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UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

Circular textile value chains

Business case: Investing in advanced recycling technologies for fiber-to-fiber production in Egypt

The challenge

Pre-consumer and post-industrial textile waste, such as scraps, trimmings, and rejected materials from the manufacturing process, as well as unused fabric and materials discarded during production, pose significant environmental challenges. They also contribute to resource depletion and economic loss for the society.

A waste mapping survey commissioned by the United Nations Industrial Development Organization (UNIDO) found that Egypt's textile and clothing industry generated 212,000 tons of pre-consumer textile waste in 2019[1]. The majority of this waste could be channelled into textile-to-textile recycling and be re-introduced in the textile value chain.

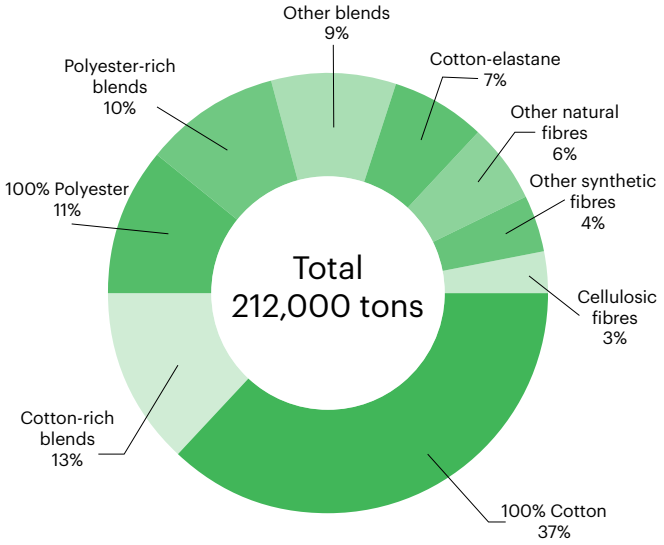
While recycling efforts in the textile supply chain are gaining momentum globally, many countries still struggle to establish efficient recycling value chains that can sort, handle, and repurpose pre-consumer and post-industrial textile waste into valuable and much-needed raw materials. Recycling, although not the primary option in the waste hierarchy of a circular economy, stands as a preferable alternative to waste-to-energy solutions. A new generation of technological innovations provides advanced solutions that can help valorize untapped resources of textile waste while adopting a more circular perspective to meet the rising market demand for recycled textile fibers.

The scope of the pilot project

In 2020, in close collaboration with the Ministry of Trade and Industry and the Ministry of Environment, UNIDO commenced the SwitchMed textile initiative under the MED TEST III project in Egypt, with the objective of promoting more circular value chains in the textile sector. Together with key expert organizations, UNIDO has undertaken an analysis of different scenarios to support the development of circular value chains for valorizing post-industrial and pre-consumer textile waste in Egypt.

A pilot project investigated the current state of innovation in mechanical and chemical recycling technologies. The aim was to understand technical constraints, feedstock requirements, investment and operational expenses, environmental impacts, and market perspectives relevant to the specific needs for the growth of textile recycling sector in Egypt. An assessment of the already existing recycling capacity in Egypt and the need for technological upgrade, provided the baseline for engaging with various technology providers and equipment manufacturers. The analysis considered also the environmental impact of alternative recycling technologies and their applicability to the pre-consumer textile waste stream generated by Egypt's textile and garment sector.

Generation of pre-consumer textile waste in Egypt by fiber



Source: Blumine/ Reverse Resources

Mechanical and chemical recycling are complementary solutions for processing Egypt's pre-consumer textile waste stream, with mechanical processes more suitable for natural or single-fiber waste while chemical processes could potentially provide a solution for mixed fibers, which make up 47% of the total annual pre-consumer textile waste stream that is generated in Egypt. Accordingly, the pilot explored the business case for investment in Egypt of two technology groups: state-of-the-art mechanical recycling equipment and innovative chemical recycling technologies.

Proper sorting, segregation, and classification of textile waste by fiber and colour is a fundamental prerequisite to an efficient, viable, and profitable recycling process, ensuring that only suitable materials are processed for recycling and the promotion of such practices is the key focus of another pilot within the SwitchMed textile initiative in Egypt.

Mechanical recycling for cotton and cotton-rich textile fibers

The mechanical recycling of textile waste is a well-established process focused on converting textile waste, using various techniques, such as tearing, shredding, or defibering, into new products through physical transformation while maintaining the molecular properties of the fibers.

Textile waste, whether pure fibers, like 100% cotton, or those with minimal contamination (usually 3-5%), or mixed fibers, are suited for mechanical recycling. Fibers that are 100% cotton are considered high quality and are mainly used in spinning for new yarns and, eventually, new clothes or other textiles, while mixed fibers are of lower quality and can only be valorized for nonwoven products like insulation and mattresses.

1 Textile waste mapping in Egypt, Published by UNIDO 2022

The market for recycled cotton is rapidly expanding, with global production reaching 270,000 tons in 2021, marking a significant increase in its share of total cotton consumption to 4.5%[2]. Major brands such as IKEA, H&M, and Inditex are leading this trend by increasing their utilization of recycled cotton. For instance, IKEA leads with a 17% utilization rate, while H&M follows closely at 11%, aiming for a 30% target by 2025. Similarly, Inditex witnessed a remarkable shift from nearly zero recycled cotton usage in 2018 to 5.6% in 2022.

The shredding process during recycling can strain fibers, impacting their quality. Thus, ensuring recycled fibers meet quality requirements for their intended end-use demands appropriate equipment. The pilot project developed a business plan for investing in mechanical recycling line in Egypt to produce high-quality recycled cotton fiber for spinning.

The business plan reveals significant potential for profitability for this investment, with a payback period of less than five years. In Egypt, where over 50% of pre-consumer textile waste is cotton or cotton-rich, proper segregation could support the operation of **15 to 20 new mechanical recycling lines, producing 30,000 tons of recycled fiber annually.** Leveraging on insights from leading European equipment manufacturers and local stakeholders, **the estimated investment required for this objective in Egypt would range from €15 to €30 million.**

Chemical recycling for synthetic and mixed fiber textile waste

Nearly half of the pre-consumption textile waste produced in Egypt consists of mixed fibers, which are not suited for recycling through mechanical processes. Chemical recycling, a family of new and advanced technologies that can be applied to synthetic or cellulose-based polymers and polymeric blends, offers a promising avenue for handling synthetic and mixed fiber textile waste in Egypt. These advanced technologies can effectively process materials like polyester (Polyethylene Terephthalate or PET) and polycotton waste into rPET (recycled polyester). Additionally, other materials found in mixed fibers, such as those in polycotton, can be separated into rPolyefines for Polyethylene or Polypropylene production, cotton mass for cellulose extraction, among other uses. The main advantage of these processes is the possibility to recover a "virgin-like" fiber, suitable for various applications, including textiles, fashion, packaging, and other industries.

A review of different studies on Life Cycle Assessment (LCA) comparing the production of virgin polyester with the production of chemically recycled one was conducted as part of a pilot project. The study found that recycling existing polyester waste either mechanically or chemically is more environmentally favorable than producing virgin polyester or resorting to energy recovery through incineration. Although mechanical recycling is less harmful to the environment, chemical recycling methods are more suitable for processing mixed fibers like polycotton waste.

In the field of chemically recycled textile fibres, the first industrial-scale plants are commencing operations in Europe, with more facilities expected to be operational starting in 2025. However, uncertainties persist regarding the array of proprietary technologies entering the market, particularly concerning operational and environmental costs. Therefore, comprehensive assessments of each technology's financial feasibility and overall impact are necessary in the country. This would require coordination between investors and technology providers, along with support from financial organizations and industrial zone authorities.

The current market conditions for rPRT are favourable. The global demand for recycled polymers is expected to increase significantly in the next 20 years and it is predicted that recycled polymers from new advanced chemical recycling technologies will grow from zero to nearly 56 million tons per year by 2040[3]. Currently, the capacity of installed chemical recycling technology is minimal, as many of these technologies are still in the process of development and scaling. According to McKinsey, over $90 billion of investments in chemical recycling plants worldwide are forecasted by 2040.

The pilot project revealed that **investments in advanced chemical recycling technology for Egypt's textile and garment sector would require substantial funding, ranging from €100 to 200 million.**

Egypt's abundant textile waste stream of mixed pre-consumer textile waste presents a significant opportunity for chemical recycling, offering benefits such as reduced carbon emissions and savings on imports of virgin materials. Although the investment in a chemical recycling facility in Egypt could enable the textile and garment value chain to handle a wider range of recyclable textile waste, including the removal of hazardous chemicals and impurities, there are still a number of uncertainties regarding the operational and environmental risks involved with investing in the new chemical recycling technologies, particularly their implementation at scale in emerging economies. These uncertainties encompass energy, water, and chemical inputs, potential climate impacts, and the global price point for financial viability.

> "There is a need to establish a modern textile recycling industry to serve the increased international demand for sustainable fibers"
>
> Mr. Hany Salam
> Board Member
> Egypt Textiles and Home Textiles Export Council

2 TextileExchange Dashboard. Retrieved November, 2023 from: https://mci.textileexchange.org/dashboard/
3 Peng Z., Simons T.J., Wallach J., Youngman A. (2022), Advanced recycling: Opportunities for growth. McKinsey & Company

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