التعاون الألماني
DEUTSCHE ZUSAMMENARBEIT

Implemented by
giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

The Hashemite Kingdom Of Jordan
Ministry of Industry , Trade and Supply

Ministry of Environment

Business Case 2: Mechanical Recycling for Industrial Symbiosis

Introducing Circularity as a Business Opportunity to Jordan's Ready-Made Garment (RMG) sector

BACKGROUND

The "Green Action in Enterprises" (GAIN) project, commissioned by the German Federal Ministry for Economic Cooperation and Development (BMZ) and implemented by the *Deutsche Gesellschaft für Internationale Zusammenarbeit* (GIZ) *GmbH,* works in close cooperation with the Ministry of Environment, the Ministry of Industry, Trade and Supply and other stakeholders towards the green industrial transition by introducing sustainable use and management of energy, water, and waste in the sector.

In Jordan, the garment manufacturers at Al-Hassan Industrial Estate (HIE) generate 35 tonnes of solid textile waste per day, which is being disposed of in municipal landfills. This textile waste is being treated as a cost factor harming Jordan´s fragile ecosystem. However, textile waste also does involve numerous opportunities and could be recognised as a valuable resource on regional and international level on the long term. Based on collected quantitative and qualitative data, a list of circularity options was explored. **5 business cases** have been developed which provide marketable solutions for textile and garment waste minimisation, prevention, and revalorisation. The primary purpose of these business case is to identify opportunities to minimise textile waste, including recycling, upcycling, and reuse measures for factories in HIE.

Business Case 1:	Investing in Material Efficient Technology and Software
Business Case 2:	**Mechanical Recycling for Industrial Symbiosis**
Business Case 3:	Mechanical Recycling for Fibre-to-Fibre Yarn Production
Business Case 4:	Chemical Recycling for Fibre-to-Fibre Yarn Production
Business Case 5:	Upcycling with Social Entrepreneurs

BUSINESS CASE 2 RATIONALE

The business case on **mechanical recycling for industrial symbiosis** focuses on the creation of an industrial symbiosis relationship. In such a relationship waste can be exchanged with other companies and sold to use it as a production input for other manufacturing processes (e.g. upholstery, insulation). This business case creates an additional stream of revenue for garment manufacturers. It further reduces the environmental burden imposed by landfilling the waste.

DESCRIPTION OF BUSINESS-AS-USUAL

CURRENT WASTE HANDLING PRACTICE

	Garment manufacturers in HIE generate around 35 tonnes of textile waste daily. The waste is collected in containers outside of their premises without separation based on textile type and colour. The waste is collected by a private contractor and transported to Al-Ekeider landfill.
	Currently, one garment manufacturer sends its quality rejects to a fluffing process (mechanical fibre separation) without sorting by colour and textile type (4 tonnes a day). The fluff is either used to produce cushions and quilts for employees or sold and exported to yarn manufacturers. The company gives this away free of charge. Hence, no VAT is paid on the fluffed waste material.
	HIE hosts many other industries, including food, chemicals, pharmaceuticals, plastics, furniture, construction, packaging and paper industries. So far, no material exchange routes are formally explored or implemented within HIE.

COSTS OF CURRENT WASTE HANDLING MODEL

- Waste pick-up and landfilling costs: 4 JOD per ton of textile waste

FINANCIAL RISKS OF CURRENT WASTE HANDLING MODEL

- Penalties for noncompliance with current waste management regulations
- Increasing costs of waste handling and transport, e.g. closing of Al-Ekeider landfill for textile waste
- Costs of compliance with export market laws (e.g. EU supply chain due diligence)
- Opportunity loss due to high prices of raw materials which is being wasted

DESCRIPTION OF BUSINESS CASE 2

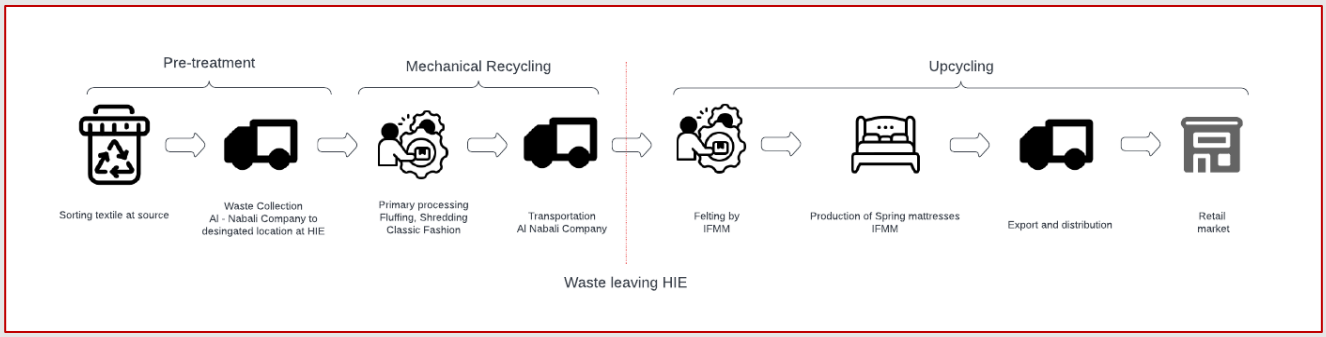
NEW WASTE HANDLING PRACTICE

This business case proposes to exchange waste materials with other companies outside HIE to establish industrial symbiosis relationships. Two material exchange routes have been identified below. However, **a change of the customs regime is essential** to incentivize sales of waste to local manufacturers.

1) Conversion into Felt

If waste is sold into the local market, it can be converted into felt which is used as upholstery for furniture and mattresses after processing (fluffing/shredding/compression). As indicated by a local furniture producer, the amount which can be fed into felt after the fluffing process is approx. 15 tonnes per day. Part of the felt will be used by for mattress production and the rest can be sold to other industries in the local and regional markets. The composition of the processed fibre will not be critical. One company in HIE has a fluffing machine with a capacity of approx. 4 tonnes a day and in order to reach 15 tonnes per day, the purchase of a second machine

might be required. The textile waste from all companies can be sent to a local company at HIE for shredding, fluffing and compression at a Capital expenditure (CAPEX) of 105,000 JOD. Around 50 workers should be hired for the collection, sorting and operation of the machines at an operational cost of 200,000 JOD per year, not including packaging and porters.



2) Selling Waste Using Online Platform

Selling textile waste to mechanical recycling companies in other countries (e.g. Turkey, China, Saudi Arabia) using an industrial symbiosis platform. By using an online platform such as https://reverseresources.net/, textile waste can be sold to third party (mechanical recycling) companies in other countries

The implementation of these pilots requires research on material characteristics and their processing for manufacturing and products of different industries in and outside HIE. **It must be noted that selling waste outside HIE requires a custom policy change to decrease/waive the sales tax**. Furthermore, new product creation requires the development of product/process prototypes that integrate textile waste into their making. Ideally, a new value chain link is established, including the collection and sorting of textile waste as well as the mechanical recycling process. More in-depth layouts of the possible value chains suggested are mentioned below.

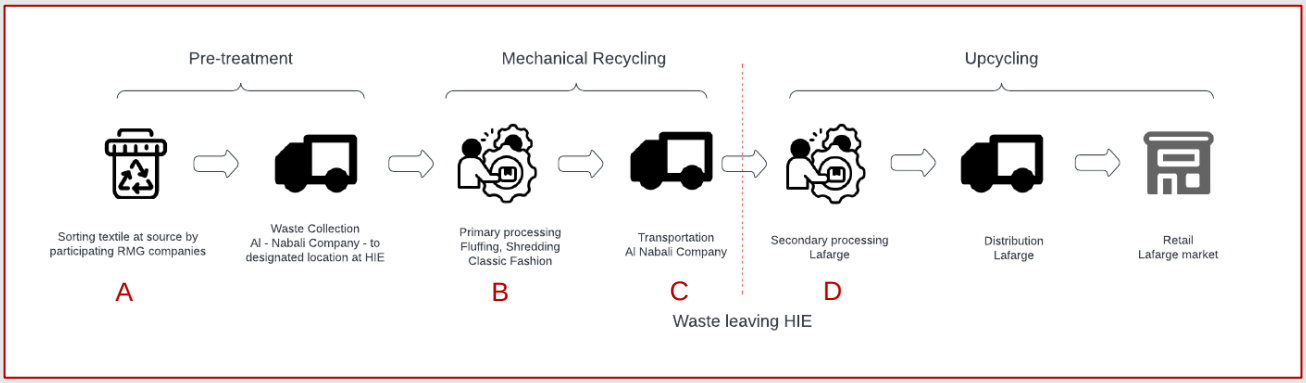
Possible new value chains to be established:

A. **Pre-treatment**: collecting textile waste and separating it by type, colour, etc. This can be implemented by garment companies at source or by the waste transportation company.

B. **Shredding and fluffing**: sorted waste will be sent for shredding and fluffing. This process already exists at one company with a capacity of 4 tonnes per day.

C. **Transportation of fluff for felting**: This step may be implemented by the waste transportation company at HIE.

D. 1. **Converting** the fluff to felt rolls using a newly installed production line.



BENEFITS FROM MECHANICAL RECYCLING FOR INDUSTRIAL SYMBIOSIS

- Additional revenue stream from selling around 30 tonnes of textile waste to other industries as production input.
- Reduced service costs for waste pick-up and disposal.
- Promotion of sustainable product and process innovation at HIE.
- Improved production efficiency for sectors and companies participating in material exchange.
- Job creation in operating logistics and infrastructure to exchange waste, and through the establishment of new value chains.
- Improved compliance with customers' and national environmental requirements.
- Improved access to international markets (EU, USA) due to implementation of circular economy measures in production processes.
- Decreased CO_2 emissions and soil pollution due to less landfilling.
- Efficient use of resources (utilising waste as production input).

For the purposes of simplicity, it has been assumed that the amount of waste will be absorbed equally by felt and concrete production (50:50 division)

	Value per unit	Number of units	Total annual benefit
For the garment manufacturers			
Cost savings on textile waste	4 JOD	30 tonnes per day	43,800 JOD
Revenues for textile industry from selling waste for felting Price of fluff is calculated based on price of felt in the market [1]	90 JOD	15 tonnes per day	492,750 JOD
Sales tax - VAT (16%) for fluff sold as felt	-	-	-78,840 JOD
Revenues for textile industry from selling waste to construction companies	2.55 JOD per cubic meter [2]	15 tonnes – 10.7 cubic meters [3] per day	9,959 JOD
Sales tax – VAT (16%) For fluff sold as concrete fibre	-	-	-1,593 JOD
CO2 emissions avoided	5.19 Kg CO_2/kg mixed fabric [4]	155.7 tonnes CO_2 for 30 tonnes per day	56,830.5 tonnes CO_2
Landfill waste avoided	30 tonnes	365 days	10,950 tonnes
Total annual benefit	-	-	**546,509 JOD**

	Value per unit	Number of units	Total annual benefit
For the felt manufacturers			
Profit from selling felt (20% profit margin of 0.4 JOD per square meter)	0.08 JOD per square meter	15 tonnes – 15,000 square meters	438,000 JOD
Total annual benefit	-	-	**438,000 JOD**

[1] Based on the following assumption:
- Price of felt 0.56 USD/Square meter.
- Average profit margin on bulk finished goods is 20%, which means that cost of the felt would be 80% of the price =0.8* 0.56 = 0.45 USD/Square Meter
- Average cost of raw material is 30% of cost of finished goods, which means that the cost of the raw material = 0.3*0.45 = 0.13 USD / Square Meter
- Density of Recycled fiber felt is 1 KG/Square meter, which means that the cost of 1 Kg of fluff would be 0.13 USD which is 0.09 JOD. The cost of one tonne of fluff = 0.09 JOD* 1000 Kg = 90 JODs.

[2] Based on information of current price 3JOD/Cubic meters, assuming 15% reduction in price

[3] Based on average density of fiber (Acrylic, Polyamide, Polypropene, etc) used in reinforced concrete of 1.4 gm/centimeter cube source: http://www.reessanj.ir/book/Synthetic%20fiber%20production.pdf

[4] Source: https://www.researchgate.net/figure/ndustrial-carbon-footprint-of-textile-fabrics-in-this-study-kgCO-2-e-kg_tbl1_303634993

COSTS AND CHALLENGES

Costs required for the new business case may include:

- Costs incurred by higher sorting requirements
- Costs of implementing mechanical fibre separation
- Costs of further processing (e.g. processing of textile waste for use in concrete mixes)
- Costs for setting up infrastructure and transporting of waste
- Costs for research
- Costs for hiring skilled workers

Challenges:

- Customs and sales tax application
- Possible environmental impact from new manufacturing processes absorbing the waste as production input (e.g. energy consumption, GHG emissions, air pollution)
- Infrastructure compatibility challenges such as the availability of space and easy and quick transportation routes
- Local standards and specifications for new products
- Finding adequate customers
- Maintaining product quality across sectors

Capital and Operational Expenditure (CAPEX & OPEX)

Textile Industry

	Cost per unit (JOD)	Number of units	Total cost (JOD)
CAPEX			
Storage hangar structure	100 JOD per square meter	500 Square meters	50,000
Fluffing machine 5	35,000	1	35,000
Shredding machine	9,000	1	9,000
Compression machines	11,000	1	11,000
OPEX			
Land leasing	20 JOD per square meter per year	500 Square meters	10,000
Workforce – storage and sorting	4,000 JOD per worker per year	50 workers	200,000
Transportation	4 JOD per tonne	30 tonnes	43,800
Electricity	0.1 JOD/Kwh	75,920 Kwh	7,592
Total costs for first year	-	-	**366,392**

[5] See Annex 1 for machines' specifications.

Felting

	Cost per unit (JOD)	Number of units	Total cost (JOD)
CAPEX			
Felting line – Capacity 14 Tons per day	700,000	1	700,000
Land	96,000	1	96,000
OPEX			
Operational cost	249,000	1	249,000
Total costs for first year	-	-	**1,045,000**

Simple Payback Periods

Industry/Stakeholder	CAPEX (JOD)	OPEX 6 (JOD)	Annual revenues-after tax (JOD)	Simple payback period
Local garment manufacturers	105,000	253,000	466,076	9 months
Felting	796,000	249,000	367,920	3 Years

ENABLING FACTORS

1. The new national solid waste management framework requires the implementation of recycling and reuse measures to avoid the landfilling of waste.
2. There are several industries at HIE which might benefit from the textile waste as production input for their processes (e.g. furniture).
3. There is a bigger local market with the same industries across Jordan which might be able to absorb the whole amount of waste.
4. There are impact investment funds which may provide financial support in the form of loans and quasi-equity investments (Amam Ventures and EBRD).

Amam Ventures	Investments in impactful, commercially viable SMEs with a track-record, which identifies an expansion opportunity and need risk capital to grow. Investments through quasi-equity instruments are entrepreneurial friendly and fair. Tickets start at $250,000 up to $2million. www.amamventures.com/funding
EBRD (Green Economy Financing Facility)	Supports Jordan businesses to invest in high-performing technologies by providing financing through local participating financial institutions. ebrdgeff.com/jordan/wed-love-to-hear-from-you/

[6] Note cost of electricity consumption is not included.

IMPLEMENTATION ROADMAP

SHORT-TERM (1 YEAR)	KPI	Timeline	Cost Incurred
Build relationships with companies that could make use of the waste	2 Memorandum of Understanding signed	Y1 Q1	No
Identify usable waste materials	Usable waste material assessment completed	Y1 Q1	Yes
Assess feasibility of textile waste integration into other industries	Feasibility assessment on textile waste integration into other industries at or outside HIE conducted	Y1 Q2	Yes
Prototype development and product testing	Prototype and product testing conducted	Y1 Q4	No
Analyse and implement required government interventions, mainly the waiver of sales tax for circular-economy products	Reduction or waiver of sales tax implemented	Y1 Q4	No
Allocate and acquire initial investment	Initial investment secured	Y1 Q4	No

MID-TERM (2-3 YEARS)	KPI	Timeline	Cost Incurred
Invest in in-house waste separation and fibre separation processes (105,000 JOD)	Operating waste and fibre separation processes	Y2 Q1	Yes
Dedicate personnel to continuously drive waste separation and collection for resell (253,800 JOD per year)	Specialised staff in waste minimisation solutions hired	Y2 Q1 – Y3 Q4	Yes
Invest in (856,000 JOD CAPEX, 249,000 OPEX), install, and commission secondary processing at receiving party	Amount of waste absorbed by the local market	Y2 Q1 – Y2 Q4	Yes
Monitor economic and environmental performance of material exchange (profitability and waste landfilling reduction)	Monitoring & Evaluation Plan developed and implemented	Y2 Q2 – Y3 Q4	Yes

LONG-TERM (5 YEARS)	KPI	Timeline	Cost Incurred
Increase capacity to utilise waste and accommodate the industry growth (cost dependent on required increase in capacity)	% Increase in amount of waste utilised for upcycling	Y5 Q1	Yes

CONCLUSION

The business case "Mechanical Recycling for Industrial Symbiosis" has high potential in terms of creating economic value for garment manufacturers by selling the waste, provided that:

1. The local market can absorb the amount.
2. Financial barriers are addressed (e.g. customs, sales tax, access to finance).
3. Infrastructure is available.
4. The regulatory framework is conducive for circular-economy-driven product innovations.

Industrial symbiosis establishes material exchange routes between different industrial sectors whereby the waste of one manufacturer may be used by another sector as a process or production input. The infrastructure of HIE supports industrial symbiosis within the estate due to their proximity and available space for sorting and exchange. Outside HIE, the upholstery sector in Jordan can absorb large amounts of waste in the form of fluff. Additionally, during the Covid crisis, the prices of the conventional material used in upholstery has increased by up to 50%, which opens the local market for cheaper alternatives such as fluffed textile waste. The third option in this business case would be selling textile waste to mechanical recycling companies in other countries (e.g. Turkey, China, Saudi Arabia) using an industrial symbiosis platform.

This business case may initially be funded through capital provided by manufacturers, green financing facilities from private agencies and international banks (e.g. EBRD) or a mix of both. The business case should cover its own operational expenses later from sales revenues of textile waste.

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