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SUSTAINABLE AND CIRCULAR TEXTILE CLUSTER IN LUDHIANA

A Stakeholder-led Roadmap to Establish a Circular and Sustainable Cluster in Ludhiana

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The Indian Apparel and Textile sector is at an interesting crossroads as the Ministry has set ambitious targets for both international and domestic markets. As the Industry gears up to deliver on these targets, sustainability and circularity become an important lever for the growth and development of the sector. However, this development needs to account for the unique set up of the Indian industry and explore cluster level initiatives. This is the time for the industry to lead the narrative on sustainability and define the roadmap for a collaborative and sustainable development

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Acknowledgement

The Ludhiana Textile and Apparel Sector cluster has long been recognised as the backbone of India's woollen and acrylic knitwear industry, supplying the bulk of the country's winter wear and supporting hundreds of thousands of livelihoods. The cluster has strengths in scale, diversity, and entrepreneurial ability. At the same time, the cluster faces mounting pressures from stagnating exports, ageing infrastructure and environmental and sustainability stress emerging from regulatory requirements in both domestic and international markets.

This report, "A stakeholder led roadmap to establish a circular and sustainable cluster in Ludhiana," responds to these stresses and charts a way forward for the cluster. It presents a structured, phased, and implementable pathway to embed sustainability and circular economy principles into the cluster's growth strategy. The report is grounded in extensive stakeholder consultations and aligns with India's 2047 goal of Viksit Bharat.

The roadmap recognises that sustainability cannot be compliance driven and cannot be pursued in isolation, it must be embedded in a circular economy principles across design, materials, energy, water, chemicals, and waste, which is supported by shared infrastructure, enabling policies, access to finance, skills development, and coordinated cluster-level action. The phased approach balances the immediate priorities such as wastewater management and cleaner energy with longer-term ambitions of closed-loop recycling, net-zero emissions, and global recognition for circular textile production.

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1. Executive Summary

The Ludhiana textile and apparel cluster is one of India's most significant industrial ecosystems, supplying nearly 90-95% of the country's woollen and acrylic knitwear and employing approximately 350,000-400,000 workers, largely within Micro Small and Medium Enterprises (MSMEs). Despite its scale and historic competitiveness, the cluster faces stagnating revenues, declining exports, increasing regulatory pressures, and acute environmental stress–particularly related to water pollution, energy intensity, and waste generation.

This report presents a **donor-ready, policy-aligned roadmap** to transition Ludhiana into a sustainable and circular textile cluster by 2047, aligned with India's Net Zero commitments, the EU Green Deal, Ecodesign for Sustainable Products Regulation (ESPR), Digital Product Passports (DPPs), and the Government of India's *Viksit Bharat 2047* vision. The roadmap is based on extensive stakeholder consultations, secondary data analysis, and alignment with global circular economy frameworks.

Key findings indicate that while export-oriented units have begun adopting sustainability practices, the cluster overall remains locked in a linear production model characterised by high resource consumption, low recycling rates, limited traceability, and fragmented infrastructure. Three Common Effluent Treatment Plants (CETPs), one Common Facility Centres (CFC), and one textile park are insufficient to address current and emerging sustainability requirements. Annual dye consumption is estimated at ~3.24 lakh tonnes, recycled yarn usage is approximately 30-40% but poorly traced, renewable energy penetration remains low, and untreated effluents continue to pollute the Buddha Nallah.

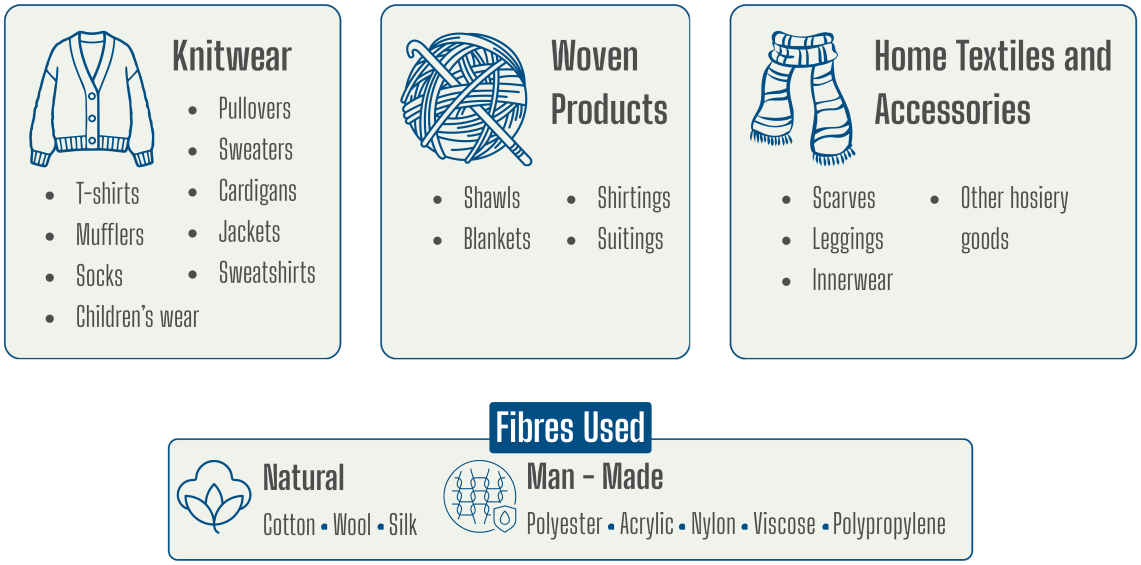
The proposed roadmap adopts a **phased transformation approach**:

- **Baseline & Early Action (2025-2027):** Data systems, pilot projects, CETP upgrades, renewable energy pilots, and workforce skilling
- **Early Transition (2030):** Shared infrastructure, 50% renewable energy, 50% waste circularity , science-based targets (SBTi) alignment, and ₹2,000 crore incremental exports
- **Scaling Circularity (2035):** Closed-loop recycling, 80-90% renewable energy, net-zero Scope 1 & 2 emissions, global low-carbon recognition
- **Vision 2047:** Energy-positive, water-positive, zero-waste cluster generating over ₹8,000 crore in incremental circular economy revenues

The report identifies priority investment areas for donors (for international agencies and for Indian foundations and philanthropies) and development partners, including shared recycling infrastructure, clean energy transition, water stewardship, digital traceability systems, MSME finance mechanisms, and skills development. Strategic donor engagement can unlock systemic transformation, de-risk private investment, and position Ludhiana as a flagship circular textile cluster in the Global South.

2. Overview and Cluster Structure

Ludhiana is the largest district of Punjab state in India and is recognised as the largest hub for **woollen and acrylic knitwear** in India as well as the largest manufacturing cluster in northern India. Ludhiana's cluster[1] produces a wide array of **textile and apparel products** supplying approximately **95% of the country's woollen and acrylic knitwear**, including:



The cluster is highly diversified, encompassing **spinning, weaving, knitting, dyeing, finishing, garment manufacturing, and textile machinery production**. It is estimated that Ludhiana hosts around **14,000[2] MSMEs**, with a breakdown as follows:

- **Micro units:** 9,800 (70%)
- **Small-scale units:** 2,800 (20%)
- **Medium-sized units:** 1,400 (10%)

Note: The definition of MSMEs is as per the official notification of the Ministry of Micro, Small & Medium Enterprises[3] based on Investment in Plant & Machinery and Annual Turn

Revised Classification applicable w.e.f 1st April 2025

Composite Criteria: Investment in Plant & Machinery/equipment and Annual Turnover

CLASSIFICATION	MICRO	SMALL	MEDIUM
Manufacturing Enterprises and Enterprises rendering Services	Investment in Plant and Machinery or Equipment: Not more than Rs. 2.5 crore and Annual Turnover not more than Rs. 10 crore	Investment in Plant and Machinery or Equipment: Not more than Rs. 25 crore and Annual Turnover not more than Rs. 100 crore	Investment in Plant and Machinery or Equipment: Not more than Rs. 125 crore and Annual Turnover not more than Rs. 500 crore

New definition of MSME, View Notification

Additionally, there are a small number of large-scale enterprises such as Nahar (Oswal and Monte Carlo), Trident, Vardhman, and Sportking, amongst others. However, the industry is predominantly MSME-driven.

[1] A cluster is a group of enterprises located within an identifiable and as far as practicable, contiguous area or a value chain that goes beyond a geographical area and producing same/similar products/complementary products/services, which can be linked together by common physical infrastructure facilities that help address their common challenges. The essential characteristics of enterprises in a cluster are (a) Similarity or complementarity in the methods of production, quality control & testing, energy consumption, pollution control, etc., (b) Similar level of technology & marketing strategies/practices, (c) Similar channels for communication among the members of the cluster, (d) Common market & skill needs and/or (e) Common challenges & opportunities that the cluster faces.(https://dcmsme.gov.in/schemes/FAQs%20MSE-CDP.pdf)

[2] https://sameeeksha.org/index.php?option=com_content&view=article&id=139&Itemid=502

[3] https://msme.gov.in/know-about-msme

The following information was gleaned through stakeholder interviews at the cluster level.

Table 1: Textile Value Chain Segments in Ludhiana

SEGMENT	APPROXIMATE SIZE/DETAILS
Knitting	~40% of total units; includes sweaters and shawls
Garmenting	~30% of units; includes T-shirts, undergarments, and embroidery
Spinning	~60 units; spinning r segment in Ludhiana
Processing	~100 units involved in various finishing operations
Dyeing	~350 units; figure based on data from the Dyeing Association
Weaving	~2,000 units with approximately **15,000 looms** in operation, comprising: - **10,000 powerlooms** - **5,000 rapier looms**

The cluster has an annual turnover of approximately ₹16,000 crores. The domestic market is the primary outlet, with a strong presence in both upper-end and middle segments. Historically, Ludhiana exported a significant share of its production, especially to the Soviet Union and other international markets. Currently, exports constitute about **20% of total turnover (to Europe, North America and Middle East)**, with the majority of production catering to domestic demand. Discussions with stakeholders highlighted that the turnover has been stagnant for the past few years with the share in exports showing a slight decline.

The textile and apparel industry is a major part of Punjab's manufacturing sector, but its share has been gradually declining. In 2012-13, textiles accounted for ~29.3% of Punjab's manufacturing Gross Value Added (GVA), and by 2023-24 (advance estimates), this fell to 26.7%. Ludhiana cluster related manufacturing (hosiery, knitwear) is still strong, but contribution is shrinking slightly, from 27.7% in 2021-22 to 26.7% in 2023-24 (Punjab Economic Survey 2023-24). Industry stakeholders also cited seasonality in production as a major challenge to be addressed as it leads to underutilization of installed capacity.

Further, the cluster is highly **labour-intensive**, providing direct and indirect employment to **350,000-400,000 people**. The Punjab Economic Survey (2024) confirms that more than 90 percent of the labour force in the textile cluster is migrant, with Ludhiana emerging as the largest destination in Punjab. However, like most other textile clusters in the country, Ludhiana faces a shortage of labour. Moreover, it has limited engagement of women workers in the manufacturing units.

At present, stakeholders have highlighted the need for upgrading the industry's infrastructure in terms of machinery, common facilities, power supply systems and decentralised clean energy systems. They have also highlighted the need to strengthen connectivity especially through better roads and having functional airports. Another lacuna is the absence of supportive policies especially to boost sustainability. Industry stakeholders across the value chain were unanimous in stating that any intervention of sustainability or circularity is driven by the industry's own initiative and can receive considerable boost through a clear and transparent policy environment.

Undoubtedly, the Ludhiana cluster is a strategic one for the Indian Apparel & Textile sector. It supports a wide ecosystem including industry associations, sub-contractors, and ancillary units. Through a large number of units providing manufacturing support to bigger firms and export houses, Ludhiana has been able to create a backward linkage and almost monopolises winter wear production for the country. Industry experts also indicated that Ludhiana is well positioned to cater to demand from small volume but high value niche buyers (demand which is usually ignored by large scale production countries such as China and Bangladesh).

Industry consultations focussing on current status of circular practices

Consultations with policy actors on leveraging existing schemes and programmes in Ludhiana

Despite its contribution, the cluster has been facing stagnation and limited growth. Some of the factors contributing to this stagnation are lack of product diversification, outdated machinery, limited uptake of sustainable practices and limited exports. While, infrastructure upgradation and industrial polies were identified as critical enables, stakeholder consultations clearly highlighted that there is a positive interest to adopt more sustainable and circular manufacturing though awareness, access to technical know-how and outdated infrastructure remain major bottlenecks. It was felt that sustainability related practices can open up new markets and growth opportunities for the cluster. Against this backdrop, it becomes imperative to define how the cluster can flourish, especially based on principles of sustainability and circular economy.

To this end, the Centre for Responsible Business undertook a project titled "*Roadmap for Developing Circular Clusters in the Apparel & Textile Sector of Ludhiana*". Funded by the Aspen Network of Development Entrepreneurs (ANDE), the project aimed to engage key stakeholders in the apparel and textile sector of the Ludhiana cluster to define their vision for a sustainable and circular cluster and to inform the development of an actionable roadmap for the textile cluster in Ludhiana. This roadmap is a step forward in the direction for the Ludhiana textile industry to develop and executing its own vision for establishing a sustainable and circular cluster. For donors and development partners, the roadmap identifies opportunities to support technology demonstrations, cluster-level infrastructure, skill development and financing mechanisms that can accelerate the transition toward a sustainable textile ecosystem.

3. Rationale for Sustainability and Circularity for the Ludhiana Cluster

Ludhiana's textile cluster, which caters to nearly 90% of India's hosiery and knitwear demand, is at a crucial transition point. While the cluster benefits from a strong domestic market base, diversified value chain, and entrepreneurial spirit, its future competitiveness hinges on embracing circularity and sustainability.

Globally, textile value chains are undergoing rapid transformation due to the European Green Deal (EGD)[4], Ecodesign for Sustainable Products Regulation (ESPR)[5], Digital Product Passports (DPPs)[6], extended producer responsibility (EPR), and stricter chemical and carbon disclosure requirements. Ludhiana's export-oriented units face rising risks of market exclusion if sustainability and traceability expectations are not met.

Closer home, the regulatory landscape in India is prioritising climate and sustainable action. This is evident through: (i) India's Nationally Determined Contributions and Goal of Net Zero by 2070, (ii) the National Guidelines for Responsible Business Conduct and the associated Business Responsibility and Sustainability Reporting (BRSR) that applies to the top 1,000 listed companies (and in turn their supply chains), (iii) provision of green finance especially for MSMEs through institutions like SIDBI, amongst other developments. The Ministry of Textiles aims to release a schematic intervention for circular textiles and is drafting a policy to establish India as a source of sustainable apparel and textiles. Further, there is a focus on facilitating knowledge sharing and collaboration across the different textile and apparel clusters in the country.

From a resource perspective, the cluster's linear business model—manufacture, sell, discard—results in high material losses, low recycling rates, and escalating costs of raw materials, water, and energy. Annual dye consumption is estimated at approximately 3.24 lakh tonnes, with a chemical footprint dominated by reactive, disperse, acid, and basic dyes. Large volumes of pre-consumer textile waste and sludge from effluent treatment remain underutilised, while post-consumer textile waste is largely unmanaged. These issues, coupled with shrinking export markets and climate risks, are pushing the industry towards a sustainability tipping point.

Circularity offers a pathway to decouple growth from resource consumption. By closing material loops, improving energy and water efficiency, and shifting towards low-impact inputs, the cluster can reduce environmental risks, improve resilience to climate shocks, and unlock new revenue streams through recycled yarns, circular products, and premium sustainable branding. Circularity also aligns with India's national priorities under *Viksit Bharat 2047*, climate commitments, and MSME competitiveness agendas.

It is a great opportunity for Ludhiana to capitalise on its strengths and at the same time explore product and market diversifications to spur growth and build economic resilience. However, without a structured sustainability roadmap, Ludhiana risks losing market share to regions like Tiruppur, Surat, Panipat and international competitors that are already adapting to new compliance standards. Tiruppur, a leading exporting and processing cluster in the Southern part of the country has adopted strong sustainability practices relating to clean energy, waste waster management, and waste management and has started investing in a strong branding and communication strategy[7]. Another cluster adopting a collective approach is the textile cluster in Surat (in the state of Gujarat in Western India) and a roadmap for the textile sector was developed through a UNEP initiative[8] in 2022-23. product and market diversifications to spur growth and build economic resilience. However, without a structured sustainability roadmap, Ludhiana risks losing market share to regions like Tiruppur and international competitors that are already adapting to new compliance standards.

[4] https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal_en
[5] https://www.regulatory-compliance.eu/ecodesign-for-sustainable-products-regulation/
[6] https://eproductpassport.eu/
[7] https://www.greenstory.io/blogs/showcasing-sustainability-green-story-and-teas-collaborative-white-paper-on-tiruppurs-achievements
[8] https://www.linkedin.com/posts/centre-for-environment-education_roadmap-for-sustainable-textile-hub-in-india-activity-7171819507257225216-rmLB/

Understanding the industry priorities through the Knitwear Club, Ludhiana

4. Current Status of Sustainable and Circular Practices in Ludhiana

Stakeholder consultations highlighted the following with regards to the current trends towards sustainability in the cluster:

- Data gaps persist in updated information on resource consumption, current sustainability practices and benefits achieved
- There is limited awareness, technical capacity and know-how on emerging sustainability norms and regulations (such as EU's Digital Product Passport or Ecodesign Regulations for Sustainable Products) or concepts such as Life Cycle Assessments (LCA)
- Domestic brands are not always open to experimenting with recycled fibres. In general, there is a negative perception/stigma attached with the concept of recycled fibres
- Sustainable practices are more prevalent in export focussed units in response to buyers' demands and requirements. This is especially true for sustainability standards and certifications wherein adoption remains limited on account of the large domestic market focus and the small size of the units
- Individual exporters are taking initiatives, but there is no unified cluster-level approach
- There is a need for targeted skill development programmes, especially with managing advanced machinery and technological innovations

A deep dive into the resource consumption/management highlighted the the following:

Energy Consumption - Energy Consumption is high especially in wet processing and spinning units. The cluster continues to rely on fossil fuels such as coal, diesel, and pet coke for thermal energy requirements. Adoption of renewable energy options such as solar PV or biomass boilers has been limited due to high upfront investments and inadequate subsidy support. While some units have shifted to rice husk as boiler fuel, scaling up alternative fuels like rice stubble (*parali*) remains constrained by technological, logistical, and storage challenges. The low adoption of clean/renewable energy leaves the cluster vulnerable to fuel price volatility and climate related disruptions. There is no systematic cluster-wide greenhouse gas (GHG) accounting, and carbon intensity remains high.

Water and Effluent Management - The cluster is heavily dependent on groundwater for dyeing and finishing processes, contributing to the depletion of local aquifers. There are growing restrictions on ground water extraction and the industry is calling out for more access to surface water.

The wastewater generated from the processing units is a major area of concern

as these units are often criticised for water and chemical pollution. The processing units often face closure of activities[9,10] on account of regulatory action or unforeseen events such as floods which leads to disruption of the entire value chain. Although three Common Effluent Treatment Plants (CETPs) are operational, their combined capacity is inadequate relative to the total wastewater generated. Smaller units, in particular, face difficulties in managing effluent treatment due to high costs and technical limitations. Zero Liquid Discharge (ZLD) systems, while installed in a few large enterprises, remain financially unviable for MSMEs because of their high capital and operational expenditure. There is limited research and innovation on low impact dyeing processes/technologies or new product categories based on new finishing technologies. Respondents from the dyeing community indicated testing with decolorants that can help reduce the sludge produced in the wastewater treatment. They further indicated that there is scope to provide subsidies or reduce import duties on such decolorants. The CETPs are also managing their sludge well and have contractual agreements with private sector companies for the pick up and proper disposal of the sludge. sludge.

Chemical Usage and Management - Dyeing and finishing operations within the cluster are highly chemical-intensive. Chemical management systems are fragmented, with limited adoption of restricted substances lists (RSL) and manufacturing restricted substances lists (MRSL). Waste generation is significant, but recycling, upcycling, and valorization initiatives remain limited. Wet processing is often outsourced to avoid compliance costs, further fragmenting accountability. Eco-friendly and certified chemical alternatives exist, but their costs are 10–12 percent higher than conventional chemicals, making adoption difficult for smaller firms. Furthermore, limited availability of in-house testing laboratories and qualified staff restricts the ability of MSMEs to consistently comply with international chemical safety and traceability standards. Stakeholders suggested chemical audits and a reevaluation of current chemical usage. UNIDO has recently launched an initiative to promote greener chemistry in the textile industry in India which offers an opportunity to MSMEs to address chemical pollution, reduce costs incurred on account of incorrect handling of chemicals and build capacities to meet requirements of international buyers and brands on safer handing of chemicals and adoption of greener alternatives.

Raw Material and Design Considerations - Design capabilities in the cluster are largely buyer-driven, with limited influence over product specifications and materials. While some units have in-house design teams, most follow trends dictated by brands, resulting in low value addition and limited integration of circular design principles such as durability, recyclability, and modularity. Digital design tools and lifecycle-based decision-making remain at a nascent stage.

Material/fibre choice is largely dictated by buyer requirements, limiting local innovation. Recycled fibres and organic cotton are used primarily when mandated by buyers rather than as a strategic choice. Traceability of fibre origin, carbon footprint, and water footprint is limited, and sustainable material sourcing is not institutionalised across enterprises.

Although recycled yarn constitutes an estimated 30–40 percent of inputs, it presents operational challenges such as increased chemical consumption, difficulty in achieving lighter colour shades, and higher processing times. The absence of large-scale recycling and fibre recovery infrastructure further limits circular material flows.

Solid Waste Management - Most of the textile waste is generated at garmenting and knitting units and industry actors indicated that they handed over textile waste to waste collectors. There is not much visibility on how this waste is further managed. Packaging waste is handled in a similar manner. Industry actors also informed that ash from the boilers is not being utilised in any manner and this could be a potential area of consideration for industrial symbiosis.

[9] https://www.texadviser.com/ludhiana-dyeing-units-shut-amid-sutlej-river-flooding-2
[10] https://www.tribuneindia.com/news/ludhiana/dyeing-units-main-culprit-in-polluting-buddha-nullah/

The table below gives a summary of the current status of circular and sustainable practices in the textile cluster of Ludhiana.

Table 2: Snapshot of Circular Textile Considerations at Various Stages of the Value Chain

PRIORITY AREA	ASSESSMENT OF CURRENT STATE
Design *Design plays a critical role in enabling circularity because product design decisions determine the materials used, durability of products, recyclability and waste generation during manufacturing.*	◆ Limited influence in designs, currently designs are dictated by buyers/brands ◆ Limited in-house design, mostly trend-following ◆ Low value addition keeps competitiveness and revenues stagnant; exports declining
Material *The materials used in textile production determine both environmental impact and the potential for circularity. In the Ludhiana cluster, commonly used materials include cotton, polyester and acrylic yarns. Improving the sustainability of these materials will require better traceability, increased use of recycled fibres and development of low-impact alternatives.*	◆ Raw material use dominated by cotton, acrylic, polyester, wool ◆ Recycled yarn and organic cotton used mainly when required by buyers ◆ Outdated equipment, uneven technology adoption, reliance on traditional processes
Energy *Energy consumption represents one of the largest environmental and cost drivers for textile production. The Ludhiana cluster can significantly improve competitiveness by reducing energy intensity and increasing the use of renewable energy.*	◆ High energy usage in dyeing, processing, spinning ◆ Reliance on pet coke, rice husk, HSD, and wood fuel ◆ Limited renewable adoption, cluster vulnerable to climate shocks
Water *Improved water stewardship is essential for reducing environmental impacts and meeting regulatory requirements.*	◆ Excessive water use, low wastewater recycling ◆ Buddha Nallah polluted with untreated textile effluents (BOD up to 580mg/L; COD up to 990 mg/L)
Chemical *Use of Greener chemicals, reduce hazardous chemicals, effective chemical management practices and systems*	◆ High chemical footprint, annual dye consumption ~3.24 lakh tons ◆ Reactive, disperse, acid, basic dyes dominate
Waste *Textile waste represents both an environmental challenge and an economic opportunity. The Ludhiana cluster generates substantial quantities of yarn waste, fabric scraps and post-consumer textile waste that could be recovered and reprocessed.*	◆ Large waste, limited recycling or upcycling initiatives ◆ Wet processing often outsourced to avoid effluent/waste norms

It is to be noted that while various aspects of circular textiles have been highlighted in the table above, the stakeholder consultations have revealed that the most urgent areas of action are wastewater treatment, better chemical management systems and transition to greener

energy. In fact, some stakeholders indicated that the processing units can be at risk of closure if there are no workable solutions for treated waste water and investing in CETPs and ZLDs through government support and schematic interventions.

An assessment of the supportive ecosystem highlights the following:

FINANCIAL ECOSYSTEM

MSMEs in Ludhiana face significant financial barriers in adopting sustainable practices. Access to affordable credit is limited, with high interest rates, stringent collateral requirements, and long payback periods acting as deterrents. This restricts investment in energy-efficient machinery, wastewater recycling systems, and the adoption of eco-friendly raw materials and chemicals. However, institutions like SIDBI and the Bureau of Energy Efficiency (ADITEEE) have programs/interventions to support renewable energy and energy efficiency investments.

WORKFORCE AND SKILLS

The cluster is highly labour-intensive and relies predominantly on a migrant workforce, over 90 percent of whom lack formal technical training. While larger enterprises have instituted health and safety systems, smaller units face persistent gaps in occupational safety, worker welfare, and skill development. Technical skills required for modern machinery operation, sustainable processing, and chemical management remain insufficiently developed. Associations such as Garment Machinery Manufacturers and Settlers Association (GMMSA) are investing in their own skilling centre and aim to create high-end jobs for handling sophisticated machinery and equipment.

POLICY SUPPORT AND INCENTIVES

There are various schemes such as Zero Effect, Zero Defect, Lean Manufacturing, GIFT and SPICE offered by the Ministry of MSME. However, the uptake of such schemes remains low and the units are unaware of sustainability trends and benefits. In addition, the industry also feels that there is not adequate clarity on policy measures thus making long term investments uncertain and risky. A list of the relevant policies and schemes is attached as an Annexure.

COLLABORATION WITH RESEARCH AND ACADEMIC INSTITUTIONS

In general, there is limited collaboration between industry and academia. The industry shared feedback that curricula and training areas for local textile colleges need to be updated and made more contemporary and relevant for current trends.

COMMON INFRASTRUCTURE

While the cluster has one textile park, one CFC, and three CETPs, existing infrastructure is insufficient to address current and emerging sustainability needs. Facilities for large-scale textile-to-textile recycling, waste-to-energy conversion, and renewable energy integration are absent, placing the burden of sustainability investments directly on individual enterprises, most of whom are financially constrained. There was a proposal to set up an apparel park which did not materialise due to low interest and agreement between the different stakeholders. Another proposal to set up a mega integrated textile region and apparel park, under the PM-MITRA scheme, was red-flagged by locals and environmentalists as it was near sensitive flood plains and forests. The cluster can benefit from common testing facilities especially for processing units and for them to adopt the principle of getting it right the first time.

5. Comparison with other Textile and Apparel Clusters

Ludhiana can benefit from benchmarking against other clusters in the country and drawing upon experiences and good practices from other clusters. Given below is a broad comparison with other clusters in the country that have similar profiles to Ludhiana.

Table 3: Comparison of Select Apparel & Textile Clusters in India

Metric	Tiruppur	Surat	Panipat	Ludhiana
Effluent Treated (MLD)	~130 MLD (ZLD) (18 CETPs connecting over 90% of the cluster)	~115 MLD (reused sewage)	Minimal documented central treatment	None documented cluster-wide 3 CETPs with around 100 + units connected
Water Reuse %	~96% recycled	~33% (to industry; target ↑) Collaboration with local Municipality for use of treated sewage water	Low / largely untreated	Low / varied by unit
Renewable Capacity	~1,950 MW installed	Not consolidated	Not reported	Not reported
Industrial Units	~300 dyeing/ processing + knitting units	~400+ dyeing/ printing units	~3,095 MSMEs	Thousands of textile/garment units
Textile Waste Processing	Recycled textile cut waste	Textile processing, some water reuse	~1 million tonnes annually	Unit-initiated, limited data
Export Impact	~55% of India's knitwear exports	Major synthetic fabric hub (~40% of national share)	~$1.7B export of recycled products	Major hosiery production, export presence

From the table, it is evident that textile and apparel clusters across the country are beginning to invest in sustainable and circular practices. Panipat is a leading hub for textile waste recycling and is drawing interest from international agencies and various donors for improving resource efficiency and cleaner production methods in the cluster. Surat has successfully implemented interventions such as the Emissions Trading Scheme, tie up with the local Municipality to supply treated sewage water for the processing clusters and set up of CETP. Surat has been identified as one of the cities for which an Economic Master Plan has been drawn up by NITI Aayog to realise the vision of Surat 2047 (developed Surat aligned to the vision of *Viksit Bharat 2047*). Tirupur clearly leads in terms of sustainable practices. The cluster has invested in robust data systems and transparency to showcase its sustainable and green strategies which have helped the cluster retain a high share of exports. The Ludhiana cluster stands at risk of losing market and being a cluster of choice if it fails to provide for sustainable and circular growth.

6. Roadmap framework - Rationale and Methodology

Based on the current landscape in Ludhiana, a roadmap for sustainability and circularity needs to address the following considerations:

- Stabilise and help improve the cluster's turnover
- Identify the infrastructure requirements and suggest an implementation plan
- Help embed sustainability and circularity as regular business decisions rather than as stand-alone initiatives
- Ensure business resilience and future proofing and minimise disruptions on account of regulatory norms/compliances
- Suggest policy interventions to facilitate the cluster's journey towards circularity
- Strengthen the enabling ecosystem support required through financing, skilling and access to technology
- To support just transition through inclusive and quality employment and strengthening of OHS standards

The roadmap envisions transforming Ludhiana into a globally recognised, innovation-driven, sustainable, and circular textile and apparel cluster by 2047. The framework is structured around phased transitions with clearly defined milestones across technology, energy, environment, decarbonisation, revenue, and stakeholder engagement. Market and Product Diversification underpin the suggested roadmap so that the cluster develops economic resilience along with environmental and social wins.

The development of the cluster roadmap began with identifying the key priorities for developing a circular economy model within Ludhiana's textile cluster; this was informed by multiple stakeholder engagement (list of stakeholders included in the Annexures) and data collection. These priorities include the adoption of clean energy, improved wastewater management, promotion of sustainable chemical practices, and reduction of textile waste. From the consultations and analysis, gaps and challenges were identified in ***six thematic pillars: design, materials, energy, water, chemicals, and waste.***

Based on these, a shared vision and targets were developed through multi-stakeholder discussions. An effort was made to get a representation of the different value chain segments viz. processing units, apparel manufacturers, weaving segments, machinery manufacturers and various government departments. The project team identified leading associations for these various segments and organised consultations with select group of members through the associations. The team was able to mobilise over 100 members through 4-5 industry associations. One on one visits were organised and planned for the government departments such as the local MSME office (responsible for centre government schemes on lean manufacturing, resource efficiency, circular economy, skill development and common infrastructure, the Textile Committee (testing and lab services), and the regional office of the Textile Commissioner (oversee the management of the schemes of the Ministry of Textiles)

Suggested Vision: ***To establish Ludhiana as a globally recognised, innovation-driven textile and apparel cluster, celebrated for excellence in knitwear and advancements in technical textiles. We envision a resilient, sustainable, and circular industry ecosystem that leverages cutting-edge technology, resource efficiency, and environmental stewardship to deliver high-quality, value-added products.***

The roadmap was then structured in phases:

6.1 Baseline (2025)

The baseline focuses on data collection, pilot demonstrations, and quick retrofits. Key actions include baseline assessments of energy, water, waste, and material flows; 2-3 demonstration pilots in waste recycling, wastewater reuse, and clean energy; and initial digitalisation through ERP systems and basic AI forecasting.

6.2 Quick Wins (2027)

By 2027, the cluster aims to transition 25% of its energy mix to renewable sources, reduce freshwater use by 20% through recycling, and achieve GHG inventories for 60% of units with a 15% reduction in carbon intensity compared to 2025. Cluster-level green branding, workforce training, and initial blended finance mechanisms are introduced.

6.3 Early Transition (2030)

The 2030 milestone emphasises shared infrastructure, advanced technologies such as waterless dyeing and AI-driven process optimisation and achieving 50% waste circularity. Renewable energy penetration reaches 50%, with electrification and hydrogen pilots underway. The cluster aligns with science-based targets (SBTi), targeting a 40% GHG reduction and generating ₹2,000 crore in incremental exports from compliant and circular products.

6.4 Scaling Circularity (2035)

By 2035, closed-loop recycling plants for cotton, polyester, and acrylic are operational at scale. Renewable energy share reaches 80-90%, water use approaches zero freshwater intake, and net-zero emissions for Scopes 1 and 2 are achieved. Ludhiana gains global recognition as a low-carbon textile cluster.

6.5 Vision 2047

By 2047, in alignment with the vision of Viksit Bharat, Ludhiana wil become an energy-positive, water-positive, and zero-waste cluster. Advanced biotechnology, nano-finishes, and biodegradable smart textiles are mainstreamed. Incremental revenues exceed ₹8,000 crore from circular and net-zero products, supported by premium branding: “Made in Ludhiana – Circular & Sustainable.”

7. Implementation Pathways

As mentioned above, the roadmap envisions transforming Ludhiana into a globally recognised, innovation-driven, sustainable, and circular textile and apparel cluster by 2047. The framework is structured around phased transitions with clearly defined milestones across energy, water, chemicals, waste and materials. In addition, the roadmap implementation considers the policy, technology, skilling and financing support required and will require collaboration and coordination amongst different stakeholders. Further, the implementation recommendations are categorised into short, medium, and long-term measures.

The pathways described below build on existing policy instruments and schemes of the Government of India and the Government of Punjab, including the Punjab Industrial and Business Development Policy, Ministry of MSME programs, Ministry of Textiles schemes and energy efficiency initiatives supported by the Bureau of Energy Efficiency. The role of financial institutions such as the Small Industries Development Bank of India (SIDBI), as well as academic and technical institutions in Punjab, is also integrated into the strategy.

It is to be noted that these measures are not exhaustive. They have been designed to progressively work towards the agreed vision based on data & scientific approaches and alignment with various national and international regulations. Accordingly, there is a clear focus on building traceability, introducing digital tools, and strengthening reporting and data systems. Given below is a description of the pathways for the various sustainability considerations.

7.1 Design Pathway

Design plays a critical role in enabling circularity because product design decisions determine the materials used, durability of products, recyclability and waste generation during manufacturing.

In the short term, the Ludhiana cluster can establish a materials database that includes biodegradable fibres, recyclable yarns and low-impact finishing technologies. This database can support designers and manufacturers in making informed sourcing decisions aligned with international sustainability requirements such as the European Union's Ecodesign for Sustainable Products Regulation and emerging Digital Product Passport systems.

To support this transition, a cluster-level Design and Materials Innovation Lab could be established. This facility may be developed through collaboration between the National Institute of Fashion Technology, the National Institute of Design and the Materials Library of India. The lab could provide material testing services, digital sampling tools and a circular materials library accessible to small and medium enterprises.

Financial support for design innovation could be mobilised through the Ministry of MSME's Design Clinic Scheme and corporate social responsibility programs of international brands sourcing from Ludhiana. In addition, the Punjab government could introduce incentives for circular design certification under the state textile policy.

Skill development is another critical enabler. Circular design training programs can be delivered through institutions such as the Apparel Training and Design Centre and the National Institute of Fashion Technology. These programs should focus on zero-waste pattern cutting, modular knitwear design, repairability and product durability.

Over the medium term, digital design tools and artificial intelligence systems can be deployed to reduce overproduction and improve demand forecasting. This will allow manufacturers to optimise inventory management and reduce unsold stock.

7.2 Materials Pathway

The materials used in textile production determine both environmental impact and the potential for circularity. In the Ludhiana cluster, commonly used materials include cotton, polyester and acrylic yarns. Improving the sustainability of these materials will require better traceability, increased use of recycled fibres and development of low-impact alternatives.

The first step is to establish a system for reporting fibre carbon and water footprints across the cluster. Such reporting will help manufacturers align with buyer sustainability frameworks and global reporting standards. A digital traceability system could be introduced to track materials from fibre to finished garment.

To support sustainable sourcing, a cluster-level fibre innovation and recycling centre could be established. This facility would provide mechanical textile recycling, yarn regeneration and recycled fibre testing services. The centre could be implemented through partnerships involving the Northern India Textile Research Association, the Textile Committee and local academic institutions such as Punjab Agricultural University.

Financing for the transition toward sustainable materials can be supported through a blended Material Transition Fund combining contributions from government programs, financial institutions and global brands. The Small Industries Development Bank of India could provide credit lines for enterprises investing in recycled fibre technologies.

Training programs on sustainable materials should also be introduced through institutions such as the National Institute of Fashion Technology and the Apparel Training and Design Centre. These programs would build capacity among designers, merchandisers and production managers to evaluate environmental impacts and adopt sustainable sourcing practices.

In the medium term, cluster-level recycling infrastructure could be developed to enable fibre-to-fibre recycling of cotton and synthetic materials. Such facilities would help achieve significant waste reduction and create new revenue streams from recycled yarn production.

7.3 Energy Pathway

Energy consumption represents one of the largest environmental and cost drivers for textile production. The Ludhiana cluster can significantly improve competitiveness by reducing energy intensity and increasing the use of renewable energy.

In the short term, enterprises should implement energy monitoring systems and adopt ISO 50001 Energy Management Systems. Cluster-level ESG dashboards can help track energy consumption and emissions across participating units.

Energy efficiency improvements such as heat recovery systems in dyeing and finishing operations should be prioritised. Financial support for energy efficiency audits and retrofits can be mobilised through the Bureau of Energy Efficiency's Assistance in Deploying Energy Efficient Technologies in Industries and Establishments (ADITEE) scheme.

Renewable energy adoption can be accelerated through rooftop solar systems, biomass boilers using agricultural residues and waste heat recovery technologies. Cluster-level solar parks developed through public-private partnerships could also help smaller enterprises access renewable electricity.

Financial institutions such as the Small Industries Development Bank of India and nationalised banks can play a critical role by providing green finance instruments and concessional loans for renewable energy investments.

Skill development for energy management should be delivered through Bureau of Energy Efficiency accredited programs and engineering institutions such as Guru Nanak Dev Engineering College. These programs can train certified energy managers and auditors who will support enterprises in improving energy performance.

By the medium term, the cluster could aim to achieve a renewable energy share of at least 50 percent while aligning with Science Based Targets for greenhouse gas reduction.

7.4 Water and Chemicals Pathway

Water management is another critical challenge for the Ludhiana textile cluster, particularly for wet processing units involved in dyeing and finishing. Improved water stewardship is essential for reducing environmental impacts and meeting regulatory requirements.

In the short term, enterprises should implement water benchmarking dashboards to monitor water use and wastewater generation. Medium and large processing units should move toward zero liquid discharge systems, while common effluent treatment plants serving small enterprises should be upgraded to improve treatment efficiency.

Financial support for effluent treatment infrastructure can be provided through capital subsidies under state industrial policies and environmental compliance programs. Development finance institutions and donor agencies can also support investments in water reuse systems and advanced treatment technologies.

Training programs on water stewardship should be introduced for plant operators and environmental managers. These programs can be delivered in collaboration with technical institutions and industry associations.

Chemical management is closely linked to water quality. The cluster should adopt Restricted Substances Lists and Manufacturing Restricted Substances Lists aligned with international standards. Digital chemical inventory systems can help enterprises track chemical usage and ensure compliance with buyer requirements.

Technical support for cleaner chemistry and safer dyeing technologies can be provided by research institutions such as the Northern India Textile Research Association and certification bodies implementing international chemical management frameworks.

Over time, adoption of enzymatic processing technologies and biodegradable chemical formulations can further reduce environmental impacts.

7.5 Waste Management and Circular Infrastructure

Textile waste represents both an environmental challenge and an economic opportunity. The Ludhiana cluster generates substantial quantities of yarn waste, fabric scraps and post-consumer textile waste that could be recovered and reprocessed.

In the short term, enterprises should adopt zero-waste standard operating procedures and establish systems for tracking waste generation. Digital waste tracking platforms can help monitor waste flows across the cluster.

Cluster-level recycling infrastructure will be essential for scaling circularity. Facilities for textile shredding, fibre recovery and recycled yarn spinning can convert waste materials into new products. Artificial intelligence-based sorting technologies can also improve the efficiency of textile waste processing.

These facilities could be developed through industry consortia with support from the Ministry of Textiles, the Textile Commissioner's Office and financial institutions such as the

Small Industries Development Bank of India.

Skill development programs for waste management and recycling should be introduced through Industrial Training Institutes and the Apparel Training and Design Centre. These programs can train workers in waste sorting, recycling technologies and circular production methods.

Municipal authorities can also play a role by establishing frameworks for textile waste collection and recycling in collaboration with industry associations.

7.6 Combined Timeline summary of the various pathways

The tables below summarize the various pathways as per short term, medium term and long term and is based on the information described above.

7.6.1 Short Term (2025-2027)

The short-term measures focus on laying the groundwork for adopting sustainable and circular practices. Most of the efforts are geared towards data collection, stakeholder onboarding and initiating pilots across various areas of intervention. The table below summarises suggested actions across the various thematic areas and the enablers needed thereof.

Table 4: Proposed Actions and Enablers for Short Term Goals in the Roadmap

PRIORITY AREAS	KEY ACTIONS	ENABLERS
Design	◆ Create material database (biodegradable, recyclable) ◆ Promote pre-/post-consumer design waste use ◆ Draft circularity policies, eco-labels, certifications ◆ Training in repair, modularity, upcycling ◆ Digitalisation pilots (ERP, AI forecasting)	◆ Finance: CSR/design grants ◆ Technology: Digital sampling ◆ Skills: Short-term certification on circular design (NIFT/ATDC) ◆ Policy: Design certification (NIFT/ NID) ◆ Stakeholders : Cluster Associations, Industry, Design Institutes
Materials	◆ Fibre carbon/water footprint reporting ◆ Align sourcing with Ecodesign for Sustainable Products Regulation/ EU/brand frameworks ◆ Cluster-wide traceable sourcing ◆ Embed sustainable sourcing in enterprises	◆ Finance: Long-term material transition fund (government + brands) ◆ Technology: Shared fibre/yarn innovation & recycling centres ◆ Skills: Sustainable materials education ◆ Policy: Incentives for >50% recycled material in exports ◆ Stakeholders: Cluster BMOs, Academia, Banks

PRIORITY AREAS	KEY ACTIONS	ENABLERS
Energy	◆ Real-time ESG dashboards ◆ Cluster-wide ISO 50001 Energy Management Systems ◆ Transition of 25% energy to renewables (solar, biomass) ◆ Heat recovery in dyeing/finishing ◆ GHG inventory (Scopes 1-3) for 60% units, 15% reduction vs 2025	◆ Finance: Green Energy Fund (PPP + associations) ◆ Technology: Advanced tech (waste heat-to-power, biomass co-gen) ◆ Skills: Certified energy manager programs ◆ Policy: Renewable Purchase Obligations (RPOs) ◆ Stakeholders: Skill Council for Green Jobs, National Power Training Institute
Water	◆ Digital dashboards for benchmarking ◆ ZLD for medium/large processors ◆ CETP upgrades for SMEs ◆ Build in-house water expertise, audit-ready	◆ Finance: Water Resilience Fund ◆ Technology: Reuse & zero-waste systems ◆ Skills: Water stewardship training ◆ Policy: Incentives + mandatory water footprint disclosures ◆ Stakeholders: Association of Water Technologies, Water Quality Association
Chemicals	◆ Real-time Chemical Management System with DPP-linked data ◆ Safe chemical use is institutionalised ◆ RSL adoption across cluster ◆ Chemical management roles & training	◆ Finance: Cluster-level Chemical Safety Fund with buyer co-investment ◆ Technology: CMS tools for inventory, traceability ◆ Skills: Chemical safety certification (operator/manager) ◆ Policy: MRSL compliance & recognition for sustainable chemistry ◆ Stakeholders: State Pollution Control Board, Buyers, Industry, Technology providers
Waste	◆ Cluster-wide ESG dashboards ◆ Zero-waste SOPs across all units ◆ Professional waste management ◆ AI-based sorting & valorization	◆ Finance: Circular Waste Fund ◆ Technology: AI/ML waste sorting & valorisation ◆ Skills: Certified waste workforce programs (ITIs, ATDC) ◆ Policy: Institutionalise “Right to Recycle” with regulatory linkages ◆ Stakeholders: Municipality, State Pollution Control Board, Industry

7.6.2 Medium Term (2027-2035)

This is a crucial stage, as it is envisaged that action will be accelerated based on the pilots undertaken and the additional information generated from the established baselines. The ground work through awareness would be done and required stakeholder collaborations will be in place. The industry will have a better understanding of the evolving national and international regulations and will be more equipped to adapt to changing market dynamics.

Table 5: Proposed Actions and Enablers for Medium Term Goals in the Roadmap

PRIORITY AREAS	KEY ACTIONS	ENABLERS
Design	◆ Collect LCA data for key products. Align information required for international norms such as the Digital Product Passports for exports to the EU/ ESPR regulations ◆ Monitor material mix & circularity barriers ◆ Promote zero-waste design, mono-materials, durability ◆ Build capacity of merchandisers/ buyers on lifecycle value ◆ Biodegradable functional finishes via shared infra labs ◆ Branding: "Made in Ludhiana Circular & Sustainable"	◆ Finance: Cluster cost-sharing, SIDBI/ZED/MSME schemes ◆ Technology: AI/ML for trend prediction & reducing overdesigning; Digital Systems with traceability/ DPP alignment ◆ Skills: Design courses on sustainability & circular fashion ◆ Policy: Recyclability/EPR disclosure policies ◆ Stakeholders: BMOs, NIFT, Ministry of Textiles, SIDBI, Industry, Consultants and Traceability solutions
Materials	◆ Report % sustainable fibers in use and LCA metrics. Institutionalize fiber carbon/water footprint reporting ◆ Build capacity for sustainability impact evaluation ◆ Establish cluster-level recycling technology (5-7% turnover from recycled yarn) ◆ Commercial adoption of nano/ biotech finishes, biodegradable smart textiles	◆ Finance: Long-term material transition fund (govt + brands) ◆ Technology: Fiber-blending & recycled yarn spinning ◆ Skills: Certified skill modules (NIFT, NITRA, ATDC) ◆ Policy: Recycled content in procurement & ESG disclosures Stakeholders: SIDBI, NIFT, Cluster Alliances, research institutes
Energy	◆ Benchmark Energy Performance Indicators per unit output ◆ Integrate KPIs into production/ compliance dashboards ◆ Solar, biomass, thermal & heat recovery pilots ◆ 50% renewable power mix ◆ Electrification of boilers & stenters, hydrogen pilots ◆ Align with SBTi, 40% GHG reduction	◆ Finance: Cluster CAPEX-sharing (e.g., solar parks) ◆ Technology: Solar PV/thermal, IoT monitoring, heat recovery ◆ Skills: EnMS certification + O&M training ◆ Policy: Clean energy incentives for MSMEs, renewable mandates Stakeholders: UNIDO, CRB, TERI, Industry, MSME bodies

PRIORITY AREAS	KEY ACTIONS	ENABLERS
Water	◆ Monitor input-output water balance ◆ Track COD, BOD, TDS at ETPs ◆ SOPs for ZLD, water use, leak detection ◆ 50% reduction in freshwater dependency	◆ Finance: Water Resilience Fund for infra & SME CETPs ◆ Technology: ZLD, foam dyeing, waterless dyeing ◆ Skills: Certified water operator courses ◆ Policy: Mandatory water footprint disclosure + incentives Stakeholders :AWT, WQA, State Pollution Control Board
Chemicals	◆ Track usage trends, toxicity, % sustainable adoption ◆ RSL/MRSL adoption cluster-wide ◆ Build audit capacity & compliance roles ◆ Scale ZDHC-compliant wet processing	◆ Finance: SIDBI subsidies for chemical automation & sustainable conversion ◆ Technology: Cleaner chemistry (enzymes, bio-finishes), ZDHC pilots ◆ Skills: Green chemistry & REACH certification ◆ Policy: State textile policy to mandate ZDHC-compliance Stakeholders : NITRA, Certification bodies, Brands
Waste	◆ Develop digital waste tracking benchmarks ◆ Achieve 50% waste circularity ◆ Embed KPIs in audits and reporting ◆ Adopt AI/ML sorting & valorisation ◆ Zero-waste SOPs across units	◆ Finance: Buyer co-investment & pooled infra finance ◆ Technology: Fabric shredders, fibre recovery, composting ◆ Skills: Waste sorting/valorisation skill certifications ◆ Policy: Incentives for certified recyclers, EPR schemes Stakeholders : Industry, Academia, Traceability providers

7.6.3 Long Term (2035-2047)

The long-term vision is aligned to the vision of Viksit Bharat 2047 (marking 100 years of India's independence). The objective is to achieve maximum circularity, shared responsibility, inclusive growth and impactful collaborations between different stakeholders.

PRIORITY AREAS	END STATE
Design	Circular design driven cluster achieved through: i. Circular by Design (durability - minimise wastage, enable maximum recycling, prioritises sustainable materials) ii. Digital first design process iii. Brand Ludhiana recognition for circularity

PRIORITY AREAS	END STATE
Materials	Cluster achieves resilient, resource-efficient sourcing aligned with global standards: i. Low impact inputs usage ii. Certified Materials with 100% traceability iii. Closed loop material flows
Energy	Energy-positive textile cluster achieved through: i. Units generate more energy than they consume ii. Surplus energy fed back to grid iii. Advanced energy efficiency iv. Cluster climate-positive and powered by renewable energy
Water	Net water positive cluster achieved through: i. 100% water treated and recycled ii. Local water body (Buddha Nallah) restored iii. Collaborative water stewardship
Chemicals	Chemically safe cluster achieved through: i. ZDHC achieved ii. 100% safe chemical use iii. Chemical recovery rate >80% (dyes, salts, auxiliaries)
Waste	A zero-waste cluster achieved through: i. Closed loop ecosystem ii. upcycling strategies iii. Design for Circularity

8. Investment Opportunity

The proposed program will support the transformation of the Ludhiana textile cluster into a sustainable and circular manufacturing ecosystem. The initiative will focus on six thematic pillars: design, materials, energy, water, chemicals and waste.

Key interventions include establishing shared infrastructure such as textile recycling facilities, materials innovation labs and renewable energy systems, while supporting enterprises to adopt sustainable production technologies. Capacity building, digital traceability systems and financial mechanisms will complement these investments.

Proposed Investment Areas

1. Circular Design and Materials Innovation Lab

A shared facility providing circular material libraries, product prototyping and testing services. The lab will support sustainable design practices and innovation in recyclable and biodegradable textiles.

2. Textile Recycling and Resource Recovery Infrastructure

Cluster-level facilities for textile shredding, fibre recovery and recycled yarn production. These facilities will enable fibre-to-fibre recycling and reduce landfill waste.

3. Renewable Energy and Energy Efficiency Systems

Deployment of rooftop solar systems, biomass energy systems and waste heat recovery technologies across the cluster. Financing mechanisms will support MSMEs in adopting these technologies.

4. Water and Chemical Management Infrastructure

Upgrading common effluent treatment plants and introducing water reuse technologies and digital chemical management systems aligned with international standards.

5. Digital Traceability and Data Systems

Development of cluster-level digital systems for tracking material flows, environmental indicators and compliance with global sustainability frameworks

9. Way Ahead

The roadmap suggested in the above pages provides a clear way ahead for the Ludhiana textiles cluster. In the current scenario of uncertain geopolitics, depleting resources, intense scrutiny of the textile and apparel sector for its adverse environmental footprint, sustainability and circularity are no longer optional but imperative choices.

Successful implementation of this roadmap will require coordinated action across multiple stakeholders. Government agencies, industry associations, financial institutions, research organisations and development partners all have important roles to play.

Financial institutions such as the Small Industries Development Bank of India can support the transition through dedicated sustainability credit lines. Government programs under the Ministry of MSME and the Ministry of Textiles can provide capital subsidies, technology adoption incentives and skill development funding.

Academic institutions and research organisations in Punjab can support innovation, testing and training. Institutions such as Punjab Agricultural University, Guru Nanak Dev Engineering College and the Northern India Textile Research Association can contribute to research and capacity building.

Development partners and donors can play a catalytic role by supporting pilot projects, technology demonstrations and cluster-level infrastructure investments. Donor funding can also support the establishment of shared innovation facilities such as materials libraries, circular design labs and recycling infrastructure.

A few other recommendations to keep in mind are:

i. Leverage other initiatives in the cluster to implement the roadmap. For example, IDH's Cluster Collective Initiative, UNIDO - GEF program to eliminate hazardous chemicals from textile supply chains can integrate the suggestions of the roadmap implementation in their activities

ii. Place the recommendations of the roadmap with the textile sub committees constituted by the Punjab Government

iii. Invest in determining a well-defined baseline for energy, water, chemicals and waste. Such a data collection exercise will have to be led by government and industry collaboration and will be critical to ensure that the targets suggested in the roadmap are well aligned to ground realities. It will also help the cluster develop a sound data collection and reporting methodology thus helping in transparency and traceability.

iv. Invest in cross cluster learning and knowledge exchange. The Ministry of Textiles along with UNEP have announced a Cluster Exchange Mechanism to accelerate the transition of the Indian textile sector towards circularity and sustainability. This is a good opportunity for the stakeholders in the Ludhiana cluster to not only showcase their strengths and good practices but also to learn from other clusters and explore partnerships and collaborations.

10. Conclusion

The Ludhiana textile cluster stands at a critical juncture. While structural challenges are significant, the scale, diversity, and entrepreneurial strength of the cluster provide a strong foundation for transformation. A phased, data-driven, and collaborative roadmap toward sustainability and circularity can enhance competitiveness, ensure regulatory compliance, and unlock long-term economic and environmental value. By aligning industry, government, finance, academia, and buyers around a shared vision, Ludhiana can emerge as a flagship example of a resilient, circular textile cluster supporting India's broader development and climate goals.

Introducing the project to relevant stakeholders in Ludhiana

Presenting the roadmap to industry stakeholders

Glimpses from workshop with multistakeholders in Ludhiana - Introducing innovations, new technologies and financing September 2025

11. Annexures

A. Technological Innovations

Exploring Potential Technologies for Diversification; Resource Efficency - Ludhiana Textile & Apparel Cluster - S Periasamy , Advisor – Sustainabilit, Trippur Expoters Association

B. Policy and Regulatory Landscape

As of late 2025, Punjab does not have a dedicated "Textile Industry Policy." A new industrial policy with a strong textile focus is expected by early 2026. Meanwhile, the sector is supported by the **PUNJAB INDUSTRIAL AND BUSINESS DEVELOPMENT POLICY 2022** [11], the Right to Business Act, and central government schemes such as PLI, SITP, and SAMARTH, which promote incentives, infrastructure, and skill development.

State Government Policies and Initiatives - Punjab Industrial and Business Development Policy 2022

AREA	SUPPORT / INCENTIVES	DETAILS	POLICY DURATION
Energy/ Water/Safety/ Environment/ Steam Audits	75% of audit cost (up to ₹1.5 lakh per audit)	Covers each audit type (Energy, Water, Safety, Steam, Environment) can be claimed once per unit	Within policy period (2022-2027)
Environmental Compliance (ZLD, ETPs)	50% financial support (max ₹25 lakh) on capital cost	For setting up Effluent Treatment Plants (ETPs): ◆ Installing Water Pollution Control Devices ◆ Installing Zero Liquid Discharge (ZLD) technology Available once during validity of the policy	2022-2027
Energy Efficiency (Plant & Machinery)	Support under ATUF + interest subsidy	For modernisation/energy efficient machinery in textiles, apparel & technical textiles	2022-2027
Clean Energy (Solar/Wind/ Boilers)	Duty exemptions & tax incentives	Electricity duty exemption on renewable energy (solar net-metering within 30 days) - Incentives for shifting to paddy-straw-based boilers: 100% SGST reimbursement for 7 years + 100% stamp duty exemption	7-10 years depending on scheme

[11] https://punjabinfotech.in/assets/pdf/Industrial_Policy_2022.pdf

AREA	SUPPORT / INCENTIVES	DETAILS	POLICY DURATION
Marketing & Branding (Eco-Labelling)	Capital recognition (up to 20% of project cost)	New textile units can set up a Design & Brand Promotion Facility at a separate location, counted in eligible Fixed Capital Investment). No separate incentive beyond this	2022-2027
Quality Certifications (Eco-Labelling / ZED)	100% reimbursement (max ₹10 lakh)	For expenses on all quality certifications, including ZED (Zero Defect Zero Effect) certification, which emphasises eco-friendly and sustainable production	2022-2027
Fiscal (SGST)	Reimbursement of net intra-state SGST: 100%	For new MSME textile units over 7 years, capped at 100% of Fixed Capital Investment (FCI)	
Fiscal (SGST)	Reimbursement of net intra-state SGST: 100%	For Anchor Units or Thrust Sector units, this can extend up to 15 years, capped at 200% of FCI	
Skill Development & Training	Financial support for training programs	Supports skill upgradation of workforce in textile and apparel units, aligned with schemes like SAMARTH	

Central Government Schemes Supporting Punjab's Textile Sector

SCHEME	OBJECTIVE	FOCUS / BENEFITS	BUDGET	CURRENT STATUS / INCENTIVES
PM MITRA Parks Scheme	Develop top-quality industrial infrastructure for textile manufacturing	Integrated, large-scale facilities for the entire value chain: spinning, weaving, processing, garmenting, textile machinery. Lower logistics cost, attract FDI, improve competitiveness	₹4,445 crore (2021-22 to 2027-28)	7 parks established in Gujarat, Maharashtra, Madhya Pradesh, Tamil Nadu, Karnataka, Uttar Pradesh, Telangana
Production Linked Incentive (PLI) Scheme	Increase manufacturing in MMF (man-made fibre) & technical textiles	Provides financial incentives for large-scale manufacturers	₹10,683 crore	Incentives for large-scale textile manufacturers

SCHEME	OBJECTIVE	FOCUS / BENEFITS	BUDGET	CURRENT STATUS / INCENTIVES
ZED (Zero Effect, Zero Defect) Schemes	Enhance competitiveness & environmental performance of MSMEs	Emphasis on defect-free & environmentally sustainable production. Certification levels: Bronze, Silver, Gold (based on compliance in leadership, safety, quality, environment). MSMEs with ISO 9001/14001 may get exemptions	Not specified	Supports *Atmanirbhar Bharat* and sustainable growth
Textile Cluster Development Scheme (TCDS)	Create integrated workspace & linkage ecosystem for textile units & clusters	Benefits: critical mass for interventions, economies of scale, lower costs, improved competitiveness, better access to technology	₹853 crore	As of Mar 18, 2025: ~1.22 lakh jobs created; ₹34.48 crore released in 2024-25
Samarth Scheme (Capacity Building in Textile Sector)	Provide skill training for textile industry workers with the Ministry of Skill Development	Skill development and job placements for textile workers	₹115 crore (FY 2023-24)	As of Mar 27, 2025: 4.78 lakh registered; 3.82 lakh trained; 2.97 lakh placed (77.74%)
National Technical Textiles Mission (NTTM)	Boost technical textiles in India (2020-21 to 2025-26)	Research, innovation, promotion, market development, education & training, exports	₹1,480 crore	As of Jan 1, 2025: 168 projects approved worth ₹509 crore in specialty fibres & technical textiles
Special Credit Linked Capital Subsidy Scheme (SCLCSS)	Support SC/ST entrepreneurs in MSMEs	25% capital subsidy on institutional loans up to ₹1 crore for machinery & equipment (max subsidy ₹25 lakh)	Not specified	Available for both new & existing MSEs (with Udyam registration). Goal: promote inclusion & growth of SC/ST-owned businesses

C. Stakeholders Consulted

Industry Representatives

- Bahadur Ke Textiles and Knitwear Association
- Knitwear and Apparel Manufacturers Association of Ludhiana
- Power Loom Association
- Representative of Dyers Association

- Garment Manufacturing Machinery and Settlers' Association
- Individual industry representatives
- CEO, Common Facility Centre, Ludhiana

Government Representatives

- Textile Committee, Ludhiana
- Regional Office of the Textile Commissioner, Amritsar
- Department of MSME, Ludhiana Skills Council

Technology Advisors

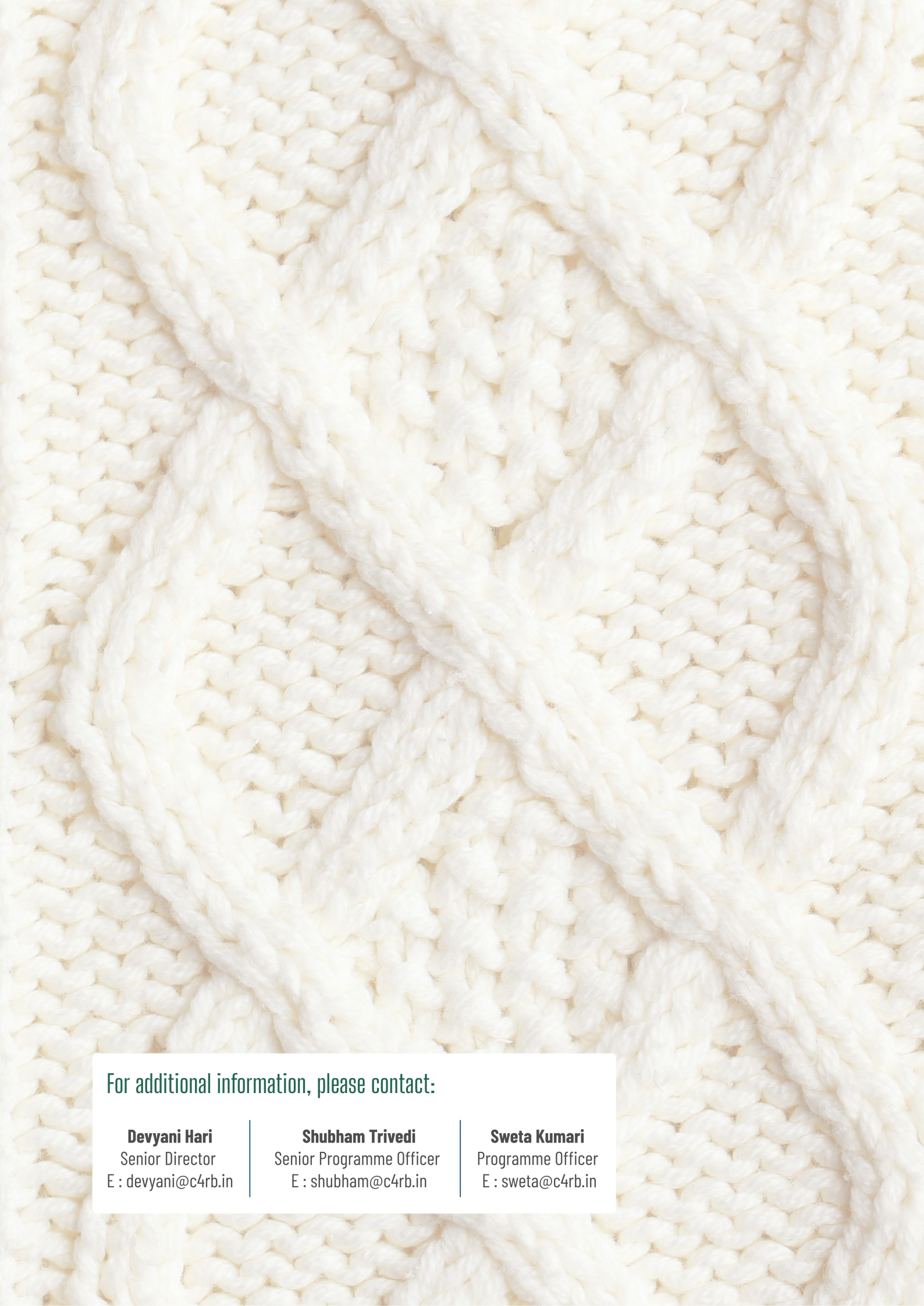
- Punjab Renewable Energy Systems Pvt. Ltd.
- Advisor, AIC-NIFTTEA

Financial Institutions/Scheme Implementers

- SIDBI
- Bureau of Energy Efficiency

Multilateral Agencies

- UNIDO



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