Circular Fashion Partnership

Pre-feasibility Analysis of Post Industrial Textile Fiber-2-Fiber Recycling in Bangladesh

About this Report

This report is authored by Reverse Resources, supported by Global Fashion Agenda (GFA) as part of the Circular Fashion Partnership. The report outlines the findings of the prefeasibility analysis of post industrial textile fiber-2-fiber recycling in Bangladesh.

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About Reverse Resources

RR is a Software-as-a-Service platform for collection of accurate and relevant data along with digital steering and tracing of waste from source to recycling. Established over seven years ago, RR has been intently focusing on investigating market barriers and best use cases of post-industrial waste streams. Having done extensive research and on-groundwork (across Europe, Asia, and parts of North Africa), RR has a demonstrated core competency in establishing textile waste feedstock routes for existing and emerging textile recycling companies. Till date RR has mapped waste across 20 countries for large fashion brands and organisations such as Accelerating Circularity and United Nations Industrial Development Organization.

About Global Fashion Agenda

Global Fashion Agenda is a non-profit organisation that fosters industry collaboration on sustainability in fashion to drive impact. Its mission is to make sustainability fashion's first priority by mobilising and guiding the fashion industry to take bold and urgent action on sustainability. The organisation has been leading the movement since 2009 and is behind the renowned event on sustainability in fashion, Copenhagen Fashion Summit and its digital edition CFS+, the Innovation Forum, and thought leadership publications including Fashion CEO Agenda and Fashion on Climate as well as its impact programme the Circular Fashion Partnership.

Acknowledgments

The authors would like to thank all of those who contributed to this publication. Special thanks go to the partners and participants of the Circular Fashion Partnership, its grantor, Partnership for Green Growth (P4G), as well as the industry experts and the broader fashion community who have contributed their time, insight and expertise to this report.

Content

Executive Summary

The Circular Fashion Partnership (CFP), an initiative of Global Fashion Agenda (GFA), Reverse Resources, BGMEA and P4G was developed as an effort to decouple environmental pressure from economic growth[1] in the global fashion industry by implementing circular systems. For its premiere iteration, CFP identified Bangladesh to create a pre-competitive environment to design, test and facilitate circular commercial collaborations in the apparel value chain that can be later replicated across other global apparel manufacturing hubs.

The existing landscape of the Bangladesh textile and apparel industry is linear in its structure, a scenario that is common in most apparel and textile producing hubs across the globe. As Bangladesh's textile and apparel industry seeks to shift to circularity, the current linear business practices provide barriers and obstacles for change. Bangladesh's large volumes of standardized recyclable post-industrial waste streams present a huge untapped potential to accelerate towards circularity by enhancing recycling infrastructure and industry.

This pre-feasibility study has been prepared with the intention to provide insights for investors, manufacturers, emerging local and global recycling technologies and other such cohorts, on the Bangladesh market landscape and the opportunities that lie thereof.

We first provide an overview of the country's

- existing textile waste management and handling practices along with the regulatory and policy framework that impact them
- post-industrial textile waste streams (and their respective volumes) being generated
- factors that influence the price and value of these waste streams
- current recycling capabilities
- massive market potential to map, capture and valorise its post-industrial waste streams by recycling them domestically

With this context, we then proceed to inform the reader on the new and emerging recycling technologies across the globe. By decoding these technologies' feedstock requirements, we matched them to Bangladesh's waste streams and offered recommendations on the type of technologies that would suit and benefit the country and hence should be considered for investment.

To further aid the investors'/recyclers' investment decisions, we also shed light on

- estimations of overall costs to implement certain types of recycling technologies
- actions required by relevant industry stakeholders to nurture a supportive environment for textile recycling in Bangladesh
- the substantial social and environmental impact potential

Equipping Bangladesh with a robust and technologically advanced domestic recycling ecosystem is crucial for both its transition to more sustainable practices and for maintaining its competitiveness globally.

[1] Phrase coined by Organization for Economic Cooperation and Development

Introduction

In recent years, the concept of circularity has taken the centre stage of the global fashion industry's dialogues. With the backdrop of climate change and growing populations, there is an increasing uncertainty regarding the availability of resources. Consumers are also becoming more aware of the impact of their consumption and are seeking products made from more sustainable and recycled materials. It has hence become imperative for the industry's stakeholders to formulate and prioritize strategies that reduce dependency on finite natural resources and increase the usage of recycled materials.

Industry actors are progressively becoming cognizant that

- circular systems can provide solutions to challenges around material availability and support in reducing environmental impacts
- circular business models have the potential (to a degree) to decouple economic growth from environmental impact by enabling efficient reuse of virgin materials
- recycling is a crucial component in the transformation of linear supply chains to circular ones
- consumers, NGOs, investors, and policy makers are gaining more awareness on the negative impacts of the fashion industry and are demanding more transparency

With this in mind, there is an urgent demand from industry actors to understand the type of waste streams global supply chains are generating and how to, accordingly, map, capture and re-introduce them back into production. For this, there is a need to organize and establish waste feedstock supply chains that can not only ensure that larger volumes of textile waste reach recycling, but also enable textile recycling technologies to scale. This will allow the global fashion industry to realize its collective vision of transitioning to a circular economy.

The Circular Fashion Partnership (CFP) was conceptualized for the very purpose of creating a pre-competitive environment to evaluate the viability of circular frameworks and aid the creation of equitable value for different industry actors in the fashion industry.

Attention is often placed on the circulation of post-consumer textile waste; however, the CFP was created to demonstrate the significant business opportunity for recycling post industrial waste. Reverse Resources estimates that globally around 35% to 40%[2] post industrial textile fiber is lost throughout apparel supply chains. Although it doesn't represent the largest share of textile waste overall, the volumes and quality of

[2] This estimate is for recyclable waste only and does not include overproduction and deadstock fabrics.

recyclable post-industrial waste streams are significant and can massively contribute to increased circularity and value creation within manufacturing (countries). Furthermore, post-industrial waste isn't challenged by a technological gap in sorting, that is currently deterring recycling post-consumer waste. Post-industrial waste can be segregated per desired composition, type, and colour at the point of generation (in the presence of appropriate waste management practices). In comparison to post-consumer waste, industrial textile waste streams are thus cleaner, more standardised and do not require disassembly, washing or other preparations for recycling. These characteristics make post-industrial textile waste the ideal feedstock for emerging recycling technologies, especially during the early development and scaling stages of their technologies. Capturing and reintroducing post-industrial waste should be taken as an important first step and prioritised prior to exploring potentially importing post-consumer waste into production countries.

As a cross-sectorial project to accelerate the transition to a circular fashion industry, the CFP set out to demonstrate a business case for recycling post industrial textile waste in Bangladesh. A successful business case will demonstrate a decrease in textile waste and increase the use of recycled fibres, distributing value throughout the fashion value cycle and generating economic benefits in Bangladesh by accelerating the domestic fibre recycling market. The partnership facilitates *Circular Commercial Collaborations* between 38 textile and garment manufacturers, 17 recyclers, 1 buying agent and 20 major global fashion brands operating in Bangladesh to capture and direct post-industrial textile waste back into the production of new fashion products. Global Fashion Agenda (GFA) leads the project in collaboration with Reverse Resources and Bangladesh Garment Manufacturers and Exporters Association (BGMEA) and with the support of Partnership for Green Growth (P4G).

For its premiere iteration, the CFP identified Bangladesh and its apparel industry as its beachhead market. 83%[3] of the country's total exports is related to ready-made-garment (RMG) exports and around 58%[4] of the country's textile flows are represented by cotton or cotton-rich materials. As the country produces large volumes of similar products, the textile waste that gets generated is fairly standardized, but a formal waste management system or strong recycling industry has not yet been established.

With arguably the largest volumes of recyclable textile waste being produced of any garment manufacturing country, Bangladesh is well positioned for its high-value waste to be suitably recycled and re-introduced into its manufacturing facilities. Doing so would allow a significant reduction of material waste and would reduce the country's dependency on finite natural virgin resources and expedite its

[3] BGMEA website

[4] Based on Reverse Resources data analysis calculations

manufacturing hubs' transition to circularity. Nevertheless, the domestic recycling capabilities of the country are currently limited, and 84.4 million USD worth of textile waste is currently being exported to other countries for recycling. For Bangladesh to take advantage of the unique opportunity of its high value waste streams, its recycling capabilities need to be scaled up. Only then can its large volumes and types of waste generated be absorbed and appropriately recycled domestically.

Since the project inception in October 2020, the CFP project partners have facilitated multiple key interventions to kickstart the transition to *circular value cycles*[5]. Segregation and necessary inventory management practices have been set up at manufacturing facilities nominated by brand participants. Traceable feedstock supply chains to recycler participants have been established. A blueprint for segregating textile waste at source and digitally tracing its chain of custody along the supply chain up until recycling has been demonstrated and provided through the Reverse Resources platform. Each of these activities have been crucial to foster the fiber-2-fiber recycling in Bangladesh and facilitate brand's ability to enter into offtake agreements with recyclers and meet their commitments to use more recycled materials.

The global and domestic apparel and textile industry is now actively seeking to invest in recycling technologies. It has also become apparent that recycling waste closer to the place of generation is most prudent and pragmatic. On that account, this report outlines a) the landscape of Bangladesh's post-industrial textile waste market, b) domestic recycling capabilities and c) recommendations on the global recycling technologies that would be suitable to foster the recycling industry of the country. Envisioned as an information memorandum for investors and recyclers (both domestic and global; looking to expand their operations and scale), this report aims to enable smart and balanced investments in the post industrial textile recycling industry of Bangladesh.

[5] Circular value cycles are new systems to replace traditionally linear "take, make, dispose" supply chains. In circular value cycles, resources such as raw materials and textiles continuously and seamlessly flow between manufacturers, brands, consumers, and recyclers by enabling the recycling and reuse of textiles at scale. Unlike linear supply chains, "waste" doesn't become "waste" as it isn't wasted but is captured and transformed into a new resource.

Post-Industrial Textile Waste Market and Landscape in Bangladesh

Profile of the Post-Industrial Waste in Bangladesh

The following sections lay out data supported facts to present the characteristics of the post-industrial textile waste market in Bangladesh.

Waste types and volumes by subsector

Bangladesh has a total volume of 993,902 tons/year of leftover textiles from textile and apparel production. The leftovers can be divided into two categories - reusable leftovers and recyclable waste. Accounting to **881,600 tonnes/year**, the recyclable waste consists of all production waste which has the potential to be recycled in optimal conditions. Examples of this waste include spinning, knitting, weaving and RMG waste. The reusable leftovers, on the other hand, constitute the deadstock fabrics and overproduced finished garments as they are in raw material or product form, respectively and therefore have a high reuse value (See Appendix A)

Breakdown by fiber composition

In addition to quantifying the volumes of post-industrial textile waste, the other vital metric to capture is the fabric composition. This becomes especially important when planning an effective fiber-2-fiber recycling industry in Bangladesh. Assured access to desired fibre composition, quality, and consistent quantities of the right type of feedstock is paramount when evaluating the viability of a recycling technology and establishing a facility. Appendix B shows the estimations on the potential breakdown by composition of the post-industrial waste in Bangladesh.

Market Scenario

In this chapter we provide a thorough background on the current landscape of the post industrial market in Bangladesh:

Informal waste handling network

The textile waste generated by textile and apparel factories is currently being managed by informal traders in, often, inefficient networks. It is hard for manufacturers to control their own waste flows as these traders are territorial with regards to their sourcing partners/manufacturers and are also influenced by local

political actors. This waste then flows through convoluted routes in informal channels and passes through numerous middlemen. As segregation and sorting undertaken throughout this section of the supply chain are done manually and often inefficiently, the contamination levels of the waste is high. This makes it impossible for local informal players who currently trade the waste streams to meet the low contamination requirements of many of the emerging chemical recycling technologies.

Lack of social compliance in the informal channels

Due to the informal nature of the waste handling networks, it is difficult to ensure the social welfare of the people working for the traders that operate within these channels. There are concerns about the wages, working conditions and labour rights extended to the people working in this section of the textile supply chain. As engaging with these informal players and networks is currently difficult, upholding accountability, establishing traceability and implementation of new circular solutions is challenging.

Low quality or lack of background information of the textile waste sourced by recyclers

When recyclers currently receive textile waste through the informal waste handling network, they have no access to the background information of their sourced material. As there are no quality control measures in place among informal traders, it is easy to manipulate the quality of the textile waste. Mechanical recyclers active in the domestic industry for a long time have observed and reported the deterioration of quality in textile waste due to purposeful contamination. Some recyclers report having to lab test every single batch of textile waste sourced to check for suitability. This further adds to the over costs of before recycling is undertaken. Traceability is the missing element that can enable recyclers to gather valuable background data of the sourced feedstock.

Incineration for Energy

With no policy directives or limitations on cotton incineration, many manufacturers consider incineration of cotton (and possibly other textile waste types) as a sustainable, cost efficient and reliable energy source. Additionally, advantageous characteristics such as high calorific value for incineration, cleaner to burn and easier to capture toxins through filters (than synthetic textiles) make cotton and cotton rich textile waste an appealing raw material for incineration. This has resulted in a system where large volumes of highly valuable and easily recyclable textiles are lost from the value cycle. Cotton waste should undergo incineration only as the absolute last resort when all options of reuse and recycling are not available/feasible. Incineration of these valuable resources works against the fashion industry's demand to increase recycling and create a circular economy.

Lack of awareness of opportunities available

Relative to other global apparel manufacturing hubs (that also grow and spin yarn domestically), Bangladesh does not have an active mechanical recycling industry. It does however have factories that manufacture textiles and garments from recycled fibre, wherein the recycled fibre is imported from neighbouring countries. There is limited knowledge and awareness of the potential economic benefits of adopting formal and digitally verified circular value cycles. Because of this reason, Bangladesh has yet to take advantage of its access to huge volumes of recyclable waste and production capabilities and accordingly invest in supporting infrastructure to develop a thriving textile recycling industry.

Regulation and Policy

Parallel to any industrial transformation comes the requirement of appropriate policy changes to support and incentivise investment and make sure there are no antiquated legal barriers obstructing the new industrial process. Specifically, within the scope of fostering a recycling industry, it is important to take into account the regulations and policies of the country that influence long term feedstock routes for recyclers. Potential regulatory/policy barriers identified in Bangladesh are:

- Securing licenses to handle waste and value-added-tax implications (VAT) for handling and moving waste, for example in and out of Export Processing Zones (EPZ)
- Utility Declaration (UD) and limitations on waste generation[6] in comparison to imported fabric and exported garments and its related taxation
- Lack of limitations on the incineration for cotton, and no incentives for or access to cheaper alternative biofuels

[6] https://www.tbsnews.net/economy/rmg/govt-decides-two-fold-hike-rmgs-wastage-rate-295009#.YSu21M70DhQ.facebook

Value of post-industrial textile waste in Bangladesh

The value of post-industrial textile waste is both local and global in nature. It is influenced by a multitude of factors such as types, compositions, colours, and the volumes available. It is also affected by the type of waste handling and collecting networks involved and where the factories and recyclers are located. These parameters vary in different parts of the world, as such the value for most post industrial waste varies globally. Only very high value textile waste such as 100% cotton has a global market value because it has universal demand. In this section we will highlight the value of Bangladesh's post-industrial waste and the various factors that impact its commerce.

The buying price of low value waste streams such as multi blended textiles varies from country to country depending on the amount of local use cases and thus the demand. As the technologies to recycle waste streams such as multi-blended textiles are currently not yet at commercial scale, they do not have a high global demand and their value depends mostly on local demand and consumption.

100% cotton knit textile waste is the most recyclable raw material and is therefore high in demand by recycling technologies. Although high value waste streams like 100% cotton knit are consumed locally, significant volumes are shipped around the globe. And so, there are global benchmarks for market prices of such high value waste streams. Buying prices for 100% knit white cotton can be as high as 0.80USD/kg - while other single colours vary form 0.19 - 0.47USD/kg. In addition, prices are volatile as they fluctuate depending on the availability of desired colours in different seasons and are also sensitive to the fluctuations of virgin cotton prices.

The prices for different types of textile waste can vary dramatically even when they are of the same composition. For example, 100% cotton knit waste has a high global price whereas 100% cotton woven denim waste has a local price structure and is worth significantly less than its knit counterpart. Colour also affects price, with pale colours most valuable and multi coloured printed textiles the lowest value.

As reflected in the previous section, Bangladesh's apparel industry is characterized by cotton rich textiles production, making its post-industrial textile waste extremely valuable. However, when textiles are not segregated at source the prices received by the factory are greatly reduced. For example, using the Reverse Resources pricing structure, we can estimate that the RMG cutting waste of over 450,000 tonnes per year (including knit, woven and all fiber compositions) if segregated can be valued at approximately USD 90 million. Currently, due to the absence of effective segregation, waste management and inventory practices and additional impediments due to the informal waste trading network, the value of RMG cutting waste for factories is approximately USD 40 million. Segregation and traceability are key drivers to valorise textile waste streams.

Factors influencing the price of waste in Bangladesh (or feedstock)

Following are the list of factors that influence the price of the post-industrial waste in Bangladesh:

Lack of segregation at source and appropriate waste management practices thereof

Factories in Bangladesh, much like factories in other parts of the globe, generally mix up all types of textile waste that is generated at their facilities; often swept off the factory floor along with the dust and packed into bags. These bags then get sold onto local traders/waste handlers, who manually segregate them by either merely feeling the waste fabric or by burning small samples of this waste to identify their composition. Apart from these waste management practices being inefficient and leading to increased levels of contamination, they also significantly reduce the recycling potential of the textile waste. Because of this, the value of the textile waste gets lowered substantially and ends up garnering a much lower selling price by factories.

Presence of numerous middlemen

Textile waste generated currently flows through informal and inefficient networks, changing hands of at least three to five different traders before it reaches the recyclers or the final buyers. With each middleman performing a different step in the journey, such as collection, segregation, cleaning, aggregation, transportation and storage, costs are added to the price of the textile waste at every step of the way.

Absence of background information

The final buyer, who is often the recycler, gets charged a high price for the desired quantity and quality of textile waste. With little to no insights on surface treatment, chain of custody, social compliance at the point of origin et al. the recycler often has to buy low quality feedstock at high prices. This price eventually impacts not only the quality but also the final price of the recycled product manufactured and becomes an impediment in the widespread consumption of recycled products.

Price setting in the context of circular value chains

It is important to mention that in a circular industry, the price of waste should not only be associated with demand but also related to the buying price of the new product that it is converted into. For example, if a manufacturer sells their cotton waste at too high a price, it will affect the competitiveness of the price of recycled cotton yarn and therefore also the ability to offer a good range of recycled products to key buyers. In a circular industry what goes around does in fact come around. As such, the price of virgin staple fibers, chips and pulp should be taken into account, when trying to value waste, so that recycled fibers can be priced competitively to their virgin equivalents. Below are price indicators of the cost of virgin raw materials:

- **Mechanical Fibre-2-Fibre recyclers:** Use virgin cotton staple fiber priced at 2.14 USD/kg[7]
- **Regenerative/Chemical cellulosic recyclers:** Mainly use cotton as their feedstock, however it needs to be priced competitive to virgin cellulose dissolving pulp which is around 0.95 USD/kg[8] (lower price than virgin cotton staple fiber)
- **Regenerative / Chemical Synthetic and Thermo Mechanical Recyclers:** Use mono fiber 100% synthetic textiles like Polyester or Nylon.
- **Regenerative / Chemical Blended Recyclers:** Need to compete with both virgin grade PET chip and cellulosic pulp. However, the blended textile waste typically has the lowest value on the recycling market and currently the only other demand is for industrial symbiosis, non-woven insulation fabrics.

[7] Article: Polyethylene Terephthalate (PET): Production, Price, Market, and its Properties

[8] Article: Global Dissolving Wood Pulp Industry Outlook, 2020-2025 - China Still Dominates the Global Market, Despite a Trade War. https://www.researchandmarkets.com/r/e048f2

Existing recycling capabilities in Bangladesh

The largest share of Bangladesh post-industrial textile waste is collected via informal waste handlers and either exported, used locally (in one way or another) or disposed of in one of several large textile dumps scattered around Dhaka and Chittagong.

Local use cases vary from recycling into coarse yarns, use as mattress stuffing or incineration as fuel for domestic cooking or in unregulated brick kilns. These local use cases can mostly be described as downcycling rather than recycling, as the true economic potential of textile fiber is not derived. Moreover, the burning of textiles outside of the factory boilers is carried out without filtration. Due to this, only a very small amount of the high volumes of waste that gets generated achieve its full recycling potential.

Typically, as in other apparel producing countries, textile waste streams are mixed up and shredded to be used as stuffing in furniture, mattresses, and pillows, however unlike other countries there seems to be less textile fiber flowing into non-woven fabrics for use in other industries. There are limited opportunities for industrial symbiosis[9] due to the high concentration of textiles and apparel manufacturing within the Bangladesh economy. With 83% of Bangladesh's exports constituting the RMG sector, there is less demand and limited use cases for recycling within other industries.

The biggest economic loss for Bangladesh, is the exporting of mostly high value waste (such as cotton) to other countries for recycling. In 2019, Bangladesh was the biggest exporter globally, exporting 84.4 million USD worth of textile scraps[10]. The valorisation of these textile fibers in other countries is creating a colossal system loss for Bangladesh.

Despite the country's large manufacturing volumes, their fibre-2-fibre recycling industry is not as active as those in its neighbouring countries such as India and Pakistan. It is hard to calculate exactly how much textile waste is recycled into new yarns in Bangladesh. There is, however, an active industry with companies shredding, selling, and spinning recycled textile fiber into coarse yarns for local consumption, specifically for the purpose of home textiles. Some of these are large companies recycling up to 400 tonnes a month, still the majority are small, often unregulated companies. Although this industry is active, we estimate the volume in Bangladesh to be limited in relation to the volumes of textiles waste being produced and of too low quality for the global apparel industry.

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[9] Industrial Symbiosis; the use of textile waste in other industries like insulation for construction or automotive industries, stuffing and other non woven applications.

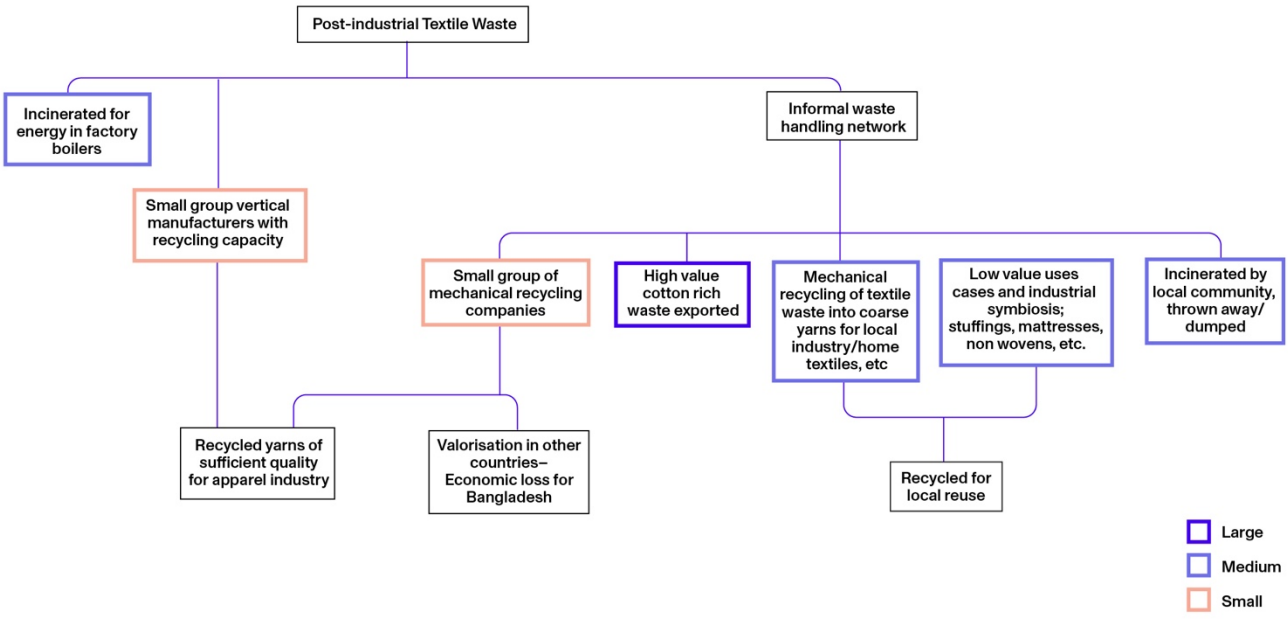
[10] https://oec.world/en/visualize/tree_map/hs92/export/show/all/116310/2019/

Nonetheless, there is a small but fast-growing industry for fibre-2-fibre recycling at global apparel quality in Bangladesh. At least seven vertically integrated companies along with six spinning facilities with some mechanical recycling capabilities have been identified. Based on these companies, the current recycling capacity for apparel quality recycled yarns is estimated at 1500 to 2000 tonnes a month. This includes companies like Cyclo and Saraz Fibre-Tech who are CFP project partners. Compared to the almost 42,000 tonnes a month of recyclable textile waste being produced, there is a significant capacity gap. Furthermore, another ten companies have been identified, who are in the process of planning or building mechanical fibre-2-fibre recycling facilities. In addition to this, most of the existing mechanical recyclers have communicated plans for expansion. A capacity increase of approximately 5,000 to 6,000 tonnes a month is expected in the coming two years: an increase of around 240% in capacity.

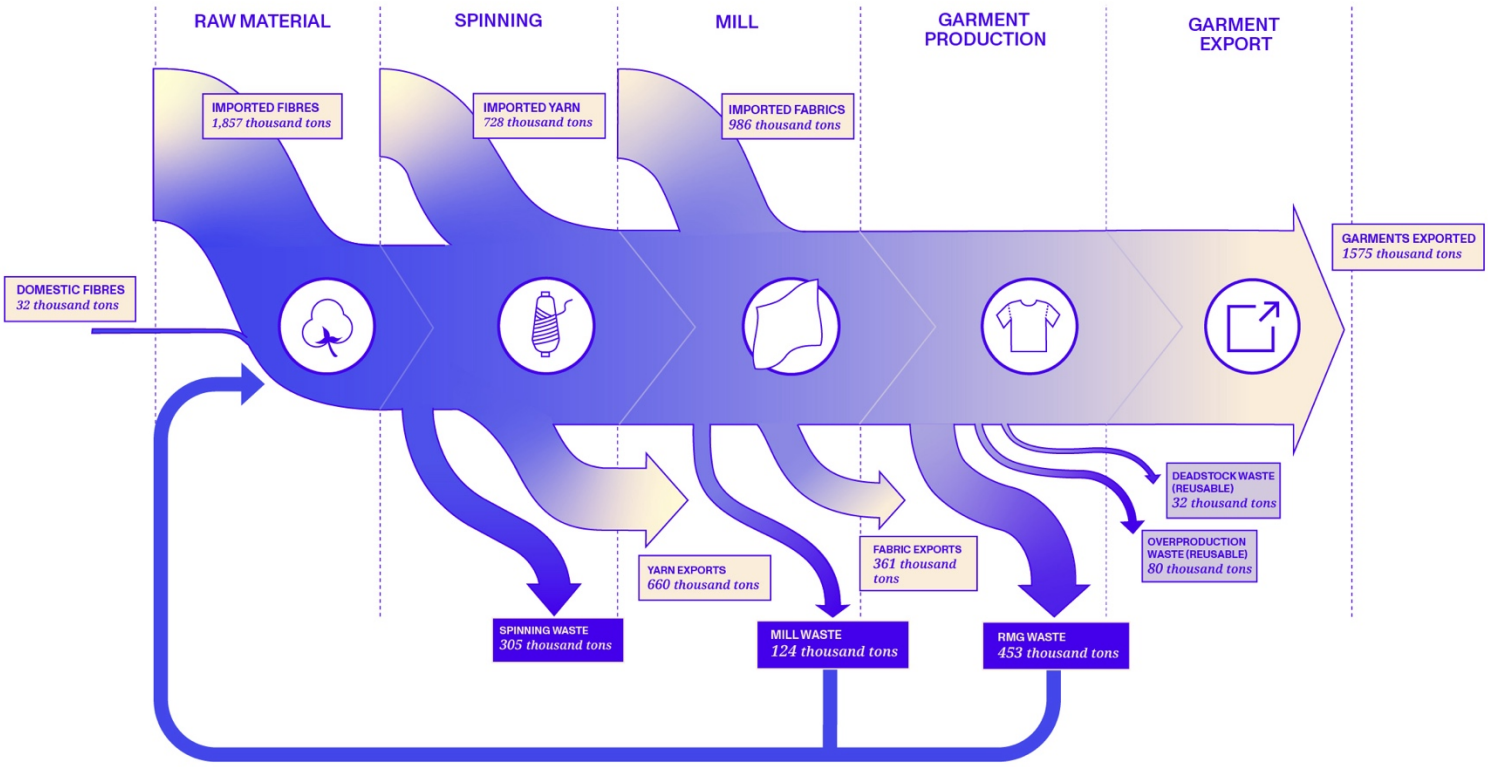
Interestingly there are 46 GRS certified spinning facilities in Bangladesh however the majority of these companies spin rPET fibre from plastic bottle recycling. The volume of rPET fibre is significantly higher than recycled cotton as supply of recycled polyester fiber is often more readily available, cheaper and of better quality.

Undoubtedly, the Bangladesh recycling industry is in a transition period today. With the recycling industry growing, many new companies are in the process of making investments in this sub-sector. The CFP establishes the 2021 recycling capacity benchmark at 2000 tonnes a month for export apparel quality recycled materials. With this benchmark it is possible to measure the emerging supply and demand as well as the acceleration towards circularity. Thereby providing insight into the economic gains associated with this transition and quantifying the impact of the CFP project.

POST-INDUSTRIAL TEXTILE WASTE FLOWS IN BANGLADESH



Total addressable market potential of recycling in Bangladesh



In 2019, Bangladesh produced approximately 577,000 tonnes of textile waste just from the Ready Made Garments (RMG) and fabrics mills of which over half (336 thousand tonnes, around 58% of the total waste) was 100% cotton and cotton elastane textile waste. For factories selling this waste it reflects a potential earning of up to 63 million USD. Bangladesh is a country heavily reliant on the importation of textile fiber so although factories are now earning from the sale of waste, the most significant economic earnings appear when this waste is valorised within the country.

For example, in 2019, the country imported 1.63 million tonnes of staple cotton fibre (with a value estimated to be 3.5 billion USD). Based on the CFP findings, if its cotton and cotton elastane waste was recycled within Bangladesh, imports could decrease by around 20%, therefore saving almost ¾ of a billion USD that would have been spent on cotton imports. The waste being produced within Bangladesh that is currently flowing into low value use cases and being exported for recycling in other countries represents a massive system and economic loss for the country.

In 2018, Bangladesh had 85 GRS certified facilities. The GRS or the Global Recycled Standard, is an international voluntary standard, developed by Control Union Certifications, intended to meet the needs of companies to verify recycled content of their products (finished and intermediary) in addition to verifying the responsible social, environmental, and chemical practices in their production. In 2020, the number of GRS certified facilities in Bangladesh was 555. The presence of this large number of RMG facilities with GRS certification shows that there is a significant volume of recycled textiles or fabrics in Bangladesh, however these are not being produced in the country. This signifies the demand for using recycled materials and the capacity gap to create them in Bangladesh.

According to a Textile Exchange report, "Overall less than 0.5% of the global fiber market was from pre- and post-consumer recycled textiles in 2020." Brands have started setting high targets for increasing recycled content in their products. Over 82 global fashion brands including Adidas, Inditex and H&M have committed to Textile Exchange's global cotton challenge, sourcing 100 percent sustainable cotton by 2025. And so, there is an expected increase in demand for recycled materials in the upcoming years, specifically recycled cotton- one of the main sustainable cotton categories amongst organic and regenerative cotton. The most pragmatic solution to feed this demand is to valorise the textile waste close to the point of generation.

"Fashion is "market reactive" – if brands send a strong signal to suppliers about wanting more recycled materials, and if we on top of that support the work that needs to be done to make this a reality – then I actually don't see why it would not happen or not make an impact. It is possible as the waste is already where the industry is: in Bangladesh. We have recyclers; we have the suppliers and the brands looking for this material. All we need is to connect the dots and do the work. Of course, it is not as easy as it sounds. But it is possible and thus achievable."

CAMILLA SKJØNNING JØRGENSEN
SUSTAINABLE MATERIALS & INNOVATION MANAGER, BESTSELLER

With Bangladesh attributing to a huge share of production for global brands, there is a large volume of waste readily available for recycling. But there is an explicit need to increase the local recycling capacity so that these huge volumes of waste can be absorbed and valorised locally. This interest and need was further underscored by the 20 global brands participating in the CFP. Significant investments in suitable recycling capabilities - latest technologies, certifications, and infrastructure, are essential for Bangladesh to be able to absorb its own textile waste. It is in the interest of all relevant stakeholders for these investments to be made and to initiate the domestic apparel and textile industry's transition to circular supply chains. The next page shows the overview of global recycling technologies and their feedstock requirements.

GROUP 1 INVESTMENT SIZE $

MECHANICAL FIBRE-2-FIBRE RECYCLING

Process
Shredding or tearing of textile to convert it back to a fibre to be re-spun into new yarn

Feedstock
Type: Typically cutting waste (knit waste often preferred) and hard spinning waste (yarns),
Chemical compliance is a high priority
Composition: 100% Cotton and wool /cashmere
Colour: Single segregated colours

GROUP 2 INVESTMENT SIZE $

THERMO MECHANICAL RECYCLING

Process
Melting of textile into a pellet or flake, sometimes then extruded into staple fiber

Feedstock
Type: Spinning, fabric mill and RMG waste
Composition: 100% Polyester and other pure synthetics
Colour: White, or any other colour mixed together, Sensitivity to coatings and fabric finishes

INDUSTRIAL SYMBIOSIS

Process
Non-wovens: multiple applications (automotive, carpet, mattress), insulation & construction, stuffing /paddings, Industrial wipers, coarse yarn for mops, low grade home textiles

Feedstock
Mixed blended textiles low quality feedstock.

GROUP 3 INVESTMENT SIZE $$$$-$$$$$

NEW GENERATION MECHANICAL RECYCLING

Process
Same process as fibre-2-fibre recycling but with improved processes and approach to achieve high quality and finer yarns

Feedstock
Type: Typically cutting waste (knit waste typically preferred) and hard spinning waste (yarns)
Composition: 100% Cotton and wool /cashmere
Colour: Single segregated colours

REGENERATIVE/ CHEMICAL CELLULOSIC

Process
Converting cotton waste back into a cellulosic pulp ready to enter the viscose/lyocell value chain

Feedstock
Type: Any textile waste often cutting waste and hard spinning waste (yarns) preferred
Composition: 100% Cotton or cotton rich
Colour: Any single colour, sensitivity to dye stuffs and optical brighteners

GROUP 4 INVESTMENT SIZE $$$$-$$$$$

REGENERATIVE/ CHEMICAL SYNTHETICS

Process
Converting a synthetic fibre back into a virgin grade pellet or flake

Feedstock
Type: Any textile waste
Composition: 100% pure mono fibre e,g 100% Polyester, 100% Nylon tec
Colour: White, or any other colour mixed together. Sensitivity to coatings and fabric finishes

REGENERATIVE/ CHEMICAL BLENDED

Process
Converting Poly cotton blended textiles back into a cellulosic pulp and PET pellet/flake

Feedstock
Type: Typically cutting waste (knit waste typically preferred) and hard spinning waste (yarns)
Composition: Poly cotton blends can accept some contamination e.g. elastane and Viscose etc
Colour: Any mixed colour Sensitivity to coatings and fabric finishes

OTHER

EXAMPLE 1: RECYCROM
Process
Recycling textile waste into a recycled dye pigment

Feedstock
Type: Cellulosic textile waste can contain small % of contamination inc. elastane. Segregated by single colour shade

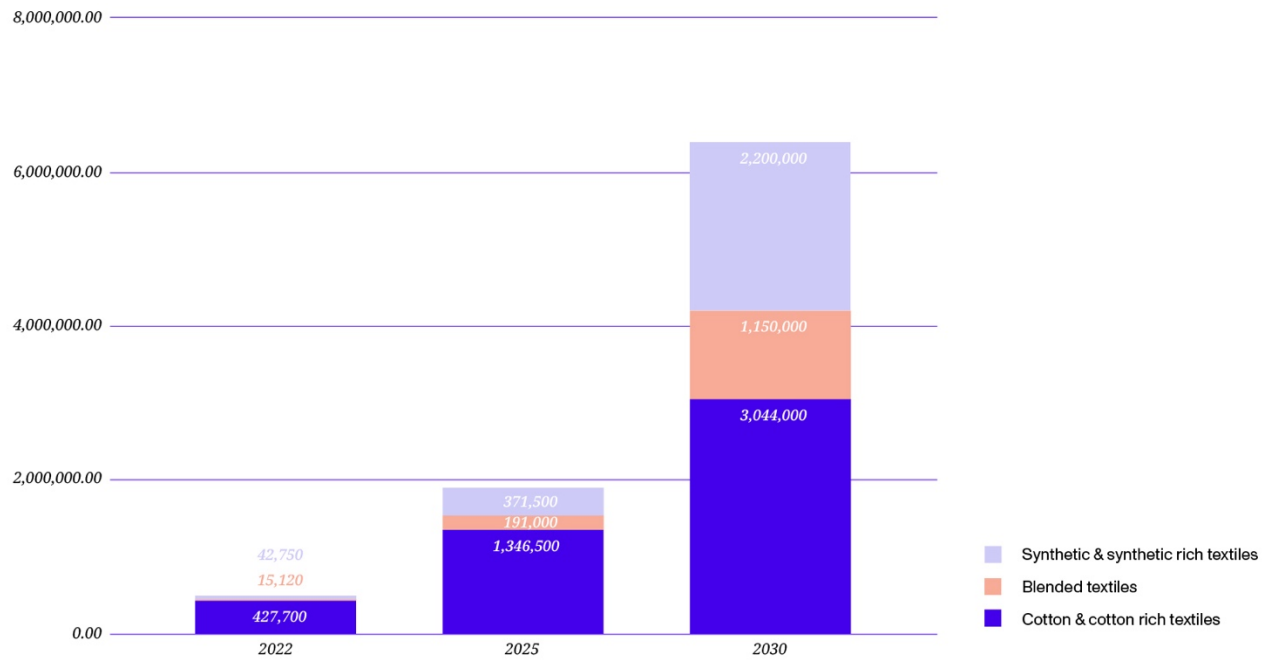
EXAMPLE 2: NATURAL FIBRE WELDING
Process
Improving the quality and strength of mechanically recycled yarns

Feedstock
Mechanically recycled cellulosic yarns.

Matchmaking of Bangladesh waste streams to recycling technologies

The most recyclable and therefore the most in demand textile waste today is 100% cotton and cotton rich as it is the preferred fiber for the active recycling technologies (mechanical fibre-2-fibre and regenerative cellulosic recycling). As new technologies emerge and scale, specifically ones that can process blended textiles like polycotton, we will gradually see an increase in use cases for a wider variety of textile waste streams. Using the CFP recycler profiles and the Reverse Resources database of over 200 recycling technologies we can begin to predict the global scaling of recycling technologies and the increase in feedstock demands and types over the coming 10 years.

ESTIMATED INSTALLED CAPACITY OF GLOBAL FIBRE 2 FIBRE RECYCLING (TONS/YEAR)



The graph above depicts the projected evolution of global installed fiber-to-fiber recycling capacity based on current demand and market intelligence from the Reverse Resources platform and network. These projections are based on current and short-term market conditions and are subjected to changes.

It can be seen from the graph that an exponential growth in installed capacity, and therefore demand, will occur in the next 10 years. Cotton will remain the central fiber in feedstock demands thanks to important recycling investments reaching maturity and hence requiring large volumes of cotton waste as well as the emergence of first industrial-scale chemical cellulosic recycling technologies.

Later, when more poly-cotton and synthetic regenerative recycling technologies are fully commercialized, the demand for other synthetic and synthetic-rich textiles will also increase; potentially overtaking cotton demand from 2030 onwards to better represent the true global fibre breakdown.

As such, Bangladesh is uniquely placed to benefit from this shift towards circularity. Today and over the next decade, Bangladesh will be consistently producing the highest volumes of the most recyclable textile waste creating a competitive advantage for the country. The current 100% cotton and cotton-elastane waste generated every year alone could satisfy **78%** of the 2022 global feedstock demand for cotton & cotton-rich fibers and **25%** of the same demand in 2025.

For a healthy textile recycling eco system it is important to have a combination of recycling technologies for fibers to flow through. With the increasing awareness of the market opportunity, in the long term there is a risk of an inordinate investment being made into old technologies, mainly such as mechanical fibre-fiber recycling. This could lead to an unbalanced over-demand for cotton waste, and cotton fiber could become too short and degraded to continue to flow through these recycling plants. As such it is important to also attract regenerated cellulosic, blended, and synthetic recyclers to Bangladesh to ensure effective circulation. The next diagram of how textile waste from a simple cotton t-shirt could be continuously recycled and circulated within an effective recycling eco system.

Regardless of capability to recycle mono materials or blends, all recyclers seek to establish long term stable feedstock routes for their plants and the building of sourcing routes is a unique challenge for the emerging recycling industry. In Bangladesh, the high-quality post industrial waste is currently flowing through informal waste handling networks where price stability and contamination levels are hard to control. If formal and traceable feedstock sourcing routes can be established, Bangladesh will become a very attractive location for many emerging chemical recycling technologies to build some of their first industrial plants.

POTENTIAL TEXTILE FIBRE CIRCULATION IN A CIRCULAR INDUSTRY

Product	*Textile waste*	*Recycling process*	*New textile*
Cotton T-Shirt	100% Cotton knit waste	Mechanical Fibre-2-Fibre Recycling	New yarn blended with virgin cotton
Cotton twill trousers	Cotton elastane textile waste	Regenerative Cellulosic Recycling	New cellulosic pulp
Lyocell T-shirt	100% lyocell	Mechanical Fibre-2-Fibre Recycling	New yarn blended with cotton & polyester
Lyocell and cotton sweatshirt	Cotton lyocell textile waste	Regenerative Cellulosic Recycling	New cellulosic pulp
Lyocell polyester & cotton shirt	Lyocell polyester textile waste	Regenerative blend recycling	New cellulosic pulp and PET Chip

Continued...

Recycling processes will always observe a certain level of material loss during their processes and therefore some of these materials may not get made into new textile

Overall cost estimation of establishing a recycling plant in Bangladesh

For the recycling industry in Bangladesh to be robust and comprehensive, it is crucial for a combination of different recycling technologies to be implemented.

Mechanical cotton fiber 2 fiber recycling is the most advanced and active in Bangladesh. But there is massive scope for not only adding more capacity within this category but also to significantly improve quality via new technology. For example, there are some facilities in Bangladesh which produce good quality recycled yarn but there is an opportunity to manufacture exceptionally high-quality yarns like ring spun yarns as well. And so, to facilitate this, additional investment in new generation mechanical technologies is as important as increasing the current traditional mechanical recycling capabilities in Bangladesh. These new generation mechanical recycling technologies are also aptly suitable to the Bangladesh market in terms of feedstock availability and ability to absorb the recycled products manufactured by these recyclers within the existing product mix of the domestic RMG sector.

Furthermore, apart from this, investing in regenerative (chemical) recycling technologies would also be very beneficial for Bangladesh. The existing regenerative (chemical) recycling technologies are globally located and are in early stages of commercialization. But as specified in the previous section, the chemical recycling technologies are projected to grow significantly in the upcoming years and will be crucial to facilitate the global fashion industry's recycling initiatives. Therefore, investing in these technologies is pivotal in the creation of a well-rounded recycling ecosystem.

Economics of investing in these recycling technologies are dependent on factors like the type of recycling technology, installed capacity, and region of establishment. We interviewed CFP recycler participants to gain rough estimations of the overall cost of establishing a recycling plant:

Regenerative(chemical) recycling plant: The scale of a chemical recycling plant could range from a demo/ pilot sized facility to a large scale industrial plant. The overall cost estimated for

a) Demo sized facility with a capacity of under 5,000 tonnes per year would be approximately under USD $20 million
b) Industrial scale plant with a capacity of above 50,000 tonnes per year would be approximately over USD $100 million

Mechanical recycling plant: Below is an estimation of a typical mechanical recycling plant based on local benchmarks in Bangladesh

a) it would approximately cost USD $1.5 - $2 million to set up a tearing/shredding facility
b) if spinning capabilities are to be added, then additional cost of around USD $3-$4 million is estimated to be incurred

Considering that Bangladesh has some mechanical recycling capabilities, we estimate on the basis of local benchmarks that a mechanical recycling facility would take roughly five years to provide a return on investment. For chemical recycling, however, there are very few operational plants globally and those that are established, are at an early stage where quantifying the potential duration before investors can earn a return on investment is difficult.

Finally, we also observed that the ideal locations for a recycling plant to be established in Bangladesh are Dhaka and Chittagong. These two cities are quite densely concentrated with textile facilities and so despite their limitations in logistical infrastructure, make for the best options to situate a recycling plant.

Preconditions to enable growth of post industrial fiber-2-fiber recycling in Bangladesh: learnings from the Circular Fashion Partnership.

The previous chapters have presented the huge untapped recycling potential in Bangladesh and the immense benefit in valorising textile waste closer to manufacturing source. This chapter now places the spotlight on the requirements of recyclers, actions needed from relevant stakeholders that would enable them to acquire investments and accordingly build the ecosystem in Bangladesh.

Priority needs of recyclers

Government support in

- Setting up local entities with reduced bureaucracy and red tape
- Availing schemes that facilitate implementation of global recycling technologies in designated areas such as the EPZs
- Securing and registering land for the facility
- Permits to construct plant and building
- Avail subsidies on taxes, secured financing, green energy and water supply
- Other relevant incentives such as VAT reduction/exemptions
- Licenses, certificates and leasing arrangements (in case collaboration between domestic entities and global recycling technologies)
- A clear guide to aid in understanding any environmental and safety legislations, restrictions, regulations, and rules concerning construction of recycling plants, including wastewater drainage and utility instalments

Operational Needs

- Partnerships or long term agreements with companies who manufacture required ingredients/other raw materials
- Recruit and train local skilled manpower
- Access to
    - market insight on textile waste volumes and availability
    - establishing long term stable textile feedstock supply in the quality, volumes, and price desired
    - green energy

- clean water supply and effluent treatment plants

Business strategy needs

- Establish supply chain partnerships with companies operating in the same value chain
- Offtake agreements with brands/manufacturers

Financing Needs

- Patient capital from impact focused investors
- Access to more affordable working capital

Actions by key stakeholders to facilitate a supportive environment for recycling in Bangladesh

Typically, brands are the entities with the most power to influence the direction of the industry and policy. But given the complex interdependencies between all industry stakeholders, collaborative and simultaneous effort is required by all parties involved. Only by working in consortium will the endeavour to foster a recycling industry be brought to fruition. The following criteria are essential in creating a supportive environment for a thriving recycling industry. In fact, these would also be critical to attract the investment needed to scale recycling capacity in the country.

Manufacturers:

- Improved waste handling and segregation of textile waste in factories/at source[11]
- Enable traceability by digitising waste streams
- Fair pricing of waste to promote competitively priced recycled yarns

Benefits: By segregating waste and enabling traceability, manufacturers can provide proof of origin and visibility of waste flows for recyclers to better control their feedstock sourcing routes and brands to steer textile waste streams to efficient recycling. Manufacturers can also create opportunities to establish agreements and access recycled fibers, yarns and textiles at commercially viable prices.

[11] Segregation should be based on the sourcing specifications of high value recyclers and does not need to be carried out at brand purchase order level

Waste handlers:

- As providers of key services like quality control, logistics and storage, a formalized waste handling network is fundamental

Benefits: By maintaining the trace of textiles, waste handlers can demonstrate compliance and maintain trust in the value chain. Waste handlers can secure long term stable business opportunities and have access to higher value recyclers whose contamination requirements they might not have previously been able to meet without the waste segregation at source.

Brands:

- Encourage waste segregation amongst their supply chain partners
- Agree to off-take commitments, to create demand for recycled materials
- Participate in collaborative, industry-aligned policy engagement activities to drive regulatory and legislative incentives and remove market barriers
- Adopt technologies for tracing and digitisation of waste streams to create transparency in origin, journey, and actors, and enable quality control and involved parties
- Empower supply chain partners to formalize waste flows by allowing ownership and earnings from waste to remain with manufacturers
- Produce clothes with fiber compositions suitable for the local recycling eco system

Benefits: Access to high quality competitively priced recycled textiles, control of waste, proof of closed loop supply chains. Traceability, digitalisation of material flows, and data capture will allow brands to measure baseline and KPIs and have insight for better systemic planning of recycling and material flows.

Investors:

- Structure investments such that impact is prioritized and maximized
- Provide patient capital that will allow investees to undertake and tackle complex unavoidable risks in challenging markets

Benefits: Investors will be able to drive circularity and demonstrate social impact facilitated via investments made in innovative emerging technologies.

Government:

- Provide well- structured thorough support packages and schemes to attract and implement global recycling technologies
- Collaborate with consortia to address needed policy reform
- Appoint a custodian Ministry to champion circularity across different governmental associations

Benefits: As the textile and apparel industry of Bangladesh constitutes a huge percentage of the country's economy, expanding its textile recycling capabilities makes for a very compelling strategic move to further boost its economy. This will not only allow the country to develop an allied sector of the textile industry but also stay relevant in the transition to a circular economy.

All the aforementioned activities, with each stakeholder, are being driven within the scope of the CFP by utilizing the Reverse Resources platform and tools. The Reverse Resources platform has facilitated collaboration across a network of players by aligning their interests in a circular value chain. This has enabled the CFP to demonstrate a successful business case to foster a thriving and investable recycling industry in Bangladesh.

Positive social and environmental impact as a result of increasing recycling capacity in Bangladesh

Bangladesh's transition towards circular supply chains not only has the presented economic benefits but also significant social and environmental benefits. Increasing the domestic recycling capabilities is key to decrease the country's apparel and textile industry's environmental footprint. Making new clothes with recycled textile fibres reduces the production of virgin cotton, oil, or wood, thus saving thousands of litres of water, decreasing land use, reducing waste, plastic pollution and emissions of both CO2 and chemicals. Which in turn also helps brands to deliver on their promises to reduce their negative environmental impact.

For example, if just half of the 100% pure cotton waste from Mill and RMG processes (approx. 100,000 tonnes) was mechanically recycled and made into a 50% recycled cotton yarn it would save 490,000 tonnes of C02 and 192,000 litres of water[12]. Though the true environmental savings would be significantly larger when regenerative recycling technologies get implemented.

This reduced carbon footprint for clothing made in Bangladesh could be used in the future within Carbon Credit systems or to avoid extra tax on non-sustainable textiles, which is expected as European legislation evolves.

When the domestic recycling capacity grows, Bangladesh will be able to limit the volume of fibre loss to other countries and benefit from the economic activity/ industry of recycling the waste within the country. In addition, this would also reduce the country's dependence on virgin materials such as cotton, PET chips, and MMCF. The existing and growing demand for recycled textiles could be met from within the domestic industry, limiting the importation of recycled materials for apparel production. With the elimination of long-distance logistics, there will not only be a reduction of carbon emissions but also costs. Enabling Bangladesh manufacturers to offer competitively priced sustainable products to their brand customers.

A key part of recycling, which is often overlooked, are the very important waste handling networks. To scale circular supply chains, waste handlers are critical players. Providing valuable services such as logistics, accumulating stock and storage, quality checking preparation and cleaning. Compliance during this stage of the supply chain will become imperative as waste handlers need to adhere to brands and recyclers' corporate social responsibility codes of conduct. The existing informal waste handling

[12] 50% recycled cotton 50%Eco Vero Viscose (based on Cyclo Yarns LCA analysis calculated by MADE2FLOW, compared to the equivalent yarn in the most commonly produced virgin cotton yarn produced in Bangladesh.

network will need to be formalized to support the scaling of the domestic recycling industry. This will in turn generate more employment opportunities with better wages and waste worker rights for the residents of Bangladesh. Transforming the informal jobs into formal ones, would be immensely impactful to foster social inclusivity in the largest sector of the country and distribute value amongst all involved. These formal waste handling networks would also facilitate transparency and traceability in circular value cycles. As more formal structures get infused into the supply chains, accurate and relevant data can be captured to monitor companies' compliances such as- working conditions requirements for workers and chemical background of textiles.

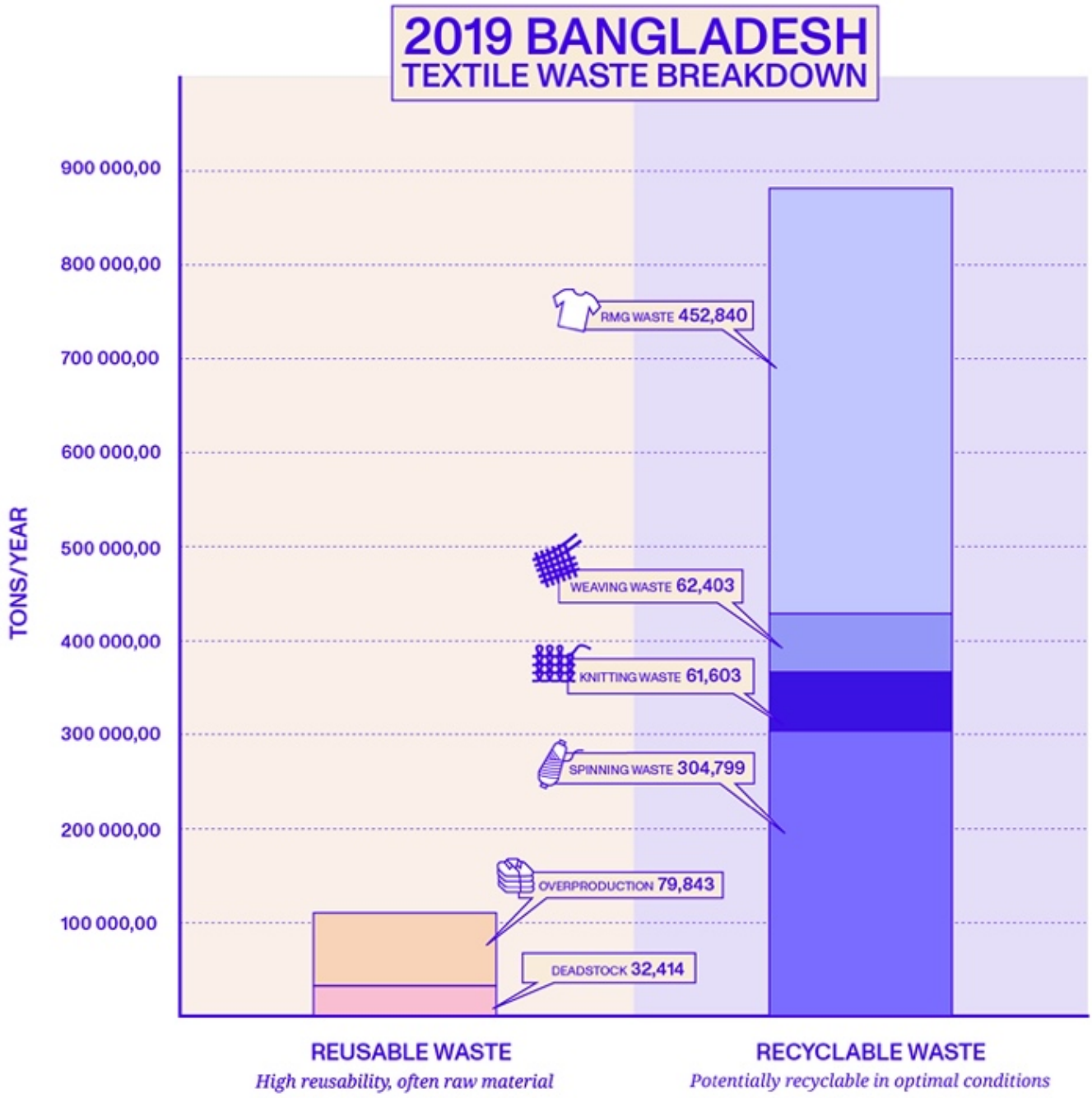
These social and economic benefits derived from increasing the domestic recycling capacity will allow Bangladesh to gain a massive competitive advantage. The apparel and textile industry of the country would be able to go beyond its tag of being a destination for just high volumes of low-priced garment/textile production. It can become a country that has in-built sustainability and circularity within its supply chains- a characteristic that brands are now actively seeking in their regions of production.

Conclusion

As emerging recycling technologies gradually scale over the next five years, Bangladesh has a window of opportunity to gain a significant competitive advantage. With the global fashion industry moving towards circularity, the current business model of the country's apparel and textile industry runs the risk of becoming outdated in the upcoming decades. With most recycler technologies currently seeking 100% cotton and cotton rich textiles, Bangladesh is a highly lucrative destination for not just sourcing but also recycling textile waste. If Bangladesh can take decisive steps towards increasing their domestic recycling capabilities, the country can reinvent themselves to stay relevant to the sustainability and circularity demands made by the industry stakeholders and consumers. When emerging recycling technologies reach commercialization, after five years, other countries would begin to invest in increasing their respective domestic recycling capabilities. By then Bangladesh would have already acquired a significant head start on establishing circular value cycles within their domestic industry. Therefore, developing a strong domestic recycling industry offers a multiplicity of opportunities and benefits for the country of Bangladesh.

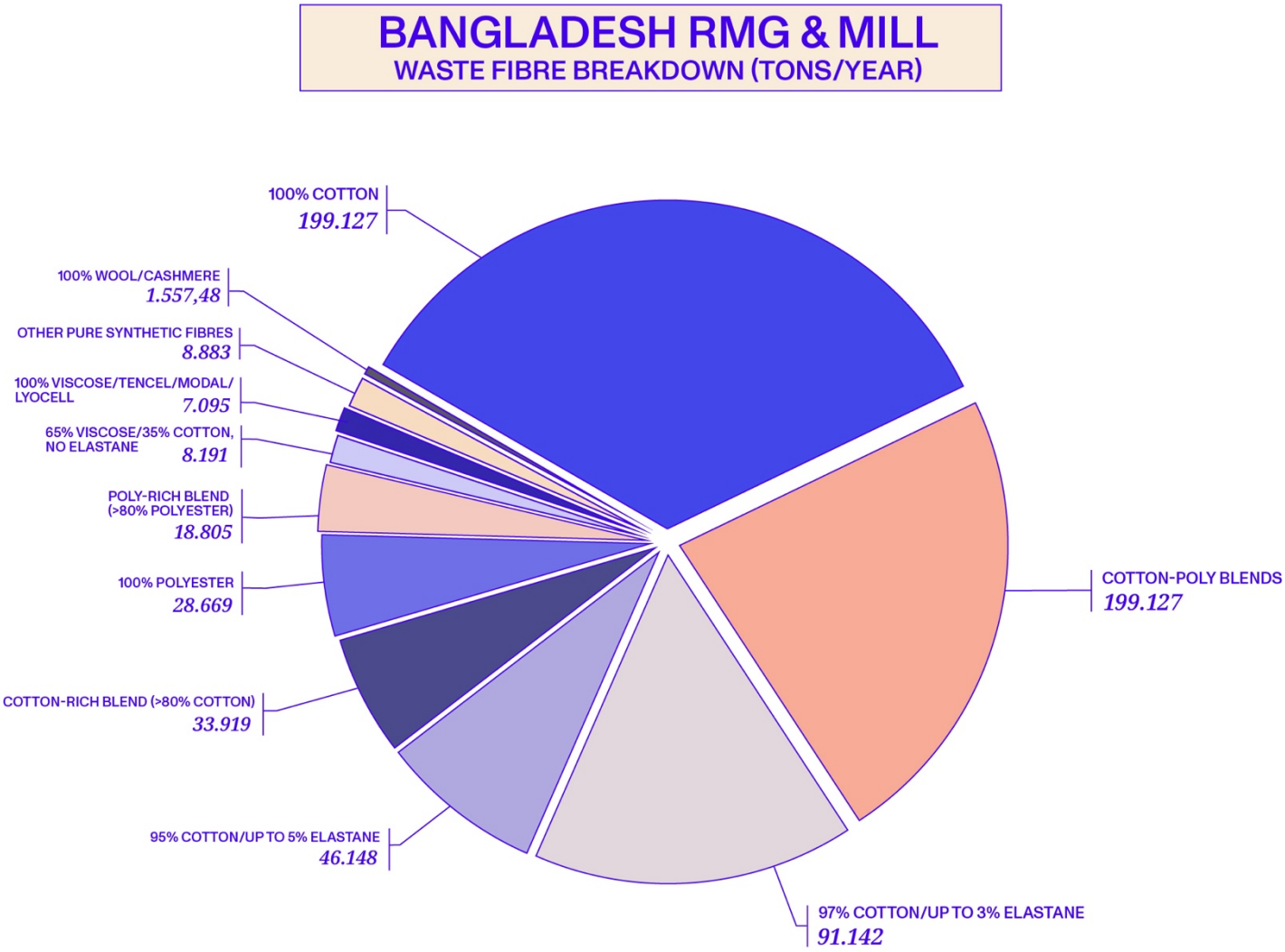
APPENDIX

Appendix A

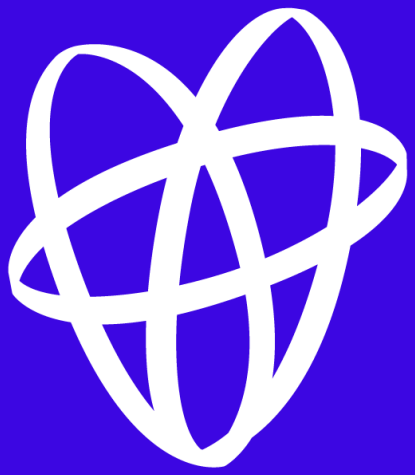


The waste volumes were estimated based on volumes of raw material imported and transformed in Bangladesh from the UN Comtrade Database and industry data collected from over 1,500 factories through the Reverse Resources network. A raw material waste percentage was calculated and applied to volumes of raw material transformed at each process to obtain an estimated yearly volume of waste generated.

APPENDIX B



In order to create fiber breakdown of the textile waste available in Bangladesh, we used data collected within the CFP from 10 brands and 128 factory waste profiles. We then applied waste percentage calculated by mills and RMG factories to estimate yearly volumes of waste by key composition (i.e., 100% cotton).



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