Green Climate Fund Concept Note

Improved Waste Management System through Public-Private Partnership Model

Royal Society for Protection of Nature

EXECUTIVE SUMMARY

Bhutan is internationally recognized for its commitment to environmental conservation, carbon neutrality, and sustainable development. However, rapid urbanization, changing consumption patterns, population growth, and increasing use of packaged goods have led to a significant increase in municipal and institutional waste generation across the country. According to the National Waste Inventory Survey, Bhutan generates approximately 172 tonnes of waste per day, of which more than 45 % is organic waste, while a significant proportion of recyclable materials such as plastics, paper, textiles, metals, and glass remain inadequately recovered and continue to be disposed of in landfills. Despite strong environmental policies, waste management systems remain constrained by inadequate segregation at source, limited recycling and recovery infrastructure, insufficient treatment of organic waste, weak market linkages for recyclable materials, limited public awareness, and inadequate data collection system and monitoring. As a result, a large proportion of waste continues to be disposed of in landfills, contributing to methane emissions, environmental pollution, resource inefficiency, and increasing financial burdens on local governments.

Climate change further exacerbates these challenges. Rising temperatures, changing precipitation patterns, and increasing climate variability affect waste decomposition processes, increase risks of water and soil contamination from unmanaged waste, and place additional pressure on already limited waste management infrastructure. At the same time, vulnerable groups, including women, youth, students, Special Educational Needs (SEN) students, persons with disabilities, and low-income households, often have limited opportunities to participate in emerging green economy sectors.

To address these interconnected environmental, climate, and socio-economic challenges, the proposed project, “Improved Waste Management System through a Public–Private Partnership (PPP) Model,” seeks to establish an integrated, climate-resilient, and circular waste management system across 75 schools and institutions across Bhutan. The project aims to transform waste from an environmental liability into a valuable resource while strengthening climate resilience, reducing greenhouse gas emissions, creating green livelihoods, promoting social inclusion, and fostering long-term behavioral change.

The project adopts an innovative Public–Private Partnership approach that combines public sector initiatives, private-sector expertise, educational institutions, community participation, and civil society engagement. The initiative recognizes schools as strategic centers for environmental learning, behavioral transformation, and community outreach. By embedding sustainable waste management practices within schools and linking them with local recycling enterprises, agricultural systems, and community networks, the project will create a replicable model capable of catalyzing nationwide transformation.

The project comprises four integrated components that promote a circular and climate-resilient waste management system. These include decentralized composting and climate-smart food

production; recycling and upcycling of textiles, plastics, and other recyclable materials into value-added products; production of arts and crafts from waste to support innovation and inclusive green livelihoods; and the establishment of a knowledge management, data monitoring system to strengthen evidence-based decision-making, accountability, and long-term behavioral change. Together, these components will reduce waste disposal, lower greenhouse gas emissions, enhance resource efficiency, create livelihood opportunities, and strengthen environmental awareness and climate resilience in schools and communities.

The project requires a total investment of **USD 8.73 million**, including **USD 7.86 million from the Green Climate Fund (GCF)** and **USD 0.87 million in co-financing from schools, Selwa and RSPN**. As a public-good intervention, the project is not intended to generate commercial profits and therefore shows a negative Return of Investment and no achievable payback period under conventional financial metrics. However, its substantial climate, environmental, social, and educational benefits including reduced landfill dependency, avoided environmental degradation, improved public health, enhanced food security, increased climate resilience, strengthened environmental awareness, and expanded livelihood opportunities for vulnerable groups strongly justify the need for grant-based climate finance to support transformative and long-term sustainable development outcomes.

The project is expected to deliver substantial and measurable climate mitigation outcomes. Annual greenhouse gas emissions reductions are estimated at approximately 1,200 tonnes of carbon dioxide equivalent (tCO_2e), resulting in cumulative lifetime reductions of approximately 24,000 tCO_2e over a 20-year period. Organic waste composting accounts for approximately 810 tCO_2e annually, representing nearly 68% of total emission reductions, making it the most significant mitigation pathway within the project. Additional reductions will be achieved through recycling, upcycling, waste diversion from landfills, local food production, and renewable energy generation through agrivoltaic systems.

Beyond direct emissions reductions, the project contributes to climate adaptation and resilience by improving soil productivity, reducing dependence on imported agricultural inputs, enhancing local food production capacity, strengthening community awareness of climate risks, and promoting sustainable resource management practices. The intervention will also improve institutional capacity for climate-responsive planning and strengthen the resilience of educational institutions and communities to future environmental and climate-related challenges.

The project directly supports Bhutan's Nationally Determined Contributions (NDCs), National Adaptation Plan (NAP), Waste Management Strategy, Circular Economy initiatives, and the 13th FYP while contributing to multiple Sustainable Development Goals. By integrating climate action, circular economy principles, environmental education, social inclusion, and green livelihood development, the project will establish a scalable and replicable model for sustainable waste management that promotes low-carbon, climate-resilient, and inclusive development across Bhutan.

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Acronyms and Abbreviations

CH_4	Methane
CH	Methane
CO_2	Carbon Dioxide
COP	Conference of Parties
CSO	Civil Society Organization
ESS	Environment and Social Safeguard System
GCF	Green Climate Fund
GHG	Green House Gases
GNH	Gross National Happiness
NAP	National Adaptation Plans
NDCs	Nationally Determined Contributions
NEC	National Environmental Commission
N_2O	Nitrox Oxide
PET bottles	Polyethylene Terephthalate bottles
PPE	Personal Protective Equipments
PPP	Public-Private Partnership Model
PWD	People with Disabilities
RSPN	Royal Society for the Protection of Nature
SDG	Sustainable Development Goals
SEN	Special Educational Needs
UNFCCC	United Nation Framework Convention on Climate Change
UNESCAP	United Nations Economic and Social Commission for Asia and the Pacific
WMD	Waste Management Division

1. Introduction

1.1 Background Information

Bhutan conserves its natural environment through a holistic and policy-driven approach that integrates ecological protection with cultural values and sustainable development. Guided by the philosophy of Gross National Happiness (GNH), the country prioritizes environmental conservation as a key pillar of national development, ensuring a balance between human well-being and ecological integrity (Generis Global Legal Service, n.d). Bhutan, despite its strong commitment to environmental conservation and carbon neutrality, waste generation is steadily increasing, especially in urban centers.

Bhutan has seen a significant rise in solid waste, increasing from around 30 tons per day in 2008 to 170 tons per day in 2019, largely due to urbanization, population growth, and higher consumption. Urban residents generate more waste (0.7 kg/day) compared to rural residents (0.4 kg/day), with cities such as Thimphu facing the greatest strain on waste management. While organic waste continues to make up the largest portion (45–50%), the share of plastics and other non-biodegradable materials is steadily growing. Waste collection remains limited, covering about 75% of urban households and only 15% of rural areas, with a significant portion of waste still ending up in landfills or open dumping sites (Namgay, 2020).

In response to the growing challenges of improper waste management, this project proposes an integrated waste management approach through a Public–Private Partnership (PPP) model, focusing on decentralized composting and climate smart agricultural system, recycling and upcycling of discarded textiles, cement bags and polyester fibers into value added product such as school and desuup uniform, socks, bags, and other useful household items, and converting waste materials into creative arts and crafts. By leveraging private sector efficiency, community engagement, and institutional effective implementation, the project aims to promote a circular economy there by reducing waste volume, reducing environmental impacts, and contributing to Bhutan's climate commitment and sustainable development goals.

Also, the proposed project on integrated waste management through a PPP model directly supports the NDCs by reducing green-house gas emission from unmanaged waste, promoting resource recovery, and minimizing landfill dependency. At the same time, it enhances climate resilience by reducing environmental pollution while supporting sustainable agriculture through compost use (UNFCCC, 2025). By aligning with national priorities on mitigation, adaptation, circular economy, and private sector engagement, the project contributes meaningfully to the implementation of Bhutan's third NDC and its broader goal of achieving climate-resilient and inclusive green growth

1.2 Waste Management Challenges in Bhutan

Bhutan faces growing challenges in waste management due to rapid urbanization, growing consumption patterns, limited infrastructure, and institutional capacity. According to Bhutan Waste Accounts Report (2021), Bhutan faces significant gaps in understanding and managing its waste flows, primarily due to limited data, inadequate tracking systems, and informal practices, which hinder evidence-based policy and planning. Although the country conducted its first national waste inventory survey in 2019, the data lacked detailed information on waste collection, treatment, and disposal, making it difficult to accurately quantify how much waste is generated by different sectors and how it is ultimately managed.

The report also highlights challenges such as mixed waste streams that are hard to segregate once collected, limited infrastructure for recycling and composting, and the need for improved statistical systems that can support monitoring of national targets such as waste recycled under Bhutan's 12th Five-Year Plan. Collectively, these challenges point to weaknesses in data quality, institutional capacity, and proper waste management practices that must be addressed to make more effective interventions and support sustainable waste management in Bhutan.

According to Zero Waste Bhutan (n.d), there is a large disparity in access to waste management services between urban and rural areas in Bhutan. While most urban households (over 75%) have some level of waste collection, the majority of rural households (around 85%) do not receive regular waste collection services, leaving them dependent on informal disposal methods such as open dumping, burning, or unmanaged composting. These lack of access to formal waste collection in rural areas highlight gaps in infrastructure, service coverage, and equity, showing that current waste management systems are insufficient to meet the needs of the entire population.

At the same time, low public awareness and poor waste segregation practices exacerbate illegal dumping and environmental pollution. The landfills in Bhutan are overflowing due to the minimal current practices of waste treatment, recovery and recycling with most of Bhutan's waste dumped in open, minimally engineered landfills without leachate collection or treatment systems. The resulting toxic leachate can contaminate soil and water, posing risks to human health and ecosystems where monitoring is limited. For example, leachate from the Memelakha landfill in Thimphu likely enters the Olarongchu stream, although its movement and composition are poorly understood. The situation calls for better site selection, baseline data, and leachate treatment systems to prevent environmental degradation as waste volumes increase (Water Research Bhutan, 2022).

Improper waste disposal, including plastic waste and construction debris, is a major cause of blocked drains in Thimphu, leading to severe flooding, waterlogging, foul odor, and public health risks during the monsoon season. The recurring drainage crisis highlights the urgent need for improved waste management, regular drain maintenance, and stricter enforcement against illegal dumping (Bhutan Today, 2026).

Thus, effective waste management requires a comprehensive approach that prioritizes reduction, reuse, and recycling, supported by robust collection, treatment, and safe disposal systems to protect the environment. It demands active public participation, strict enforcement of regulations, and investment in modern infrastructure and technology. By embracing sustainable practices and innovative solutions, societies can significantly reduce the environmental and social health impacts of waste while advancing a circular economy and long-term ecological resilience.

1.3 Waste and Climate Impact

Waste significantly contributes to climate change through both direct and indirect greenhouse gas emissions. When organic waste such as food, paper, and yard materials decomposes in landfills without oxygen, it releases methane (CH_4), a highly potent greenhouse gas that traps far more heat than carbon dioxide (has global warming potential of approximately 27 to 30 times the CO_2 over 100year time period). In addition, waste management processes such as incineration emit carbon dioxide (CO_2); while composting and wastewater treatment can produce nitrous oxide (N_2O), another powerful greenhouse gas. Beyond these direct emissions, waste also contributes indirectly through the entire lifecycle of products including resource extraction, manufacturing, and transportation which generates substantial greenhouse gas emissions (Climate Change Academy, 2024). Thus, waste plays a significant role in global warming by contributing to emissions at multiple stages of production, consumption, and disposal.

Waste management has emerged as a critical entry point for climate action, as unmanaged waste, particularly organic fractions generates significant amounts of methane through anaerobic decomposition in landfills. Recognizing this, at **COP29 (2024)** in Baku, over 30 countries committed to reduce methane emissions from organic waste, targeting roughly **30 % below 2020 levels by 2030.** The declaration highlights the climate, health, and biodiversity benefits of cutting methane from landfills and unmanaged organic waste. It emphasized scaling up climate finance and technical support to promote climate-resilient and low-emission waste management systems, particularly in developing countries, aligning mitigation and adaptation objectives within a circular economy framework inclusion in NDCs with equitable solutions for vulnerable populations affected by poor waste management (COP 29 Presidency, 2024).

1.4 Institutional and Policy Framework on Waste Management

Bhutan addresses waste management through a comprehensive policy and regulatory framework designed to reduce waste generation, proper segregation at source, promote recycling, and ensure environmentally sound disposal. Institutional mechanisms, led by the Waste Management Division under the Department of Environment and Climate Change, erstwhile- National Environmental Commission secretariat, coordinate implementing and collaborating agencies, monitor compliance, collect data, and ensure alignment with international obligations such as the Basel Convention on the Control of Transboundary Movements of Hazardous Waste and their Disposal. Together, these policies and regulations combine legal enforcement, technical guidelines, capacity building, and advocacy to address Bhutan's growing waste challenges

systematically (National Environmental Commission, n.d). In order to address the issue of waste, legislations and policies have been put in place which includes the following:

- **Waste Prevention and Management Act 2009**

Provides the legal framework for environmentally sound waste management across the country. It covers all waste types and sources, promotes waste minimization, segregation, reuse, and recycling, and defines the responsibilities of government agencies, the private sector, and citizens. The Act applies the **polluter pays principle**, requiring polluters to bear environmental and health-related costs, and includes provisions for waste management planning, financial incentives, public awareness, research, monitoring, and enforcement to ensure compliance.

- **Waste Prevention and Management Regulation 2012 and its amendment 2016**

Operationalizes the 2009 Act by establishing requirements for waste collection, segregation, treatment, recycling, and safe disposal. It mandates waste management plans, record-keeping, and cost recovery mechanisms, prohibits illegal dumping, and defines responsibilities for individuals and organizations. The Regulation also provides enforcement measures, penalties, and controls on waste import and export to ensure environmentally sound waste management.

- **National Waste Management Strategy 2019**

Aims to achieve **"Zero Waste Bhutan by 2030"** by promoting a circular economy approach. It focuses on waste reduction at source, reuse, recycling, and resource recovery while minimizing landfill disposal. The strategy emphasizes improved waste collection and treatment systems, stronger institutional coordination, sustainable financing, enhanced infrastructure, and active participation of government, private sector, and communities. It also seeks to reduce environmental pollution and greenhouse gas emissions from the waste sector.

- **National Zero Waste Hours**

It is a nationwide campaign launched by Her Majesty the Gyaltsuen to support Bhutan's goal of becoming a **zero-waste society by 2030**. Observed on the second day of every month, it encourages citizens to dedicate time to waste collection, segregation, recycling, and composting. Guided by the principle **"My Waste, My Responsibility,"** the initiative promotes behavioral change, public awareness, community participation, and environmental stewardship while helping reduce pollution and climate impacts.

- **Waste Management Flagship Program**

The Waste Management Flagship Program is a national initiative aimed at transforming Bhutan's waste management system and achieving the goal of "Zero Waste Bhutan by 2030." The program focuses on reducing waste generation, promoting waste segregation, recycling, and resource recovery, improving waste collection and treatment infrastructure, and minimizing reliance on landfills. It also seeks to strengthen public awareness, institutional capacity, and private sector participation to establish a sustainable and circular waste management system across the country.

Despite Bhutan's comprehensive national policies, regulations, and frameworks on waste management, the country continues to face escalating waste challenges due to rapid urbanization, population growth, limited infrastructure for segregation and recycling, and low public awareness on sustainable waste practices. Landfills are expanding, organic and plastic waste generation is rising, and existing systems struggle to process increasing volume of waste efficiently, highlighting a critical gap between policy ambition and on-the-ground implementation. Strengthening institutional coordination, implementing waste processing technologies, and promoting community engagement remain urgent priorities to achieve Bhutan's vision of sustainable and zero-waste management.

1.5 Alignment with National 13th Five Year Plan (2024-2029)

This project is closely aligned with Bhutan's 13th Five-Year Plan (2024–2029), particularly its priorities on sustainable waste management, circular economy development, inclusive social development, and climate resilience. The project promotes waste segregation, recycling, composting, organic waste management, and waste monitoring systems to reduce landfill disposal and strengthen environmental sustainability. It also supports skills development, livelihood creation, and economic inclusion for Special Educational Needs (SEN) students and Persons with Disabilities (PWDs) through vocational training and waste-based livelihood activities. Furthermore, the project contributes to climate resilience, improved environmental governance, and evidence-based planning through enhanced waste data collection, community awareness, and sustainable resource management practices. The proposed project on directly aligns with Bhutan's 13th Five-Year Plan by contributing to several National Key Result Areas (NKRAs), particularly:

1. Sustainable Environment, Climate Resilience, and Carbon Neutrality: The project promotes integrated waste management through composting, recycling, upcycling, and circular economy practices that reduce greenhouse gas emissions, landfill waste, and environmental pollution while supporting Bhutan's climate resilience and carbon neutrality commitments. The project also builds climate resilience and adaptive capacity among SEN students, their caregivers, and persons with disabilities by promoting climate-smart agriculture, and the production of fresh, nutrient-rich crops through greenhouse, hydroponic, and aquaponic systems.

2. Enhanced Economic Productivity, Diversification, and Employment: The project supports green economic development through waste-based innovative business ideas, recycling industries, upcycling of textile products, compost production, and circular economy business models that create green jobs and livelihood opportunities.

3. Operational Shock-Responsive, Inclusive, and Comprehensive Social Protection System: The project promotes inclusive development by creating livelihood, training, and participation opportunities for SEN students, caregivers, women, youth, and persons with disabilities through collaboration with SELWA and other institutions.

4. Improved Access to Quality and Wholesome Education and Lifelong Learning: The project strengthens practical learning and environmental education through decentralized composting in schools, hydroponics, aquaponics, recycling, and sustainable agriculture systems that build technical and vocational skills among students and communities.

5. Improved Health and Wellbeing for All Bhutanese: The project contributes to cleaner environments, reduced pollution, improved sanitation, proper waste management, and production of fresh and nutritious food through sustainable agriculture systems within institutions.

6. Strengthened Governance, Public Service Delivery, and Digital Transformation: Through the Public–Private Partnership (PPP) model, the project strengthens collaboration among government agencies, schools, private sector actors, civil society organizations, and local communities to improve sustainable waste management systems and service delivery.

1.6 Alignment with United Nation Sustainable Development Goals.

The proposed project strongly aligns with the Sustainable Development Goals (SDGs) by promoting sustainable waste management, climate resilience, inclusive development, circular economy practices, and environmental sustainability through an integrated Public–Private Partnership (PPP) approach. By addressing waste reduction, resource recovery, livelihood creation, renewable energy integration, and social inclusion, the project contributes significantly to the sustainable development priorities and supporting global commitments toward climate action, equitable growth, and environmental protection.

1. Alignment with SDG 8-Decent Work and Economic Growth: The project creates green jobs, strengthening local entrepreneurship, and promoting sustainable economic growth through circular economy interventions. By converting waste into valuable products such as compost, reusable bags, recycled textiles, handicrafts, and agricultural produce, the project creates livelihood opportunities for SEN students, women, caregivers, and persons with disabilities. It also enhances technical skills in recycling, composting, sustainable agriculture, and textile

production while promoting private sector engagement and local market development for long-term economic sustainability.

2. Alignment with SDG 10-Reduced Inequalities: The project ensures inclusive participation of vulnerable and marginalized groups, particularly Special Educational Needs (SEN) students, caregivers, women, and persons with disabilities. Through SELWA, the initiative creates accessible and meaningful livelihood opportunities in areas such as textile-based useful household goods production, awareness activities, packaging, and product marketing. This inclusive approach promotes equal opportunities, social integration, skills development, and economic empowerment while reducing social and economic inequalities.

3. Alignment with SDG 13-Climate Action: The project aims to reduce greenhouse gas emissions through sustainable waste management, composting, recycling, and renewable energy integration there by significantly reducing methane emissions while producing nutrient-rich compost that improves soil health and carbon sequestration. The integration of solar-powered agrivoltaics, greenhouse farming, hydroponics, and aquaponics further strengthens climate resilience, resource efficiency, and low-carbon development, contributing to Bhutan's climate change mitigation and adaptation goals.

4. Alignment with SDG 15- Life on Land: It reduces environmental pollution, improves soil fertility, and promotes sustainable land management through composting and climate-smart agriculture, reduces soil degradation and environmental contamination. The use of organic compost enhances soil health, biodiversity, and water retention while reducing reliance on chemical fertilizers, supporting more resilient ecosystems.

2. Problem Statement and Objective

2.1 Project Rational

According to the Bhutan Waste Accounts Report (2021) by the United Nations Economic and Social Commission for Asia and the Pacific, a major constraint is the lack of reliable and consistent data on waste generation and management which hampers effective tracking of waste flows and the development of evidence-based policies. In addition, Bhutan faces limited recycling and resource recovery infrastructure, weak institutional coordination, and insufficient financial and technical capacity at the local government level. Existing waste collection systems and drop-off centers are inadequate to cope with the increasing volume of waste. These challenges are further compounded by low public awareness and weak enforcement of regulations, underscoring the urgent need for improved infrastructure, stronger governance, and a transition toward circular economy approaches.

In response to these challenges, the Royal Society for the Protection of Nature (RSPN) proposes to strengthen Bhutan's waste management system through a circular economy approach

supported by a Public–Private Partnership (PPP) model. This approach seeks not only to reduce waste volumes, but also to transform waste into valuable resources by promoting recycling, composting, and innovative reuse practices. By engaging the private sector, the PPP model introduces collaboration, technical expertise, and operational efficiency, while enabling risk-sharing and enhancing the financial sustainability of the interventions. It also supports the development of market-based solutions, strengthens accountability, and ensures the long-term viability of waste management systems beyond reliance on public funding.

In Bhutan, where waste generation is increasing and institutional capacity is limited, a Public–Private Partnership (PPP) approach provides a practical pathway to improve waste management, extend waste management services available to more people and cover large area, and support national climate and environmental objectives, including the country's commitments under its Nationally Determined Contributions (NDCs) and National Adaptation Plan (NAP) along with other related policy frameworks. The overall goal of the proposed intervention is to establish a scalable, climate-resilient, and inclusive waste management system in Bhutan through a Public–Private Partnership (PPP) model, which promotes circular economy practices by converting waste into valuable resources.

2.2 Objective

The main objective is to develop a GCF Concept Note on Waste Management through Public-Private Partnership Model incorporating a strong climate rationale, and ensure alignment with Bhutan's national policies, climate strategies, and the six thematic areas of RSPN.

2.2.1 Specific Objectives

1. **To identify and develop innovative, climate-resilient waste management business models through integration of circular economy principles into waste management practices** (e.g., composting, recycling, and upcycling) that reduce landfill waste and greenhouse gas emissions.
2. **To design a Public-Private Partnership (PPP) framework** that enables collaboration between government, private sector, and communities for sustainable waste management solutions.
3. **To quantify the climate mitigation and environmental benefits** of proposed waste management interventions, including reduction in methane emissions and improved resource efficiency.
4. **To promote inclusive socio-economic development** by creating green jobs and livelihood opportunities, particularly for SEN students and their care giver, women, youth, and persons with disabilities.

5. **To strengthen awareness and capacity on sustainable waste management practices**, including waste segregation, recycling, and composting at institutional and community levels.
6. **To ensure alignment of the concept note with national policies and climate strategies of Bhutan** as well as the Green Climate Fund (GCF) investment criteria and RSPN thematic areas.
7. **To develop scalable and replicable waste management models** that can be implemented across different dzongkhags, including both urban and rural contexts.
8. **To build technical capacity and skills** among stakeholders (SEN students and their care giver, local communities, institutions, and private sector actors) in innovative waste management technologies.

3. Overview of the Proposed Project Concept

3.1 Geographic Scope

The project will be implemented in seventy-five (75) selected schools and institutions across Bhutan with primary inclusion of Special Education Needs (SEN) schools and their care giver. It will also engage civil society organizations such as SELWA for product display and marketing, along with private sector entities for technical processing and machinery. A phased and scalable approach will be adopted, starting in selected schools and gradually expanding over other dzongkhags across Bhutan on a voluntary basis. The model is designed to be replicable, enabling wider adoption of sustainable and inclusive waste management practices across Bhutan.

3.2 Background Information on SEN Schools and People with Disabilities.

Bhutan has made significant progress in promoting inclusive education and strengthening support systems for persons with disabilities (PWDs) through the development of Special Educational Needs (SEN) programs and national disability policies. The National Policy on Special Educational Needs (2012), introduced by the Ministry of Education and Skills Development, provides the foundation for inclusive education by promoting equal access to education, early intervention, trained teachers, assistive technologies, and accessible learning environments. In collaboration with the Ministry, Bhutan Foundation has supported the expansion of SEN services since 2008, resulting in more than 41 schools providing SEN programs, supporting over 800 children with special needs, and training more than 600 teachers in inclusive education approaches.

Despite these efforts, significant gaps remain with studies indicating that **around 70% of children with disabilities are still out of school**, due to barriers such as limited accessibility, shortage of trained teachers, inadequate learning materials, and social stigma (Australia Awards Africa, 2018). According to the Bhutan National Health Survey, approximately 48,325 persons with disabilities represent 6.8% of Bhutan's population aged five years and above. The *Review*

Report on the State of Persons with Disabilities by the Disabled People's Organization of Bhutan (2024) highlights persistent barriers including inaccessible infrastructure, shortage of trained SEN professionals, limited assistive technologies, inadequate rehabilitation and support services, unemployment, weak social protection systems, and continued social stigma and discrimination. Many schools, particularly in rural areas, still lack disability-friendly facilities such as ramps, accessible toilets, and adaptive learning environments, limiting participation of children with disabilities in education.

Given these gaps and vulnerabilities, the project specifically focuses on SEN schools and persons with disabilities as they represent some of the most marginalized and underserved groups in Bhutan. SEN schools provide an important platform for reaching vulnerable children, caregivers, and communities through targeted support, awareness, capacity building, and inclusive participation. The project aims to strengthen accessibility, institutional capacity, livelihood opportunities, and social inclusion for PWDs and caregivers while promoting dignity, independence, and equal opportunities. This approach aligns with Bhutan's commitment to inclusive development and the principle of "Leaving No One Behind" under the United Nations Sustainable Development Goals (SDGs).

3.3 Technical Scope of the Intervention

The project will implement an integrated waste management and resource recovery system combining multiple components:

Component 1: Integrated Composting and Sustainable Agriculture Systems

- Establish decentralized composting systems (e.g., Takakura method) in SEN schools and their care givers.
- Setup greenhouse-based agriculture using compost.
- Setup hydroponics, aquaponics and agrivoltaics in schools and other institutions.
- Promote climate-resilient and nutrient rich food production within the institutes.

Component 2: Clothing and Household Items from Recyclable Materials.

- Recover and process discarded textiles, cement bags and polyester fibers from polyethylene terephthalate (PET-bottles) into value added products such as clothing and household items.
- The value-added products include school and desuup uniforms, socks, foot mats, carpets, rugs, reusable bags, and polyester-based textiles through circular economy approach.

Component 3: Arts and Craft from Waste Materials

- Strengthen waste segregation at the source.
- Improve collection, storage, transportation and proper management of waste.

- Transform wood, bamboo, and paper waste into creative handicrafts and souvenirs.

Component 4: Knowledge Management, Data and Monitoring

- Strengthening waste segregation at source, improved collection, storage and management of waste.
- Capacity building and awareness on proper waste management.
- Training on waste composting, agriculture, agrivoltaics, recycling, upcycling, and creating arts and crafts from waste materials.
- Establish waste data collection and monitoring systems in schools to support evidence-based decision-making, GHG computation and accountability in sustainable waste management.

3.4 Introduction to the Project Concept

The Pre-Feasibility Study on Waste Management conducted by the SELWA seeks to address the increasing waste management challenges in Bhutan by identifying practical and innovative business opportunities that could be implemented through a Public–Private Partnership (PPP) framework and guided by circular economy principles. The study examines the feasibility of establishing sustainable and inclusive waste management systems by assessing waste generation patterns, current collection and disposal practices, existing institutional and policy framework, and the potential for private sector engagement. In addition, it explores business models that encourage resource recovery, waste valorization, and the shift toward a more circular and sustainable economy.

The findings of the study indicate that waste generation in Bhutan is steadily increasing, particularly in urban centers such as Thimphu, driven by rapid urbanization and changing consumption patterns. Despite progress made through national policy initiatives, the waste management system continues to face significant challenges, including limited waste segregation at source, inadequate recycling and resource recovery infrastructure, heavy reliance on landfills, and financial and technical constraints. The study further highlights the climate implications of inefficient waste management, particularly methane emissions from the decomposition of organic waste. It also emphasizes the significant potential of composting, recycling, upcycling practices and extended use of the products through creative arts and crafts to reduce greenhouse gas emissions and contribute to national and global climate change mitigation goals.

Importantly, the study identified key waste streams such as organic waste, plastics, textiles, paper, and wood residues as valuable resources that can be converted into marketable products. Through a structured assessment process, 22 potential waste-based business ideas were initially identified, which were later narrowed down to eight promising options and ultimately refined into three priority interventions. These interventions provide a scalable and replicable pathway for promoting circular economy practices and strengthening sustainable waste management systems across Bhutan.

In addition, the study recognized that sustainable waste management requires not only infrastructure and business solutions, but also strengthened technical capacity, public awareness, and effective monitoring systems. Therefore, a fourth component has been incorporated to support technical training, awareness on proper waste management practices, and the establishment of monitoring, reporting, and verification (MRV) systems to enhance accountability and promote a more inclusive and sustainable circular economy framework in Bhutan.

The four priority interventions are as follows.

(1) Integrated Composting and Sustainable Agriculture System

(2) Production of Clothing and Household Items from Recyclable Materials,

(3) Arts and Crafts from Waste Materials, and

(4) Knowledge Management and Monitoring

The project recognizes the importance of inclusive development by actively engaging individuals with Special Education Needs (SEN) and their caregivers, including persons with disabilities, where their participation is meaningful and practical. These individuals often face barriers to education, employment, and social participation; therefore, the initiative seeks to create meaningful opportunities for their inclusion in project activities. Their engagement will also serve as a platform for raising awareness within schools and communities, demonstrating that inclusive practices can effectively contribute to environmental sustainability and climate action.

3.4.1 Component 1: Integrated Composting and Sustainable Agriculture System

The proposed project component on Integrated Composting and Sustainable Agriculture Systems is conceptualized as a holistic circular model that integrates waste management with sustainable food production within institutional settings, particularly Special Education Needs (SEN) schools and their caregivers. This component aims to address the growing challenge of organic waste by converting it into valuable agricultural inputs, while simultaneously promoting the production of diverse, nutrient-rich, and locally grown organic food through climate-resilient farming practices.

At its core, the model integrates multiple complementary components, including decentralized composting systems, greenhouse cultivation, and the establishment of hydroponics aquaponics, and agrivoltaics technologies such as installation of solar panels on the roof of the greenhouse. Composting will be carried out within institutional premises, eliminating the need to transport food waste and other biodegradable materials to distant landfills or centralized facilities.

Organic waste generated within the institutions, such as food scraps and other biodegradable materials, will be systematically collected and processed into compost using the Takakura composting method. The resulting compost will be used to enhance soil fertility in greenhouse-based agriculture, while the hydroponics and aquaponics systems will be

incorporated to promote climate-resilient, resource-efficient, and integrated food production, combining soil-less cultivation with closed-loop nutrient recycling. The incorporation of agrivoltaics systems, where solar panels are installed on the greenhouse roof, will provide a renewable energy source to support greenhouse operations, thereby enhancing energy efficiency and reducing reliance on conventional power sources.

In addition, this component emphasizes sustainable packaging solutions. It proposes the repurposing of discarded textile materials into reusable bags for commercial purposes, thereby transforming textile waste that would otherwise contribute to environmental pollution into value-added products and minimizes the use of plastic bags. This approach ensures that agricultural outputs are handled, stored, and distributed using environmentally friendly materials. By creating a closed-loop system in which waste is continuously reintegrated as a resource, the initiative significantly reduces the burden on landfill sites, minimizes greenhouse gas emissions from organic waste decomposition, and strengthens institutional nutrient rich and self-sufficiency in food production.

Persons with disabilities will be actively engaged in various stages of the value chain, including waste segregation, compost production, agricultural activities, and packaging, thereby promoting economic participation and ensuring equitable sharing of project benefits within communities. Furthermore, the project concept is designed to be both scalable and replicable. Its implementation within institutional settings will serve as a practical demonstration of circular economy principles in action. The knowledge, systems and best practices generated through this initiative can be readily adopted and expanded across other schools throughout Bhutan. In this way, the project holds strong potential to contribute to national priorities, including sustainable waste management, climate change mitigation, enhanced food security, and inclusive socio-economic development.

Figure 1. Integrated Composting and Agriculture system through Greenhouse, Aquaponics and Hydroponics.

3.4.1.2. Implementation and Operational Framework for the project component 1.

1. Proper Waste Collection and Segregation at Source

A proper waste collection and segregation system in schools is essential for maintaining a safe, hygienic, and environmentally responsible learning environment. Schools generate mixed waste such as food scraps, paper, plastics, and sanitary waste, which, when not segregated at source, leads to contamination, foul odors, pest infestation, and increased health risks. Effective segregation enables the recovery of recyclable materials and proper treatment of organic waste, reducing landfill disposal and lowering management costs.

Establish a school-wide waste collection and segregation system by providing clearly labeled and color-coded bins for organic (wet) and non-biodegradable (dry) waste in key locations such as dining halls, kitchens, classrooms, and hostels. Designated waste collection points will be established, and regular collection schedules will be implemented. Awareness campaigns and behavioral change activities will encourage students to segregate waste correctly and minimize food waste by taking only the amount of food they can consume.

2. Takakura Composting and Utilization in Agriculture

Segregated organic waste will be treated using the Takakura composting method, a simple and low-cost decentralized composting system suitable for schools. Organic waste will be composted on-site through a participatory approach involving students, teachers, and non-teaching staff, promoting environmental stewardship and practical learning while reducing waste disposal and methane emissions.

The compost produced will be utilized in school greenhouses, gardens, and agricultural activities to improve soil fertility and support sustainable food production. This approach reduces reliance on chemical fertilizers, strengthens circular resource management, enhances resource efficiency, and contributes to improved food security and climate resilience within the school community.

3. Establishment of Greenhouse and Hydroponic Systems

Climate-resilient greenhouses and hydroponic systems will be established to address challenges related to limited access to fresh vegetables, dependence on imported food, inadequate dietary diversity, and food waste in schools. The systems will enable year-round production of nutritious crops while efficiently utilizing water and space.

This intervention will improve the availability and diversity of fresh vegetables for school meals, enhance food security and nutrition, reduce food procurement costs, and create opportunities for income generation through sale of surplus produce. It will also strengthen local food production, resource efficiency, and climate resilience within schools.

4. Establishment of Aquaponic Systems

An aquaponics system will be established in schools, integrating fish farming and plant cultivation in a closed-loop system. Fish such as tilapia, carp, or catfish will produce nutrient-rich waste that is converted by beneficial bacteria into nutrients for plant growth, while plants help filter and recycle water back to the fish tanks. The system will be operated under controlled conditions to enable year-round production of fish and vegetables.

5. Agrivoltaics Integration through Solar Panel Installation

Solar photovoltaic panels will be installed on greenhouse rooftops to provide renewable energy for operating hydroponic and aquaponic pumps, lighting systems, and other equipment required for food production activities.

6. Harvesting, Utilization, and Marketing of Agricultural Products

Agricultural products harvested from the greenhouse, hydroponic, and aquaponic systems will be utilized primarily for school meals. Surplus produce and compost will be marketed locally through partnerships with private-sector entities. Appropriate storage facilities and regular monitoring systems will be established to minimize post-harvest losses and ensure efficient operations.

7. Sustainable Packaging through Textile-Based Reusable Bags

Discarded textiles will be repurposed into reusable bags for packaging compost and agricultural products as part of the project's sustainable packaging initiative. This activity reduces textile waste, minimizes environmental pollution, and promotes alternatives to single-use plastic, while engaging students in practical skills development in design and production. The reusable bags will be designed to be durable, breathable, and functional for compost and fresh produce packaging. Including school logos and environmental messages will strengthen project identity and raise awareness, while student participation fosters creativity, ownership, and stronger environmental responsibility.

3.4.1.3 Collaboration with Private Partners for Marketing and Sell of Surplus Products.

To ensure the sustainability and economic viability of the project component, strategic collaboration with private partners will be established for the sale of surplus compost and agricultural produce. While the primary objective of production is to meet school consumption needs, any surplus output will be channeled to local markets through structured private partnership, generating additional income. These funds can be used for operation and maintenance, student incentives, and administrative support.

3.4.1.4. Inclusion of Person with Disabilities (SELWA)

Supported by SELWA, persons with disabilities (PWDs) will actively participate in the Integrated Composting and Sustainable Agriculture System in an inclusive and structured manner. Their engagement will be facilitated across key activities, including awareness-raising,

waste segregation at source, composting processes, and other sustainable waste management practices within schools and communities.

3.4.1.5 Climate and Environment Impact

Converting organic waste into compost reduces the volume of waste sent to landfills while delivering significant environmental, agricultural, and climate benefits. According to the United States Environmental Protection Agency (2025), composting diverts organic waste from landfills, thereby reducing methane emissions, a potent greenhouse gas, while recycling food scraps and plant residues into nutrient-rich compost that improves soil fertility. In addition, compost application reduces soil erosion, decreases reliance on chemical fertilizers, improves water quality by limiting nutrient runoff, and supports biodiversity by enhancing soil organisms.

Composting also contributes to climate change mitigation. The United States Composting Council (2020) reports that compost applied in the United States in 2020 sequestered approximately 333,839 metric tonnes of CO_2-equivalent in soils, and that compost can increase soil organic carbon by up to 46% compared to untreated soils, improving both soil health and carbon storage. Furthermore, the University of Maryland Extension (n.d.) notes that aerobic composting in the presence of oxygen, is environmentally friendly as it produces carbon dioxide (CO_2) rather than methane; although CO_2 is emitted, it is biogenic and part of the natural carbon cycle, making its climate impact relatively low. In contrast, anaerobic decomposition in landfills generates methane (CH_4), a far more potent greenhouse gas, which is avoided through the Takakura composting method that maintains oxygen-rich conditions to promote aerobic decomposition, minimize methane formation, and reduce overall greenhouse gas emissions.

3.4.1.6 Economic and Social Benefit

Composting of organic waste through the Takakura method offers multiple social and economic benefits beside environmental significance. It significantly reduces waste volume while providing practical, hands-on learning opportunities that strengthen the capacity of students and staff in sustainable waste management and organic farming practices. The system also enables the production of nutrient-rich vegetables for school consumption, and any surplus produce can be sold in local markets to generate additional income. This additional income will support institutional sustainability and operational needs

3.4.2. Component 2: Clothing and Household Items from Recyclable Materials

Discarded textiles and plastic-based materials are becoming significant waste streams in Bhutan, contributing to environmental pollution, landfill congestion, and inefficient resource utilization. Stakeholder consultations conducted during the development of the GCF Concept Note highlighted that many students discard clothing before leaving for vacations, while limited awareness regarding reuse and repurposing practices further increases textile waste generation. According to the Bhutan Trade Statistics (2024), Bhutan imported Nu. 2.09 billion worth of textiles and textile articles, indicating a high dependence on imported finished apparel and increasing volumes of textile waste and second-hand clothing.

In response, the second component of the proposed project adopts a circular economy approach by transforming discarded textiles, cement bags, and polyethylene terephthalate (PET) bottles into value-added products such as school and Desuup uniforms, socks, rugs, carpets, reusable bags, and other polyester-based textile products. The collected waste materials will be sorted, cleaned, shredded, and processed into fibers for the production of durable clothing and household items. This process promotes sustainable production and consumption practices while reducing the volume of waste disposed of in landfills.

The initiative will generate both environmental and socio-economic benefits by reducing pollution, minimizing greenhouse gas emissions, and conserving natural resources through material recovery and reuse. At the same time, it will create inclusive livelihood and skill development opportunities for SEN students, caregivers, women, and persons with disabilities, thereby strengthening entrepreneurship and community participation in circular economy practices. A similar initiative was taken up by the Clean Bhutan Circular Innovation Project which promotes the environmentally sound recycling of PET bottle waste into useful products such as cushions, textiles, mattresses, toys, and other household items (Clean Bhutan, 2025).

3.4.2.2. Implementation and Operational Framework for the project component 2.

1. Professional support

a. Partnerships with NGOs: Collaborate with organizations such as Clean Bhutan to gain expertise in waste management practices and community engagement strategies. These partnerships will enhance credibility, outreach, and implementation effectiveness.

b. Academic Collaborations: Partner with local universities for research support, curriculum development, and innovation in textile and leather recycling technologies. This also provides opportunities for student internships and applied research projects in textile waste management.

c. Consultants and Local Experts: Engage experts in sustainable fashion and circular economy, along with local craft experts, tailors, and artisans experienced in working with recycled materials. They can provide hands-on training, demonstrate upcycling techniques, support product design and quality standards, and guide packaging and simple marketing. They can also help in selecting appropriate tools, equipment, and safe working spaces, ensuring the upcycling process is efficient, safe, and practical.

2. Waste Collection and Segregation in Schools.

During stakeholder consultations, there was strong support for upcycling discarded textiles, cement bags, and PET bottles into polyester-based products such as school uniforms, socks, rug, carpet, reusable bags and other useful household items. This initiative was recognized not only for its environmental benefits, but also for its strong potential to promote skill development and upskilling opportunities within communities.

However, due to the need for specialized machinery and technical expertise, stakeholders agreed that in-school processing facilities would not be feasible. Instead, a public–private collaboration model was proposed, where schools collect and supply segregated waste materials (discarded textiles, cement bags, and PET-bottles) from schools and related private sources to designated recycling enterprises equipped with appropriate processing facilities. The school will then procure finished recycled products in return. This approach reduces landfill waste, lowers methane emissions from decomposing materials, and supports climate change mitigation.

3. Collaboration with the Private Sectors for the Production of Clothing and Household Items.

Schools can actively contribute to upcycling initiatives by partnering with private sector entities that possess the necessary machinery, technical expertise, and operational capacity to process discarded textiles, cement bags, and polyester fibers. Polyester fibers, which are man-made fibers derived from plastic materials such as recycled PET bottles, are commonly used in the production of textiles and fabrics. These private sector partners may include local recycling companies, textile upcycling enterprises, small-scale manufacturing units, and eco-waste management firms. Through such collaborations, waste materials can be efficiently processed and transformed into useful products such as school uniforms, socks, foot mats, carpets, reusable bags, and other polyester-based textile items.

3.4.2.3 Role of Private Sector in Recycling and Upcycling Value Chains.

Given the operational limitations faced by schools, private sector partners will play a central role in the processing and valorization of collected waste materials, in line with environmental and social management principles. Schools will be responsible for collecting and segregating recyclable materials (discarded textiles, cement bags, and PET-bottles) at the source. These materials will be safely stored and periodically dispatched to designated private partners equipped with the necessary machinery and technical expertise.

The private sector partners will collect and transport the materials to their processing facilities, where they will undertake secondary sorting, cleaning, and pre-processing to ensure compliance with established quality standards. Discarded textiles and PET bottles will be shredded and converted into uniform fibers for the production of institutional garments including school and Desuup uniforms, and hospital garments which are stronger and more durable. The cement bags will be assessed and directed into appropriate recycling or upcycling streams, such as the production of durable and reusable bags. All processing activities will adhere to environmental safeguards and occupational health and safety requirements, as guided by the Environmental and Social Safeguard Management Plan (ESMP). The resulting products will be supplied to schools, Desuups, hospitals, and other institutions, which will procure them as part of a closed-loop circular system.

3.4.2.4 Process of Converting PET-bottles in to Fibers

The process involves collection and cleaning of post-consumer polyethylene terephthalate (PET) bottles which are then melted and extruded to form of continuous synthetic fibers. These fibers can subsequently be utilized in the production of textiles, yarns, or other value-added materials, thereby providing an effective method for converting plastic waste into reusable industrial resources while contributing to environmental sustainability (Simon and Milad, 2019).

1. Collection and Preparation of PET Bottles: Used PET bottles are collected and sorted to remove non-PET items and contaminants. They are then cleaned to remove labels and residues.
2. Cleaning and Preparation: Once sorted, the collected materials will undergo cleaning and preparation processes to ensure hygiene and usability. This stage is critical to ensure that recycled materials meet basic quality standards before further processing.
3. Shredding into PET Flakes: The clean bottles are shredded into small flakes, which serve as the basic raw material for recycling. These flakes are suitable for melting and further processing.
4. Plastic Extrusion: The PET flakes are fed into an extrusion machine where the thermoplastic PET is heated and melted. PET's thermoplastic nature allows it to be remelted and reshaped repeatedly.
5. Air Stretching to Form Fiber: As the molten PET exits the extruder, compressed air is blown through the melt to pull and stretch it into continuous synthetic fibers.
6. Cooling and Solidification: The extruded fibers are cooled and solidified, resulting in synthetic fibers that can be used as stuffing, packaging material, or further processed into yarn in spinning mills.
7. Post-Processing (Optional): Depending on the intended product, the fibers can be processed in textile facilities to make polyester yarn or blended with other materials.
8. Manufacturing and Product Development: The processed materials will then be used to produce a range of clothing and household products as follows. However, the private partner in this project will mainly be engaged in the production of uniforms for schools and institutions such as DeSuups' uniforms and hospital garments.

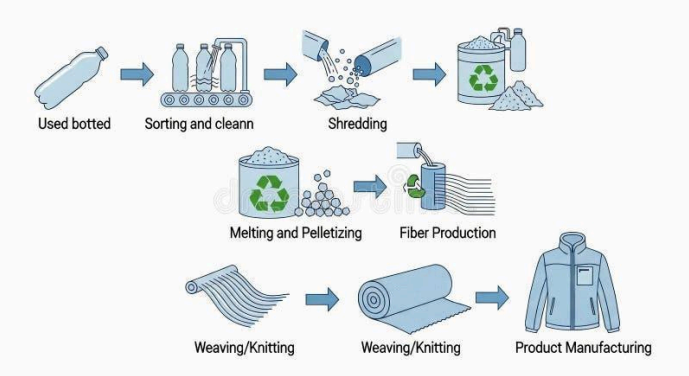


Figure 2.1The process of transforming PET-bottles into polyester fibers and then woven into desired cloths.

Similarly, old textiles can be renewed through mechanical or chemical recycling processes. Mechanically, fabrics can be shredded and re-spun into new yarns or repurposed into new products such as insulation, mats, rugs or infill for cushions. While this is cost-effective, repeated mechanical recycling can weaken fibers making it more suitable for sturdy, single-material fabrics such as cotton.

Chemically, fibers from old textiles can be broken down to their basic molecular components and then regenerated into new fibers of quality similar to virgin material which works even for blended fabrics such as cotton-polyester mixes. Additionally, old textiles can be upcycled into new products without breaking them down for example, by redesigning worn garments into bags, mats, or other household items (United State Government Accountability Office, 2024). These methods allow textiles to have a second life, reducing waste and supporting a circular economy. For this reason, the project's second component aims to produce clothing and useful household items through the inclusion of people with disabilities (PWD) through Selwa.





Figure 2.2 Bags, socks, rugs and Uniforms made from discarded cloths and polyester fibers

3.4.2.5 Inclusion of People with Disabilities

Persons with disabilities (PWDs) will have a meaningful and inclusive roles across selected components of the project, particularly in activities that are safe, accessible, and aligned with their skills and capacities. Their engagement will primarily focus on non-labor-intensive functions, including waste segregation at source, awareness-raising on sustainable waste management practices, and support in the organization and handling of collected materials within schools and surrounding communities.

In addition, PWDs will be actively engaged in small-scale value-added production activities using semi-processed recycled materials supplied through private sector partnerships. These activities may include sorting, basic stitching, assembling, finishing, and quality assurance of products such as reusable bags, school uniforms, and household items. Through these engagements, PWDs will not only contribute to the effective implementation of the project, but will also benefit from enhanced skills development, improved livelihood opportunities, and strengthened social inclusion, thereby reinforcing the project's dual objectives of environmental sustainability and inclusive economic empowerment.

3.4.2.6 Climate and Environmental Impact.

According to Kiron (2024), the textile industry has a significant environmental footprint, generating approximately 92 million tons of textile waste annually, much of which ends up in landfills, contributing to land and soil pollution and consuming valuable landfill space. Only about 60% of this waste is recycled, while the remaining are still disposed off, highlighting the environmental burden of unmanaged textile waste. Recycling and upcycling help reduce this impact by diverting waste from landfills and conserving natural resources. Recycling discarded textiles and plastics also significantly reduces carbon emissions. Virgin textile production is highly energy-intensive and can emit up to 10–20 kg CO_2 per kg of textile produced. In contrast, recycling and upcycling can reduce emissions by 50–90% per unit of material while also conserving water and reducing pollution (Planet Aid, 2024).

In the context of Bhutan, a study based on 2020 import data of textiles from India shows that the country imported approximately 883,070 kg of textiles, over 6.68 million square meters of textile materials, and more than 8.4 million textile items, indicating rising dependence on imported textiles and associated waste generation. The study estimates textile-related emissions at around 4.13 $GgCO_2e$ annually under the baseline scenario and highlights significant mitigation potential through recycling and upcycling. In response, the proposed project promotes localized circular economy systems to convert discarded textiles and PET materials into reusable products, thereby reducing waste, lowering emissions, decreasing import dependence, and supporting Bhutan's low-carbon development goals.

3.4.2.7 Socio-Economic Impact

This initiative delivers comprehensive socio-economic benefits by promoting inclusive employment, innovative business opportunities, and community empowerment. By actively engaging SEN students and their caregivers, women, marginalized groups, and persons with disabilities in activities such as sorting, upcycling, sewing, weaving, packaging, and quality inspection, the project fosters sustainable income generation while strengthening skills development and capacity building in environmentally responsible production systems.

Collaboration with SELWA ensures that vulnerable populations can actively participate in production processes thereby creating a socially inclusive model. The establishment of local recycling and production units can help reduce Bhutan's dependence on imported textiles,

strengthen local supply chains, and stimulate small-scale enterprise development. Schools and communities by acting as collection points, contribute raw materials to private partners linking education, local employment, and industry in a circular economy framework. Additionally, the production and marketing of upcycled clothing and household items support local markets, increase community awareness of sustainable consumption, and promote entrepreneurship, thereby creating long-term, resilient socio-economic impacts that align with sustainable development goals.

3.4.3 Component 3: Arts and Craft from Waste Materials.

The increasing generation of waste materials presents both an environmental challenge and a significant opportunity for resource recovery and sustainable livelihood development. A substantial proportion of waste materials is currently discarded despite possessing considerable potential for reuse and value addition. To address this issue, the third component of the project, **Arts and Crafts from Waste Materials**, proposes the systematic recovery and transformation of waste materials into marketable products, with a particular focus on supporting Special Educational Needs (SEN) schools, their caregivers, persons with disabilities, and other vulnerable groups.

The initiative aims to recover waste materials such as discarded wood, bamboo, paper and leathers that are being typically discarded during construction, carpentry, packaging processes, and everyday household activities. These materials can be transformed into a range of handicraft products such as papier-mâché masks, religious statues for puja, decorative souvenirs, wind chimes, food doom, key chains and other craft items. The initiative is rooted in traditional Bhutanese craftsmanship while integrating contemporary sustainable design approaches.

The intervention aligns with circular economy principles by extending the lifespan of materials that would otherwise be discarded as waste. By transforming these materials into both artistic and functional products, the initiative not only reduces waste generation, but also creates new income-generating opportunities for SEN students and their caregiver, people with disabilities, and vulnerable communities.

The finished products will be displayed and marketed through SELWA centres, which will serve as dedicated spaces for exhibition, promotion, and direct sales of value-added products. In addition, SELWA can strengthen market access by collaborating with private sector partners, including retail outlets, tourism operators, and social enterprises to expand the distribution of these eco-friendly and culturally inspired handicrafts and souvenirs produced from waste materials. Transforming waste into arts and crafts not only provides environmental benefits, but also creates inclusive livelihood opportunities for SEN schools and their caregivers, women, youth, artisans, and persons with disabilities, while promoting sustainable production practices.

3.4.3.2 Implementation and Operational Framework for the Project Component 3.

1. Collection and Sorting of Waste Materials for Arts and Craft

The initiative will prioritize the recovery of waste materials with high potential for value addition, including discarded wood and bamboo, paper waste, plastics, textiles and other waste materials. The schools and institutions will establish a systematic waste collection and segregation system in selected SEN schools and institutions to ensure a reliable supply of recyclable materials for arts and crafts production. Clearly labeled and color-coded bins for wet and dry waste will be installed in classrooms, kitchens, dining halls, hostels, and public areas to promote segregation at source. Designated collection points and scheduled collection systems will be established to facilitate efficient waste management and prevent environmental and health risks associated with improper waste disposal. Student-led waste management teams, supervised by teachers, will support waste collection, sorting, storage, and monitoring activities. Schools will also be encouraged to establish arts and crafts clubs and small workspaces where students, particularly those from SEN schools, can participate in practical learning and creative activities using waste materials.

2. Art and Craft Production from Waste Materials

Following the collection and sorting of waste materials and the establishment of Arts and Crafts Clubs based on students' interests, professional guidance will be provided to support the transformation of these materials into creative, functional, and marketable products. Skilled artists and craft instructors will conduct training workshops and practical demonstrations, providing technical support and supervision throughout the production process. Through hands-on learning, students will acquire knowledge and skills in various crafting techniques while learning the safe and efficient use of materials, tools, and equipment. This approach will enhance creativity, build practical vocational skills, and enable students to produce high-quality value-added products from recovered waste materials.

a) Paper Craft Production

Waste paper can be repurposed into paper mache products such as traditional masks and decorative statues used in puja or religious ceremonies. The paper mache process typically involves soaking the waste paper, mixing it with binding agents, shaping the mixture using molds, and allowing it to dry before painting and finishing. This technique not only reduces the paper waste, but also encourages artistic expression and creativity (Vaessen-Creative, n.d.). Waste paper materials can be used to create paper mache products**,** including:

Figure 3.1 Traditional Masks and Religious Statue from Paper Mache Arts

Figure 4 Decorative Ornamental and Souvenirs

b) Bamboo and Wood Crafting

Discarded bamboo and wood can be transformed into decorative and functional items, including wind chimes, home décor accessories, small furniture, and craft souvenirs. The crafting process involves cutting, shaping, sanding, assembling, and finishing the materials to produce durable and aesthetically appealing products.

The following table outlines the essential materials and step-by-step process for creating decorative and functional items from discarded bamboo and wood. Following these instructions ensures durable, attractive, and practical craft products suitable for home décor, souvenirs, and small furniture. Waste bamboo and wood can be used to produce various decorative and functional items, such as:

Figure 5 Wind Chimes and Food Dome made from bamboo and woods.

Figure 6 Key Chains made from discarded wood and leathers.

Figure 7 Crafts Souvenirs made from discarded woods.

c) Textile-Based Craft Items

Waste fabrics and textile scraps can be turned into household and decorative items, such as table runners, quilted décor, and other fabric-based craft products designed by quilting enthusiasts. These items are produced through processes such as cutting, stitching, and applying decorative designs, allowing for both functionality and artistic creativity. The following table presents the materials required and step-by-step process for transforming waste fabrics and textile scraps into

functional and decorative items. Waste fabrics and textile scraps may be repurposed into decorative and household products**,** including:

Figure 8 Table runner and tote bags made from discarded cloths.

Figure 9 Quilted Decorative Items

d) Finishing and Quality Control

Finally, all products undergo finishing processes to enhance their appearance, durability, and overall quality. This may include painting and decorative finishing for paper crafts, polishing or varnishing for bamboo and wood items, and ensuring the design is integrated in textile products. Quality control checks are conducted to maintain consistency, meet market expectations, and uphold high craftsmanship standards.

Through this structured approach, the Art and Craft Club provides SEN students and their caregiver, people with disabilities, unemployed youths and interested community people to

creatively reuse waste materials, develop practical artistic skills, and produce high-quality products all under the mentorship of professional artists.

3.4.3.7 Marketing and Distribution Strategy

Finished products will be packaged using sustainable and environmentally friendly materials such as recycled paper or reused textiles to maintain consistency with the waste-to-craft approach. In terms of marketing, all finished products will be displayed at the SELWA Center, which will play a key role in promoting and assisting in the sale of products. To ensure market acceptance and avoid generating further waste, only products that meet optimum quality standards will be selected for display and sale.

In addition to centralized marketing through the SELWA center, schools can actively participate in selling their products within the school premises and local communities. This can be done through school exhibitions, local markets, and partnerships with other organizations, retail outlets, or community groups. Broader distribution channels may include local handicraft markets, souvenir shops, tourism markets, cultural exhibitions, community festivals, and online platforms that promote sustainable products with artistic value. This multi-channel approach helps reach diverse customers while encouraging community engagement.

3.4.3.9 Economic and Social Impact

This initiative will initially be implemented in SEN schools and include their care givers, providing them practical opportunity to engage in arts and craft production using waste materials. By introducing skills such as sewing, painting, carving, and assembling at an early stage, the project intervention builds creativity, environmental awareness, and practical knowledge within a structured learning environment. At the same time, it is designed with a long-term vision for sustainability and scalability, allowing successful practices to be expanded beyond schools into communities and small-scale enterprises.

The craft production sector offers significant opportunities for women, youth, and marginalized groups to participate in income-generating activities. Many of these activities can be carried out in small workshops or home-based settings making them especially accessible to women and individuals with limited mobility. As the initiative grows, it can be replicated at the community level, creating broader livelihood opportunities.

3.4.4 Component 4: Knowledge Management, Data and Monitoring

This component focuses on creating awareness, providing technical training, and building capacity, while also establishing a strong data collection and monitoring system for sustainable waste management. It targets Special Educational Needs (SEN) students, persons with disabilities (PWDs), caregivers, schools, and local communities to promote inclusive participation and environmental responsibility. The component recognizes that effective waste management requires not only infrastructure, but also behavioral change, practical skills,

community participation, and reliable data systems to support informed decision-making and long-term sustainability.

The project will implement awareness programs on proper waste management practices at school and community levels, with special focus on SEN schools and persons with disabilities. These programs will promote waste segregation at source, reduction of plastic waste, recycling, composting, responsible consumption, and environmental stewardship. Activities will be delivered through school campaigns, interactive learning sessions, practical demonstrations, and community outreach programs. The project will also provide technical training and capacity building through engagement of professionals, and technical experts in composting, sustainable agriculture, textile upcycling and recycling, and arts and crafts using waste materials. Participants will gain practical, market-oriented skills that support income generation and inclusive livelihood opportunities. Demonstration sites and hands-on learning activities will be established to strengthen practical learning.

To ensure effective implementation on waste monitoring data, systematic data collection, recording, reporting, and analysis across all implementing stakeholders will be implemented. The implementing institutions will be responsible for collecting and recording data on waste generation, waste segregation at source, waste dispatched to private sector entities for processing and upcycling purposes, and the waste diverted from landfills. This will ensure accurate tracking of waste flows within school institutions. Private sector partners will be responsible for collecting and recording data on waste received, waste processed, and waste converted into value-added products, including recycled and upcycled materials. This will ensure proper documentation of waste utilization and value creation along the supply chain.

Regular reporting will be conducted on a monthly and quarterly basis, with semi-annual and annual consolidated reports prepared and submitted to the project management team. All data will be compiled, analyzed, and used to support decision-making, performance tracking, and project learning and importantly for greenhouse house gas emission reduction calculation. This system will strengthen transparency and accountability, enable evidence-based management, and support the assessment of environmental and social outcomes over time. Overall, this component will strengthen awareness, build practical skills, enhance inclusive participation, and ensure strong data-based monitoring, contributing to a more sustainable and inclusive waste management system.

4. Theory of Change

4.1. Problem Statement

Improperly managed waste contributes directly to climate change through the release of greenhouse gases, particularly methane from decomposing organic waste materials. A large portion of waste especially the organic waste is disposed of in the open dumping areas or unmanaged landfills leading to methane emission, soil and water contamination through leachate, air pollution from open burning of waste and pungent odor from decaying of organic waste that increases the vulnerability of the ecosystems and communities to climate risks.

In addition, climate change exacerbates waste-related risks such as increased rainfall, flooding, and extreme weather events further aggravate waste-related problems by dispersing pollutants, contaminating water sources, drainage blockage and overwhelming already fragile waste management systems (Fei, Fang, and Wang, 2021). This creates a reinforcing cycle, where poor waste management accelerates climate change, and climate change, in turn, worsens the impacts of unmanaged waste. The core problem was that inefficient and unsustainable waste management systems in Bhutan are contributing to increased greenhouse gas emissions, environmental degradation, and reduced climate mitigation and resilience.

4.2. Barrier Analysis

Bhutan's waste management challenges are expected to intensify further due to a complex set of deeply interlinked barriers that continuously reinforce one another. Therefore, a transformative approach that simultaneously addresses institutional, financial, technological, and behavioral barriers is not only necessary, but urgent to break this cycle and transition toward an innovative, sustainable, and climate-resilient waste management system.

I. Institutional Barriers

- **Weak coordination among agencies:** Waste management in Bhutan involves multiple institutions, including the National Environment Commission and local governments (thromdes and dzongkhags). However, coordination among these entities remains fragmented with overlapping mandates, unclear roles, and weak communication. This leads to gaps in planning, duplication of efforts, and inefficiencies in service delivery, ultimately weakening the overall effectiveness of the waste management system.

- **Limited capacity for managing waste systems:** Local governments, particularly in smaller thromdes and rural dzongkhags, face significant capacity constraints including limited technical expertise, insufficient human resources, and lack of infrastructure for waste collection, segregation, and treatment. Financial limitations further restrict their ability to invest in improved waste management systems, resulting in irregular or inadequate waste management services.

- **Insufficient enforcement of waste regulations:** Despite having a strong policy framework enforcement remains weak due to limited manpower, inadequate monitoring systems, and low institutional capacity. As a result, compliance with waste segregation and disposal regulations is inconsistent, allowing unsustainable practices to persist.

II. Financial Barriers

- **Limited investment in waste infrastructure (composting, recycling facilities):** Investment in waste management infrastructure in Bhutan remains low, resulting in a shortage of essential facilities such as composting plants, recycling centers, and material recovery facilities. As waste generation increases, the absence of adequate infrastructure limits the country's ability to process and recover resources efficiently, leading to continued reliance on landfills and open dumping.

- **Lack of sustainable financing mechanisms:** Waste management in Bhutan lacks long-term, sustainable financing models to support operation, maintenance, and expansion of services. Existing systems rely heavily on limited government budgets, with minimal cost recovery mechanisms such as user fees or revenue generation from waste-based products. This makes it difficult to scale up or sustain improved waste management solutions over time.

- **Dependence on public funding with minimal private sector participation:** The waste sector in Bhutan is largely driven by public institutions, with limited involvement from the private sector. This dependence restricts access to additional investment, innovation, and operational efficiency that private actors can provide. Without stronger public–private partnerships, the sector struggles to develop financially viable and scalable waste management solutions.

III. Technological Barriers

- **Absence of limited composting, recycling, and waste processing technologies:** Waste management system is constrained by the limited composting, recycling, and waste processing technologies. As a result, much of the waste is not efficiently treated or recovered, leading to continued reliance on landfills and missed opportunities for resource recovery and emission reduction.

  Also, decentralized and small-scale waste management solutions remain limited, particularly at the community and institutional levels. Technologies such as Takakura composting, hydroponics, and localized recycling systems are not widely adopted, restricting the potential for on-site waste treatment, resource efficiency, and climate-resilient practices.

IV. Social and Behavioral Barriers

- **Low awareness and poor waste segregation practices:** Many communities and institutions in Bhutan have limited awareness of proper waste management, resulting in inadequate segregation of waste at the source. This hinders efficient recycling, composting, and resource recovery, and increases the burden on disposal sites.
- **Limited participation in circular economy practices:** Engagement in circular economy practices such as reusing materials, resource recovery, and sustainable consumption is generally low. This constrains the potential for reducing waste generation and optimizing resource efficiency.

V. Market Barriers

- **Weak market linkages for recycled and compost products:** The market for recycled and compost products in Bhutan is underdeveloped, with limited distribution channels and weak linkages between producers and consumers. This restricts the commercialization of waste-derived products and reduces incentives for investment in recycling and composting initiatives.
- **Low demand and perception issues for recycled products:** Recycled products face low demand due to perception challenges, including doubts about quality, safety, or aesthetics. This limits consumer adoption, discourages producers, and slows the growth of circular economy practices.

VI. Gender and Social Inclusion Barriers

- **Limited livelihood opportunities for women and persons with disabilities**: Women and people with difficulties often face challenges in their livelihoods because they have less access to education, skills, and job opportunities. They also experience social barriers and discrimination which limit their ability to earn income and participate fully in economic activities. This limits their economic empowerment and participation in sustainable waste initiatives, reducing the social inclusiveness of circular economy practices.

4.3. Long-Term Vision (Impact Statement)

The long-term vision of the project is to establish a climate-resilient, low-emission, and circular waste management system in Bhutan through an inclusive Public–Private Partnership model that transforms waste into value-added products, reduces greenhouse gas emissions, and enhances sustainable livelihoods.

This vision directly contributes to:

- Bhutan's **Nationally Determined Contributions (NDCs), 13th FYP, Sustainable Development Goals.**
- Transition toward a **low-carbon and climate-resilient development pathway.**

- Promotion of **circular economy and green growth.**
- Strengthening **climate adaptation and mitigation outcomes.**
- Balancing environmental conservation with socio-economic development which is a key component of **Gross National Happiness.**

At its core, the project aims to shift Bhutan from a linear **"take-make-dispose"** waste system to a circular, resource-efficient system where waste is systematically reduced, reused, recycled, and reintegrated into productive use. Through the adoption of an integrated Public–Private Partnership (PPP) model, the project envisions a future where waste is no longer treated as an environmental burden, but as a valuable resource that contributes to economic development, environmental and climate protection, and social well-being.

The initiative supports reductions in greenhouse gas emissions from landfills and organic waste, which is a key focus of the NDCs. The integrated PPP model enhances institutional coordination, mobilizes private sector collaboration, and fosters community participation, reflecting the NDC's emphasis on policy coherence, inclusive engagement, and innovative solutions. By promoting composting, recycling, and circular economy practices, the project not only advances Bhutan's goals of carbon neutrality and resource efficiency, but also supports climate resilient development, generates socio-economic benefits, and creates equitable livelihood opportunities across the waste value chain.

4.4. Pathway of Change (Outcomes and Causal Linkages)

Using a back-casting approach, the project defines a clear causal pathway from early interventions to long-term transformational impact. The pathway demonstrates how targeted activities lead to systemic changes in waste management, resource use, and climate mitigation and adaptation.

Table 4 Outcomes and Causal Linkages for Pathway of Change

Early Outcomes (Preconditions)	**Intermediate Outcome**	**Ultimate Outcome**
The success of the pathway depends on achieving the following enabling conditions: ✔ Awareness and sensitization programs are effectively implemented ✔ Functional waste segregation systems	1: Improved Waste Management Systems ✔ Increased waste segregation at source across institutions and communities ✔ Establishment of decentralized composting and recycling systems	The project contributes to the following long-term impacts. ✔ Reduced greenhouse gas (GHG) emissions from the waste sector through landfill diversion and resource recovery. ✔ Improved climate resilience of

are established at source ✔ Partnerships with private sector are formalized ✔ Infrastructure for composting, recycling, and upcycling is installed and operational.	2: Increased Resource Recovery and Circular Economy ✔ Organic waste converted into nutrient-rich compost ✔ Plastics and textiles recycled and upcycled into value-added products ✔ Waste transformed into economic resources. 3: Strengthened Public–Private Partnership (PPP) Engagement ✔ Increased private sector collaboration in waste value chains. ✔ Establishment of market linkages for recycled and upcycled products. 4: Enhanced Climate-Resilient Agriculture ✔ Application of compost to improve soil health and productivity. ✔ Adoption of greenhouse farming, hydroponics, aquaponics, and agrivoltaics systems. 5: Increased Awareness and Behavioral Change ✔ Improved waste segregation and	communities and ecosystems through sustainable practices. ✔ Transition toward circular economy systems that promote resource efficiency and sustainability.

	management practices at source. ✔ Adoption of sustainable consumption and production behaviors 6: Inclusive Livelihoods Created ✔ Employment opportunities generated for women and persons with disabilities ✔ Skills development in recycling, upcycling, and sustainable agriculture.	

4.4.1. Activities Linked to Outcomes and Associated Risks

This section outlines the specific activities required to achieve each identified outcome, ensuring that all enabling conditions are met for successful implementation. The design of activities takes into account key barriers such as limited technical capacity, weak waste segregation practices, market constraints, and low private sector engagement. In addition, potential risks are identified and assessed based on their likelihood and impact, along with indicative mitigation measures.

Table 5 Outcomes and Associated Risks

Expected Outcomes	**Key Activities**	**Risks Associated**	**Mitigation Measures**
1. Improved Waste Management Systems	✔ Establish waste segregation systems at source (schools, institutions, communities) with clearly labeled bins and guidelines. ✔ Conduct hands-on training on waste segregation and decentralized waste management practices	Low adoption of waste segregation practices Operational challenges in composting systems (odor,	Create awareness campaigns, behavior change incentives, and institutional enforcement mechanisms.

	✔ Provide training on decentralized composting systems (Takakura method) for organic waste composting. ✔ Set up basic infrastructure for collection, sorting, and storage of recyclables ✔ Develop operational guidelines and monitoring systems for waste management.	maintenance issues) Limited institutional ownership and accountability	Regular technical support, training, and standardized operating procedures. Assign clear roles and responsibilities within institutions and integrate into existing management systems.
2. Increased Resource Recovery and Circular Economy	✔ Establish recycling and upcycling units for plastics (e.g., PET bottles) and textiles Promote arts and crafts initiatives using waste materials (bamboo, paper, textiles, wood) ✔ Train stakeholders in recycling, upcycling, and product development skills ✔ Facilitate collection and aggregation systems for recyclable materials ✔ Support innovation in waste-to-resource product design	Low market demand for recycled/upcycled products. Inconsistent supply of segregated waste materials Limited technical skills for upcycling and product development	Product quality improvement, branding, and awareness campaigns to promote eco-friendly products Strengthen segregation systems and ensure steady collection mechanisms Provide continuous capacity building and partner with technical experts
3. Strengthened Public–Private Partnership (PPP) Engagement	✔ Identify and engage private sector partners in waste collection, recycling, and product marketing ✔ Develop PPP frameworks, agreements, and incentive structures	Low private sector interest due to perceived low profitability Weak coordination	Provide financial incentives, risk-sharing mechanisms, and demonstrate viable business models

	✔ Facilitate investment in waste processing and recycling infrastructure ✔ Create linkages between waste generators (schools/communities) and private sector processors ✔ Organize stakeholder platforms for collaboration and coordination	between public and private stakeholders Policy or regulatory constraints	Establish clear governance structures and regular coordination platforms Align project with national policies and engage relevant authorities early.
4. Enhanced Climate-Resilient Agriculture	✔ Promote the use of compost in school and community agriculture ✔ Establish greenhouse systems for controlled environment farming ✔ Introduce hydroponics and aquaponics systems for efficient food production ✔ Integrate agrivoltaics (solar energy + agriculture) in pilot sites ✔ Provide technical training on climate-resilient agricultural practices	Limited technical knowledge for system operation and maintenance Climate-related risks such as extreme weather affecting infrastructure	Provide training, technical support, and user-friendly system design. Climate-resilient design and site selection.
5. Increased Awareness and Behavioral Change	✔ Conduct awareness campaigns on waste management, climate change, and circular economy. Integrate waste and sustainability education into school activities. ✔ Organize community engagement programs, demonstrations, and campaigns.	Resistance to behavior change and cultural habits Short-term engagement without long-term retention	Use participatory approaches and continuous engagement Institutionalize practices within schools and communities

	✔ Use behavior change communication strategies (nudges, incentives, peer learning)		
6. Inclusive Livelihoods Created	✔ Provide skill development programs in recycling, upcycling, composting, and sustainable agriculture ✔ Partner with organizations such as SELWA to support women and persons with disabilities Facilitate small-scale enterprises and income-generating activities ✔ Develop market linkages for products created by vulnerable groups	Limited participation of vulnerable groups Market barriers for products	Targeted outreach and inclusive program design Produce quality products and collaborate with private sector. Use online platform to reach wider audience.

4.4.2. Assumptions

The successful implementation and impact of the project depend on a set of key assumptions, which are external conditions necessary for the project to progress from activities to outputs, outcomes, and ultimately long-term impact. The risk–assumption linkage table identifies key external conditions required for success and translates them into potential risks, along with appropriate mitigation measures. Together, these tables demonstrate the project's technical robustness, feasibility, and preparedness to manage uncertainties, ensuring effective delivery of results and long-term sustainability.

Table 6 Assumptions, Risks, Likelihood Impact and Mitigation Measures

Assumption (Positive)	**Risk (Negative Form)**	**Likelihood / Impact**	**Mitigation Measures**
Communities are willing to participate	Low participation in waste segregation	Medium / High	Continuous awareness campaigns, incentives, school-led enforcement
Training is effective	Skills not applied in practice	Medium / Medium	Hands-on training, follow-up mentoring

Infrastructure installed on time	Delays in procurement/installation	Medium / High	Advance planning, phased implementation
Technical expertise available	Poor operation of systems	Medium / Medium	Technical support and capacity building
Private sector willing to engage	Low private sector interest	Medium / High	Incentives, viable business models, PPP frameworks
Waste segregation maintained	Mixed waste reduces efficiency	Medium / High	Monitoring systems and accountability mechanisms
Supply of recyclable waste available	Insufficient material for recycling	Medium / Medium	Strengthen collection systems
Products meet quality standards	Poor quality reduces demand	Medium / High	Standardization and quality control
Consumers accept eco-products	Low demand for recycled products	Medium / High	Branding, awareness, eco-labeling
Policy supports PPP	Regulatory barriers emerge	Low / High	Policy alignment and stakeholder engagement
Agriculture systems function well	System failure or misuse	Medium / Medium	Training and technical support
Awareness leads to behavior change	Temporary or no behavior change	Medium / High	Long-term engagement strategies
Vulnerable groups participate	Low inclusion of target groups	Low / Medium	Targeted outreach and inclusive design
Market demand exists	Products remain unsold	Medium / High	Market linkages and diversification
No major disasters occur	Climate events disrupt project	Low / High	Climate-resilient infrastructure design
Funding is timely	Delayed funding affects progress	Medium / High	Financial planning and buffer mechanisms
Strong stakeholder coordination	Poor coordination among actors	Medium / Medium	Governance structures and coordination platforms

5 Alignment of the Project with GCF Investment Criteria

5.1 Paradigm Shift Potential

The project demonstrates a strong potential to deliver a paradigm shift by fundamentally transforming Bhutan's waste management system from a conventional linear model "take–make–dispose" into a circular, resource-efficient, and climate-resilient system. This transformation is not limited to isolated interventions, but promotes systemic change across the entire waste value chain.

By integrating composting, recycling, upcycling, and climate-resilient agricultural practices, the project addresses both mitigation and adaptation objectives. Organic waste is diverted from landfills and converted into compost, significantly reducing methane emissions which is a major greenhouse gas while improving soil health and agricultural productivity. At the same time, recycling and upcycling activities reduce resource extraction and energy use, contributing to a low-carbon economy while generating green livelihood opportunities.

The introduction of a Public–Private Partnership (PPP) model further strengthens the transformational nature of the project by institutionalizing private sector engagement in waste management. This approach:

- Enhances efficiency and innovation through private sector expertise
- Mobilizes additional financial and technical resources through collaboration with the private sectors
- Establishes sustainable business models that ensure long-term viability beyond project support

Importantly, the project is designed to be replicable and scalable across other dzongkhags, creating a nationwide model for integrated waste management based on interest. By demonstrating a successful circular economy framework, the project contributes to Bhutan's transition toward a low-emission, climate-resilient development pathway aligned with national priorities and global climate commitments.

5.2. Grant-Equivalent Financing and Transparency

The project adopts a structured and transparent financing approach that enables GCF funding to be clearly accounted for in grant-equivalent terms and evaluated across different financial instruments.

GCF financial support will be strategically utilized for public-good components such as infrastructure development, institutional strengthening, and capacity building, while leveraging additional contributions from the private sector such as revenue generated from selling of products to reallocate for incentivizing or for maintenance and operational purposes. This combination ensures that financial resources are used efficiently and directed toward activities that generate the highest climate and socio-economic returns.

The PPP framework strengthens financial governance and accountability by:

- Clearly defining the roles and responsibilities of public institutions and private entities
- Establishing mechanisms for monitoring financial flows, outputs, and outcomes
- Ensuring transparency in procurement, implementation, and reporting processes

Furthermore, the project incorporates robust monitoring and evaluation systems to track measurable climate impacts (e.g., emission reductions) as well as socio-economic benefits (e.g., job creation, income generation). This ensures alignment with international best practices and GCF standards for transparency and accountability.

5.3. Minimum Concessionality

The project follows the GCF principle of minimum concessionality, meaning it only asks for the support needed to make the project viable. GCF funding will mainly support initial investments and important activities that private investors are less likely to fund including:

- Development of waste management infrastructure (segregation systems, composting facilities, recycling units)
- Capacity building and technical training for communities, institutions, and enterprises
- Awareness campaigns to promote behavioral change and waste segregation practices

At the same time, the project incorporates several revenue-generating components that will gradually enhance financial sustainability and reduce reliance on financial grants. These include:

- Sale of compost and organic agricultural inputs
- Production and marketing of upcycled textile and craft products
- The project will support the establishment of financially sustainable recycling systems that are driven by market demand for recycled materials and products.

As these revenue streams mature, they will improve cost recovery and attract further private investment, thereby minimizing the long-term need for GCF grant support.

5.4. Integrated Finance and Leveraging Additional Resources

The project promotes an integrated financing approach by combining support from the Green Climate Fund with private sector participation and institutional contributions through a Public-Private Partnership (PPP) model. This approach enables the efficient use of financial resources while strengthening the long-term sustainability of project activities. Private sector partners will primarily support the processing of waste materials and the production of school and institutional uniforms, activities that cannot be effectively managed within school settings due to technical, operational, and infrastructure limitations. Their contributions will include:

- Provision of machinery and technical expertise for waste processing and recycling
- Investment in operational systems and production facilities
- Manufacturing of uniforms and other recycled textile products
- Purchasing finished products produced by schools, including compost, surplus agricultural produce, and arts and crafts products.

Through this collaboration, schools and institutions will function as collection, segregation, and community production centers, while private sector partners will serve as processing, manufacturing, and market-linkage entities. This integrated system strengthens value chains by linking waste recovery and local production with commercial markets.

The blended financing structure increases the overall level of investment available for the project while promoting operational efficiency, innovation, and market sustainability. GCF resources will be strategically utilized to reduce investment risks and support public-good components, thereby encouraging additional private sector engagement and resource mobilization. This approach ensures that a GCF financial grant is used effectively to leverage broader public and private investments, in line with GCF's objective of maximizing climate and socio-economic impact.

6. Justification for Green Climate Fund (GCF) Funding Request

This section provides the justification for seeking support from the Green Climate Fund (GCF) to implement a project which is a climate-resilient waste management transformation in Bhutan. While the country has established a robust policy and regulatory framework, significant systemic barriers continue to hinder effective implementation at scale. These include market uncertainty, limited financial instruments, weak public-private sector collaboration, and a persistent gap between policy commitments and on the ground implementation.

GCF support is therefore critical to address these constraints by providing catalytic and concessional financing that can unlock large-scale investments, enable public–private partnerships, and drive a transition toward a circular economy. The proposed intervention is designed to deliver transformational impact by scaling integrated waste management systems

across the country, reducing greenhouse gas emissions, and strengthening climate resilience, while establishing an enabling environment that facilitates and progressively attracts private sector participation over time.

6.1 Absence of Funding Alternatives

Despite Bhutan's strong policy framework on waste management, there is a significant financing and implementation gap at the national level. Waste management systems, particularly those aligned with circular economy and climate objectives are not yet commercially viable nor adequately financed through existing sources.

Key barriers include:

- **High upfront investment needs**: Nationwide infrastructure for segregation, composting, recycling, and resource recovery requires substantial capital, which exceeds available public budgets.
- **Limited domestic financing instruments**: Existing initiatives in Bhutan demonstrate growing efforts toward a circular economy transition, supported by partners such as the United Nations Development Program and donor-funded projects. However, these remain small-scale, grant-dependent, and fragmented, reflecting the absence of sustained financing mechanisms. Limited national capacity to access green finance further constrains expansion, underscoring the need for catalytic support from the Green Climate Fund.
- **Underdeveloped private sector market**: Waste-to-resource business models are still emerging in Bhutan, facing high perceived risks, underdeveloped value chains, and uncertain demand for recycled products. These factors limit private sector engagement and constrain investment in circular economy initiatives, making it difficult to scale operations or achieve nationwide impact without targeted support and catalytic financing.
- **Public funding constraints**: Government resources are limited and prioritized toward core sectors such as health, education, and infrastructure, leaving insufficient allocation for large-scale waste system transformation.

Available public and private financing are limited and insufficient to enable a nationwide, climate-resilient waste management transition, making catalytic support from the Green Climate Fund essential. Therefore, support from the Green Climate Fund is critical to bridge this gap and enable transformational change.

6.2 Adequacy of Financial Instruments

The proposed grant-based financing is fully aligned with the project's national-scale objectives and addresses the key barriers to a climate-resilient waste management transition. Private sector actors can collaborate through a Public–Private Partnership (PPP) model, providing technical expertise and operational support, but are unable to provide direct funding. The GCF grant is

therefore essential to bridge the financing gap, de-risk the PPP approach, and enable transformational, system-wide interventions. This structure ensures that financial resources are adequate, targeted, and catalytic, maximizing both climate impact and private sector engagement. At the national level, a significant portion of project activities are non-revenue-generating but critical for system transformation, including:

- Nationwide awareness campaigns and behavioral change initiatives
- Capacity building of the stakeholders and communities.
- Establishment of enabling infrastructure and systems

Given that these components cannot generate sufficient financial returns, government and private sector actors are unable to provide direct funding. Instead, private sector engagement will occur through technical collaboration and service delivery, leveraging their expertise without direct financial contribution. The grant from the Green Climate Fund is therefore essential to enable these transformative activities at scale.

6.3 Long-Term Financial Sustainability of the Project

The GCF funding is critical for the initial establishment and startup phase of the project, providing the necessary financial support to set up infrastructure, procure materials, and implement foundational activities. Once operational, the project is designed to generate its own income streams, which will be reinvested to cover ongoing operation and maintenance costs, ensuring long-term financial sustainability without further reliance on external funding.

The project is designed to become financially sustainable through:

- **Development of waste-based value chains** (compost, recycled materials, upcycled products)
- **Private sector participation through PPP models**, ensuring operational efficiency
- **Cost recovery mechanisms** (e.g., service fees, product sales)
- **Reduced public expenditure** on landfill management and waste disposal.

6.4 Exit Strategy

6.4.1 Internal Sustainability

To ensure the long-term continuity of the project beyond GCF support, internal sustainability will be achieved through several key measures:

- **Institutionalization of Waste Management Systems:** The project will integrate waste management practices and protocols into its operational framework, ensuring that responsibilities, standards, and monitoring mechanisms are clearly defined, assigned, and enforced within the project's activities and management structure.

- **Capacity Building of Stakeholders:** Technical, managerial, and operational capacities of stakeholders, including schools and community groups will be strengthened through collaboration with private entities via targeted training programs, knowledge transfer, and hands-on experience. This approach ensures that stakeholders can independently manage waste systems and effectively address operational challenges.
- **Established Infrastructure and Systems:** Waste processing facilities, collection networks, and resource recovery systems will be put in place, along with operational guidelines, maintenance plans, and monitoring frameworks. This foundation allows ongoing functionality without continuous external funding.

6.4.2 External Sustainability (Scaling and Replication)

To maximize the impact and replication potential of the project, external sustainability measures will focus on expansion and integration:

- **Replication of PPP-Based Models:** The public–private partnership (PPP) approach piloted in initial locations will be documented, standardized, and scaled across all dzongkhags, enabling other districts to adopt similar sustainable waste management practices with minimal startup risk.
- **Expansion of Markets for Recycled and Upcycled Products:** By developing and formalizing supply chains for recycled, composted, and upcycled materials, the project will stimulate demand, foster entrepreneurship, and create income-generating opportunities that reinforce the financial viability of waste management operations.
- **Integration into National Policies and Development Plans:** Successful approaches, guidelines, and lessons learned will be integrated into national strategies, policy frameworks, and long-term development plans. This ensures that waste management improvements become a core component of Bhutan's sustainable development trajectory, facilitating ongoing support, regulatory reinforcement, and scaling potential.

Through this combination of institutional, technical, and market-oriented strategies, the project is designed to sustain its environmental, social, and financial impacts well beyond the initial GCF investment.

7 Environmental and Social Safeguards (ESS) and Gender Integration

The proposed project will adhere to the Green Climate Fund's (GCF) Environmental and Social Safeguards (ESS), which form part of the broader Environmental and Social Management System (ESMS). The ESS ensures that social and environmental considerations are fully integrated into project design, decision-making, and operations. The ESS framework is based on the International Finance Corporation's (IFC) eight Performance Standards (PS1–PS8), including one overarching standard on assessment and management of environmental and social risks (PS1), and seven standards addressing specific issues such as labor conditions (PS2), resource

efficiency and pollution prevention (PS3), community health and safety (PS4), land acquisition and resettlement (PS5), biodiversity conservation (PS6), indigenous peoples (PS7), and cultural heritage (PS8).

1.Assessment and Management of Environmental and Social Risks (PS1)

The project will conduct comprehensive environmental and social risk assessments prior to implementation. Risks associated with waste handling, composting, recycling, and upcycling activities will be identified, and mitigation measures integrated into project design. Operational protocols, monitoring systems, and accountability mechanisms will ensure that environmental and social safeguards are implemented effectively at all project stages.

2.Labor and Working Conditions (PS2)

The project will prioritize safe and equitable working conditions for all participants, including students, school staff, community members, and persons with disabilities engaged through SELWA. Occupational health and safety measures will be applied in waste handling, composting, hydroponic, aquaponic, and recycling operations. Training, protective equipment, and structured supervision will minimize hazards and promote safe work practices.

3.Resource Efficiency and Pollution Prevention (PS3)

Through circular economy principles, the project minimizes waste generation, prevents environmental pollution, and optimizes resource use. Organic waste is composted on-site using the Takakura method, while textiles, PET bottles, and cement bags are processed into reusable products. Energy efficiency measures, including greenhouse-integrated solar systems (agrivoltaics), reduce dependence on conventional electricity, while proper handling of chemical inputs ensures minimal environmental impact.

4.Community Health, Safety, and Security (PS4)

By establishing safe collection points, segregated waste streams, and hygienic composting practices, the project mitigates risks to community health. Awareness campaigns in schools and communities will educate participants about the hazards of unmanaged waste, reducing exposure to pollutants, vectors, and methane emissions. Safety protocols for equipment and operational areas will protect students, staff, and workers.

5.Land Acquisition and Involuntary Resettlement (PS5)

The project does not involve land acquisition or resettlement. All activities will be implemented within existing institutional spaces, ensuring no displacement or disruption of communities.

6.Biodiversity Conservation and Sustainable Management of Living Natural Resources (PS6)

By promoting organic composting and climate-smart agricultural practices, the project enhances soil fertility, conserves local biodiversity, and avoids harmful agrochemical inputs by eliminating the use of chemical fertilizers. Sustainable agricultural systems, including hydroponics, aquaponics, and greenhouse cultivation, minimize ecological disturbance and support environmental resilience.

7.Indigenous Peoples (PS7) and Cultural Heritage (PS8)

The project is designed to respect Bhutanese cultural practices and the rights of local communities. Educational and institutional programs will integrate traditional knowledge especially in the project concept 3 where waste materials are made into traditional masks and religious statues from paper mache arts that promote awareness of local environmental and cultural heritage. Engagement with stakeholders ensures inclusive decision-making while safeguarding cultural values.

8 Gender Policy and Integration

Gender equality is central to project design, implementation, and monitoring. The project aligns with GCF's Gender Policy and Gender Action Plan to promote equitable participation, access, and benefits. Key measures include:

- **Inclusive Participation:** Women, youth, and persons with disabilities will actively participate in composting, recycling, upcycling, and agricultural activities. The collaboration with SELWA ensures accessible roles for persons with disabilities in skill-based tasks such as textile upcycling, packaging, and product finishing.
- **Capacity Building:** Technical and operational capacities of schools, community groups, and stakeholders will be strengthened through training, knowledge transfer, and hands-on training in collaboration with private sector partners. This empowers participants to independently manage waste systems and adopt climate-resilient practices.
- **Equitable Access to Benefits:** Income generated from sale of surplus compost, agricultural produce, and upcycled products will benefit the stakeholders from institutions and communities, ensuring fair distribution and reinforcement of economic opportunities for women and marginalized groups.
- **Gender-Sensitive Monitoring:** Project indicators will track gender-disaggregated participation, access to training, livelihood opportunities, and decision-making roles. Awareness campaigns and behavioral change programs will address gender-related barriers to participation in waste management and circular economy practices.

Through adherence to GCF ESS and gender policies, the project ensures that environmental, social, and gender considerations are systematically addressed, risks are minimized, and positive impacts maximized. By integrating these safeguards with inclusive, capacity-building, and participatory approaches, the project promotes environmentally sustainable, socially equitable,

and economically empowering outcomes, while contributing to Bhutan's national climate priorities and commitments under its NDCs.

9. Implementation and Monitoring Framework

9.1 Comprehensive Implementation Approach of the Project

The implementation of the project will adopt an integrated and participatory approach, based on the Public–**Private Partnership (PPP) model**, which combines the strengths of public institutions, private sector efficiency, and community engagement. This approach is particularly relevant in the Bhutanese context where institutional capacity constraints and financing gaps require collaborative and innovative solutions.

The project will be implemented across selected schools of interest which will serve as demonstration hubs for decentralized waste management and circular economy practices. These sites will provide practical learning environments while generating measurable environmental, social, and economic benefits.

The implementation strategy emphasizes:

- ✔ **Decentralization:** Managing waste at the source (e.g., schools and institutions) by segregating and treating waste locally, including composting organic waste within school premises. This reduces transportation costs, landfill burden, and emissions while promoting ownership and accountability at the community level.
- ✔ **Integration:** Linking waste management with sustainable agriculture through the establishment of greenhouses, agrivoltaics, hydroponics, and aquaponics systems. Organic waste is converted into compost and nutrients, which are then reused for food production, creating a closed-loop system that enhances climate resilience and resource efficiency.
- ✔ **Inclusion:** Ensuring active participation of vulnerable groups, particularly persons with disabilities, women, and individuals with limited employment opportunities. Through targeted capacity-building, skills development, and livelihood opportunities (e.g., composting, recycling, upcycling, and farming), the project promotes equitable economic participation and social empowerment.
- ✔ **Market Orientation:** Promoting income generation by converting waste into value-added products such as compost, surplus agricultural products, and upcycled or recycled goods. The project supports market linkages, branding, and entrepreneurship to ensure financial sustainability and long-term viability.
- ✔ **Circular Economy Approach:** Embedding circular economy principles across all project components by minimizing waste and maximizing resource reuse. This includes transforming organic waste into compost for agriculture, converting discarded textiles and plastics into clothing and household items and producing creative or functional products from recyclable materials. By closing material loops and extending product life

cycles, the project reduces environmental impact while creating economic value and green jobs.

9.2 Institutional and Operational Arrangements

The success of the project will depend on clearly defined roles and strong coordination among stakeholders.

a. Lead Implementing Entity (RSPN)/ Accredited Entity

The Royal Society for the Protection of Nature will act as the central coordinating body responsible for:

- ✔ **Project Management and Strategic Oversight:** This involves coordinating all project activities, ensuring alignment with project goals, and providing high-level direction. It includes planning, stakeholder coordination, risk management, and ensuring that implementation stays on track and within scope.
- ✔ **Technical Guidance and Quality Assurance:** This ensures that all technical components of the project (e.g., waste management systems, agricultural technologies, and upcycling processes) are implemented according to established standards and best practices. It includes providing expert support, reviewing outputs, and maintaining the quality and effectiveness of interventions.
- ✔ **Financial Management and Reporting to GCF:** This covers budgeting, fund allocation, financial tracking, and ensuring transparency and accountability in the use of funds. It also includes preparing and submitting financial reports in compliance with Green Climate Fund (GCF) requirements and guidelines.
- ✔ **Monitoring, Evaluation, and Knowledge Management:** This involves tracking project progress against targets, assessing outcomes and impacts, and identifying lessons learned. It also includes documenting best practices, sharing knowledge among stakeholders, and using data to improve decision-making and support future scaling or replication.

RSPN will also ensure alignment with Bhutan's national policies, including the National Integrated Solid Waste Management Strategy and climate commitments under the NDC.

b. Private Sector Partners

Private sector actors are central to the PPP model and will:

- ✔ **Provide technical expertise in waste processing, recycling, and upcycling:** This involves applying specialized knowledge and skills to efficiently sort, treat, and transform waste materials into higher-value products.
- ✔ **Operate processing units for textiles, plastics, and other materials:** This includes managing and running facilities where different types of waste are collected, processed, and converted into reusable materials and new products.

- ✔ **Develop market linkages for compost and recycled products:** It involves creating connections with customers, businesses, and markets to sell compost and recycled goods, ensuring a sustainable demand and income stream
- ✔ **Ensure quality control and product standardization:** This involves maintaining consistent product quality by following set standards, so that compost and recycled products are safe, reliable, and market-ready.

Their participation enhances efficiency, innovation, and financial sustainability, while also reducing the burden on public systems.

d. Civil Society Organizations (CSOs)

Organizations such as SELWA will:

- ✔ **Facilitate inclusive participation, particularly for persons with disabilities:** Enable people with disabilities to actively engage in proper waste management practices, empowering them to take part in sorting, recycling, and upcycling activities. Their participation will naturally create awareness in the wider community about sustainable waste practices.
- ✔ **Support market linkages:** Help showcase and sell finished products by displaying them at the SELWA center and collaborating with private sector partners to reach broader markets, ensuring that persons with disabilities directly benefit from income opportunities.
- ✔ **Engage in selected value-chain activities (e.g., packaging, product finishing, marketing):** Involve marginalized groups in practical aspects of the project, providing hands-on experience and income opportunities while strengthening the overall project operations.

Through these actions, the project promotes social equity, empowerment, and inclusive development, ensuring that benefits reach all members of the community, especially those often left behind.

e. Institutions (Schools and Monasteries).

Institutions such as schools and monasteries will act as the primary implementation units by:

- ✔ **Managing waste segregation systems:** Establish and oversee proper collection and sorting of organic, recyclable, and non-recyclable waste within the campus, ensuring that each type of waste is handled appropriately.
- ✔ **Operating decentralized composting systems:** Set up and maintain composting units on-site, converting organic waste into nutrient-rich compost that can be used in school gardens or greenhouses.
- ✔ **Integrating compost into greenhouse and agriculture components:** Apply the compost in agriculture and greenhouse projects, demonstrating the link between waste

management and sustainable food production through climate-smart agriculture and also create practical learning experiences for students.

- ✔ **Participating in awareness and capacity-building initiatives:** Engage students, teachers, and staff in learning activities that build knowledge and skills on sustainable waste practices, recycling, and circular economy principles.
- ✔ **Demonstrating circular economy practices:** Serve as an example of how waste can be transformed into valuable resources, showcasing innovative approaches and inspiring peers, families, and the wider community to adopt sustainable practices.

By actively engaging in these roles, schools and institutions become **central to embedding lasting behavioral change, environmental stewardship, and community-wide adoption of circular economy principles**, ensuring the project's impacts are visible, scalable, and enduring.

9.3 Implementation Phases.

The implementation of the project will follow a structured, phased, and evidence-based approach to ensure effective delivery of intended outcomes. Building on the preparatory work already completed, including stakeholder consultations, baseline reviews, and conceptual design, the implementation phase will translate plans into actionable activities guided by data, best practices, and continuous learning. Each phase will be carefully sequenced to ensure coordination among stakeholders, efficient use of resources, and timely monitoring of progress against defined indicators.

The approach emphasizes adaptability, allowing for iterative refinements based on feedback, contextual realities, and emerging insights, thereby ensuring that the project remains responsive, impactful, and aligned with its overall objectives. Importantly, the proposed phases will be further refined and validated through stakeholder engagement processes prior to full-scale implementation.

Phase 1: Preparatory Phase

The preparatory phase has established the groundwork for the project through:

- Stakeholder consultations with relevant institutions, private sector actors, and community representatives to validate needs and priorities.
- A comprehensive desktop review assessing existing waste management practices, policy frameworks, and system gaps.
- • Development of the inception report, outlining the project scope, objectives, and proposed implementation framework.

Result: A validated preliminary framework, aligned with stakeholder priorities and national context, ready for further refinement.

Phase 2: Detailed Design and Validation Phase

This phase will focus on translating the initial concept into operationally actionable and context-specific plans, while incorporating feedback from stakeholders.

Key activities include:

- ✔ Identification and confirmation of pilot sites (schools and monastic institutions) primary driven by interest.
- ✔ Preparation of detailed technical designs and implementation plans for waste segregation, composting, recycling/upcycling, and integrated agriculture systems.
- ✔ Development of institutional arrangements and Public–Private Partnership (PPP) frameworks and implementation mechanisms.
- ✔ Finalization of roles and responsibilities among implementing partners and stakeholders, followed by formalization of agreements and operational procedures to ensure effective coordination and execution.
- ✔ Development of detailed implementation plans, including timelines, resource allocation, and coordination mechanisms for executing project activities.
- ✔ Validation of design, approach, and implementation strategy through stakeholder consultations and technical reviews

Result: A fully validated, stakeholder-endorsed implementation plan.

Phase 3: Capacity Building and Institutional Strengthening

This phase will ensure that stakeholders have the necessary skills, knowledge, and systems to sustain project interventions.

Key activities include:

- ✔ **Capacity building** for teachers, students, non-teaching staff, and community members in sustainable waste management and climate-smart agricultural practices, delivered through structured training programs, demonstrations, and experiential learning activities.
- ✔ **Technical training** on waste management, composting (Takakura composting), recycling and upcycling of waste materials into value added products, and sustainable agriculture practices along with safety measures**.**
- ✔ **Strengthening of institutional system** through the development and implementation of clear operating procedures, defined roles and responsibilities, and improved coordination mechanisms among the stakeholders. Additionally, systems for monitoring, reporting, and continuous learning will be established to ensure accountability, track progress, and enable ongoing improvements in institutional performance.

Result: Strengthened institutional and community capacity to effectively manage waste and apply climate-smart agricultural practices, supported by clear systems, defined roles, and

improved coordination. This will enable sustainable resource recovery, enhanced environmental practices, and long-term continuity of project outcomes.

Phase 4: Scaling-Up and Replication

Based on lessons learned from the pilot implementation, the project will be scaled up and expanded to new locations to replicate and extend its successful approaches.

Key activities include:

- ✔ **Documentation of best practices and lessons learned**: Systematic documentation of successful approaches, challenges, and lessons learned will be carried out throughout implementation to generate evidence, guide decision-making, and inform future scaling and replication efforts.
- ✔ **Replication of successful models across additional institutions and regions**: The validated project model will be adapted and replicated in other institutions and regions, taking into account local contexts, stakeholder capacity, and resource availability to ensure effective and sustainable expansion.
- ✔ **Strengthening of market linkages and private sector engagement:** Efforts will be made to build strong partnerships with the private sector and market actors to promote the adoption of value-added products and commercialization of recycled and upcycled products, thereby enhancing sustainability and economic viability.
- ✔ **Promotion of the model as a replicable circular economy framework**: The project will be promoted as a scalable and replicable circular economy framework through knowledge sharing, stakeholder engagement, and dissemination of results to encourage wider adoption and policy integration.

Result: Establishment of a well-documented, scalable, and validated circular economy model that can be effectively replicated and adapted across institutions and regions. This will strengthen market linkages, enhance private sector engagement, and promote sustainable adoption and policy integration of value-added waste management practices.

Phase 5: Monitoring, Evaluation, and Learning (MEL)

A robust Monitoring, Evaluation, and Learning (MEL) system will be applied throughout the project lifecycle to ensure accountability, track progress against defined indicators, and support adaptive management. The system will facilitate continuous data collection, performance assessment, and evidence-based decision-making, enabling timely identification of challenges and opportunities for improvement. It will also promote learning and knowledge sharing among stakeholders, ensuring that insights are used to enhance project effectiveness, efficiency, and overall impact.

Key activities include:

- ✔ **Monitoring of key performance indicators (waste reduction, emissions reduction, compost production, livelihoods):** Continuous tracking of key indicators will be conducted to measure project performance, assess environmental and socio-economic impacts, and ensure progress toward targets.
- ✔ **Periodic progress reviews and reporting:** Regular review meetings and structured reporting will be undertaken to assess achievements, identify challenges, and ensure transparency and accountability among stakeholders.
- ✔ **Incorporation of feedback into adaptive project management:** Feedback from stakeholders, monitoring results, and review findings will be systematically integrated into project planning and implementation to enable timely adjustments and improvements.
- ✔ **Knowledge sharing with stakeholders and relevant institutions:** Lessons learned, best practices, and key results will be shared with stakeholders and partner institutions through structured reports and dissemination meetings. Additionally, information will be shared through digital platforms or presentations to promote learning, transparency, and wider adoption of successful practices.

Result: Evidence-based decision-making and continuous improvement will be achieved through the systematic use of monitoring data, stakeholder feedback, and learning insights, enabling more effective, adaptive, and impactful project implementation.

Phase 6: Sustainability of the project.

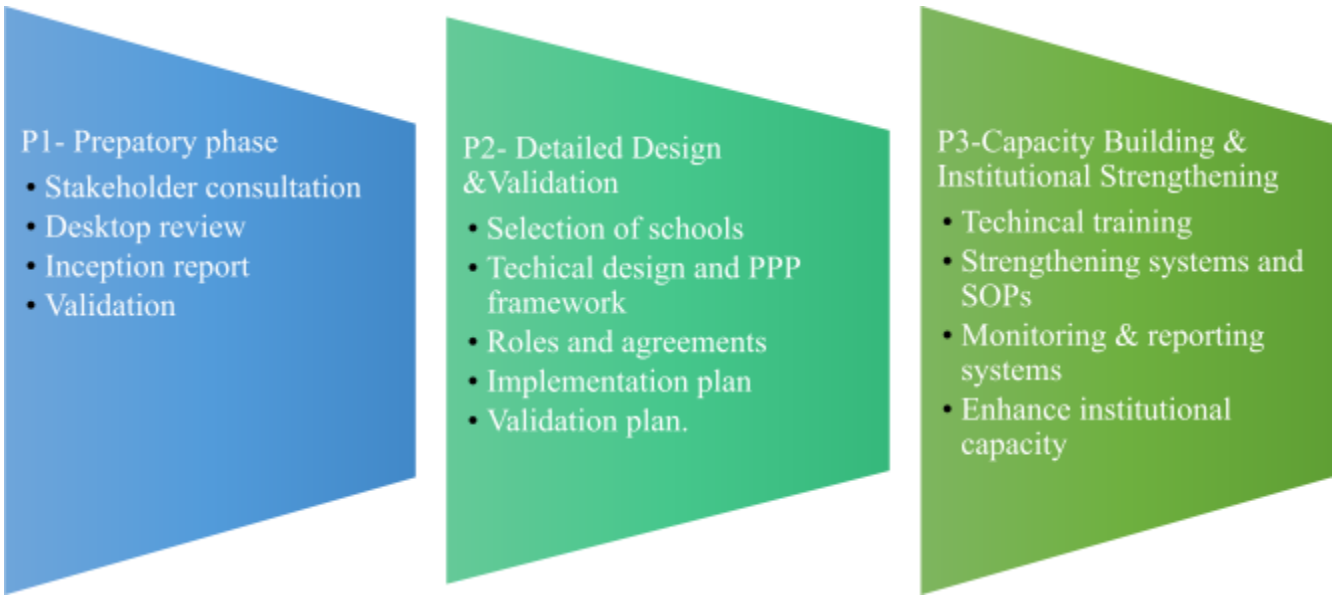
This phase will focus on ensuring long-term sustainability beyond project support.

Key activities include:

- ✔ **Strengthening local ownership and institutional integration:** The project will promote active involvement of local institutions, teachers, and communities, ensuring that they take responsibility for planning, managing, and sustaining activities by integrating them into existing institutional structures and routines.
- ✔ **Establishing financial sustainability mechanisms (e.g., revenue from compost and recycled products):** Income-generating activities such as the sale of compost and value-added recycled products will be explored to generate funds that can support ongoing operations, maintenance, and expansion of project activities.
- ✔ **Embedding systems within institutional operations and policies:** Project activities, guidelines, and procedures will be integrated into institutional systems and formalized through policies to ensure they are consistently implemented and sustained as part of regular operations.

✔ **Continued engagement with private sector partners:** Continuous collaboration with private sector actors will be maintained to support market linkages, technical support, and opportunities for scaling, ensuring long-term viability and impact of the project.

Result: The outcome of these measures is the establishment of a sustainable, well-integrated project that is institutionalized within existing systems, financially viable, and supported by strong stakeholder and private sector partnerships. This will ensure the continued operation, maintenance, and scaling of project benefits beyond the project period.



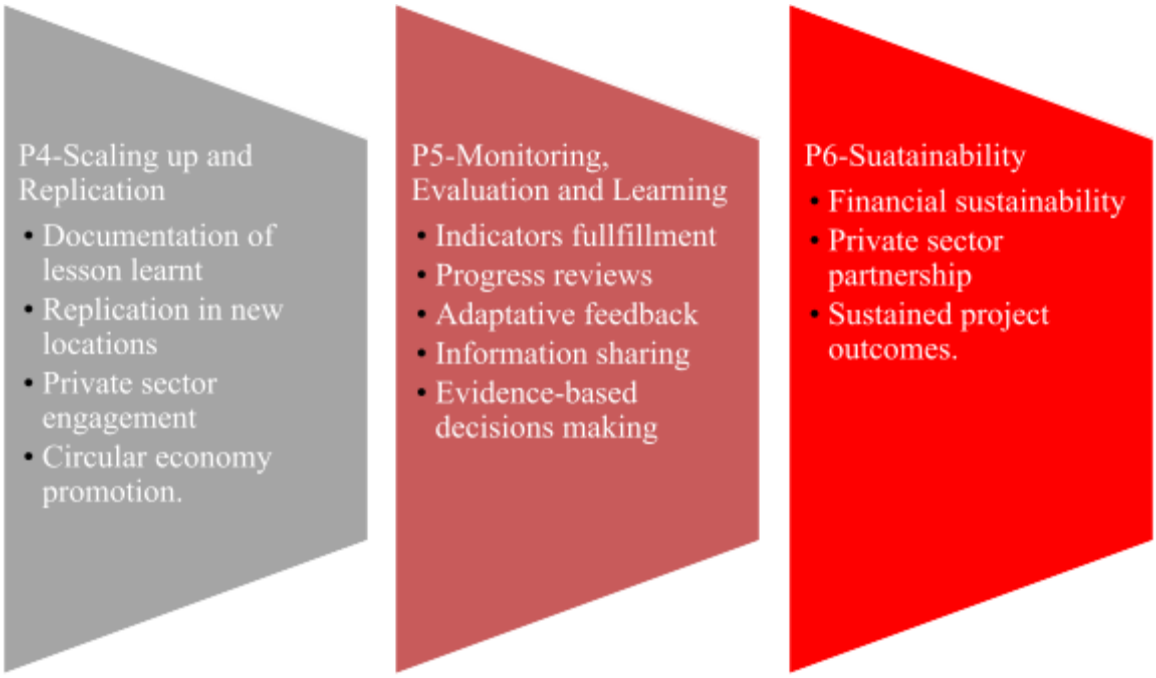


Figure 10 Implementation Phases of the Project

10. Sustainability, Scalability, and Replicability

10.1 Sustainability

a. Financial Sustainability

The project is designed to gradually transition from grant dependency to self-sustaining operations.

Revenue streams will include:

- Sale of compost and agricultural products
- Sale of recycled and upcycled goods
- Incentives for proper waste management

At the same time, cost savings from reduced waste disposal and on-site production will enhance financial viability. The PPP model ensures shared investment and risk, making the system more resilient.

b. Institutional Sustainability

The project will be embedded within existing institutional structures such as schools and monasteries. Capacity-building efforts will ensure that stakeholders can independently manage and sustain activities. Strong policy alignment will further reinforce institutional sustainability.

c. Environmental Sustainability

By promoting waste reduction, recycling, and composting, the project contributes to long-term environmental benefits, including:

- Reduced landfill pressure
- Lower greenhouse gas emissions and climate impacts
- Improved soil health and biodiversity
- Improved public health

d. Social Sustainability

The project promotes inclusive development by:

- Creating livelihood opportunities for disadvantages people
- Empowering women and persons with disabilities besides students
- Building environmental awareness and responsibility regarding the proper waste management

10.2 Scalability

The project is first going to be implemented in 75 schools and gradually expand to 500 schools and institutions across Bhutan. The project is inherently scalable due to its adaptable and flexibility, allowing it to be easily adapted and expanded across different contexts. The use of simple, low-cost technologies further supports replication in various settings. Initial implementation of the project will serve as demonstration models to encourage adoption by other institutions, while standardized guidelines and training materials will facilitate effective scaling. In addition, private sector participation will support expansion by providing investment, technical support, and improved market access.

10.3 Replicability

The project model is highly replicable because it:

- ✔ Uses locally available materials and resources, reducing dependency on external inputs and ensuring accessibility across different contexts
- ✔ Relies on simple and adaptable technologies that can be easily understood, implemented, and maintained by local stakeholders
- ✔ Is based on clear operational frameworks, including defined roles, procedures, and guidelines that support consistent implementation
- ✔ Is supported by standardized training materials and capacity-building mechanisms that facilitate easy adoption and scaling

10.4 Exit Strategy

The exit strategy of the project is designed to ensure a smooth transition from GCF-supported implementation to a fully self-sustaining system, while preserving and scaling the environmental, social, and economic benefits achieved during the project period. It focuses on ensuring both internal and external sustainability through institutional strengthening, financial viability, and strategic scaling.

10.4.1 Internal Sustainability

Internal sustainability will be ensured by embedding project components within existing institutional systems and strengthening the capacity of local stakeholders. Waste management practices, composting systems, and recycling and upcycling activities will be institutionalized within schools and partner organizations, with clearly defined roles, responsibilities, and operational procedures. Continuous capacity building and technical support will enable teachers, students, and community members to independently manage and sustain project activities. In addition, established infrastructure, operational guidelines, and monitoring systems will ensure the continued functioning of the systems beyond the project period.

10.4.2 Financial Sustainability

The project will transition from grant dependency to a self-sustaining financial model through the development of revenue streams from compost production, recycled and upcycled products, and agricultural outputs. Cost recovery mechanisms, combined with private sector engagement under the Public–Private Partnership (PPP) model, will ensure efficient operations, shared investment, and reduced financial burden on public institutions. These mechanisms will support long-term maintenance, expansion, and operational sustainability of the project.

10.5.3 External Sustainability (Scaling and Replication)

The project will promote external sustainability by scaling successful approaches beyond initial implementation sites. Initial implementation sites will serve as learning and replication hubs, supported by standardized guidelines, training materials, and documented best practices. The project model will be replicated across different institution primarily driven by interest that is feasible to local contexts, stakeholder capacities, and resource availability. Strategic partnerships with the private sector will further enhance market access, investment opportunities, and wider adoption of the circular economy model.

11 Results Management Framework (RMF) for the Proposed Project

The proposed project on *Improved Waste Management System through a Public–Private Partnership (PPP) model* is fully aligned with the Green Climate Fund's Results Management Framework (RMF), which provides a structured approach to ensure that project interventions deliver measurable climate results while contributing to a broader paradigm shift toward low-emission and climate-resilient development pathways. The RMF not only guides how results are defined and tracked, but also ensures that project outcomes are consistent with the strategic

objectives of the GCF at both national and global levels. The RMF is operationalized through two key components: the **Logic Model (LM)** and the **Performance Measurement Framework (PMF)**.

11.1. Logic Model (LM): Results Chain

The Logic Model establishes a clear results chain that links project inputs and activities to outputs, outcomes, and long-term impacts, reflecting the project's Theory of Change and its contribution to mitigation and adaptation goals. It helps demonstrate how integrated waste management interventions such as composting, recycling, and circular economy practices translate into reduced greenhouse gas emissions, improved resource efficiency, and enhanced climate resilience.

Logic Model Diagram

🌱 **INPUTS**

- ✔ GCF grant financing and PPP collaboration.
- ✔ Technical expertise
- ✔ Institutional support
- ✔ Infrastructure
- ✔ Capacity-building resources and training programs

⚙️ **ACTIVITIES**

- ✔ Establish decentralized composting systems (Takakura method) within the institutes.
- ✔ Implement recycling and upcycling systems for textiles, plastics, and waste materials.
- ✔ Setup greenhouse, hydroponic, and aquaponic systems as climate smart agriculture.
- ✔ Strengthen waste segregation, collection, and processing systems.
- ✔ Conduct awareness campaigns and capacity-building programs.
- ✔ Facilitate PPP partnerships for processing and marketing of waste-based products.
- ✔ Collection, monitoring, and reporting of waste generated by schools and waste dispatched by private-sector partners on a semi-annual and annual basis.
- ✔ Promote inclusive livelihood opportunities (women, youth, persons with disabilities)

📦 OUTPUTS

- ✔ Functional composting units and recycling systems in institutions.
- ✔ Improved waste segregation and collection mechanisms.
- ✔ Production of compost, recycled textiles, and upcycled products.
- ✔ Increased awareness and technical skills in waste management.
- ✔ Established partnerships with private sector.
- ✔ Creation of green jobs and livelihood opportunities.
- ✔ Sustainable and nutrient rich agricultural products.
- ✔ Quantity of greenhouse gas emission reduction.

🌍 OUTCOMES

- ✔ Reduced methane emissions from organic waste
- ✔ Reduced CO_2 emissions through recycling and reduced reliance on virgin materials
- ✔ Decreased landfill waste volume

Adaptation Outcomes:

- ✔ Enhanced resilience to climate risks (e.g., reduced landfill overflow, pollution control)
- ✔ Improved food security through climate-resilient agriculture systems
- ✔ Strengthened institutional and community capacity in sustainable practices

🌍 IMPACT (Fund-Level and Paradigm Shift)

- ✔ Contribution to low-emission development pathways by reducing waste-related greenhouse gas emissions
- ✔ Contribution to climate-resilient development through sustainable waste and agricultural systems

- ✔ Promotion of a circular economy model in Bhutan
- ✔ Scalable and replicable model for nationwide implementation

11.2 Performance Measurement Framework (PMF)

The Performance Measurement Framework provides an indicators and methodologies to monitor, report, and verify progress throughout the project lifecycle. It enables the tracking of key performance indicators related to emission reductions, waste diversion, capacity building, and socio-economic benefits, ensuring accountability and evidence-based decision-making. Together, the LM and PMF ensure that the project delivers tangible, scalable, and transformational impacts in line with GCF investment criteria and Bhutan's national climate priorities. The PMF provides a structured system to monitor and evaluate progress using measurable indicators at output, outcome, and impact levels.

11.2.1. Key Indicators

Table 7 Key Indicators Framework

Mitigation Indicators	Adaptation Indicators	Socio-economic Indicators
Volume of waste diverted from landfills (tons/year)	Number of institutions adopting climate-resilient waste systems	Number of jobs created (gender & disability disaggregated)
Reduction in methane emissions (tCO_2e reduced)	Number of beneficiaries with improved adaptive capacity	Income generated from waste-based products
Quantity of compost produced and utilized	Area under climate-resilient agriculture	Number of people trained
Volume of recycled/upcycled materials (textiles, plastics)	Reduction in environmental pollution	Level of private sector participation in PPP model

11.2.2. Monitoring and Reporting

- ✔ **Regular data collection through school records, project monitoring systems, and partner reports:** Data will be collected routinely from schools, private partners, and implementing agencies using logbooks or reporting templates. This ensures consistent documentation of activities such as waste segregation, compost production, recycling outputs, and participation levels, enabling accurate monitoring of project progress.
- ✔ **Periodic evaluation of compost production, waste reduction, and product outputs:** At regular intervals (e.g., monthly or quarterly), collected data will be reviewed to assess the quantity and quality of compost produced, the reduction in waste sent to landfills, and the volume of recycled or upcycled products generated. This helps measure performance against targets and identify areas for improvement.
- ✔ **Tracking of emissions reductions using standard methodologies:** The project will estimate greenhouse gas emission reductions particularly methane and carbon dioxide by

applying recognized calculation methods and emission factors. This allows for quantification of climate benefits resulting from activities such as composting and recycling.

- ✔ **Feedback mechanisms for continuous improvement:** Feedback will be gathered from students, teachers, private partners, and stakeholders through meetings, reports, and consultations. This information will be used to identify challenges, improve implementation strategies, and enhance the overall effectiveness and sustainability of the project.

11.3. Integration of Indigenous Peoples and Social Safeguards

The project aligns with GCF principles by:

- ✔ Respecting rights of Indigenous peoples, including land, culture, and livelihoods
- ✔ Promoting inclusion and participation of local communities
- ✔ Integrating traditional knowledge and practices into waste management and agriculture
- ✔ Supporting equitable access to project benefits

The project's Results Management Framework demonstrates a clear, measurable, and results-oriented approach. It effectively links project activities to tangible climate mitigation and adaptation outcomes, ensuring that interventions such as composting, recycling, and circular economy practices translate into real environmental benefits. The framework is well aligned with Bhutan's national climate priorities and its Nationally Determined Contributions (NDCs), reinforcing the country's commitment to low-emission and climate-resilient development.

Furthermore, the project promotes a paradigm shift toward a circular economy by transforming waste into valuable resources and strengthening sustainable waste management systems. At the same time, it ensures accountability, transparency, and long-term impact through the application of robust monitoring, reporting, and evaluation mechanisms, enabling continuous tracking of progress and informed decision-making throughout the project lifecycle.

12. GCF Financing Rationale, Economic Analysis and Investment Assessment.

12.1. Executive Summary

This chapter presents the revised project cost, financing requirement, economic analysis and GHG emission reduction estimate for the updated project scope. The revised scope covers 75 schools/institutional locations, each assumed to serve 200 students, reaching approximately 15,000 students in total. The polyester textile production facility from recycled waste has been removed from the investment package. The SELWA waste display, interactive center and sales counter is retained as one central demonstration and market-linkage facility.

All monetary values in this chapter are presented in USD using the planning exchange rate of USD 1 = BTN/Nu. 90. Detailed calculation tables, assumptions and source notes are provided in the annexures. For detailed costing, refer to Annexure 1; for income and economic analysis, refer to Annexure 2; and for GHG emission reduction assumptions and calculations, refer to Annexure 3.

Table 8 Summary of Revised 75-school project scenario

Parameter	Value
Number of schools/institutional locations	75
Students per school	200
Total students covered	15,000
Polyester textile production facility	Removed
SELWA waste display, interactive center and sales counter	Included
Exchange rate used	USD 1 = BTN/Nu. 90
Total project cost	USD 8,728,888.89
GCF grant request at 90%	USD 7,856,000.00
Co-financing at 10%	USD 872,888.89
Annual gross benefits / income value	USD 1,140,666.67
Annual operating cost	USD 2,156,000.00
Annual net economic benefit	USD -1,015,333.33
Annual GHG emission reduction	1,200 tCO2e/year
20-year GHG emission reduction	24,000 tCO2e
Cost per tCO2e reduced	USD 363.70/tCO2e

12.2 Summary of Revised Financing Requirement

The total project cost is estimated at USD 8.73 million. Applying the agreed 90:10 financing ratio, the proposed GCF grant request is USD 7.856 million, while the expected co-financing requirement is USD 0.873 million. The financing structure reflects the public-good nature of the project, particularly the school-level composting, climate-smart agriculture, waste segregation, awareness and education components.

Table 13.2 Revised Financing Requirement

Financing Source	Amount (USD)	Share
GCF grant request	7,856,000.00	90%
Co-financing	872,888.89	10%
Total Project Cost	**8,728,888.89**	**100%**

12.3 Summary of Cost Estimation

The revised project cost includes capital investment and first-year operating costs for 75 schools, and a single centralized SELWA waste display, interactive center and sales counter. The polyester textile production facility from recycled waste is excluded from the revised project scope.

Table 13.3 Summary of Cost Estimation

Budget Component	Total Cost (USD)
School-level capital investment for 75 schools	6,500,000.00
First-year operating cost for 75 schools	2,100,000.00
SELWA waste display, interactive center and sales counter	128,888.89
Total Project Cost	8,728,888.89

12.4 Summary of Income and Economic Analysis

The revised project is not commercially viable without grant support. Removal of the polyester textile production facility reduces commercial revenue potential, while the school-level investments generate mainly public-good benefits, including waste reduction, school nutrition, climate education and behavior change. The annual net economic benefit is negative when direct monetized benefits are compared against annual operating costs.

Table 13.4 Summary of Economic Analysis

Parameter	Value
Total capital investment	USD 6,628,888.89
Annual gross benefits / income value	USD 1,140,666.67

Parameter	Value
Annual operating cost	USD 2,156,000.00
Annual net economic benefit	USD -1,015,333.33
Simple payback period	Not achieved
Annual ROI	-15.3%
NPV at 8%, 20 years	Approximately USD -16,597,581.22
IRR, 20 years	Not financially viable / negative cash flow
Benefit-Cost Ratio	0.40x

13. Summary of GHG Emission Reduction

The revised project is estimated to reduce approximately 1,200 tCO2e per year, equivalent to approximately 24,000 tCO2e over a 20-year project life. The largest mitigation benefit comes from organic waste composting across 75 schools, followed by local food production, school-level recycling, textile upcycling, arts and crafts from waste materials, and small-scale agrivoltaics/solar energy use.

Table 14.1 Summary of GHG Emission Reduction

Activity Category	Annual Reduction (tCO2e/year)	Share
Organic waste composting	810.0	67.5%
School-level recyclables	112.5	9.4%
Local food production	180.0	15.0%
Textile upcycling and reusable bags	37.5	3.1%
Arts and crafts from waste materials	30.0	2.5%
Agrivoltaics / solar energy	30.0	2.5%
Total	**1,200.0**	**100%**

13.2 Conclusion

The revised 75-school project is best positioned as a GCF grant-financed climate and public-good intervention. The project will expand circular waste management, composting, climate-smart food production, student-led environmental education and waste-based enterprise awareness across 75 schools and institutions. Although the direct financial indicators are weak, the project generates significant public benefits that are not fully captured by direct income, including reduced landfill-related emissions, improved school nutrition, strengthened climate education, circular economy practices, and inclusive opportunities through SELWA.

14. Conclusion

The proposed Integrated Waste Management System through a Public–Private Partnership (PPP) Model provides a comprehensive, climate-responsive, and socially inclusive framework for addressing Bhutan's growing waste management challenges while contributing to national and global climate objectives. The project recognizes that ineffective waste management is not solely an environmental concern, but also a critical climate, socio-economic, institutional, and public health issue requiring integrated and long-term interventions. The increasing generation of organic, plastic, textile, and construction waste, combined with inadequate segregation practices, limited recycling infrastructure, and dependence on landfill disposal, has intensified environmental degradation and greenhouse gas emissions, thereby highlighting the urgent need for transformative and sustainable waste management solutions.

The proposed project responds to these challenges through the adoption of a circular economy approach that emphasizes waste minimization, resource recovery, recycling, upcycling, decentralized composting, sustainable agriculture, renewable energy integration, and inclusive livelihood creation. By converting waste streams into economically valuable resources, the project seeks to reduce landfill dependency, lower methane emissions, strengthen climate resilience, and promote sustainable production and consumption practices. The integration of composting systems, hydroponics, aquaponics, greenhouse cultivation, and agrivoltaic technologies further demonstrates the project's commitment to advancing climate-smart and resource-efficient development pathways.

Importantly, the project places strong emphasis on inclusive development and social equity by actively engaging SEN students, caregivers, women, youth, and persons with disabilities throughout the project cycle. Through targeted livelihood opportunities, vocational skills development, awareness creation, and meaningful participation in recycling, composting, sustainable agriculture, and waste-based enterprise development, the initiative contributes to enhanced social inclusion, economic empowerment, and community resilience. In doing so, the project operationalizes the principle of "Leaving No One Behind" while ensuring that vulnerable and marginalized groups are integrated into Bhutan's broader climate and sustainable development agenda.

The Public–Private Partnership model proposed under the project further strengthens its operational and financial sustainability by facilitating collaboration among government institutions, private sector entities, civil society organizations, schools, and local communities. The involvement of private sector actors is expected to enhance technical efficiency, innovation, market access, and long-term viability of waste valorization systems while reducing dependence on public financing alone. In parallel, the establishment of monitoring, reporting, and verification (MRV) systems and strengthened waste data management mechanisms will improve evidence-based planning, institutional accountability, and policy implementation.

The project demonstrates strong strategic alignment with Bhutan's national development priorities, including the 13th Five-Year Plan, Bhutan's Nationally Determined Contributions (NDCs), National Adaptation Plan (NAP), Waste Management Flagship Program, and the national vision of achieving "Zero Waste Bhutan by 2030." Furthermore, the initiative contributes substantively to global climate and sustainable development agendas by promoting greenhouse gas emission reductions, climate adaptation, environmental sustainability, circular economy practices, and inclusive green growth.

In conclusion, the proposed intervention represents a transformative and scalable approach to sustainable waste management in Bhutan. Through the integration of climate mitigation and adaptation measures, circular economy principles, renewable energy systems, inclusive livelihood development, and institutional strengthening, the project has the potential to generate long-term environmental, social, economic, and climate benefits. With support from the Green Climate Fund (GCF), the initiative can serve as a nationally replicable model for climate-resilient and inclusive waste management systems, thereby contributing significantly to Bhutan's transition toward a sustainable, low-carbon, and climate-resilient future.

References

Bhutan Ecological Society. (n.d.). *Waste*. https://bes.org.bt/waste/ (bes.org.bt)

Bhutan Today. (2026). *Monsoon woes: Thimphu struggles with mounting drainage problems prompting calls for urgent action*. Bhutan Today. https://www.bhutantoday.bt/monsoon-woes-thimphu-struggles-with-mounting-drainage-problems-prompting-calls-for-urgent-action/

Borgen Magazine. (2020). Zero Waste Hour in Bhutan. https://www.borgenmagazine.com/zero-waste-hour/

Clean Bhutan. (2025). *Environmental and social management plan (ESMP): Circular Bhutan innovations project – Polyester wool from PET bottles*. https://please-project.org/wp-content/uploads/2025/04/Clean-Bhutan-ESMP.pdf

Climate Change Academy. (2024). *Climate change and waste: Understanding the critical connection*. https://climatechange.academy/mitigation-adaptation-to-climate-change/climate-change-and-waste-connections/

COP 29 Presidency. (2024). *COP 29 Declaration on Reducing Methane from Organic Waste.* https://cop29.az/en/pages/cop29-declaration-on-reducing-methane-from-organic-waste

Disabled People's Organization of Bhutan. (2024). *A review report on the state of persons with disabilities*. https://dpobhutan.org/wp-content/uploads/2024/09/A-Review-Report-on-the-State-of-Persons-with-Disabilities.pdf

Fei, X., Fang, M., & Wang, Y. (2021). Climate change affects land-disposed waste. *Nature Climate Change*, 11, 1004–1005. https://www.nature.com/articles/s41558-021-01220-5?utm_source

Generis Global Legal Services. (n.d.). *Conservation policies in Bhutan: A commitment to protecting biodiversity*. https://generisonline.com/conservation-policies-in-bhutan-a-commitment-to-protecting-biodiversity/

IERE Team. (2025, June 6). *How does recycling affect the environment?* The Institute for Environmental Research and Education. https://iere.org/how-does-recycling-affect-the-environment/

International Panel for Climate Change. (2023). Chapter 11: Industry. In *Climate Change 2023: Mitigation of Climate Change. Contribution of Working Group III to the Sixth Assessment*

Report of the Intergovernmental Panel on Climate Change (pp. 1–62). Cambridge University Press. https://www.ipcc.ch/report/ar6/wg3/chapter/chapter-11/

Japan International Cooperation Agency. (n.d.). *Takakura Composting Method*. Retrieved from https://www.jica.go.jp/english/activities/issues/env_manage/study_takakura.html

Kiron, M, I. (2024). *Sustainable Textile Solutions through Recycling and Upcycling.* Textile Learner. https://textilelearner.net/sustainable-textile-solutions-through-recycling-and-upcycling/

Ministry of Finance, Royal Government of Bhutan. (2025). *Bhutan trade statistics 2024*.https://mof.gov.bt/wp-content/uploads/2025/03/Bhutan-Trade-Statistics-2024.pdf

National Bureau of Statistics of Bhutan & United Nations Economic and Social Commission for Asia and the Pacific. (2021). *Bhutan Waste Accounts Report* (Version as of March 2021). United Nations Economic and Social Commission for Asia and the Pacific.https://www.unescap.org/sites/default/d8files/2021-04/Bhutan_Waste_Accounts_Report_2021.pdf

Namgay, T. (2020). *Nation's waste on the scale: The first Bhutan waste inventory report*. *Statistical Journal of the IAOS, 36*(4), 915–924. https://doi.org/10.3233/SJI-200742

National Environmental Commission. (n.d). Waste Management Division. http://www.nec.gov.bt/secretariat/division/waste-management-division

National Environment Commission (NEC). (2009). *Waste Prevention and Management Act of Bhutan, 2009.* Royal Government of Bhutan. https://www.bmf.bt/wp-content/uploads/2018/11/Waste_Prevention_and_Management_Act_2009_English.pdf

National Park Service. (n.d.). *Hydroponics*. Retrieved from https://www.nps.gov/articles/hydroponics.htm

Planet Aid. (2024). *Driving environmental change through cloths recycling and textile reuse*. https://www.planetaid.org/mission

PLEASE Project. (n.d.). *Waste Management Flagship Programme – Zero Waste*. Retrieved April 3, 2026, from https://please-project.org/sar-initiative/waste-management-flagship-programme-zero-waste-2/

Purdue University, Department of Food Science. (n.d.). *Big Project News*. Retrieved from https://ag.purdue.edu/department/foodsci/big-project/sub-news.html

Rai, A. (2024). *Thimphu City's Municipal Solid Waste Pollution A Case Study*. PrePrints Organization.https://www.preprints.org/frontend/manuscript/d13a1c75e210300edff5bf0a895b9fba/download_pub

Royal Government of Bhutan. (2025, November 10). *Third Nationally Determined Contribution (Provisional)*. United Nations Framework Convention on Climate Change. https://unfccc.int/sites/default/files/2025-11/Third%20NDC%20%28Provisional%29_10%20November%2025.pdf

Royal Government of Bhutan. *Thirteenth Five Year Plan (2024–2029)*. Cabinet Secretariat, Office of the Cabinet Affairs and Strategic Coordination, Thimphu, Bhutan, 2024. https://www.pmo.gov.bt/api/uploads/plans/document-1751451996345.pdf

Royal Government of Bhutan. (2019). *National Waste Management Strategy 2019*. National Environment Commission. https://leap.unep.org/en/countries/bt/national-legislation/national-waste-management-strategy-2019

Simon, K., & Milad, M. (2019). *Recycling plastic bottle into synthetic fiber.* ResearchGate. https://www.researchgate.net/publication/338232283_Recycling_Plastic_Bottle_into_Synthetic_Fiber (researchgate.net)

United Nations Environment Programme (UNEP). (2012). *Waste Prevention and Management Regulation, 2012 (Bhutan).* https://leap.unep.org/en/countries/bt/national-legislation/waste-prevention-and-management-regulation-2012

United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP), & National Statistics Bureau, Royal Government of Bhutan. (2021). Bhutan Waste Accounts Report 2021. https://www.unescap.org/sites/default/d8files/2021-04/Bhutan_Waste_Accounts_Report_2021.pdf

United Nations Framework Convention on Climate Change (UNFCCC). (2025). *Bhutan's Third Nationally Determined Contribution (NDC 3.0) (Provisional, 10 November 2025). https://unfccc.int/sites/default/files/2025-11/Third%20NDC%20%28Provisional%29_10%20November%202025.pdf*

University of Maryland Extension. (n.d.). *Composting and climate change*. https://extension.umd.edu/resource/composting-and-climate-change/

United State Government Accountability Office. (2024). *Science & tech spotlight: Textile recycling technologies*. https://www.gao.gov/products/gao-24-107486

Vaessen-Creative. (n.d.). *How to paper mache*. Retrieved March 27, 2026, from https://www.vaessen-creative.com/en/blog/paper-mache

Water Research Bhutan. (2022). *Managing toxic landfill leachates in dumpsites across Bhutan*. https://www.waterresearchbhutan.org/post/managing-toxic-landfill-leachates-in-dumpsites-across-bhutan

Zero Waste Bhutan. (n.d.). *About Zero Waste Bhutan*. Government of Bhutan. Retrieved March 30, 2026, from https://zerowastebhutan.gov.bt/homepage/about

Annexures

Annexure 1: Detailed Cost Estimate

This annexure provides the detailed cost tables for the revised 75-school scenario. All amounts are converted from BTN/Nu. to USD using the planning exchange rate of USD 1 = BTN/Nu. 90.

Annex Table 1.1 Overall Project Cost

Sl.	Budget Component	Unit Cost (USD)	Quantity	Total Cost (USD)
1	Initial capital investment for school/location-level activities	86,666.67	75 schools	6,500,000.00
2	First-year operating cost for school/location-level activities	28,000.00	75 schools	2,100,000.00
3	SELWA waste display, interactive center and sales counter	128,888.89	1 central facility	128,888.89
	Total Project Cost			**8,728,888.89**

Annex Table 1.2 Detailed Capital Cost for 75 Schools

Sl.	Component	Cost per School (USD)	Total for 75 Schools (USD)
1	Awareness and IEC materials	1,111.11	83,333.33
2	Training and capacity building	4,444.44	333,333.33
3	Waste segregation and collection system	2,222.22	166,666.67

Sl.	Component	Cost per School (USD)	Total for 75 Schools (USD)
4	Takakura composting unit	3,333.33	250,000.00
5	Greenhouse infrastructure	33,333.33	2,500,000.00
6	Hydroponic system	6,666.67	500,000.00
7	Aquaponic system	6,666.67	500,000.00
8	Agrivoltaics / solar integration	11,111.11	833,333.33
9	Sustainable packaging unit	3,333.33	250,000.00
10	Arts and craft demonstration unit	3,333.33	250,000.00
11	Monitoring and documentation	2,222.22	166,666.67
12	Product handling and market linkage	3,333.33	250,000.00
13	Miscellaneous and contingency	5,555.56	416,666.67
	Total Capital Investment	86,666.67	6,500,000.00

Annex Table 1.3 Detailed First-Year Operating Cost for 75 Schools

Sl.	Operating Cost Item	Cost per School (USD)	Total for 75 Schools (USD)
1	Part-time school project coordinator / focal teacher allowance	4,000.00	300,000.00
2	Support staff / caretaker allowance	2,666.67	200,000.00
3	Seeds, seedlings, nutrients, fish feed, compost starter replenishment	2,666.67	200,000.00
4	Utilities and solar system maintenance	4,000.00	300,000.00
5	Maintenance of greenhouse, hydroponics, aquaponics and tools	2,666.67	200,000.00
6	Transport and local market linkage	2,666.67	200,000.00
7	Continued awareness and outreach	4,000.00	300,000.00
8	Packaging and labels	2,666.67	200,000.00

Sl.	Operating Cost Item	Cost per School (USD)	Total for 75 Schools (USD)
9	Miscellaneous operating cost	2,666.67	200,000.00
	Total First-Year Operating Cost	28,000.00	2,100,000.00

Annex Table 1.4 SELWA Center Cost

Sl.	SELWA Center Component	Cost (USD)
1	Waste display, interactive center and sales counter	128,888.89
	Total SELWA Center Investment	128,888.89

Annexure 2: Income, Benefits and Economic Analysis

This annexure provides detailed income, benefit and economic analysis tables. The school-level values include both cash income and in-kind economic value, while the SELWA center includes direct gross revenue, operating cost and estimated net income.

Annex Table 2.1 Annual Income and Economic Value from 75 Schools

Sl.	Income / Benefit Stream	Annual Estimate per School (USD)	No. of Schools	Total Annual Estimate (USD)
1	Vegetables used in school meals	4,000.00	75	300,000.00
2	Surplus vegetable sales	2,666.67	75	200,000.00
3	Fish used in school meals	1,333.33	75	100,000.00
4	Surplus fish sales	666.67	75	50,000.00
5	Compost used internally	800.00	75	60,000.00
6	Surplus compost sales	533.33	75	40,000.00
7	Reusable textile bags	1,333.33	75	100,000.00
8	Arts and crafts	1,333.33	75	100,000.00
9	Sale of segregated recyclables	666.67	75	50,000.00
10	Eco-events, demonstrations and training fees	666.67	75	50,000.00

Sl.	Income / Benefit Stream	Annual Estimate per School (USD)	No. of Schools	Total Annual Estimate (USD)
	Total Annual Income / Economic Value	14,000.00	75	1,050,000.00

Annex Table 2.2 SELWA Interactive Center Annual Income

Sl.	Revenue Stream	Monthly Revenue (USD)	Annual Revenue (USD)
1	Sales of upcycled products	5,555.56	66,666.67
2	Workshop and training fees	1,111.11	13,333.33
3	Grants and government support	555.56	6,666.67
4	Sponsorships / corporate partnerships	333.33	4,000.00
	Total Gross Revenue	7,555.56	90,666.67

Annex Table 2.3 SELWA Interactive Center Net Income Estimate

Item	Monthly (USD)	Annual (USD)
Gross revenue	7,555.56	90,666.67
Operating cost	4,666.67	56,000.00
Estimated net income	2,888.89	34,666.67

Annex Table 2.4 Combined Annual Benefits

Project Component	Annual Gross Income / Value (USD)	Annual Net Income / Value (USD)
75 school locations	1,050,000.00	1,050,000.00 economic value, including savings
SELWA waste display, interactive center and sales counter	90,666.67	34,666.67
Total	1,140,666.67	1,084,666.67

Annex Table 2.5 Economic Analysis Inputs

Parameter	Value
Number of schools	75
Students per school	200
Total students covered	15,000
School capital investment	USD 6,500,000.00
SELWA interactive center capital investment	USD 128,888.89
Total capital investment	USD 6,628,888.89
School annual operating cost	USD 2,100,000.00
SELWA interactive center annual operating cost	USD 56,000.00
Total annual operating cost	USD 2,156,000.00
Annual gross benefits / income value	USD 1,140,666.67
Annual net operating position	USD -1,015,333.33
Analysis period	20 years
Discount rate	8%

Annex Table 2.6 Economic Parameters

Parameter	Result
Total capital investment	USD 6,628,888.89
Annual gross benefits / income value	USD 1,140,666.67
Annual operating cost	USD 2,156,000.00
Annual net economic benefit	USD -1,015,333.33
Simple payback period	Not achieved
Annual ROI	-15.3%
NPV at 8%, 20 years	Approximately USD -16,597,581.22
IRR, 20 years	Not financially viable / negative cash flow
Benefit-Cost Ratio	0.40x

Annexure 3: GHG Emission Reduction Estimate

This annexure presents the screening-level GHG emission reduction estimate for the 75-school scenario. The polyester textile production facility is removed; therefore, emission reductions from PET-to-polyester production are excluded. The estimate is based on school-level composting, recycling, upcycling, local food production and agrivoltaics.

Annex Table 3.1 GHG Emission Reduction Assumptions

Sl.	Parameter	Assumption Used
1	Number of school/institutional locations	75
2	Students per school	200
3	Total students covered	15,000
4	Organic waste composted per school	18 tonnes/year
5	Total organic waste composted	1,350 tonnes/year
6	Avoided landfill methane and compost benefit	0.60 tCO2e/tonne organic waste
7	Polyester textile production facility	Removed
8	School-level recyclables diverted	Scaled from school-level estimate
9	Local vegetables and fish replacing external procurement	Scaled from 75 schools
10	Solar PV / agrivoltaics	School-scale systems in 75 schools
11	Assessment period	20 years

Annex Table 3.2 Annual GHG Emission Reduction Estimate

Sl.	Activity	Basis of Calculation	Annual GHG Reduction (tCO2e/year)
1	Organic waste composting in 75 schools	1,350 tonnes organic waste/year x 0.60 tCO2e/tonne	810.0
2	School-level sale and transfer of segregated recyclables	Mixed recyclables diverted from landfill and sent to recyclers	112.5
3	Reusable textile bags and textile upcycling	Avoided textile disposal and partial replacement of new bags/products	37.5

Sl.	Activity	Basis of Calculation	Annual GHG Reduction (tCO2e/year)
4	Arts and crafts from waste materials	Avoided paper, bamboo, wood and small material disposal/replacement	30.0
5	Local vegetable and fish production in schools	Reduced external procurement, transport, storage and food loss	180.0
6	Agrivoltaics / solar energy for greenhouse operations	Solar energy replacing grid/imported/backup energy use	30.0
	Total Estimated Annual GHG Reduction		**1,200.0**

Annex Table 3.3 Lifetime GHG Emission Reduction

Item	Estimate
Annual GHG emission reduction	1,200 tCO2e/year
Project life	20 years
Total lifetime GHG emission reduction	**24,000 tCO2e**

Annex Table 3.4 GHG Scenario Range

Scenario	Annual Reduction (tCO2e/year)	20-Year Reduction (tCO2e)
Conservative case	860	17,200
Base case	1,200	24,000
Higher case	1,725	34,500

Annex Table 3.5 Main Sources of GHG Reduction

Activity Category	Annual Reduction (tCO2e/year)	Share
Organic waste composting	810.0	67.5%
School-level recyclables	112.5	9.4%

Activity Category	Annual Reduction (tCO2e/year)	Share
Local food production	180.0	15.0%
Textile upcycling and reusable bags	37.5	3.1%
Arts and crafts from waste materials	30.0	2.5%
Agrivoltaics / solar energy	30.0	2.5%
Total	**1,200.0**	**100%**

Annex Table 3.6 Cost Effectiveness

Item	Value
Total project cost	**USD 8,728,888.89**
Lifetime GHG emission reduction	**24,000 tCO2e**
Cost per tCO2e reduced	**USD 363.70/tCO2e**

Annexure 4: Source Notes and Calculation Basis

Annex Table 4.1 Source Notes and Calculation Basis

Data / Assumption	Source / Basis
School package and activities	Draft Concept Note dated 5 April 2026, including school-based composting, greenhouse, hydroponics, aquaponics, agrivoltaics, waste segregation, reusable textile bags, awareness and SELWA-related inclusion components.
Investment cost categories and benchmark rates	Pre-Feasibility Study on Improved Waste Management dated 27 March 2025, including benchmark costs for training, equipment, facility setup, waste interactive center and operating cost categories.
Removal of polyester textile production facility	User instruction for revised scope. The investment and revenue from polyester textile production have been excluded from the revised scenario.
Number of schools	User instruction for revised scope: 75 schools.
Exchange rate	User-provided planning exchange rate: USD 1 = BTN/Nu. 90.

Data / Assumption	Source / Basis
Organic waste composted per school	Screening-level planning assumption based on school-level composting activities; to be verified through waste audits during full proposal preparation.
Avoided landfill methane and compost benefit	Screening-level emission factor of 0.60 tCO2e per tonne of organic waste diverted from landfill and composted. This should be refined using an approved GHG accounting method during full proposal development.
Economic analysis period	20-year planning period used for infrastructure and GHG lifetime assessment.
Discount rate	8% planning discount rate used for concept-level economic analysis.