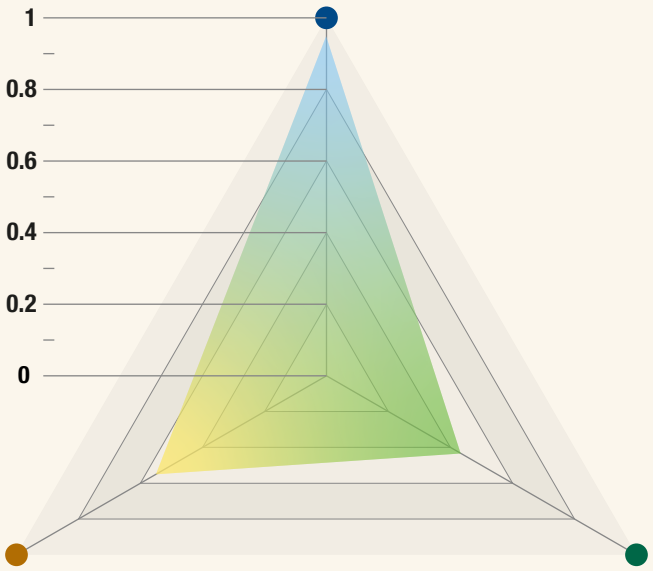
## | 3.8 Plastic-to-Ghar Project

**The Plastic-to-Ghar (P2G) is a locally led platform aimed at reducing plastic pollution in Nepal and improving living conditions for marginalized highland residents by transforming plastic waste into durable housing products.** With SMEP programme support and organized by Impact Hub Kathmandu and the University of Cambridge, local entrepreneurs were identified and selected through MAKEathon sessions, which consisted of two rounds of master classes and 21 coaching sessions with six teams. The project has shortlisted five initiatives led by local entrepreneurs to develop innovative solutions and incubating these into start-ups and franchises with small-scale plastic upcycling production units across Nepal, namely:

1. **Paramendo in Ree Gaun, Dhanding** roofing tiles and roofing repair sheets;
2. **Scavengers in Koshi, Kathmandu** roofing tiles and sheets;
3. **Geodome in Kathmandu** disaster relief shelter building;
4. **Green Decision Labs and Research (GD Labs) in Bhalamchaur, Lamjung, and Kathmandu** heat / acoustic insulation products for roofing (floss material); and
5. **Plastic Hearts** multi-purpose upcycled plastic beams (e.g., for furniture making or structural materials), based in Kathmandu.

▸ End-of-life solutions

The reason for setting up small decentralized remanufacture units near customers is due to the country's mountainous terrain and consequently significant logistical challenges. Along with reducing plastic pollution, projects aim to create job opportunities and provide access to innovation opportunities for all.




**Social Impact**

- Capacity building and skills trainings provided for women
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- Capacity building and skills trainings provided for community
- Positive impact to livelihood of immediate community
- Positive impact outside the value chain and immediate community
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- Full-time jobs created

**Business Sustainability**

- Long-term sustainability of revenues
- Manageability of costs
- How many sources of revenue can the project generate
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**Technology & Innovation**

- Capacity building for using the technology needed
- Ease of maintenance
- Ease of importing technology
- Ease of usage of this technology for the project
- Ease of technology transfer
- Technology transfer needs
- Technology developed nationally or imported

↑ Figure 14. Plastic-to-Ghar's estimated social impact, financial sustainability, and technology readiness

*Source*
*Survey with project developers; and Focal points of SMEP Plastics portfolio*

### 3.8.1 Paramendo

Paramendo is a company in Nepal, focusing on recycling, upcycling, and converting plastic waste into usable products across mountain villages. The company's goal is to address waste issues through collaboration with local communities and the government. This partnership tackles plastic pollution, aiming for a waste-free community by raising awareness, establishing a circular economy, and selling recycled products, thereby creating employment for the local community. The objective is to build Community Recycling Centers (CRCs) in targeted villages, starting with Ree village in Dhading, where CRC operations have commenced. Currently, Paramendo offers LDPE wraps and recycled tiles for roofing repair. The team, formed during the "Plastic-to-Ghar" MAKEathon session in November 2022, organized by Impact Hub Kathmandu, underwent a seven-month incubation to develop and finalize their products using plastics collected in the CRC.

Plastic waste poses a significant challenge in Nepali villages, particularly in Ree, Dhading. Improper waste management, including open burning, affects both the environment and residents' health. Roofing issues (water leakages, noise coming from the Corrugated Galvanized Iron (CGI) sheet roofs, thermal insulation problems, etc.), unemployment and unskilled labor are other major challenges faced by the villages in Ree.

Paramendo explores a circular economy model, utilizing plastic waste from Ree to create value. Since recycled building materials are limited in the Nepali market, the project focuses on waste collection, segregation, and upcycling for building materials competing with alternatives such as M-seal, tapes, sprays, and existing roofing panels for roof repairs. The project's two core products are: i) recycled LDPE sheets and ii) recycled HDPE and PP tiles for roofing. LDPE wraps, made

↑ Image 31. Paramendo trains Ree Village youth in waste management and plastic upcycling

© Paramendo Nepal

from common Nepali plastics, underwent extensive design iterations and testing for roof repair. HDPE and PP plastics are used for 10mm tiles, and are currently in development. Given the potential inclusion of chimneys, the project is also considering incorporating fire retardant materials, especially in areas where chimneys will be installed. This proactive approach aims to enhance safety measures and reduce potential risks.

The project is currently in a phase dedicated to gathering scientific data through material testing, which could attract first-time buyers, and foster confidence in the quality and effectiveness of the upcycled products. Both products, the roofing tiles and the sheets, are planned to be sold to local communities, in particular the villages around Ree and Dhading Besi. The location of the CRCs plays an important role given the transportation challenges, considering accessibility, employment opportunities, and potential reluctance from other wards due to increased transport costs. Thus, the project is exploring possibilities for mitigating additional transport costs for waste transportation to ensure broader community participation. Since the project is in its early stage, it has yet to evaluate its potential scale to determine whether it justifies having a full-time upcycling machine at each location, considering economic feasibility and impact on waste management efficiency.

The project offers capacity-building events and training to youth and the local community of Ree village to equip them with knowledge and skills on how to turn the plastic waste problem into an economic opportunity. Once the project is well established, it could generate employment, and diversify, and increase revenue, hence ensuring long-term financial sustainability.

### 3.8.2 Plastic hearts

Plastic pollution is significant in Kathmandu, with plastic waste constituting half of the recyclable waste. Formed during the Plastic-to-Ghar program at Impact Hub Kathmandu, the Plastic Hearts project aims to address plastic waste by producing beams and furniture using common types of plastics, such as PP and HDPE. Currently, the project is in a prototype phase, focusing on the development and design of the products. After the prototype beams are built, Plastic Hearts will start a company registration process.

The project aims to change community perceptions toward waste through awareness and participation in recycling initiatives, reduce the need for new plastic production, reduce plastic furniture imports, and save on waste disposal costs. The project's objective is to divert waste from landfills, replace wood and virgin plastics in furniture with recycled plastic, and offer high-quality, locally produced and eco-friendly furniture.

Plastic beams and furniture (e.g., chairs) are currently the project's two core products and are planned to be sold through: i) business-to-business channels, such as offices, restaurants, furniture makers and retailers, or ii) business-to-customer directly, involving individual households, schools and makers. Initial prototyping involved creating moulds and extruding plastic beams from PP pellets, which are easily available in Nepal, cheaper and more rigid. A folding chair prototype was produced using plastic beams and PET bottles for joints. HDPE caps of large 20-liter water bottles were also used in testing. PP pellets are purchased, brought in, processed by heat in an extrusion machine and moulded to prepare the beams (standard size used in construction: 34x20mm). Different types of metal moulds (e.g., iron moulds are produced in FabLab, supported by the Impact Hub) are used to make different types of beams. To avoid generating microplastics, beams are polished using wet sand technology.

The Plastic Hearts project is considering developing three products or services:

1. Basic plastic beams;
2. Furniture made from plastic beams - enhancing marketing for products, and involving craftsmen to produce high-quality beams; and
3. Teaching methods for rural villages on how to produce beams for small repairs and furniture making locally (selling instructions to municipalities and purchasing machinery for processes). This could economically empower artisans, involving the broader local community in plastic beams and furniture production, thus diversifying economic dependency and job creation.

Once the products are proven to work the project is easily scalable. It will need new machinery to expand production and organize the business process to be more efficient. It comes as an advantage that the qualified workforce is readily available due to the project's geographical focus on industrial areas in Kathmandu. However, machines are usually imported from India, resulting in higher costs of operations due to transport and importing fees.

In the future, there might be a possibility to explore a broader range of applications far beyond furniture. Overall, there are opportunities for how the project could advance applications of plastic beams, optimize the assembly process, and strategically target markets (e.g., tourism) by emphasizing sustainability in design.

### 3.8.3 Green Decision Labs

GD Labs is developing and testing an insulation product from discarded plastic waste. Discarded plastics are purchased from waste collectors (aggregators) and taken to a third-party pelletizing company specializing in producing PP pellets. Once PP pellets are delivered to GD Labs, they are processed into floss, which is similar to rock wool, and then, using cress machines shaped into a blanket, which itself is a product. The project aims to further add value by assembling it in the form of a modular panel for thermal insulation or heat protection used in construction (e.g., houses, schools, resorts, etc.) or in soundproofing (e.g., recording studios). Apart from PP pellets, machines have been upgraded to process PET pallets, shredded and unshredded PP and PET.

Core products GD Labs develops are:

1. Insulation roll with decorative wallpaper made from recycled plastic wool, and intended for use as an insulation product below the galvanized metal roof of the homestays in Bhalamchaur. It has a layer of decorative wallpaper beneath the insulation roll.
2. Insulation roll with decorative wallpaper made from discarded plastic converted into wool with the help of a floss machine. It has fire-resistant properties.

↓ Image 32. Poly+ Rolls cutting for installation at Khokana piloting site by Green Decision Labs and Research

© GD Labs

Projected sources of revenue would be from the sale of polyfloss blankets made from PP and PET, boards, and PET floss (e.g., filling material for jackets, pillows, dolls). The project is scalable through expansion, but additional machines would be needed to allow for continuous production. This requires substantial financial investment as machines are imported from France and cost around 2.7 million Nepali rupees (about US$20,000). There are some locally manufactured machines available for 1.2 to 1.8 million Nepali rupees (US$9,000 to 13,500), potentially a cheaper option.

### 3.8.4 Geo Dome

The Himalayan region of Nepal is frequently plagued by natural disasters, including earthquakes, landslides, and floods. These disasters result in the loss of lives, homes, and livelihoods for vulnerable communities in remote areas. The construction industry in Nepal faces several challenges when it comes to disaster-resistant housing. Traditional building materials are often costly and construction methods are time-consuming. This is particularly problematic in remote regions where access to resources and skilled labor is limited. Moreover, the prevalence of plastic waste exacerbates environmental concerns. While there are various disaster-resilient housing solutions globally, many are expensive and not tailored to the specific needs of Nepali communities.

Determined to make a difference, Geo Dome embarked on a journey of innovation and social impact, culminating in the founding of Project Geodome. The project offers a solution that transforms recycled plastic waste into durable and disaster-resistant geodomes for remote communities in Nepal. These geodomes provide a safe, environmentally sustainable and affordable housing option for communities vulnerable to natural disasters. The geodomes have proven to be a transformative solution for disaster-prone communities in Nepal. Their unique design and construction using recycled plastic materials make them resilient and well-suited to withstand the harsh conditions of the Himalayan region. Furthermore, they offer unparalleled safety during earthquakes, landslides, and floods, providing a secure shelter for families. As a symbol of hope and resilience, these geodomes are not considered just buildings; they are seen as beacons of progress and security in the face of adversity.

Currently, the project accounts for three core products:

1. **Recycled plastic geodomes:** their primary product, the geodomes are constructed using recycled plastic materials and are designed to withstand natural disasters;
2. **Community engagement services:** the project provides training and support to local communities for plastic waste collection, fostering a sense of ownership and involvement; and
3. Consultation and education: the team offers consulting services and educational programs to promote sustainable practices in disaster-prone regions.

## 3.9 Other Projects

**Two additional projects were initially confirmed and supported during Phase I, however they did not advance to Phase II.**

### 3.9.1 PA Consulting Project

In 2022, the SMEP programme, in collaboration with Global Access Diagnostics Ltd (GAD) selected and funded a project led by PA Consulting, a consultancy specializing in innovation and transformation to develop diagnostic cassettes made from cellulose fiber-based alternative. Sourced from local agricultural waste such as bagasse or bamboo, this alternative material eliminates the use of single-use plastic in lateral flow tests. These cassettes are widely used in diagnostics for diseases such as malaria, HIV, COVID-19, dengue, measles and cholera, where early treatment is of great importance but also generate tons of plastic waste (Solanki, A., n.d.).

The project's goal was to introduce the cellulose fiber-based product as a substitute for the existing products manufactured by GAD and their in-country partners. Using local agricultural waste fibers could provide substantial local benefits (e.g., jobs and manufacturing opportunities). The design of these cassettes aimed to match the cost and performance of their plastic counterparts, ensuring compatibility with current assembly equipment and minimizing the need for equipment upgrades or investments, which would enable quick adoption and integration by offering a comparable-cost product with notable environmental benefits.

In collaboration with Swedish R&D and IP company, PulPac (e.g., development of Dry Molded Fiber (DMF) technology), the project produced a prototype. After numerous tests on variations of the cassette, PA Consulting has demonstrated that cassettes made from organic material were mechanically stable, and trials have indicated that there is little effect when the cassettes are stored for prolonged durations in their existing packaging.

### 3.9.2 B-PRISM

The goal of the Bangladesh-Plastic Pollution Reduction through Industrial Symbiosis Matching (B-PRISM) was a SMEP supported initiative to promote industrial symbiosis in Bangladesh, redirecting plastic waste away from disposal sites. These efforts aimed to alleviate the adverse environmental and social effects caused by pollution from manufacturing industries.

International Synergies Limited (ISL) led the project of industrial symbiosis (e.g., one company or industry leveraging the underutilized resources of another, encompassing waste, by-products, energy and materials, to extend the productive lifespan of resources). It seeks to unify stakeholders within the plastics industry in Bangladesh through a consolidated platform facilitated by SYNERGie® software, aiming to mitigate the economic, environmental, and social impacts of plastic waste. Using materials that would otherwise be discarded and integrating recycled materials into manufacturing processes, the project would curtail energy consumption and carbon emissions compared to producing new products from raw materials.

B-PRISM has received widespread backing for its project phase supported by the SMEP programme from the industry, government, informal sector, and NGOs. The industrial symbiosis support tool SYNERGie® has been established in Bengali for Bangladesh, and both SYNERGie® and industrial symbiosis training have been conducted in collaboration with the country partner Maxwell Stamp Limited. Even though the project has engaged with various stakeholders, including industries, the project did not advance to the next phase of the SMEP programme cycle.

# 4.
# Conclusion

**The good news:** Global plastic recycling rates are expected to increase from 9 per cent in 2019 to 17 per cent in 2060.

**The bad news:** This progress remains woefully insufficient, as unsustainable methods of waste disposal e.g., incineration and landfilling continue to dominate plastic waste management. Plastic pollution has reached alarming levels with severe impacts on ecosystems, biodiversity, human health, and the global economy. Its pervasive presence in terrestrial and marine ecosystems disrupts food chains, damages habitats, and poses serious health risks from microplastics and hazardous chemicals in plastic products and waste. Furthermore, plastic production and disposal contribute to greenhouse gas emissions, underscoring plastic pollution's role in accelerating climate change. Vulnerable countries and communities, particularly Small Island Developing States (SIDS), and least developed countries (LDCs) – often lacking regulatory tools, robust infrastructure and financial resources – disproportionately bear the brunt of the escalating plastic pollution crisis and its wide-ranging impacts.

**The turning point:** Increasing environmental awareness and mounting scientific evidence about the impacts of plastic pollution highlight the urgency for sustainable solutions, driving the growing demand for recycled products, non-plastic substitutes and viable alternatives. This shift is amplified by international calls for targeted plastic product management, sustainable design, and phased reductions in harmful chemicals, as highlighted in the Intergovernmental Negotiating Committee (INC) discussions on an international legally binding instrument on plastic pollution, including the marine environment (ILBI). Public and private efforts are now focused on developing solutions that not only address the rising volumes of plastic waste (mitigation) but also reduce dependence on virgin plastic production (prevention). These actions align with SDG Targets, specifically, 12, 13, 14, 15 and 17, and broader objectives of both the Kunming-Montreal Global Biodiversity Framework (GBF), the Basel, Rotterdam and Stockholm (BRS) Conventions, and the Paris Agreement under the United Nations Framework Convention on Climate Change (UNFCCC), demonstrating how tackling plastic pollution supports sustainable development by driving nature-positive outcomes, and enabling climate change mitigation and adaptation.

Given that a comprehensive ILBI for plastic pollution control is still under negotiation, existing control measures remain limited and vary in their scope and enforcement across regions. Addressing this regulatory gap requires enabling environments as highlighted by SMEP programme's eight plastic portfolio projects on (i) the importance of innovative localised solutions, and (ii) the potential for developing countries to transform plastic pollution into economic opportunities by creating new capacities and livelihoods and expanding exports.

The SMEP plastics projects use different business models emphasising long-term social, environmental and financial sustainability, and transforming how businesses define, generate, deliver and capture value. However, adapting business models to evolving market dynamics and shifting policy landscapes takes time and resource optimisation. As early-stage initiatives, SMEP plastics projects face high start-up costs, particularly for small, local businesses, and require further support to succeed despite their environmental and social significance. Persistent challenges such as access to finance (e.g., general availability of R&D funding), high costs of material inputs for projects working with material substitution, inadequate or poorly enforced national policies related to plastics, stand against opportunities created by the growing global demand for recycled and sustainable products. Additionally, barriers to technology imports e.g.,

transport costs (47.6%), import taxes (31.5%), and permits (10.5%) (Figure 3), further hinder the scalability of SMEP initiatives, especially those dependent on advanced production processes. Despite these challenges, this report's key messages highlight SMEP plastic projects' capacity to advance practice and policy for circular economies, contextualized innovation, and community empowerment while addressing pressing health and environmental risks:

- **Circular economy and lifecycle approaches:** Key drivers, such as increasing demand for sustainable solutions and leadership opportunities (Table 3), propel SMEP plastics projects like Flipflopi, Plastic-to-Ghar, and Ghana Clean-up in operationalising circular economy principles. These initiatives reduce plastic leakage, retain value within waste streams, and operationalise lifecycle approaches by addressing plastics across production, usage, and end-of-life stages. SMEP's community-driven solutions reflect international calls for lifecycle management and circularity, particularly under SDG 12, GBF Target 7, Basel Convention (Plastic Waste Amendments) and the INC framework, which emphasise sustainable product design and context-specific solutions for developing countries. However, addressing barriers such as financing gaps and technical constraints (Table 4) through targeted policies and financial mechanisms is essential to maximise their impact on global plastic governance.

- **Innovative material substitution and product redesign:** Projects like Catchgreen's biodegradable fishing nets, CSIR's (Agrimulchfilm's) mulch films, and FreshPPact Hub's packaging innovations address plastic dependency in high-impact sectors, such as marine fishing, agriculture, and packaging. These scalable innovations operationalise INC discussions on an ILBI, which prioritise targeted product management and material substitution, as well as broader frameworks like SDGs 2, 12, 14, and 15, the Basel (Plastic Waste Amendments) and Stockholm (specifically on Persistent Organic Pollutants [POPs]) Conventions, and the Global Biodiversity Framework. These frameworks emphasise reducing plastic pollution through nature-positive solutions and supporting sustainable product lifecycles to minimise ecosystem impacts. Figure 1 highlights these projects' potential for reducing conventional plastic use and advancing lifecycle approaches. However, as noted in Table 4, scaling these solutions requires addressing financing gaps and resource constraints. Strengthening enabling environments through targeted policy and financial mechanisms is essential to maximise their impact.

- **Enabling environments for scaling innovation:** SMEP plastics projects like CSIR (Agrimulchfilm), Catchgreen, and FreshPPact Hub highlight the critical role of enabling environments in overcoming systemic barriers (Table 4) to scaling sustainable innovations. As illustrated in Table 3, future regulatory measures e.g., Extended Producer Responsibility (EPR), recycling targets, and public procurement are expected to have significant positive impacts on SMEP plastics projects, driving market demand for alternatives and recycled materials. Trade measures e.g., import bans and tariffs on virgin plastics further support projects developing alternative materials by addressing supply and demand dependencies, aligning with WTO's Trade and Environment Work Programme under the Dialogue on Plastic Pollution and Environmentally Sustainable Plastics Trade (DPP). However, overly restrictive measures, such as complete bans on plastics (Table 1), could negatively impact recycling-focused initiatives. Additionally, the absence of dedicated HS codes for innovative and sustainable materials, including plastic substitutes and alternatives, leads to high tariffs and inconsistent classifications across borders, increasing costs and reducing competitiveness with petroleum-based plastics. To address these challenges, targeted policies that balance support for material innovation with circular economy goals are crucial to maximising SMEP's impact on global plastic management.

- **Empowering communities through just transitions is crucial to addressing plastic pollution sustainably while ensuring socio-economic equity:** Vulnerable groups, such as waste pickers and informal workers, play a vital role in waste management but often lack formal recognition and support. SMEP plastics projects like Ghana Clean-up and Flipflopi demonstrate the potential of formalising informal work, enabling capacity and new skills, and creating sustainable livelihoods. However, challenges like limited financing, high input costs, and regulatory gaps, as highlighted in Table 6, constrain scalability. Mechanisms like EPR, public procurement incentives, and trade reforms (Table 3) are essential to overcome these barriers and enable community-driven solutions. By strengthening capacities and promoting inclusive policies, these measures support SDG 8 (Decent Work and Economic Growth), SDG 10 (Reduced Inequalities), UN Guiding Principles on Business and Human Rights and other frameworks such as the ILO's Just Transition guidelines, driving resilient and equitable pathways for plastic pollution management.
- **Mitigating the health and environmental risks of plastic pollution is critical to safeguarding ecosystems, biodiversity, and human well-being:** SMEP plastics projects e.g., Catchgreen, Chinhoyi University Roofing Tiles Initiative, and FreshPPact Hub demonstrate innovative approaches to reducing the toxic impacts of plastic pollution. These include scalable material substitution (e.g., biodegradable fishing nets and sustainable construction materials), safer recycling practices, and reducing exposure to microplastics and hazardous chemicals. Addressing these risks requires systemic interventions, including regulatory measures for chemical controls (Table 3), investment in sustainable technologies, and strengthened compliance mechanisms (Table 4). By supporting innovation and demonstrating consistency with global frameworks like SDGs 3, 14 and 12, the BRS Conventions, the Global Biodiversity Framework and INC discussions, these initiatives advance nature-positive solutions that mitigate the impacts of plastics on human and environmental health.

Addressing plastic pollution requires transparency and inclusive stakeholder engagement to tackle the interconnected challenges of pollution, climate change, and biodiversity loss SMEP plastics projects, supported by enabling environments, provide actionable, scalable models and insights for advancing circular economies, reducing plastic waste, and delivering equitable solutions, directly aligned with key INC priorities. By integrating lifecycle management, material substitution, and interfacing with their respective policy and enabling environments, SMEP's plastics initiatives provide evidence to negotiators and policymakers on how to operationalise international goals under the SDGs, GBF, Paris Agreement, and other major global trade and environmental policy frameworks. Embedding these principles into national and global strategies is essential to achieving effective, nature-positive, and climate-resilient outcomes that turn international commitments into tangible progress for the people and the planet.

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