UNLOCKING INDIA'S NEXT GEN ECONOMY

The (Untapped) Investment Frontiers in Material Substitution in India's Pulp, Paper and Textile Industries

2024

canopy

Section 1: INTRODUCTION

A minimum of 800 million tonnes of textile waste and agricultural residues is generated globally each year. Close to 500 million tonnes of these residues are burned.[1][2][3]

Lost in this disposal is the opportunity to leverage these materials into a new economic value chain — one that could transform the paper packaging, pulp, and textile sectors globally from high-impact and carbon-intensive, to lower-carbon and circular within a decade.

Material substitution, as a mechanism for industrial decarbonization, means shifting from using higher carbon primary forests as pulp feedstock to Next Generation (Next Gen) fibres created from material residues such as wheat and rice straw, banana fibres, sugarcane bagasse, industrial food waste, and waste polyester/cotton textiles. These materials offer lower-carbon alternatives to the conventional forest fibres used in the paper packaging and fashion industries today.

When compared to conventional wood fibres, these Next Gen Solutions offer 88–100% lower land use, 5 × lower impact on biodiversity, and produce ~4 tonnes less C02 per tonne of product.[4]

Processing with the most up-to-date pulping tech can also reduce manufacturing energy, water, and chemical use by 50% and more compared to conventional wood pulping.[5]

In addition to being lower- carbon, these waste feedstocks have a myriad of co-benefits. Re-purposing agricultural residues and textile waste as the raw material inputs for pulp gives farm communities and urban textile waste collectors the opportunity to improve their livelihoods by valorizing these raw materials. Reducing the annual burning of crop residues and polyester/cotton textiles, will also help alleviate air quality issues that impact human health. Finally, diverting these materials into advanced Next Gen processing facilities will support the development of vibrant and resilient pulp, paper, packaging and textile supply chains in the face of a rapidly changing climate.

An estimated 13 billion to 15.6 billion USD of investment over the next decade is required for India to become a prominent and preferred supplier of low-carbon pulp and end products into global markets.

Creating this Next Generation economy requires a cohesive industrial strategy which includes regulatory frameworks as well as capital availability. Policy support mechanisms, such as credit guarantees, feed-in tariffs, and carbon credits utilized in the renewable energy space, can help stimulate this material shift. Tax subsidies for low carbon material inputs for pulp could be a novel mechanism to stimulate growth in this space. **Canopy Planet estimates that 78 billion USD is required over the next decade to scale 60 million tonnes of Next Gen alternative fibre infrastructure capacity globally**. This scale-up would displace the use of primary forests and restoration-priority landscapes from the 'fibre basket', and in doing so, help support global climate and biodiversity targets. In addition to the financing required for new pulping infrastructure, additional capital will be needed to catalyze fibre and supply chain innovation, pulping technology, and the soft tech for materials collection and tracking.

India has the opportunity to be at the forefront of the global transition to low-impact materials. The country has significant agricultural residues and domestic and imported textile waste, which could be converted to higher-value products. India also has a well-established non-wood paper industry and skilled technical workers. These are important foundations for increasing Next Gen pulp production for domestic supply and to increase its position in global paper and textile trade. An estimated 13 billion to 15.6 billion USD of investment over the next decade (based on average of 1300 USD per tonne of CAPEX per facility[6]) is required for India to become a prominent and preferred supplier of low-carbon pulp and end products into global markets. This is especially relevant as key markets, especially in Europe, are increasingly regulating and restricting imports of high-carbon products to reduce demand pressures on climate-critical forests and to stimulate circular manufacturing.

A concerted industrial development strategy in India that aligns technology, feedstock supply, national and global policies, investment and green job creation to address urgent issues of climate, pollution, poverty, and biodiversity loss is compelling. Securing a focused, early infusion of climate finance capital into both innovation and infrastructure to simultaneously build up Next Gen feedstock delivery and pulping capacity, would support the decarbonization of two key industrial sectors (paper and textiles) in India through material substitution and create an opportunity for the country to take global leadership.

1.1 Current Climate Investment Capital Flows

A variety of data sets highlight the current focus of climate finance capital.

According to Climate Watch, 73% of climate finance capital flows are targeted towards the energy, transportation, and building sectors.[7]

Pitch Book, a database of private market deals, shows the volume of climate-oriented equity transactions in private markets increased from 75 billion USD in 2019 to 196 billion USD in 2022, with the power and transportation sectors attracting two-thirds of this capital and the industrial manufacturing sector receiving less than 1%.

According to a new book called Zero Carbon, author Jeffrey Rissman estimates the industrial manufacturing sector is receiving less than 3% of climate finance although industrial emissions are responsible for 33% of GHG emissions.[8]

Currently, the manufacturing sector is receiving less than 3% of climate finance. PitchBook, a database of private market deals, reinforces this trend. Their data shows the volume of climate-oriented equity transactions in private markets increased from 75 billion USD in 2019 to 196 billion USD in 2022, with the power and transportation sectors attracting two-thirds of this capital and the manufacturing industry receiving less than 1%.

This focus, however, is beginning to change. Global industry has now been dubbed the "heart of the decarbonization transition", and we are at the beginning of a curve that is highly likely to accelerate.[9] Policymakers are recognizing that decarbonizing large-emitting industries such as iron and steel, chemicals and cement are key in addressing the climate crisis. Public investments reflect this growing trend. At the end of August 2024, the German government announced a 3.7 billion USD program to help decarbonize industry, specifically focusing on their more energy-intensive industries. In the U.S., the Inflation Reduction Act has allocated four billion USD to the procurement of low-carbon materials and over 14 billion USD in clean manufacturing grants, and in Canada, a recent Buy Clean initiative has the potential to significantly alter governmental purchasing decisions.[10]

Even though more decision makers are aware of the importance of shifting impact sectors outside of the fossil fuel industry, the world's seventh largest-emitting industrial sector, pulp and paper (635 million metric tonnes CO_2e annually), is rarely mentioned, nor is the textile industry. Not only do these industries have enormous direct-process emission profiles — the total wood harvest of 3.5 to 4.2 billion tonnes of wood fibre for paper packaging and Man-Made Cellulosic Fibre (MMCF) for fabrics such as viscose adds an estimated 350 to 420 million additional metric tonnes of CO2e emissions annually.[11]

While countries begin to implement industrial decarbonization and carbon capture programs, finding ways to reduce the commodity-driven pressure on ecologically-critical forests, and allowing trees to continue to capture carbon, is considered one of the fastest, cheapest, and most effective solutions to mitigating climate change and preserving biodiversity.[12 13 14 15 16 17]

COST

3.5 TO 4.2 BILLION TONNES OF WOOD FIBRE

TOTAL WOOD HARVEST FOR PAPER PACKAGING AND MAN-MADE CELLULOSICS (MMCF) SUCH AS VISCOSE

↓

350 TO 420 MILLION METRIC TONNES OF CO_2E

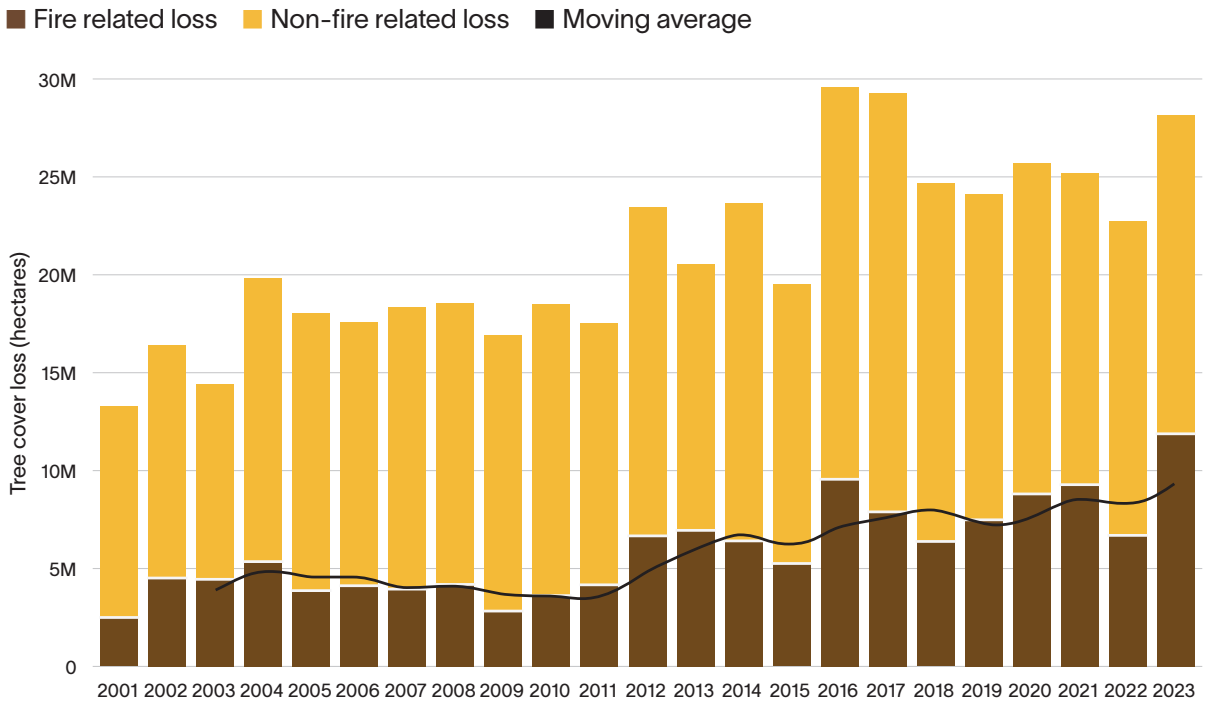
ESTIMATED ADDITIONAL EMISSIONS ANNUALLY.[11]

1.2 Conventional wood supply under pressure

Of the 413 million tonnes of pulp for paper produced globally every year, nearly half (184 million tonnes) comes from virgin wood fibre. Approximately half of that wood (92 million tonnes) comes from Ancient and Endangered Forests.[18] Given rapidly shifting ecological and regulatory realities, all fibre originating from Ancient and Endangered Forests presents significant business risk — as does a continued heavy reliance on fibre from the world's forests more broadly.

Longer-term access to wood-based pulp is expected to become increasingly volatile within the next five to ten years due to multiple, compounding pressures which will create a growing need for alternatives.

Tree cover loss due to fires compared to other drivers, 2001 – 2023



Source: World Resources Institute. Global Trends in Forest Fires. Available from: https://www.wri.org/insights/global-trends-forest-fires#:~:text=Nearly%2012%20million%20hectares%20%E2%80%94%20an,all%20tree%20cover%20loss%20globally. Accessed August 29, 2024.

Compounding Pressures on Wood Supply

1. REGULATIONS

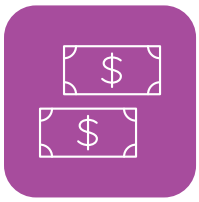
Policies such as EU Climate Disclosure Act, EU Deforestation Regulation, U.S. state level procurement policies, global and country specific biodiversity targets, and others constrain market access for non-compliant forest products. This will significantly reduce the amount of wood fibre that is available to sell into key markets like Europe, and place a strain on existing forest fibre that clears the regulatory bar.

2. SHIFTING MARKET PREFERENCES

Currently, 1000 brands, representing two trillion USD of annual revenue, have voluntarily adopted a Canopy policy to eliminate sources of paper, packaging, and viscose that originate from Ancient and Endangered Forests. Companies signed on include H&M, adidas, Ben & Jerry's, Walmart, Amazon, Inditex, and Flipkart.

3. INSECURITY OF FUTURE SUPPLY

Climate feedback loops have increased forest fire frequency and intensity, causing the loss of decades of wood supply in several producer regions in the northern and southern hemispheres. The World Resources Institute calculated that the area burned by forest fires increased by about 5.4% per year from 2001 to 2023. "Forest fires now result in nearly six million more hectares of tree cover loss per year than they did in 2001 — an area roughly the size of Croatia."[19]



4. PRICE VOLATILITY

Reduced feedstock supply, increased regulatory constraints, and demand growth generally lead to higher prices. The price of wood pulp has shown steady increases, as has the price of recycled kraft linerboard paper for packaging. In June 2024, the cost of kraft linerboard was 26% higher than pre-pandemic levels[20]

A suite of compounding pressures including regulations, market trends and increasing frequency and intensity of forest fires will likely create a shortfall in wood pulp and price volatility over the coming years — creating a growing need for alternative supply.

Section 2:
UNLOCKING INDIA'S GREEN POTENTIAL

India is currently better poised than any other country in the world to become an early global leader in low-carbon alternative fibre feedstock pulp and textile fibre

In pulp and paper, India could become a preferred supplier of end products to the world. It is currently a minor player globally, with only 7–8% of paper products exported into this growth sector.[21]

India also has the most developed waste textile recycling in the world. Even so, millions of tonnes are either downcycled, burned, or landfilled. Advanced recycling technology that can capture the materials trapped together in common poly-cotton blend fabric waste will support the creation of a circular value chain to address domestic needs, and feed into its existing textile production chain, including MMCF for global markets.

India holds the potential to produce 10+ million tonnes of Next Gen pulp for paper, packaging, and viscose for domestic use and global markets

India holds the potential to produce 10+ million tonnes of Next Gen pulp, paper, packaging, and textiles, both for domestic consumption and to feed into the global market.

Close to eight million tonnes of waste textiles and 100 million tonnes of agricultural fibre residues are available for use in pulp, paper, packaging, and MMCF in India.[22] This offers a distinct opportunity to leverage currently underutilized low-impact feedstocks.

Using 20 million tonnes of India's crop residues could produce approximately 10 million tonnes of pulp for paper and packaging — adding just over one-third additional capacity to the 29.2 million tonnes of current production in the country.[23] Diverting approximately two million tonnes of India's blended polyester/cotton textile waste from incineration and landfills into advanced recycling facilities could produce enough cellulose pulp to supply the entirety of India's top viscose producer Aditya Birla's operations. Adiya Birla is the world's second-largest viscose producer.[24] The recycled polyester collected could also feed into the circular manufacturing value chain for the fashion sector.

India is in an enviable position. It not only possesses Next Gen resources in large quantities, it also has a long history and expertise in making pulp and paper with alternative fibres to wood. It is currently the second-largest producer in the world of pulp and paper from agricultural fibres. Approximately 1.2 million tonnes, just over 10% of global non-wood pulp, is produced in India.[25]

India is also a leading textile manufacturer, exporter, and the world's top importer of used textiles. Its robust textile recycling industry processes between 4–5 million tonnes of waste textiles/year of the 7.8 million tonnes of textile waste in the country.[26] Most, however, is currently down-cycled to lower-value uses and some 1.35 million tonnes are disposed of, leaving room to significantly expand and capture higher value from this resource.[27]

Next Gen alternative fibres present a transformative opportunity for India's economy, one that will create a new industrial ecosystem which creates jobs in under- resourced communities and provides substantive financial, environmental, and human health benefits.

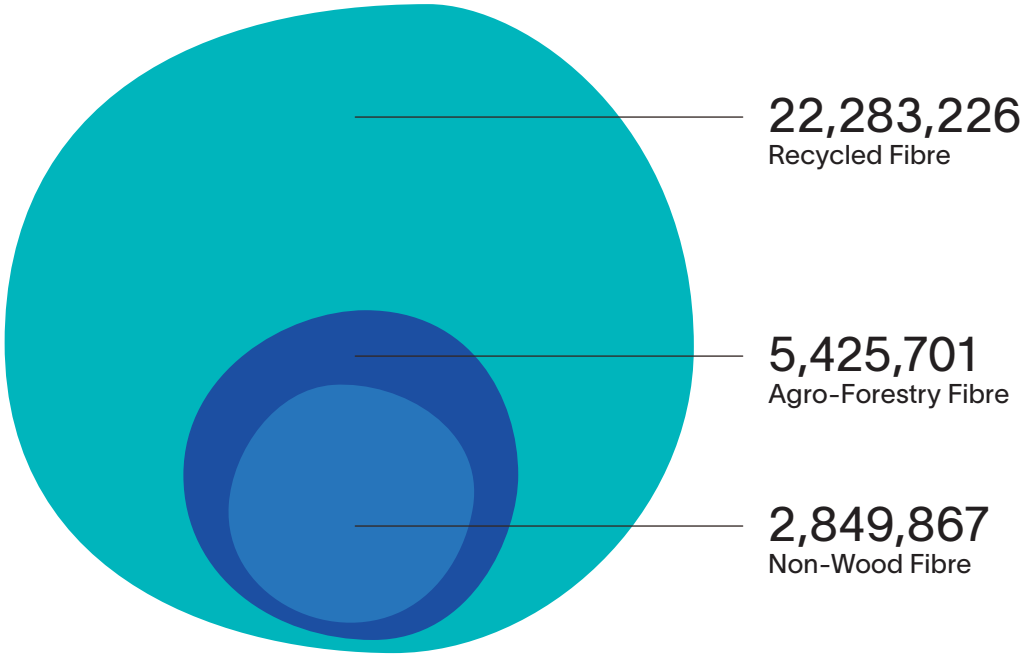
Section 3:
OPPORTUNITIES IN THE PULP AND PAPER MARKET

According to the India Paper Manufacturing Association, India is the fastest-growing paper market in the world with domestic consumption of packaging paper and paperboard growing at 8.2 per cent in 2023 – 24.

The Paper Packaging Market size was estimated at 12.87 billion USD in 2024, and is expected to reach 17.74 billion USD by 2029, growing at a Compound Annual Growth Rate (CAGR) of 6.63% from 2024–2029.[28] This compares to an expected global growth rate of ~3.9% over the same time period.[29]

This growth is being driven across multiple categories. Paper packaging use has increased due to trends including e-commerce expansion, demands from FMCG and the pharmaceutical industry, as well as the government bans on single-use plastics and increased manufacturing of goods in India. The use of printing and writing grade paper is also increasing, albeit at a slower rate due to rising literacy rates, especially in rural areas, fueling the demand for writing and printing-grade papers. India has managed to grow domestic production of paper and packaging alongside demand growth, reaching almost 29.2 million tonnes of total production capacity in 2023, a CAGR of 9.5% over the 2018 – 2023 time period.[30] Growing fibre inputs have come from agro-forestry plantations, and the rapid expansion of recycled paper, which increased from 5.5M tonnes in 2018 to over 16M tonnes in 2023.

Consumption of Fibre for Pulp/Paper (tonnes) — India 2022



Source: FisherSolve Next 4.0.23.0921

3.1 Paper Imports Rising Quickly

The difference between demand growth and supply growth is being filled by imported pulp and paper.

India is the third-largest importer of pulp and paper in the world. The total value of wood pulp and paper imported by India during 2004 was 171.9 million USD, which increased to approximately 745 million USD by 2013[31] and to 3.36 billion USD by 2023.[32]

According to the latest data from the Directorate General of Commercial Intelligence & Statistics (DGCI&S), the volume of paper and paperboard imports in India surged from 1.145 million tonnes in 2021-22 to 1.929 million tonnes in 2023 – 24. Imports from China have skyrocketed by 181% over the past two years, while those from Association of South East Nations (ASEAN) countries have surged by an astounding 247% due in part to zero tariffs.[33]

High imports of pulp and paper impact the domestic industry and also create risks associated with sourcing. While India has strict forest protection legislation, many countries do not, creating concerns that imported pulp and paper could be driving the destruction of Ancient and Endangered Forests. While supply chain transparency with India-based production is relatively easy to track, filtering through the opacity of paper brokers and supply back to forests of origin in some countries creates challenges

Approximately 51 million tonnes of agri-fibre pulp is needed for global paper production to meet climate and biodiversity goals over the next decade.[34]

INDIA IS THE THIRD-LARGEST IMPORTER OF PULP IN THE WORLD

THE TOTAL VALUE OF WOOD PULP IMPORTED BY INDIA:

— 2004	171.9 MILLION USD
— 2013	744.5 MILLION USD
— 2023	3.36 BILLION USD

3.2 Decarbonizing The Paper Supply Chain

Decarbonizing the paper supply chain is critically important to help meet global planetary targets. It presents significant sustainability returns for companies, investors, and governments. Over 3.1 billion trees were used globally to make paper packaging in 2023. Fifty percent of these trees come from areas important for carbon storage and biodiversity, including deep peat soil forests converted to plantations and original forests (primary, old-growth, or ancient forests.[35]

Displacing the use of Ancient and Endangered Forests in paper packaging requires:

Substituting 50% of current wood supply and all of future supply growth with lower-impact, alternative sources of cellulose

Increasing recycled paper production

Increasing resto-ration and agro-forestry on degraded lands

Ensuring growth in pulp production uses lower-impact alternatives to wood feedstocks v

Globally, only 1.5% of paper (5.8 million tonnes) is currently made from agricultural fibre, excluding bamboo. The volume of agri-fibre pulp for paper needed as a material substitute for wood fibre from high carbon and high biodiversity value forests, over the next decade, is approximately 51 million tonnes.[36] This is the contribution needed from the pulp and paper industry, along with further expansion of recycled fibre, to help meet global CO2 and biodiversity goals. To build and retrofit pulp mills for this volume of production close to abundant sources of agricultural residues around the world — from India to North America to Europe, Latin America, and China — will require an investment of approx-imately 66.3 billion USD.[37] Additionally, there will need to be financing for pulp tech innovators, processing tech refine-ments, and innovation, and both grants and investment to set up systems for farmers to aggregate and deliver the agricultural residues they sell to the mills.

Fifty-one million tonnes is a big volume by any measure. For context, however, in the 1990's the pulp and paper industry built 60 million tonnes of recycled paper capacity around the world and in the decade from 2000–2010 built an additional 70 million tonnes of recycled capacity.[38] This shifted the balance of material supply into the industry from primarily virgin wood fibre to 54% recycled. While the volume of virgin paper manufacturing has continued to grow, the ramp-up of recycled capacity illustrates that investment in Next Gen mill infrastructure to shift future paper supply to non-wood alternatives is well within the sector's capability and comfort globally.

FORESTS, INCLUDING THEIR SOILS, ARE THE LARGEST AND MOST EFFECTIVE TERRESTRIAL CARBON STOREHOUSES

ORIGINAL FORESTS (PRIMARY, OLD GROWTH, OR ANCIENT FORESTS), IN PARTICULAR, ARE 40 TIMES MORE EFFECTIVE AT SEQUESTERING CO2E/HECTARE THAN PLANTATION FORESTS.

3.3 India's Contribution

India's contribution to this industrial material substitution solution could be 10+ million tonnes of annual agri-fibre pulp production capacity within a decade.

At a 50% yield of pulp from agricultural residues, this would require 24 million tonnes of feedstock/year, less than 25% of the agricultural residues India currently burns.[39]

The effort to scale agri-residue production capacity offers an extensive suite of benefits. Crop residues full of cellulose fibre are being field burned on an annual cycle, causing 40% of Delhi's air pollution[40] [41] and reducing life expectancy by up to 10 years in rural and urban areas.[42] In recent years, crop residue burning has contributed to levels of harmful particulate matter (PM2.5) concentrations in Northern India, 15–45 times higher than the World Health Organization safety guidelines. Since laws against crop burning have been unsuccessful, it's crucial to explore ways to add economic value to cellulose-rich crop residues to incentivize farmers to address this critical health issue affecting millions. Creating higher value for these residues would help add income for farmers as well as address pressing air pollution issues.

CHEERS TO NEXT GEN

India is already a leading jurisdiction in the production of pulp made from agricultural residues such as wheat straw and bagasse.

Rice paddy straw burning is a particularly large source of air pollution in India. A number of Indian innovators, including Craste and Oryza Fibres, are successfully working with rice straw to make paperboard and moulded fibre. Removing silica content in rice straw has historically created challenges in the use of this fibre in a broader range of paper types, however in moulded fibre, silica acts as a water barrier eliminating the need to remove it during the pulping process.

CRASTE AND ABINBEV INDIA AGRI-FIBRE PACKAGING TRIAL

Craste is working to scale the production of agricultural waste pulp for packaging products to address the pollution from crop burning. Craste used barley straw to create a six-pack beer packaging for Corona.

Section 4:
MAN-MADE CELLULOSIC FIBRE TEXTILES — INDIA'S POTENTIAL IN CIRCULAR FEEDSTOCKS

The global fashion industry is valued at approximately three trillion USD, accounting for about 2% of the world's Gross Domestic Product (GDP).[43]

Annually, the textile industry produces over 100 billion garments,[44] contributing up to 10% of global carbon emissions.[45] It is estimated that approximately 96% of emissions from fashion brands with approved Science-Based Targets (SBTs) are attributed to Scope 3 activities. The majority of these emissions originate from two key areas: raw material extraction and material production.[46] The industry also incurs an estimated annual loss of 500 billion USD due to unused clothing and an insufficient recycling ecosystem[47]

The global textile industry is facing mounting pressure to tackle the environmental challenges associated with conventional materials, which have a significant environmental footprint. A critical step towards decarbonization in the textile industry involves unlocking the transition from "take, make, waste" supply chains to lower-carbon, circular Next Gen production.[48]

In the fashion sector, more than 50% of the fashion industry's environmental footprint lies in its raw material sourcing. There is currently a market gap as producers are yet to develop high-quality, low-carbon alternatives at competitive prices and commercial scale.[49]

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BILLION GARMENTS PRODUCED ANNUALLY

4.1 Let's Talk About Man-Made Cellulosic Fibre

Man-Made Cellulosic Fibre (MMCF) is the third-largest fibre category in the textiles sector, following polyester and cotton.[50] This group of fibres includes viscose, rayon, lyocell, modal, acetate, and other trademarked varieties. These semi-synthetic textiles are primarily made of wood with a small percentage of production utilizing bamboo or cotton linters.

Since 1990, global MMCF production has more than doubled, growing from around three million tonnes to approximately 7.2 million tonnes in 2021.51 This upward trend is expected to continue, with projections estimating that production could increase by another six to 11 million tonnes by 2035 52 with an expected CAGR of 7.8%.[53]

MMCFs are primarily derived from wood, Canopy estimates that approximately one-half of MMCF is sourced from Ancient and Endangered Forests — posing a grave threat to the environment, frontline communities, and planetary stability. As demand for sustainable alternatives from both brands and consumers rises, alternative MMCFs offer significant advantages by reducing reliance on fossil fuel-based synthetic fibres whilst also reducing the risks associated with sourcing carbon-rich forests and/or water-intensive cotton. These alternative sources of cellulose can be derived from cotton textile waste, agricultural residues, and food waste, and carry a fundamentally lower carbon and biodiversity impact due to reduced reliance on virgin forest feedstocks.

There are also production efficiencies associated with Next Gen utilization. It takes just one tonne of cotton textile waste to produce one tonne of Next Gen MMCF, whereas 2.5–3 tonnes of wood are required to produce the same amount of MMCF from conventional tree fibre.[54]

There are three key aspects of producing Next Gen dissolving pulp that contribute to a significantly lower carbon footprint compared to conventional wood pulp:

1. Low-Carbon Feedstock: The primary factor is that forest fibre has a much higher carbon footprint than recovered textile waste, annual crop residues, or microbial cellulose as a feedstock. Life Cycle Analyses (LCAs) conducted by SCS Global Services for Stella McCartney Inc., along with several other privately commissioned LCAs, reveal that wood fibre, regardless of the region it comes from, is the largest source of carbon emissions in the pulping process. This is because trees and the soils they grow in are highly effective at sequestering carbon from the atmosphere. A harvestable tree acts like a carbon bank account, accumulating carbon over many years. The soils in which trees grow store carbon for generations, protected by the trees. Logging and pulping release the carbon stored in the tree trunks and branches, and exposed soils can emit carbon for upwards of 15 years, even after new trees are planted.
2. Waste Repurposing: Using feedstocks that would otherwise be burned avoids emissions as does preventing textiles from decomposing into methane in landfills, in addition to avoiding other impacts from pollutants.
3. Energy Efficiency: Emerging tech has developed more energy efficient processes for converting and extracting cellulose from soft feedstocks like used textiles, agricultural fibres, or microbial cellulose, than the high pressure and temperature and chemical intensive conventional pulping processes used to for break down tree trunks and separate the lignin from the cellulose. Depending on the technology or process, Next Gen dissolving pulp can be produced using 50–70% less energy.[55]

4.2 India's Role in Next Gen MMCFs — From Big to Better

India, as one of the world's largest textile producers and exporters, holds a unique and pivotal position in the global MMCF industry. Within India, the textile industry, which employs over 45 million people,[56] plays an important role in the national economy owing to its major contribution to GDP, industrial production, employment, and exports.

India is working towards its target of achieving 600 billion USD worth of textile exports by 2047, from 44 billion USD recorded in 2021–22.[57] Given rising global demand for low-impact fibres and the abundance of alternative feedstocks, India is well-positioned to lead in the development of Next Generation MMCF solutions — and in doing so, meet this growing global demand.

India accumulates approximately 7.8 tonnes of textile waste annually, accounting for about 8.5% of the global total. This waste comprises 51% domestic post-consumer, 42% pre-consumer, and 7% imported post-consumer textiles. Of this total, 59% is reused or recycled, though only a small fraction is reintroduced into the global supply chain due to quality and traceability issues. The remaining 41% of the waste is either downcycled (19%), incinerated (5%), or sent to landfills.[58] Recovering cellulose from two million tonnes of blended polyester/cotton fabrics — and converting that into regenerated MMCF would be equivalent to all of MMCF production at the world's second-largest manufacturer, which is based in India.

Regulatory frameworks and policy directives in India are aligned to expedite this shift. The global textile industry's predicted consumption of 26% of the global carbon budget by 2030 highlights the urgency for effective waste management and recycling strategies.[59] The Indian Textile Ministry has launched several initiatives, such as the introduction of distinct Harmonized System of Nomenclature (HSN) codes for tracking recycled textiles[60] and an increased budget for the sector, with the aim to position India 'as a global hub for circular textiles by establishing textile recycling clusters'.[61] Furthermore, the European Union's Strategy for Sustainable and Circular Textiles, which mandates that all textile products must be durable, recyclable, and primarily made from recycled fibres by 2030, sets a global benchmark that India is well positioned to achieve.[62]

Recent years have seen a surge in Next Gen MMCF technologies, with several promising start-ups successfully transitioning to commercial-pilot mills, and one that has been built at full commercial scale. These innovations include the production of dissolving pulp or its direct conversion into viscose staple fibres from recycled cotton textiles. Notably, seven established dissolving pulp and viscose staple fibre producers from several parts of the world have begun integrating recycled textile content into their products, including Birla Cellulose in India, Lenzing Group, Tangshan Sanyou, Yibin Grace, as well as others.

India is also the second-largest agricultural-based economy in the world and has the largest crop production volumes for many high-cellulose crops including sugarcane bagasse, rice straw, husks and hulls, wheat straw, banana stems/fronds, and pineapple leaves.

A number of private trials are underway using wheat straw, banana fibre, microbial cellulose grown on food waste, and other materials as a new source for alternative MMCF feedstocks. Technical and economic success would open up markets for other lower-carbon fibre options, which could further displace wood-based viscose as well as some polyester.

Despite these efforts, the industry is unlikely to achieve the necessary transformation without a substantial increase in financing to accelerate the solutions. Current levels of commitment and funding are inadequate to sufficiently decarbonize the fashion and textile industry by 2050.

Section 5:
INVESTMENT OPPORTUNITIES — WHERE TO FROM HERE?

As the push to stabilize increasingly volatile supply chains and decarbonize material inputs expands, the opportunities to invest in the scaling of Next Gen alternative fibres will grow significantly in material innovation, innovative processing technologies, and infrastructure development.

For the most part, material substitution and Next Gen scaling is not on the radar of investors. The focus has been on energy systems and transportation. In India, specifically, of the $2.6 billion deal flows that India Impact Investors Council tracked in 2023, just 20 deals and $80 million of capital flow, representing 3% of total capital allocation, went into waste management and circularity.[63] Much of this investment went towards battery and other non-fibre related recycling. This is an indicator of current investor focus. It represents a gap to be filled or an opportunity to be taken, depending on your perspective.

As wood fibre supplies become increasingly vulnerable to fires and water shortages, it is anticipated that the scaling of alternative fibres will parallel other emerging markets, such as renewables, where modest initial growth has hit a parabolic tipping point. Investing in an alternative Next Gen fibre value chain offers high growth potential, and reduces risks, addresses supply-demand imbalances, and fosters new innovation.

For the Next Gen alternative fibre market to emerge and scale, impact investors need to be at the forefront of leveraging their funds to drive systemic change. Financing is required along the value chain to help create viable low-carbon Next Gen cellulose materials in paper, packaging and MMCF textiles — be it infusing capital to support the collection and sorting of waste materials, or investing in cleantech and infrastructure that will turn these fibres into paper, packaging, and viscose products.

Detailed below are specific areas of investment opportunity.

TECHNOLOGY DEVELOPMENT

- Cellulose Extraction Technologies: Technologies that effectively capture cellulose from cotton or poly-cotton textile waste, agricultural residues, or can grow microbially on food waste for use in commercial pulps for paper and MMCF textiles.
- Processing Technologies: Additional to Next Gen technologies, there are processing innovations that improve mill efficiencies at the front end and recovery stages as well as enhance product quality.

Infrastructure Development including:

- Mechanical and Advanced Recycling Facilities: State-of-the-art commercial facilities that efficiently separate, clean, and process textile waste as feedstock. Investment in the expansion and scaling of textile-to-textile advanced recycling tech for polyester/cotton textiles, is essential for fostering circular production systems. Traditional mechanical recycling methods often face challenges with blended materials, resulting in degradation and higher costs compared to producing new fibres, or an inability to utilize them at all. However, there is a rapidly emerging pipeline of technologies in chemical, biological, and advanced mechanical recycling that are addressing these challenges, enhancing both the efficiency, quality and viability of polyester/cotton recycling processes.
- Agri-Fibre Pulp and Paper Mills: Retrofitting of underutilized or mothballed mills to develop ag-fibre pulp and paper capacity; adding ag residue pulp lines at existing wood-based mills located near high-density agricultural feedstock areas; building greenfield mills in high-density feedstock areas.

SUPPLY CHAIN:

- Collection and Sorting Systems: Retrofitting, modernizing, and expanding capacity at companies in the middle of the value chain to develop and install new technology and infrastructure for the efficient collection, sorting, and processing of textile waste and agricultural residues. This includes setting up collection points, sorting facilities, and recycling centres for textiles, and developing infrastructure for the collection, storage, handling, and transport of agricultural residues to ensure a steady supply of raw material inputs.

5.1 Capital Type and Requirements

Building out Next Gen Solutions tech and manufacturing infrastructure in India will require 13 billion to 15.6 billion USD in infrastructure capital (through a combination of equity and debt capital) plus the capital requirements in fibre innovation, supply chain development, and the other sub-segments highlighted earlier. Below is some greater detail on the requirements by capital type.

5.5.1 Catalytic and Low-Cost Capital

The infusion of catalytic capital into this new market is required to support research and development (R&D) and to put the right mechanisms in place to drive adoption and scaling. The segment could offer lucrative opportunities for early investors. According to the Council on Foundations, "Catalytic first-loss capital refers to socially-and environmentally-driven credit enhancement provided by an investor or grant-maker who agrees to bear first losses in an investment in order to catalyse the participation of co-investors that otherwise would not have entered the deal."[64]

As with any emerging market, risk is inherent. Governments, philanthropic foundations, multilateral banks, and Development Finance Institutions (DFIs) should look to designate a portion of their investment as de-risking capital for low-carbon material development in the Global South. Allocating an initial large, low-cost capital pool in India to accelerate supply chain and infrastructure development could become a large-scale proof-of-concept for developing a Next Gen textile and pulp and paper economy. Contributing catalytic and low-cost capital to accelerate the pace of infrastructure development can support SDGs, as well as national and regional mandates.

Engagement by DFIs, alongside enabling support from Indian state and federal governments, has a high potential to create timely sector-wide shifts that benefit rural communities through supplemental income streams and improved air quality, whilst supporting forest conservation in India as well as other countries. Building wheat straw pulp mills contributes to rural economic development and addresses the significant respiratory health issues caused by the annual burning of straw residues. Recycled textile pulp mills can be strategically placed to provide jobs for underemployed urban populations in addition to diverting expensive waste from municipal landfills.

One model is the development of large pooled equity funds, where government bodies and development banks earmark 10 – 20% of equity funds as catalytic first-risk investments. This approach will allow additional traditional capital to flow more easily, helping scale investments in this space.

India's businesses can attract both conventional equity and debt capital, and the country is eligible for DFI and philanthropic investments. This presents opportunities for blended finance that include de-risked and low-cost capital for mill infrastructure combined with infrastructure grants and programs to support development of the business ecosystem of material collection and sorting.

The largest infusion of capital, alongside lower-cost capital from catalytic investors, will be debt and equity for alternative fibre pulping tech and mill infrastructure. India has not been a significant producer of pulp and paper for global markets. In recycled textiles, the country has global bench-strength, but total recycled volumes, are still small compared to virgin fibre textiles, providing significant room for growth. With India's recent target of two trillion USD in exports by 2030 (including 600 million USD from textiles), these industries will gain much-needed attention and support for growth.[65]

5.5.2 Venture Capital and Private Equity

Overall, there are a limited number of funds with a specific focus on low-carbon textiles, pulp and paper or materials, yet the space is ripe for leaders to move larger amounts of patient capital. Some that have engaged in this space include Circulate Capital, Pangaea Ventures, H&M Venture Group, Material Impact, Upaya Social Ventures, Closed Loop Ventures, Breakthrough Energy, and Prelude Ventures. The majority of these funds focus at venture-level financing, both seed and Series A. A broader pool of committed investors is now needed to unlock these game-changing technologies with both the capital depth and long-term ambition to take them through to economies of scale production. Funds with an impact-oriented investment thesis and an allocation of capital to climate solutions, should definitely allocate a percentage of the funding envelope to Next Gen scale-up.

5.5.3 Debt Capital

Debt Capital for infrastructure will be particularly important to unlocking this sector. This market is materials, hard-tech, and commodities. Building or retrofitting pulp mills is capital expenditure (CAPEX) intensive, but newer, more efficient technologies and lower-cost feedstocks can significantly improve operating expenditure (OPEX) and add environmental and social benefits. Getting to those benefits requires willingness, knowledge, transformative room, and a patient opportunity mindset. Equity investors that are willing to allocate monies towards commercial scale infrastructure, and Local and Multilateral Development Banks that are willing to offer debt financing towards commercial scale infrastructure need to be part of this capital mix.

> "Among other milestones, by 2030, 100% of our textile products will be made exclusively from materials with a smaller environmental footprint. Also, in line with our biodiversity commitments, we will support projects for the protection, restoration or regeneration of up to 5 million hectares by 2030".
>
> — Javier Losada, Director of Sustainability at Inditex

Section 6:
GLOBAL REGULATORY CLIMATE AND THE PUSH FOR CIRCULARITY

Global conservation agreements such as 30×30, Tropical Forests Forever, and other initiatives are channeling billions of dollars in funding into forest conservation and their governing countries for the ecosystem services they provide.

At a global level there are regulatory and conservation initiatives which are supportive of a push to mitigate industrial impacts on climate and biodiversity.

For example, in Europe, the EU Strategy for Sustainable and Circular Textiles includes a suite of new regulations that will directly impact company operations. The Ecodesign for Sustainable Products Regulation seeks to extend the lifetime of clothing, by stipulating that companies make materials more durable or recyclable, use waste as a raw material for fabrics, and offer consumers repair services or second-hand collections. Extended Producer Responsibility (EPR) for Textiles will hold fashion brands and retailers fully responsible for the entire lifecycle of textiles as well as ban the destruction of unsold or returned textiles and require the separation of textile waste from other types of waste. Additionally, the Waste Framework Directive is being updated in Europe to halt the export of textile waste.

In the packaging sector, the EU Deforestation Regulation codifies some of the strongest language around primary forest degradation seen to date in a regulatory context. It applies to wood, palm oil, soy, coffee, cocoa, rubber, and beef, as well as many products derived from these commodities. While the extent of this regulatory burden varies depending on how and when a company is selling or distributing the product, all companies throughout the supply chain have some form of due diligence requirement when trading items in the EU.

Regulators are increasingly requiring companies to publicize their climate-related risks and mitigation initiatives as a means to prevent greenwashing. The U.S. Securities and Exchange Commission's Climate Risk Disclosure Rules require climate-related disclosures by public companies — including their climate goals/targets and material climate-related risks, such as severe weather events, regulatory costs, and lower crop yields, as well as their Scope 1 and 2 greenhouse gas emissions. The EU has adopted similar accountability mechanisms, such as the Green Claims Initiative and Corporate Sustainability Due Diligence Directive.

Additionally, CBD COP agreements requiring nations to adopt plans for protection of 30% of ecosystems is forcing countries to look at innovative conservation measures and financing schemes to protect forests. The scaling of alternative fibres as a tool to protect forests globally is a unique way to achieve our planetary targets.

When taken together, the increasing regulatory burden on fashion and consumer products and goods (CPG) companies and governments mean that supply chains will need to be re-examined and sustainability claims will need to be backed with sound science and definitive action.

6.1 Government Role: Enabling Conditions for Next Gen Scaling

There is plenty of precedent for governments to use their levers to support the development of an industrial sector. The types of policies that create enabling conditions for a green industrial strategy are already being deployed within India and other jurisdictions in the renewables and transportation sectors:

- **Research and Development (R&D) grants in circular technologies** — Funds to support technology advancement in sorting and processing of poly-cotton blended textiles and further development of pulping technologies for agricultural residues.
- **Tax Incentives, commercialization grants, rebates, and market subsidies** — Early-to-market commercial production with new technologies can carry a premium until economies of scale and supply chain efficiencies hit stride. Development of renewable energy and electric vehicles provide numerous examples of governments using policies to address price premiums in the initial phase of production and to incentivize customers.
- **Financial support for small-to-medium enterprises (SMEs)** — Low-interest loans and/or grants help innovators establish pilot mills, transition from pilot phase to full production, and support the value chain to grow and/or adapt their processing capabilities.
- **Regulatory schemes** — Regulation can encourage or mandate the reduction, reuse, and recycling of materials across industries, supported by municipal infrastructures for textile recycling and sorting, to ensure reliable feedstocks and reduce the cost of processing post-consumer separated fibres and agricultural residues.
- **Extended Producer Responsibility (EPR)** — Schemes that require brands and retailers to take responsibility for the entire lifecycle of their products, incentivize brands to transition to circular products, and create financial resources to finance collection and sorting of materials for circular manufacturing. Derived funds can be redirected by government back into programs that help scale solutions.
- **Sustainable procurement policies** — Governments are major customers of paper products and of MMCF textiles (i.e. in uniforms, hospital bedding, furniture upholstery etc.) and can significantly incentivize the scaling of circular production.
- **Public-Private Partnerships (PPPs)** — PPPs facilitate the sharing of resources, knowledge, and infrastructure, foster collaboration between global investment agencies and regional governments, and de-risk commercial proof-of-concept projects.
- **Government-led educational campaigns** — Inform consumers about the benefits of Next Gen.

Global investment agencies and governments can also collaborate to meet mutual goals of economic development, environmental improvement, and community benefits by strategically dedicating significant funds, together, into development of a whole sector to leverage and accelerate success.

FINDING WAYS TO REDUCE THE COMMODITY-DRIVEN PRESSURE ON ECOLOGICALLY-CRITICAL FORESTS, ALLOWS TREES TO CONTINUE TO CAPTURE CARBON.

Section 7:
MARKET TRENDS
Customers Looking for a New Supply

Commodities such as pulp are volume-driven, with margins that require keen attention to market trends.

Material substitution of Next Gen for conventional wood inputs is particularly important in the context of shifting regulations, increasing volatility of conventional supply chains, and brand and consumer focus on sustainability.

This has led to thousands of corporations making voluntary sustainability commitments — many with clear targets and timelines for achieving them.

These voluntary corporate commitments are coupled with regulations such as the EU Deforestation Regulation that limits what forest-based products can enter that key market. There are a host of other waste directives and policies in the EU, UK, China, and U.S. that limit landfilling of certain products, favouring circular manufacturing, and encouraging low-carbon production utilizing lower-carbon raw material inputs

These two trends are coupled with the recognition that linear, extractive supply chains no longer provide customer brands with the medium and long-term security of supply they need. All three factors have begun to create a push towards alternative Next Gen fibres, however this is currently a diffuse market without sufficient supply of commodity products, at the right price, to feed it.

Pulling millions of tonnes of Next Gen pulp into production globally is not dependent on market growth but rather on activating existing demand for alternatives. Substituting Next Gen materials to replace non-compliant and/or high-risk pulp products (paper and MMCF) is what brands and retailers need to operate their businesses. However, the end customer is diffuse and therefore not in control of the materials at the far end of these supply chains

Activating the market can begin with a few of the larger CPG's engaging their suppliers, providing off-take agreements, and even making small anchor investments in production to de-risk it for other investors to come in. The early commercial scale-up stage will require some coordination. Nonprofits such as Canopy influencing paper and packaging decisions and several organizations in circular fashion including Canopy, Fashion for Good, IDH, and The Fashion Pact are creating pre-competitive initiatives to prime the pump for circular and Next Gen products to have clear pathways from the mill to the brand/CPG. Once the supply chain becomes comfortable with the new product, it becomes a regular part of the production process and accessible to the 80% of the buyers, which are small and medium-sized enterprises.

As brands assess their material impact, they are increasingly interested in investing in circular and Next Gen fibres. In recent work conducted by Sustainable Advisory Services, half of the brands they interviewed regarding material innovation suggested they have R&D and Finance Teams looking at this space.[66] Yet, due to the CAPEX intensive nature of this supply chain, brand investments are generally geared towards pre-commercial stages of innovation. The supply chain is complex, and entrenched in processes developed decades ago. Brands must take a stronger position on scaling innovation to mobilize support and funding. Therefore, when introducing new products into these established supply systems, collective action is required for effective pull-through the entire system.

By coupling relatively small investments into commercial Next Gen pulp facilities with offtakes, brands and retailers can leverage significantly more investment capital from conventional pools of investment into their supply chains. Their product offtake commitments de-risk infrastructure investments for much larger equity and debt investors. By signaling interest in and demand for these technologies whether with offtakes letters or investments—brands give other investors the confidence to invest.

Globally, incoming legislation and climate risks are making innovation a necessity, rather than a nice-to-have — meaning the funding gap is becoming more pressing." At every stage of the fashion supply chain, there are opportunities for reimagining how we make, sell and consume products," says Danielle Joseph, managing director at Closed Loop Partners, a U.S.-based asset manager that facilitates investment in circular economy solutions.[67] The same can be said in the pulp and paper sector.

wheat straw pulp and paper mill, Satia Paper

Section 8:
CONCLUSION AND RECOMMENDATIONS

There is an unprecedented opportunity for India to take the pole position as a global leader in alternative fibre development and processing.

There is room for both innovators and incumbents to scale Next Gen Solutions in textiles and paper packaging, opening opportunities domestically and in global markets. India's unparalleled access to alternative fibre feedstocks, its existing infrastructure of mills, an experienced workforce, and a goal to be a global leader in manufacturing and trade, means the country is well-positioned to be a leader in low-carbon materials

10+

MILLION TONNES ANNUAL CAPACITY THAT CAN BE ADDED BY BUILDING OUT NEXT GEN SOLUTIONS

Building out Next Gen Solutions tech and manufacturing infrastructure in India will require 13 billion to 15.6 billion USD and will add 10+ million tonnes annual capacity into both a new circular textile economy and the Next Gen pulp and paper sector.

This scaling of infrastructure would build out a business ecosystem which supports 100–200 alternative fibre pulp and paper lines and 10–15 chemical textile recycling facilities based on the feedstock tonnage available. In addition, there will be opportunities to support innovation and supply chain development which offer myriad opportunities for entrepreneurs, farmers and waste collectors.

India is extraordinarily well positioned to secure a diverse blend of capital to finance this transition. India's businesses can attract both conventional equity and debt capital, and the country is eligible for DFI and philanthropic investments. This presents opportunities to bring together a spectrum of blended investment and finance vehicles that include de-risked and low-cost capital for mill infrastructure combined with infrastructure grants and programs to support development of the business ecosystem of material collection and sorting. R&D grants and skill development programs could also be supported by CSR contributions by India based companies.

Which countries capitalize on the opportunity to capture markets clamouring for low-carbon supply of Next Gen pulp, textiles, and paper is dependent on access to capital for mill infrastructure and an industrial development strategy by governments to accelerate building and retrofitting of mills.

To encourage the deployment of a successful material substitution strategy, Canopy recommends the following interventions:

1. **Defined national objectives:** As part of India's national economic, trade and environmental strategy, key government agencies such as agriculture, industry, textiles, environment and health will need to connect and collaborate on setting targets and timelines for low-carbon Next-Gen textile and pulp and paper manufacturing. These can include both domestic production as well as export targets.
2. **Enabling Policy Frameworks:** Develop policies which align production and government financing with health and environmental objectives, trade targets, global and national climate and biodiversity targets, and socio-economic objectives,
3. **Build out financial incentive tools:** Successful models utilized to stimulate growth in the renewables market — production subsidies, feed-in tariffs, rebates, and other financial mechanisms should be examined and adapted.
4. **Leverage Development Finance Investment:** DFIs which focus on impact investment with climate, biodiversity and socio-economic benefit, could make capital grants and low-cost loans available for scaling pulping infrastructure (mills) and for development of feedstock supply capacity.
5. **Scaling Venture Capital:** In India there are a variety of VCs with a climate/impact focus where there is opportunity to signal the marketplace and make capital available for alternative fibre R&D and early-stage development. VCs stepping into this space publicly is a key element for long-term market success.
6. **Pooled Equity Vehicles:** Equity is key in unlocking the transition. Private capital, sovereign wealth funds, corporate and institutional investors including pension funds, can create specialized pooled capital vehicles that kickstart industrial production of low-carbon materials and feedstock supply capabilities.
7. **Blended Finance Tools:** Multilateral Developmental Banks should explore opportunities for creating blended low-cost capital vehicles to kickstart industrial production of low-carbon materials and feedstock supply capabilities. These vehicles can attract government engagement as well as capital from private debt and equity financiers. Hybrid structures combining private, public and philanthropic capital can bridge differences related to risk and return expectations, enabling large conventional investment tickets, which will support the growth in these emerging hard-tech sectors.
8. **Direct Private Investments:** Strong opportunities for scaling-levels of private equity and debt exist. Private capital, corporate and institutional investors including insurers and pension funds, can invest directly in mill infrastructure, technologies or feedstock supply capabilities.

The development of higher-efficiency processes and tech for pulping used textile and agricultural fibres has burgeoned in the last five years. Next Gen feedstocks and tech have been attracting innovators because they reduce reliance on conventional, high-impact fibre sources and optimize the efficient use of raw materials. Cleantech to convert agricultural fibres to pulp for paper is already emerging into the commercial market with innovators in China, the U.S., the EU, and India building modern and clean commercial and pilot mills.

Forest products from numerous countries face increasing barriers to market access as a growing number of jurisdictions and corporations eschew use of high carbon and biodiversity-value forests. Next Gen products sourced from India would avoid such restrictions and the complex tracing required of conventional wood products in key markets.

This presents an opportunity for India to become a preferred supply region for large global markets.

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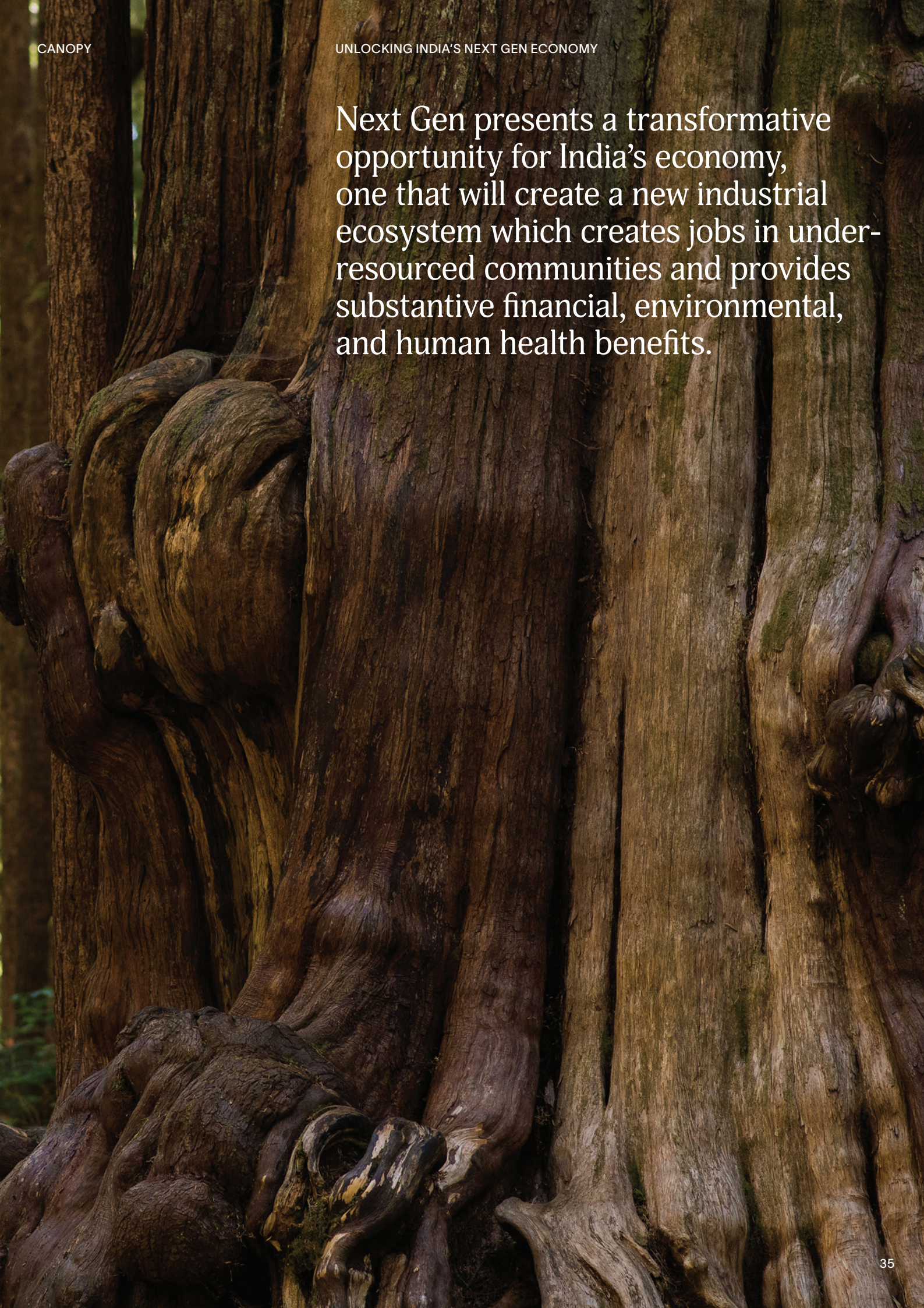

Next Gen presents a transformative opportunity for India's economy, one that will create a new industrial ecosystem which creates jobs in under-resourced communities and provides substantive financial, environmental, and human health benefits.

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"As global demand for circular solutions rises, the need for NextGen material innovations in textiles and packaging has never been more critical. At Birla Cellulose, we are committed to pioneering this shift, ensuring India becomes the frontrunner in tapping into the NextGen economy."

— Sucharu Uppal, Joint President, Brands and Retail, Birla Cellulose.

"As India's homegrown e-commerce platform, we understand the urgency of shifting towards circular solutions. Our commitment lies in fostering innovation and collaboration to ensure that sustainable materials become the new norm across industries."

— Nishant Gupta, Head of Sustainability, Flipkart

"India has all the ingredients — abundant feedstock, technical expertise, and a culture of innovation. What's needed now is targeted investment, industry collaboration, and government support to scale this vision into reality."

— Nicole Rycroft, Founder and Executive Director, Canopy