TOWARDS A CIRCULAR ECONOMY IN LEBANON

JUNE 2020

ACTED

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Executive Summary

In light of Lebanon's compounding economic crises, ACTED has undertaken an extensive analysis to show how a Circular Economy presents key opportunities for growth and employment creation, while also addressing the critical problems of resource degradation and environmental contamination, which have been a major part of calls for reform and improved governance in the past year.

This report examines efforts underway in Lebanon to create economic opportunities via circular economic models, and various methods of engaging key stakeholders – solid waste management service providers, industry, retailers, policymakers and consumers – to make such opportunities a reality. The report also recommends policies and initiatives to expand sustainable waste management methods, to support best practice and to encourage innovation, to harness the substantial economic potential of this field.

The report characterizes the processing of waste products as a 'value-chain,' a series of opportunities to extract economic benefit from discarded materials. The materials concerned are bio-waste (including agricultural waste), e-waste (electronic equipment), plastics, paper, fabrics (clothing and textiles) and glass. The report concludes with recommendations for greater efficiency in the energy sector and for support to retailers in on-selling recycled products.

The report's analysis focuses on calculating efficiency dividends, cost recovery, economy of scale and employment opportunities within the Lebanese waste management and recovery sector. The discussion of each value-chain assesses the potential value that can be extracted from waste materials. Through trend analysis of comparable international best practice, the report indicates larger markets in which key Lebanese waste management industries can source or export goods at competitive rates.

The findings of ACTED's research draw attention to the economic and commercial viability of sustainable waste management practices, as well as to their environmental benefits.

Key Findings

The most substantial national benefits are likely to be gained in the agricultural and e-waste repair sectors. Introducing bio-digesters to recycle organic waste generated by agro-businesses, opening Lebanon to global Organic Produce markets and reforming Lebanon's Organic Produce sector are areas with high potential to contribute to economic development.

In the e-waste value-chain, introducing government regulation of the informal repair industry and sales of second-hand goods, establishing energy efficiency ratings for electronic goods to inform consumer choices, and facilitating third-party logistics to support repairs of electronic goods, are also likely to **generate employment opportunities, improve household cost savings and result in efficiency dividends** from extracting valuable metals from electronic circuits.

In the plastics, paper, fabrics and glass value-chains, technological innovations and national government regulation of recycling, accompanied by logistical support and technical training at the Municipal level, are likely to **create employment opportunities in particular regions while reducing waste and environmental destruction.**

Limited data availability made it difficult to estimate the number of jobs that could be created in the economy from investments in circular markets. However, using the 2011 report from ILO and UNDP "Green Jobs Assessment in Lebanon" as a guiding resource for growth in green jobs and the Circular Economy, **it is estimated that 2,900 new jobs could be created per year,** conservatively. The report estimated the number of green jobs as follows: **an estimated 5,333 jobs over 9 years in the renewable energy sector (including manufacturing), 900 jobs per year in the construction sector (according to Banque du Liban estimates), at least 1,040 new jobs with the introduction of environmental regulations and an additional 1,900-2,500 over 9 years in the waste management sector, and an estimated 1,600 jobs over 9 years in agriculture.** This does not include other potential opportunities within circular economies, such as manufacturing jobs in eco-friendly packaging, the repair economy, refurbishment etc. Thus, the actual gains to the economy are likely to be much higher than the conservative estimate provided here.

The report considers the potential of **cost recovery from material value**, with estimates for the highest potential (where sufficient data is available) as follows:

- Estimated 64 million USD cost recovery from e-waste
- Estimated 2.6 – 21.81 million USD cost recovery from paper waste
- Estimated 0.55 million USD cost recovery from beer bottles alone

In the waste management sector, **the cost of recovering and recycling waste in Lebanon is too high, making waste an unprofitable resource.** Most sorting facilities are not run with profitability as the main objective, and in models that ACTED explored, most cost recovery seems to be achieved through subsidizing waste collection and sorting, either through charging a fee for waste pick-up per household, or through payment of municipal fees funded through taxes. One of the biggest problems that emerged is the lack of organization in the sector, with the presence of many actors, a high level of competition and a notable lack of efficiency in logistics driving up the costs. **This sector overall lacks economy of scale, which increases**

processing costs. ACTED's findings therefore reinforce standing proposals that the waste sector should be organized into service areas, which are geographically-bound areas with efficient waste collection routes, larger processing facilities, and higher levels of automation to reduce costs. Moreover, the sector could benefit from further regulation to incentivize municipalities to treat waste and ensure it reaches a facility, instead of opting for dumping or landfilling. Based on findings from municipal-level assessment, it is recommended that considerations are made to prohibit public bins in order to facilitate treatment and sorting by improving feedback and accountability loops between residents/polluters and SWM services.

It should be noted that these estimations have been made from the limited data available, and **the actual value added to the Lebanese economy from proper waste recovery is likely to be much higher if systems can be set up to minimize leakages**. As many materials in these value-chains can be recycled or re-used many times or indefinitely, regional and local initiatives are likely to reinforce the benefits of national ones by reducing overall waste and sustaining economic activity in manufacturing and retail.
The report is based on extensive qualitative and quantitative research, in a field not previously investigated to this breadth or depth. No national-level data on waste categorization in Lebanon exists, in the public or private sectors, which limited the research in each value-chain to discrete regions and groups of industries. This report's primary data are therefore varied in nature and scope. However, extensive qualitative investigation into the available data – via Key Informant Interviews (KIIs), questionnaires with a high response rate, and Focus Group Discussions with key subject matter experts in the waste management sector, as well as trend analysis of best practice in markets accessible to Lebanon – has allowed ACTED to draw sufficiently robust conclusions, many applicable nationally.

These conclusions can inform a**dvocacy, programming and decision-making**, involving the following key stakeholders:

1) Government stakeholders responsible for regulatory reforms; contractors managing waste management systems;
2) Private sector industries that design and manufacture products (both from recycled and virgin materials), especially packaging manufacturers;
3) Collection, sorting and recycling agencies, including private companies and Municipalities;
4) Repair and redistribution actors who keep products in the economy and support re-use (mainly for electronics, furniture and fabrics);
5) Agricultural sector actors such as farmers, food processing industries and cooperatives;
6) Retail shops and Food and Beverages industry entities.

Given the complexity of reforming market systems, this report also will serve as a basis from which further in-depth analysis can be done within the specific waste streams, to design programs for particular products, areas or stakeholders.

Research Objectives and Methods

1.1 Objectives

This report presents the concept of a Circular Economy as a sustainable development pathway in Lebanon, and identifies opportunities for investment and employment in a new industry of waste-reduction.

A Circular Economy recycles, re-uses and repairs used products, to extract more value from their materials and reduce waste. A Circular Economy creates a 'closed loop' system of value, involving technical and logistical processes that can sustain a large workforce, while providing services and new products to support the wider economy.

This report presents case studies of best practice in value-extraction in the fields of recycling and waste management, and specific opportunities for innovation that can benefit the Lebanese economy. The report illustrates existing small-scale pilots, policies and advocacy efforts that are already underway in Lebanon, and presents evidence of their potential to expand into a true industry that offers the Lebanese new jobs, skills and livelihoods, while stimulating economic growth. The report also investigates methods for developing the innovative programs that are needed to build a Circular Economy in Lebanon.

1.2 Research Questions

This report is the result of extensive research, consultation and data-collection, seeking answers to the following questions:

1. Who are the main actors working in the Circular Economy?
2. What types of activities are these actors engaged in?
3. What resources are they using and what outputs are they producing?
4. What are their limitations for growth/expansion?
5. What policy frameworks/incentives are needed to improve the circularity of a Value-Chain?
6. What employment opportunities are available in a Circular Economy?

The diagram overleaf (Figure 1) presents the conceptual framework that shaped the investigation of this subject of this report and informed its recommendations. The research was centered on assessing the 'wins' from implementing Circular Economy initiatives in Lebanon. These 'wins' are organized into three categories: Environmental Wins, Social Wins and Economic Wins. The framework was designed to assess the inflows (inputs) and outflows (output) of materials, and to identify how their re-use or recycling can lead to 'wins' in each category.

1.3 Summary of Methodology

ACTED's recommendations are based on quantitative and qualitative data collected from a wide range of sources. There is no national-level data in Lebanon, in public institutions or the private sector, quantifying recycling or the economic re-use of materials. Neither do national industries keep systematic macro-level records of their use of materials. Rather, data and subject-matter expertise are highly localized at the micro-level, confined to the records of single organizations (Municipalities, NGOs, private companies) and the personal knowledge of individuals. To gain a robust and reliable dataset from these highly diverse, dispersed and distinct sources, a method was needed that maximized the likelihood of obtaining a broad sample with achieving depth of insight.

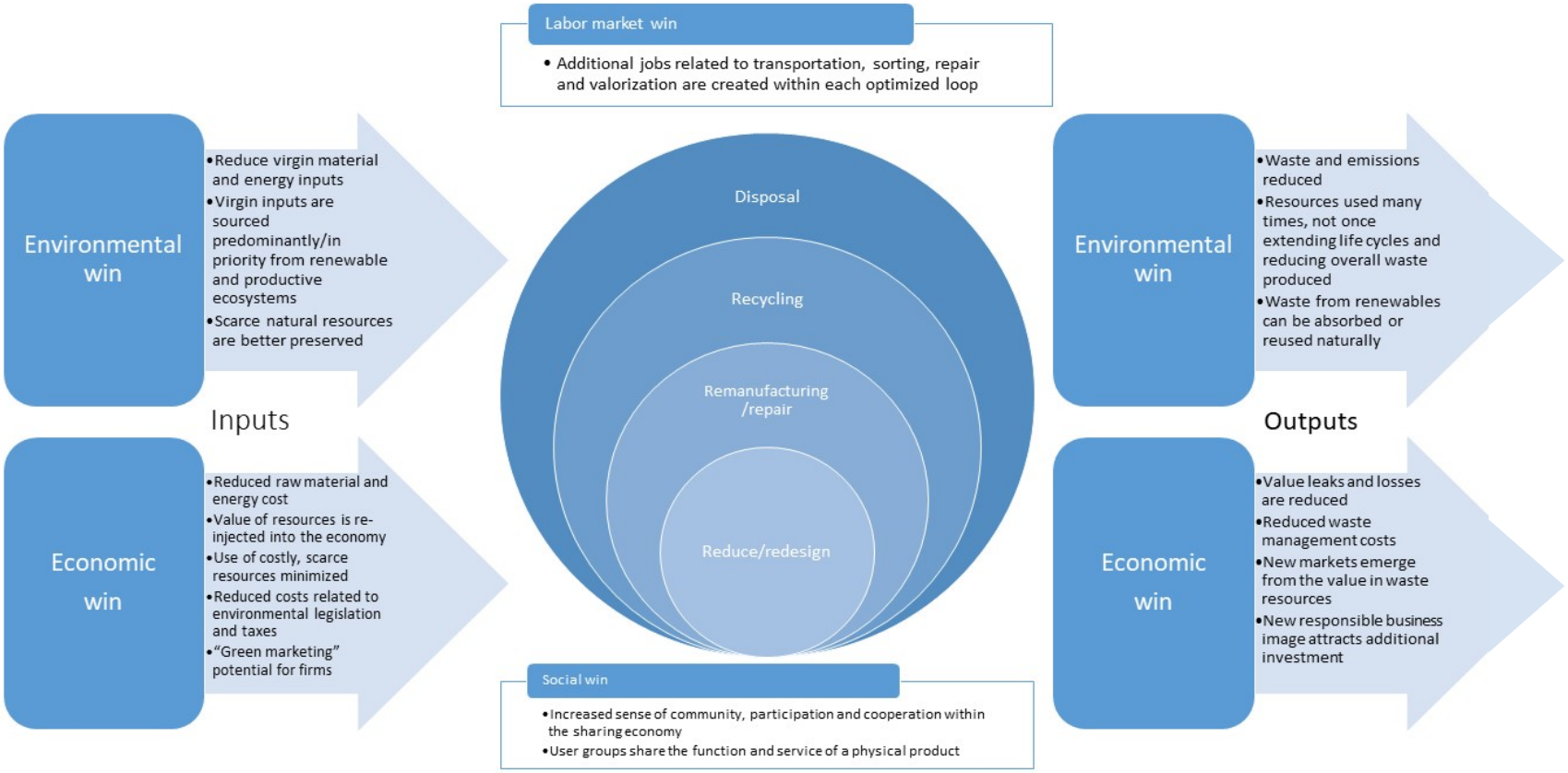


Figure 1: Conceptual Framework for Circular Economy Wins Assessed; Source: Adapted from Korhonen et al. (2018)

ACTED's researchers believed the best tools with which to approach this task were extensive Key Informant Interviews (KIIs – in-depth discussions with recyclers with specialized and long-term experience), widely-circulated questionnaires, and Focus Group Discussions. In all, ACTED received 214 responses from the 241 respondents contacted, achieving a 89% success rate.

The data received was in many cases revealing, but it should be noted that taken together it still does not represent a comprehensive national-scale survey. Only a research program coordinated by government and industry, using nation-wide resources, will achieve that degree of reliability. Due to the diverse range and individual data-retention methods of ACTED's sources, and to differing scales of activity in different industries, insights into some recycling value-chains are limited. Furthermore, due to the voluntary nature of ACTED's surveys, it is possible that valuable or illuminating datasets may exist, but have not been sampled. Even so, as demonstrated by the high number and wide distribution of respondents, and the quality of the data obtained, ACTED's research is among the most robust and wide-ranging yet undertaken on this subject in Lebanon.

A more detailed explanation of ACTED's methodology is given in Annex 2.

2. Background

2.1 Lebanon's economic conditions

Lebanon has struggled to deal with the enormous demographic burden and social and economic consequences of the Syrian crisis since it began in 2011. The financial crisis which arose in the second half of 2019 has put the country under further strain. A liquidity crisis and poor fiscal management has exacerbated pre-existing structural inefficiencies in the Lebanese economy, leading to a devolution of the Lebanese currency, capital flight and banking restrictions (mainly on small businesses) in an import-dependent economy. It is estimated that more than 220,000 jobs have been lost since October 2019, with salaries and the minimum wage also slashed by 40% and 60% respectively. Moreover, the cost of goods has risen by 45% as the cost of imports has inflated with the local currency devaluation.

2.2 A Circular Economy model for Lebanon

A traditional Linear Economy focuses on extractive industries and manufacturing processes that generate waste. A Circular Economy, by contrast, is based on three principles:

1: Designing out waste and pollution

2: Keeping products and materials in use

3: Regenerating natural systems[1]

Figure 2, overleaf, presents a model Circular Economy.

Mismanagement of the nation's waste kicked off initial civil movements in 2015 and 2016. These movements were able to gather critical mass behind apolitical demands for government accountability, demands which have been echoed in the crisis of 2019-2020.

The current civil movements which erupted in 2019 have also highlighted the issue of solid waste management as a symbolic theme. They demonstrate the inefficiencies of the current systems and highlight the positive role of engaged citizens: anti-establishment protesters have cleaned public demonstration areas and local organizations set up a "model zero waste village" in central Beirut.[2]

However, the state of environmental management in Lebanon represents a complex crisis, which requires holistic solutions that move beyond infrastructure investments in waste collection and sorting. As this report highlights, the focus on waste collection and sorting, as opposed to reduction and reuse in industrial systems, has created a waste management system that is unsustainable.

Circular Economy models that propose the 'cascading' and return of materials, either to the soil or to industrial production systems, offer an important and sustainable resolution to Lebanon's waste crisis. In this context, ACTED conducted a research initiative between April 2019 – December 2019 to understand the major opportunities for (and constraints on) developing a Circular Economy in Lebanon. ACTED's assessment focused on how six types of material move through the Lebanese economy, a process this report refers to as a 'Value-Chain.' The materials are Plastics, Paper, Fabrics (Clothing and Textiles), Glass,

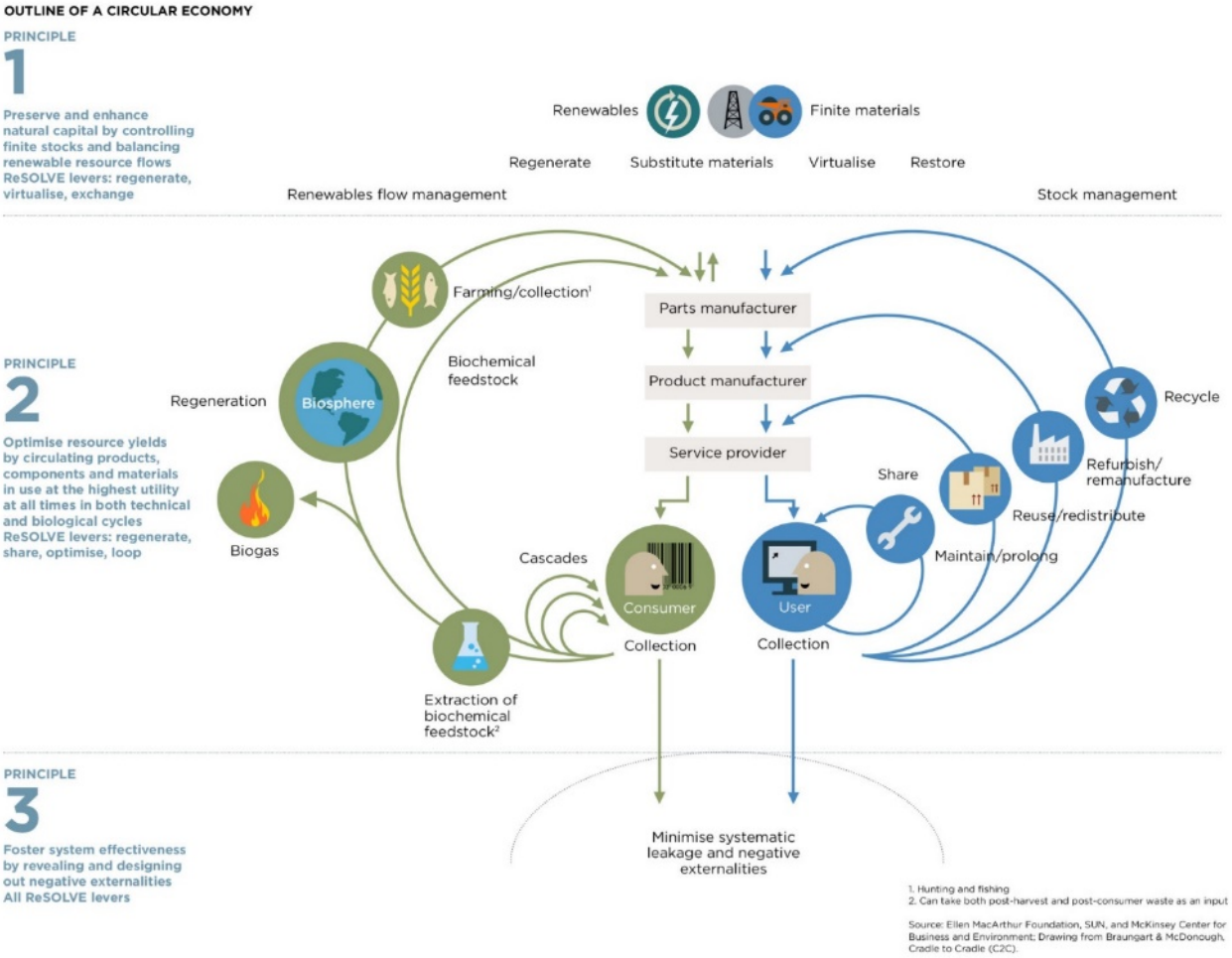


Figure 2: Infographic on Circular Economy SOURCE: Ellen McArthur Foundation

E-Waste, and Circular Bio-Cycles (Bio-Waste and Agricultural Produce Waste). This report identifies opportunities for recycling, repairing and reusing these materials, as well as design innovations – which do currently exist in Lebanon – for reducing waste in each Value-Chain.

On the topic of recycling, ACTED's research considered the economics of waste recovery, including price incentives in the market for specific types of waste. It is difficult to estimate prices in the Lebanese market, as no national systems exist for tracking such data or for categorizing waste by material type and quality. This report relies on self-reported data from various Lebanese actors, including NGOs, private sector companies and Municipalities, as well as import and export price records.

On the topic of repair and reuse, ACTED explored the business models of a range of informal actors, who mainly work on restoring and extracting new value from unbranded products.

Finally, in order to understand design innovation, ACTED explored current industries that have adopted a Cradle-to-Cradle (C2C) design model, and also considered future market opportunities for their products. C2C is a biomimetic approach to the design of products and systems, modelling human industry on the processes of nature and viewing materials as nutrients circulating in healthy and safe metabolism. In the C2C model, all materials used in industrial or commercial processes—such as metals, fibers and dyes—fall into one of two categories: "technical" or "biological" nutrients.

Technical nutrients, for example metals or specific types of plastics, are non-toxic, non-harmful synthetic materials that have no negative effects on the natural environment. In an ideal model, they can be used in continuous cycles, as the same product, without losing their integrity or quality. In this manner these materials can be used over and over again instead of being "downcycled" into lesser products, ultimately becoming waste. **Biological Nutrients,** for example specific types of paper packaging, are organic materials that, once used, can be disposed of in any natural environment and decompose into the soil, providing food for small life forms without affecting the natural environment.

Overall, ACTED's assessment identified five main groups of stakeholders that could collectively help establish a robust Circular Economy in Lebanon:

1) Private sector industries that manufacture products (both from recycled and virgin materials), especially packaging manufacturers;

2) Collection, sorting and recycling agencies, including private companies and Municipalities;

3) Repair and redistribution actors who keep products in the economy and support re-use (mainly for electronics, furniture and fabrics);

4) The Agricultural sector, such as producers, food producers and cooperatives;

5) Retail shops and Food and Beverages industry entities;

In addition, ACTED assessed Lebanese end-consumer preferences for eco-friendly products in a Circular Economy. The assessment informed this report's proposals for initiatives to influence purchasing habits and to incentivize the development of a Circular Economy at a national level.

3. Findings and Potential

3.1 Economics of Waste Recovery in Lebanon

In Lebanon, as in much of the developing world, per-capita waste generation has been increasing. Despite a lack of reliable national-level data, recent analysis by international experts has produced realistic estimates of Lebanon's waste generation rate, per capita. **The World Bank's *What a Waste 2.0* report of 2018 has estimated that Lebanon has one of the highest rates of waste generation per capita in the region – 0.98 kg/person/day – second only to Iraq,** as shown in Figure 3 below. A report in 2014 by GIZ SWEEP-Net (the Regional Solid Waste Exchange of Information and Expertise Network, representing ten countries across the MENA region) estimated the weighted average of waste per capita, per day, to be 1.05 kg.

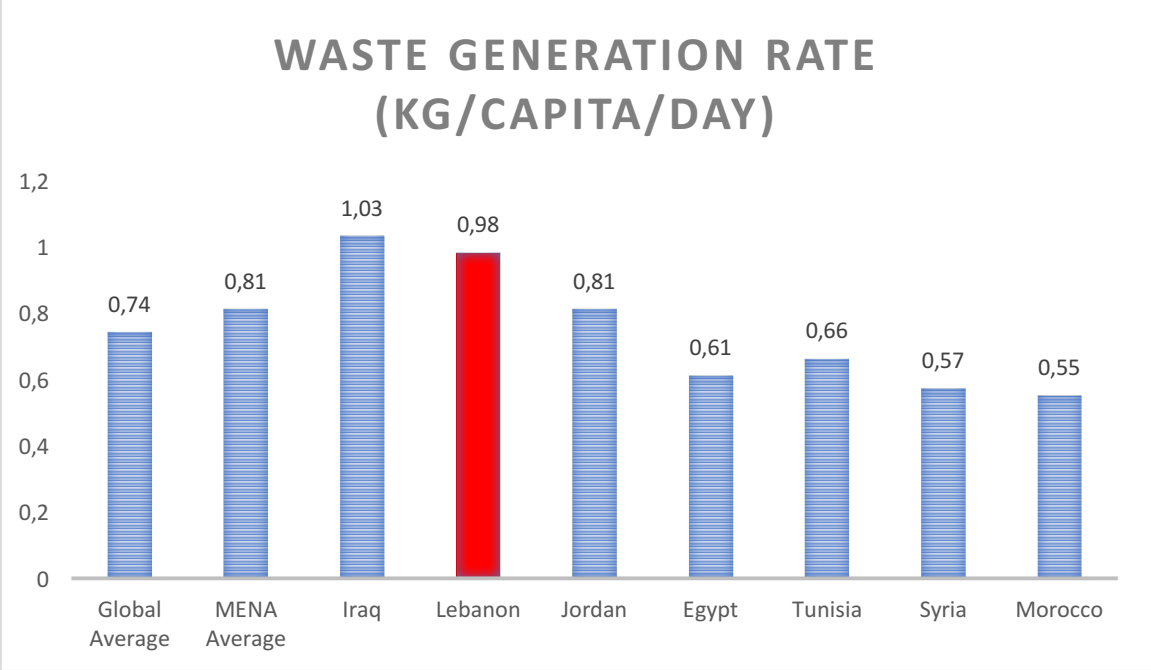


Figure 3: Waste Generation Rate in the MENA Region; Source: What a Waste 2.0, World Bank

As well as generating such high levels of waste, the overall Solid Waste Management (SWM) value-chain in Lebanon has been extremely ineffective. Its mismanagement culminated in the garbage crisis of 2015 that prompted the formation of citizens' movements and led to protests in the streets. In response, several donors- and private-sector-funded initiatives have been launched in waste recycling across Lebanon. However, many of these initiatives have failed to be economically viable, with many sorting facilities shutting down or becoming inactive.

This trend could be explained by the high cost of waste recovery in Lebanon. The recycling value-chain is undergoing a crisis globally. China's "National Sword" policy, enacted in January 2018, banned the import of most plastics and other materials headed for that nation's recycling processors, which had handled nearly half of the world's recyclable waste for the past quarter-

century.[3] As a consequence, the costs of the logistics of waste recovery, and of the energy and water needed for recycling, are increasing, as profitability is decreasing. In 2018, the World Bank estimated that **basic SWM systems covering collection, transport and sanitary disposal in low-income countries cost 35 USD per ton at a minimum, and often much more.**[4] Furthermore, the World Bank found that SWM typically comprises nearly 20% of municipal budgets in low-income countries, and more than 10% in middle-income countries.

The costs of waste recovery and sorting in Lebanon are much higher than the global average. As early as 2005, the Ministry of the Environment conducted a study of cost recovery of SWM systems in Lebanon. The Ministry estimated, with the exception of Morocco, that the cost was much higher than other countries in the region:

	Lebanon	Syria	Jordan	Egypt	Tunisia	Morocco
Total Cost per year of SWM (Million USD)	**69**	30-39	22-26	32-37	33-45	97-128
Average Cost per Ton (USD/Ton)	**50**	9-11	17-20	2-3	19-25	16-21

Figure 4: Cost of Solid Waste Management Systems in the MENA Countries

In fact, Lebanese Municipalities assessed within the framework of this study reported approximate costs of 120 – 169 USD per ton of waste collected, with a total spending amounting to an estimated 39% of municipal budgets. This is almost five times the global average of 35 USD per ton. The cost of the overall system reported by municipalities differed depending on how waste was managed: 179,166 LBP per ton for municipalities taking their waste to a nearby facility, 225,975 LBP for municipalities dumping their waste and 271,286 LBP for municipalities that had their own treatment facility. Secondary sorting and treatment at a centralized facility should be encouraged, and the related costs municipalities pay to ensure such a system is in place should reflect the economic and environmental benefits of waste treatment. Imposing a dumping fee for municipalities to ensure cost of dumping outweighs the cost of environmentally sound waste treatment and disposal, including those dumping on private land, could encourage prior treatment of waste, thus additional resources on the ground to enforce this fee structure would lead to more waste being properly treated. Private and public landowners receiving untreated waste from municipalities could pay a dumping fee to reflect the true cost lost in the economy through not recovering these materials, and also reflect the true cost to the environment, while contributing to remediation of the land once a more sustainable waste management solution is found.

Municipalities contacted **were not able to provide an accurate figure on the waste generated monthly in their region**, often reporting volumes beyond the realistic average waste generated per capita per day of 0.8kg, and relying on the reported volumes at waste disposal locations[5] where they are dumping waste. The Municipalities also reported collecting an average of 77 tons of waste a month[6]. Based on the GIZ SWEEP-Net report of 2014, Beirut alone generates around 600 tons of waste a day. It is recommended that municipalities are informed on the average volume of waste generated by their community to ensure fees are relevant and their service cost/cost recovery calculations are made on this basis. Furthermore, there were inconsistencies in the reported cost of the municipal solid waste management system when compared to the total

number of reported solid waste management workers in the municipalities: 20% of municipalities reported the monthly cost of the system was less than the total cost for the workers[7].

Mayors play a central role in waste management in municipalities, although they are locally elected officials and probably have limited expertise in waste management. The majority of respondents (89%) reported mayors as part of the municipal team responsible for waste management along with municipal staff (85%), waste collectors (27%) and contractors (7%). Of the municipalities reporting a contractor as a key focal point responsible for solid waste management, all stated that there was sufficient solid waste management experience within the municipality, whereas the 80% of the municipalities without contractors stated that they had sufficient technical experience. Although the vast majority of municipalities reported they had sufficient technical capacity, when contacting municipalities, ACTED requested to speak to the most relevant focal point in the municipality managing solid waste, yet only 9% of municipalities had a focal point that was a supervisor of waste management services.

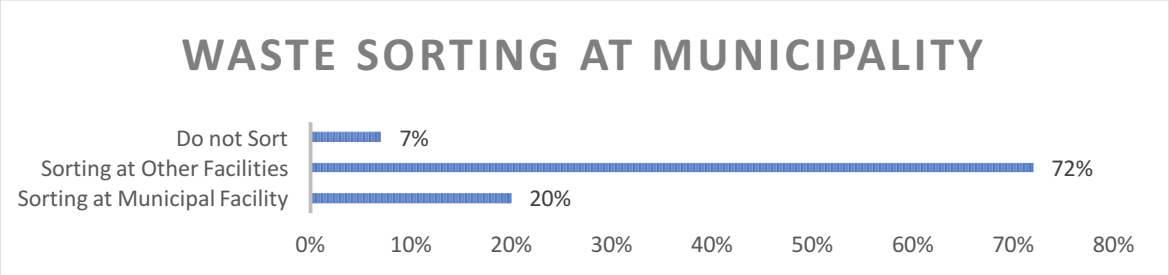
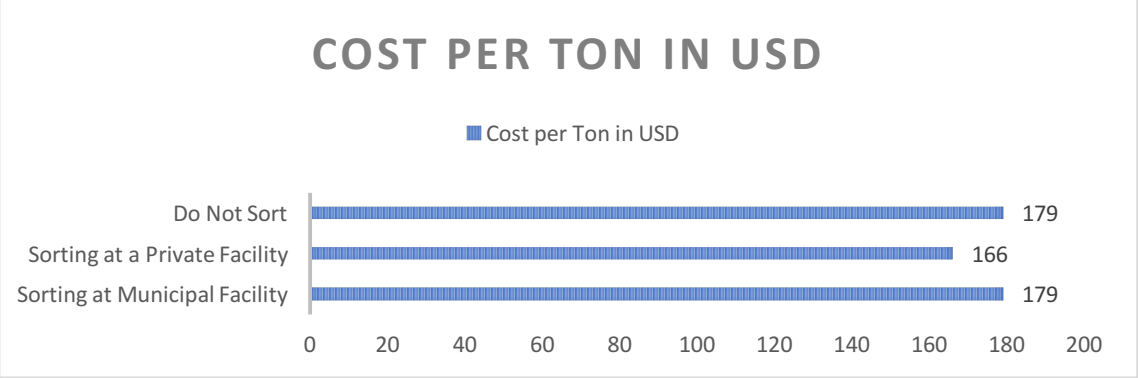


Figure 5a: % of assessed municipalities that reported sorting waste
Figure 5b: Cost per ton of processing waste



Municipalities that processed the waste at their own facility had an average of 18.5 workers employed in **waste collection** (average tonnage of waste collected and treated: 488 tons per month / 27 tons per worker), a much **higher efficiency of collection** compared to those who took their waste to a nearby facility who employ on average 4.75 workers to collect 22.4 tons per month (5.41 tons per worker), or those that take their waste directly to landfill and employ 6.71 workers to collect on average 45 tons per month (5.19 tons per worker). **Such a sharp disproportion in the average numbers of staff, especially considering the ratio of staff to tonnage of waste,**

raises questions about efficiency of waste collection at municipality level, indicating that clustering of municipal services could lead to greater efficiencies. Municipalities **sorting waste** had an average of 7.5 workers in their sorting facilities, treating an average of 32 tons of waste per worker per month.

Municipalities sorting and treating their own waste were more willing to impose taxes on citizens not sorting: 45% compared to only 8% of municipalities who were taking their waste directly to landfill. This is probably due to the fact that 80% of municipalities sorting their waste are collecting their waste from household level, whereas no municipalities taking their waste to landfills are collecting from household level and instead collect from designated communal bins and cannot determine or hold accountable the households properly sorting. **Prohibiting communal bins in Municipalities and ensuring household- or building-level waste collection** could improve accountability loops in waste recovery in Municipalities, and could also increase the opportunity for employment at the local level through collection, recovery and sale of waste materials.

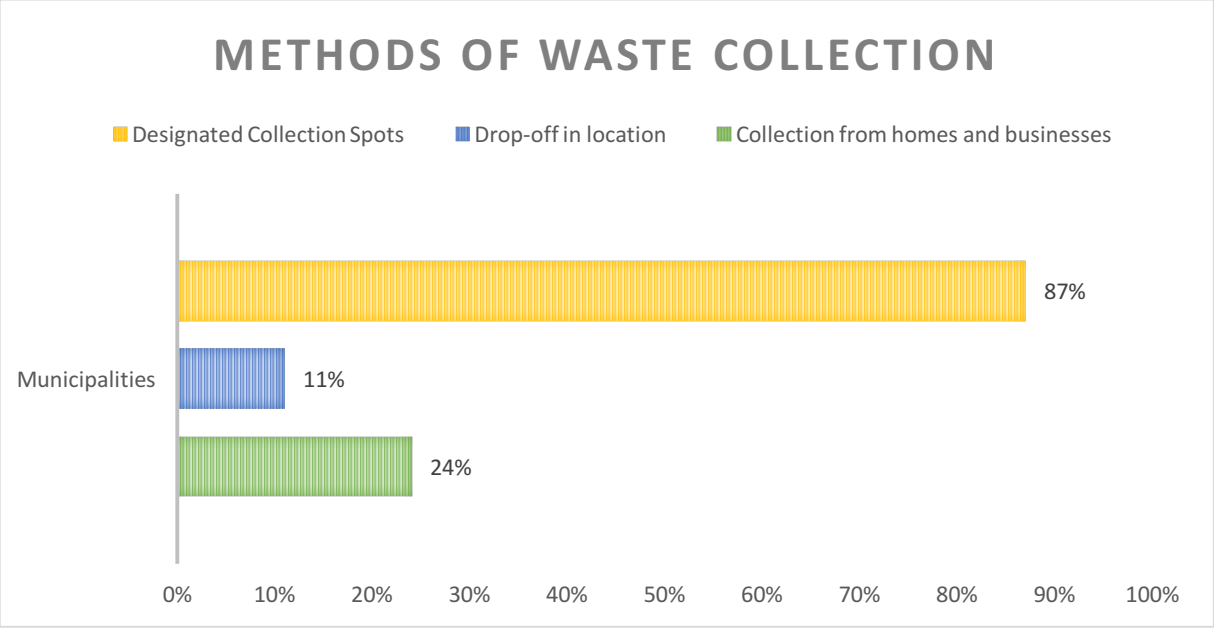


Figure 6: Methods of waste collection used by surveyed municipalities

ACTED's SWM hotline[8] received 147 calls between February 2019 and 2020, 47% of which were from citizens requesting where they could take their sorted waste. Of the municipalities interviewed, only 8% possessed facilities where individuals or businesses can drop off their waste. **This demonstrates a service gap in the market for many citizens willing to recycle waste.**

To address this, the municipalities as well as waste-contractors, both private and non-profits, which ACTED consulted during KIIs stated that if there is an opportunity to create local demand for the reuse of special waste streams, such as furniture, electronic waste etc., *before* collection, then this could reduce the cost burden on these waste services. For example, Municipalities could promote reuse of furniture by encouraging residents to leave their old furniture on the street for a few days, and promote the idea that other local residents may freely pick it up.

Cleaning sorted waste increases the value of the waste for resale, but it is water-intense. On average, 52% of Municipalities reported that they were willing to clean waste after sorting. Surprisingly, it should be noted that those already treating waste were less willing to clean it while those not currently treating their waste were more willing to clean sorted waste. This could demonstrate that Municipalities that do not already have the experience of treating their waste have limited understanding of the intensity of this process. It is also possible that Municipalities that are already sorting do not see the need to invest in additional treatment of the waste, as they are able to sell it directly without cleaning.

However, as mentioned in the section relating to the plastics waste stream (Section 3.5), private sector enterprises in Lebanon cited lack of treatment of plastic waste as the key constraint preventing them from using recyclates in the manufacturing process. Indeed, they highlighted that there are no unified standards for Municipalities to treat waste, and thus might receive post-consumer waste with different degrees of contamination from different Municipalities, making it difficult to standardize the recycling process. Moreover, as stated below, KIIs with actors in plastic industries clearly highlighted a lack of willingness to invest in treatment of post-consumer plastic waste, and their preference for recycling pre-treated waste from Municipalities. Therefore, further work towards **creating unified standards related to cleanliness of plastics, as well as improving understanding Municipalities' knowledge of market demand and cleaning costs, would improve plastic valorization along the value chain**, allowing more plastic recyclates to be absorbed in the local market.

ACTED also asked recycling facilities about the methods of waste collection – that is, how they receive waste. A vast majority of the facilities collected the waste directly from households or bought waste from other collectors. This indicates that some facilities have the capacity to buy from other areas, thus leading to economy of scale and greater economic gains. Their responses are shown in the next chart.

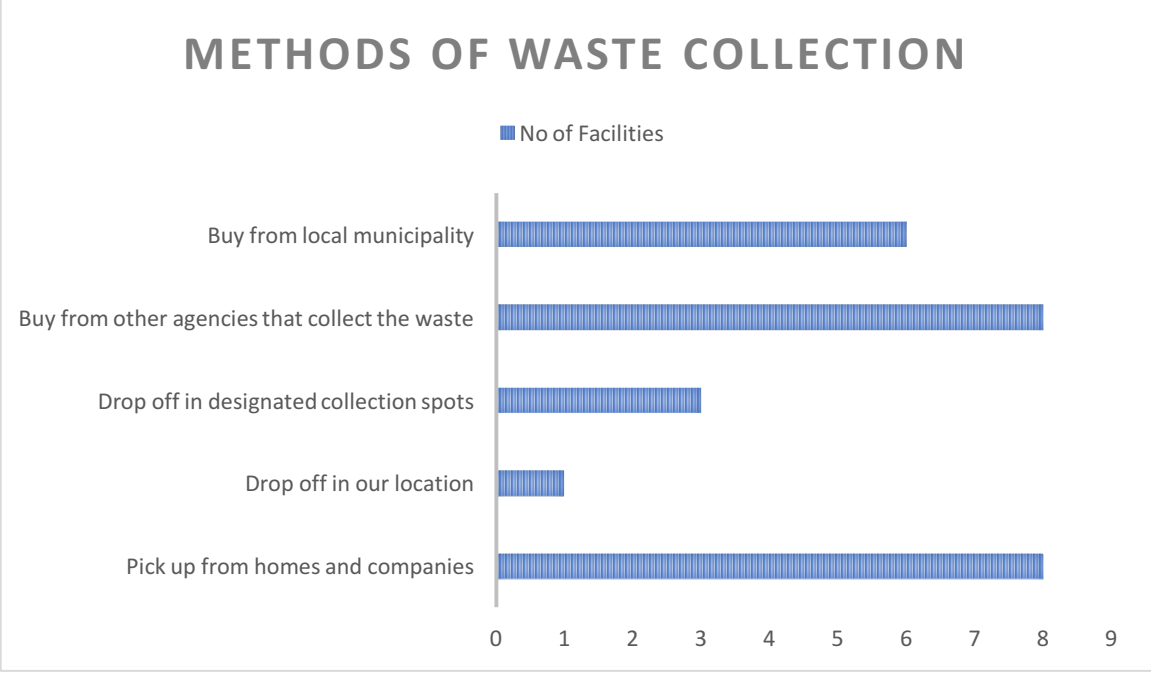


Figure 7: Methods of waste collection used by recycling facilities

The Municipalities that ACTED interviewed generally consider that **local and international NGOs can support in improving waste management services at the municipal level**, with 22% reporting that they believe local organizations can support municipalities, and 60% reporting that international organizations could do so. Although NGOs can provide technical support, training and financing for capital (facilities, equipment, transport) and initial operational costs (staff, consumables), most NGOs receive a fixed grant or donation funding, and Municipalities themselves should be prepared to finance the operation and maintenance cost of service continuation.

ACTED inquired about the costs involved in municipal waste collection, sorting and recycling, in order to profile the overall cost-recovery that such schemes can make possible in Lebanon. ACTED assessed three categories of costs: labour, transportation and running costs of warehouses.

The cost of labour was difficult to determine precisely, due to lack of reliable data. ACTED's estimate is based on the average numbers of workers reported by Municipalities, at national minimum wage rates.

Interestingly, compared to other key cities in the MENA region, cities such as Beirut and Saida transport their waste over relatively small distances, which would suggest that the cost managing waste disposal would be less, but as has been reported above, Lebanon remains one of the most expensive countries to process waste in the region. However, a number of factors could contribute to this including cost of fuel, labour costs to drive the trucks, and other external costs which were not considered in this study.

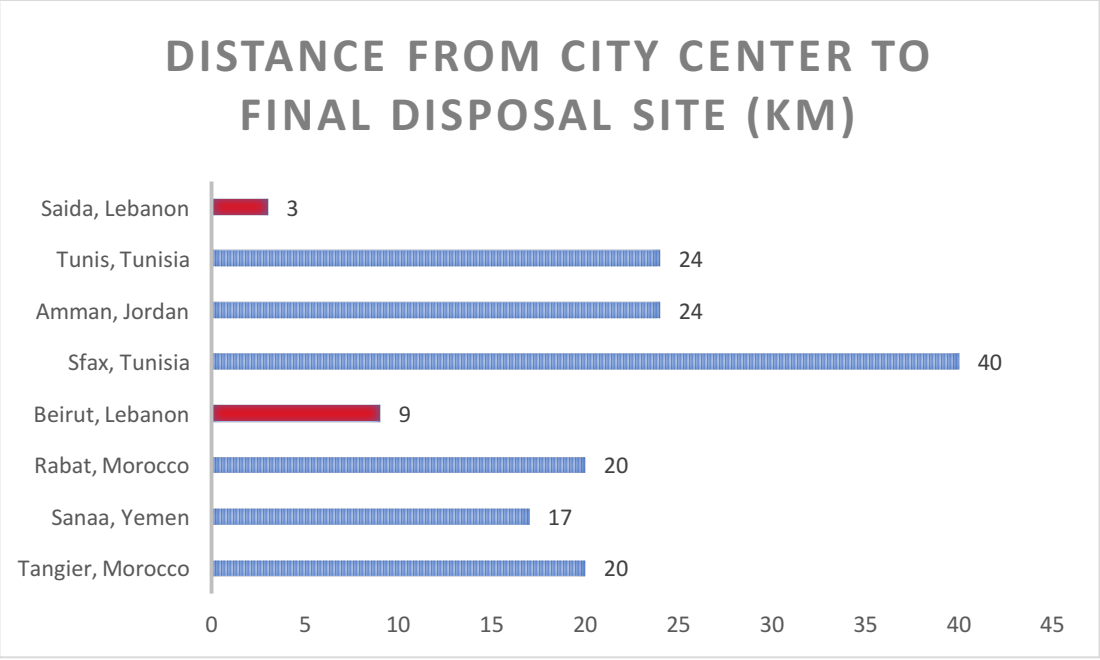


Figure 8: Distance waste transported across major cities in MENA region

When ACTED asked Municipalities which problems were most affecting SWM services in their areas, the vast majority indicated problems on the supply side (waste arriving at facilities, from consumers) rather than the demand side (resale of waste). The next chart shows municipal perception on major issues relating to SWM in Lebanon. The blue bars represent the input-related issues, while the orange bars represent issues relating to output and cost recovery.

The key problems that Municipalities highlighted were a lack of awareness among households, or their refusal to sort waste at source; households not opting into municipal waste collection programs (and dumping their waste instead); lack of resources for waste collection, including trucks, staff, infrastructure and facilities. Only 18% of the Municipalities indicted that they lacked buyers for their waste, and only 2% indicated a problem with low market cost for recyclables.

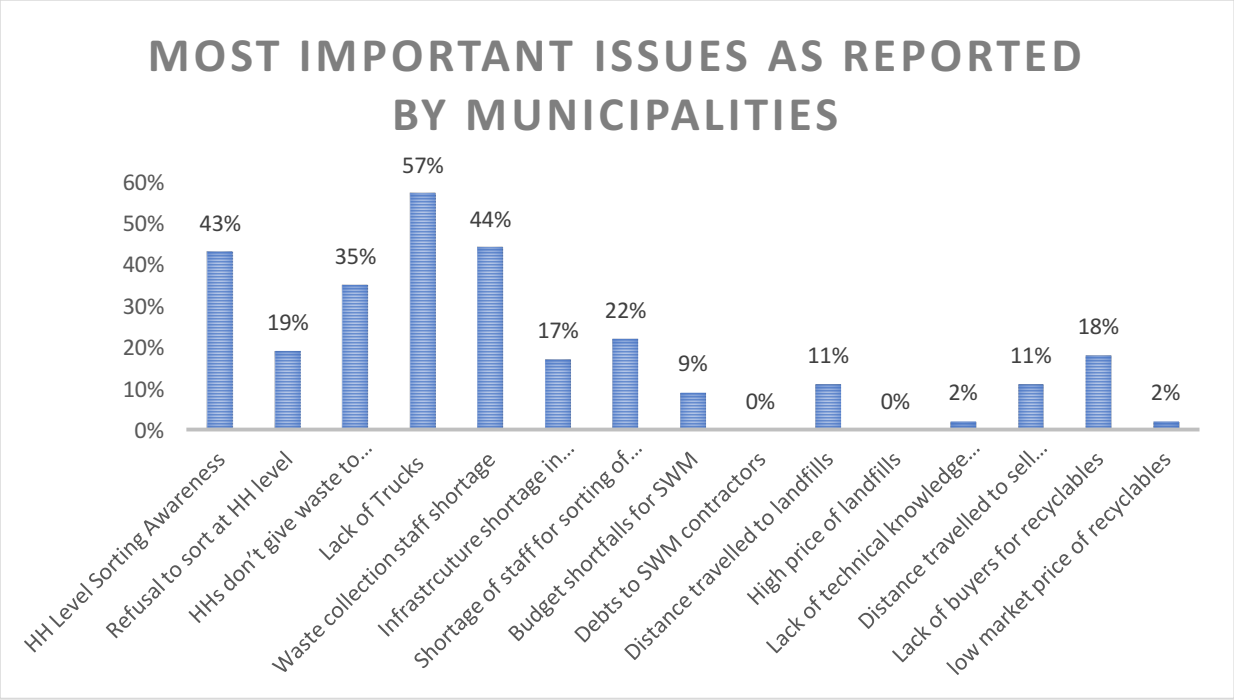


Figure 9: Most important issues in SWM services as reported by municipalities

As indicated in the chart above, according to municipalities, more investment and focus is needed on the supply side as there are more problems there, than at the demand side. As a consequence, municipalities have focused heavily on collection and sorting of waste rather than on the sale/valorization of waste to ensure cost recovery.

In this context, **it is vital to support Municipalities to operate with an understanding of SWM market systems to develop strong upward linkages into SWM value-chains as well as focus investments on supply-side fixes on waste streams that have strong market potential.** This will ensure that municipal collection schemes better consider existing end markets in their design, and that Municipalities achieve effective cost recovery. But a new understanding of existing marketplaces for the valorization of waste will require not only technical capacity at municipal sorting facilities, but also a shift in attitudes towards such services.

Further, KIIs have indicated that there is no clear understanding among municipalities and waste contractors on the economic value of special waste streams. Lack of national market systems have also resulted in data gaps, which hinder the development of these value-chains. Lack of reliable and real-time data on waste characterizations have made price estimations of such waste streams impossible.

The EU-funded report on SWM practices, *Support to Reforms – Environmental Governance* (2016), assessed current recycling trends in Lebanon. The report estimated that of all the waste generated in Lebanon, 50% is organic waste and recyclables constitute an estimated 35%. This is similar to the findings of the GIZ SWEEP-Net report in 2014, which estimated recyclables to comprise around 36.5% of total waste.

Although there is no national-level data to assess the quantities and proportions of different types of waste materials, the following table provides an approximate breakdown, based on values reported to ACTED by 14 recycling actors, including NGOs and privately-owned facilities.[9] These are mainly facilities that sort and/or transform waste to some extent, before selling it.

Type of waste material	Average Tonnage (per month)	Median Tonnage (per month)
Paper	769	110
Glossy Paper	110	110
Corrugated Cardboard	1306	105
TetraPak	140	140
PET Bottles	638	210
HDPE	432	8
PVC	718	150
LDPE	669	3
PP	431	4
PS	668	3
Other plastics	669	3
Aluminum cans	4	5
Copper Wires	1	1
Other metals	3.5	3.5
Glass	6	1
Rubber Tires	150	150
Organic Waste	198	198
E-waste other than batteries	2	2
Batteries	61	61

Figure 10: Average amounts of collected material reported by recycling facilities

ACTED asked recycling facilities to name the most profitable recyclates they process. The following chart summarizes their responses:

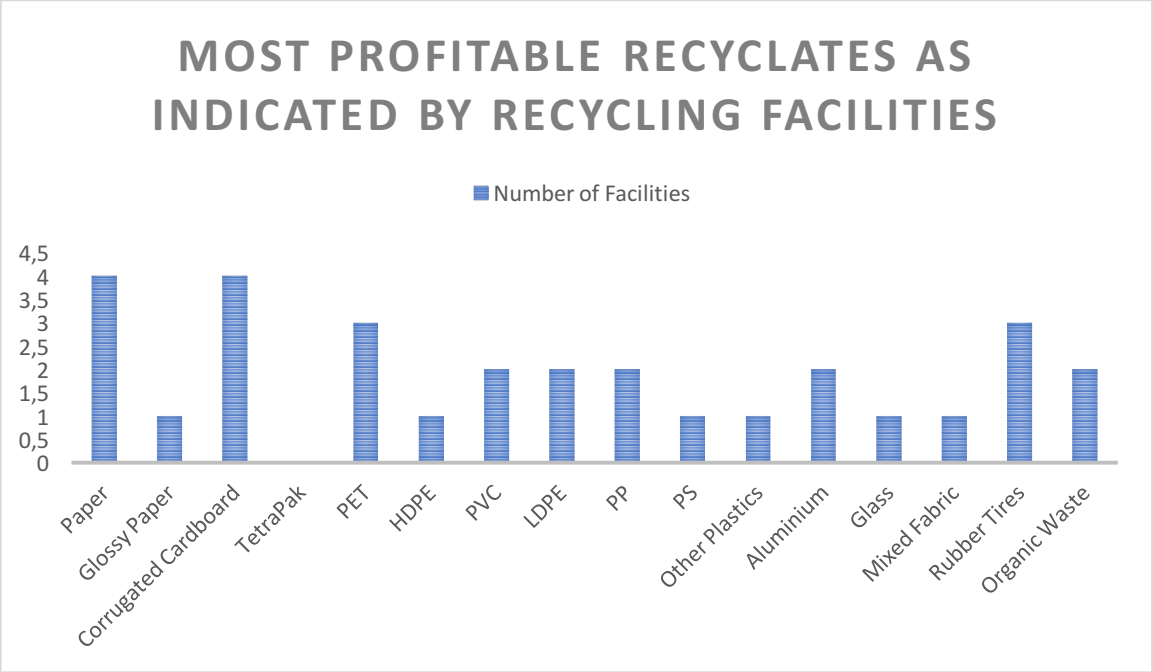


Figure 11: Most profitable recyclates as reported by recycling facilities

In summary, **the cost of recovering and recycling waste in Lebanon is too high, making waste an unprofitable resource.** Most sorting facilities are not run with profitability as the main objective, and in models that ACTED explored, most cost recovery seems to be achieved through subsidizing waste collection and sorting, either through charging a fee for waste pick-up per household, or through payment of municipal fees funded through taxes.

One of the biggest problems that emerged is the lack of organization in the sector, with the presence of many actors, a high level of competition and a notable lack of efficiency in logistics driving up the costs. **This sector overall lacks economy of scale, which increases processing costs.** ACTED's findings thus reinforce standing proposals that the waste sector should be organized into service areas, which are geographically-bound areas with efficient waste collection routes, larger processing facilities, and higher levels of automation to reduce costs.

Furthermore, KIIs have revealed that most of the private waste contractors who buy and sell recyclables ship them out of the country to Syria, Turkey, Iran, the Gulf and, to a limited extent, China. Such overseas sales represent a geographical leakage of value. There is also a lack of accountability for the quality of the exported materials. Indeed, most waste contractors that ACTED assessed were unable to name the final destination of the recyclables they collected, which indicates a disjointed waste value-chain and potentially high loss of value. Many key stakeholders stressed that it is imperative to reuse the sorted waste locally and to ensure, wherever feasible, that value-extraction from waste is locally anchored.

The next several sections will explain how specific market-based and environmental initiatives can lead to feasible cost recovery, in the value-chains supported by plastics, paper, fabrics, glass, e-waste and biological and agricultural products. A more efficient use of resources in each value-chain, and their aggregate contributions to manufacturing and agricultural sectors, is the key to promoting a Circular Economy framework in Lebanon.

3.2. Current Legal Frameworks for Waste Management

Steps were taken in 2019 that clarified the roles and responsibilities of various stakeholders through the adoption of Law 80/2018 on Integrated Waste Management Systems. This laid the foundation for the approval of the Ministry of Environment's Integrated Solid Waste Management (ISWM) Road Map 2019-2030 on August 27, 2019, by the Council of Ministers (CoM).

The Road Map set guidelines to increase the financial and legal capacity of local authorities to directly implement solid waste treatment options at the decentralized level if the required technical and financial requirements are met. More specifically, the following legally binding decisions were made to support improved waste management:

- The household solid waste sorting-at-source draft decree, based on the Court of State recommendation number 603/2018-2019 dated 21/8/2019, was approved.
- The MoIM was assigned to request from the Municipalities and the Union of Municipalities to coordinate with the Governors and Relevant stakeholders to define locations for establishing and operating sanitary landfills.
- CDR was assigned to launch the bids for the operations of the existing sorting and treatment Facilities, and to rehabilitate and construct new ones where needed according to the proposed road map and based on specific requirements.
- The MoE, MoIM, and the Ministry of Finance (MoF) were requested to a draft cost recovery law for sweeping, collection and treatment
- Approved to allocate a budget of 5 Million USD to the MoE over a period of 5 years (1 Million USD/year) for training, awareness and communication campaigns over 5 years, to activate the implementation of the principles of Reduce, Reuse and Recycle.

The Ministry of Environment is currently preparing the legal framework needed for the implementation of the Road Map. This involves developing several technical specifications, standards, and guidelines in order to establish a clear ISWM system in Lebanon, including guidance for sanitary landfills. While these measures could indeed improve effectiveness of SWM services in Lebanon, the current political and financial crises will be slowing progress on the implementation of the road map. In the absence of policy advancements to reform the governmental services in the SWM sector, market-based interventions and incentives to reduce the valorize waste materials and reduce the burden of waste on Lebanon's environment and public services become even more relevant and pressing.

The following sections also present in more detail specific legal and policy issues within the 6 studied value chains, along with a general market analysis and recommendations.

3.2 Bio-Waste

Increasing population growth and consumption are driving global demand for biological materials, with intensive agricultural production trying to keep pace with the demand resulting in depletion of natural resources. Demand is rising for food as well as feedstock for other industries, such as corn and oil palm for biofuels, cotton for the fabric industry, and so forth.

Within the concept of Circular Economy, *biological cycles* consist of managing the flow of renewables. Such a flow may include:

1) Using renewable materials as feedstock for products: for example, support for using municipal waste, agricultural waste or other organic matter to produce various types of feedstock, such as biogas or bioplastics.

2) Support for regenerative agriculture: this involves supporting the agricultural sector to move away from intensive farming that depletes the soil, extracts and overuses resources such as water and fertilizers, and leads to large-scale impacts on global climate.

Within the context of Lebanon, this report considers economic opportunities that arise from recycling municipal and agricultural waste for the production of nutrients, recovery of cooking oil for the production of bio-diesel, transforming produce waste to increase its shelf-life, and reducing leakages in agricultural value-chains through post-harvest improvements. While regenerative agriculture presents the best environmental outcomes for Lebanese farmers, it requires a drastic shift in practice in agricultural techniques and resource management, compared to the status quo. This report considers specific opportunities in organic production, which creates definite market opportunities and is more feasible to implement as a first step in the immediate term.

3.3.1 Recycle: Bio-digestion Recommendations

Improving National Systems and Regulations

- Establish national regulations to incentivize the sorting of bio-waste in households and at other sources. Regulations, monitoring and compliance frameworks should build on successful pilots such as those developed in Bifkaya Municipality and for application of the new law 603/2018-2019 dated 21/8/2019, pertaining to sorting at source.
- Establish national regulations to incentivize business models that create economy of scale for bio-waste recovery. Regulations should build on successful models developed by restaurants and shopping malls, for recovering nutrients from organic waste.
- Train Municipal services to install bio-digesters (see text box below). This would increase efficiency in bio-waste recovery, as anaerobic digestion has major advantages over traditional composting.
- If centralized bio-digestion facilities are preferred, then they should be equipped to collect methane gas as fuel for generating electricity.

Improving Industrial Systems

- Support the purchase and installation of anaerobic bio-digesters in agro-businesses (large-scale farms and food producers) and train workers in the necessary technical skills, to enable agro-businesses to recover nutrients from their own waste, within their own facilities. Anaerobic digesters are highly recommended, as they are sanitary and require little space, and produce gas that can complement other gas sources for cooking and heating. This will reduce costs for businesses and the carbon footprint of waste transport.

Improving Consumer Awareness

- Conduct a consumer awareness campaign to encourage positive attitudes towards biogas and counteract negative perceptions.
- Conduct a consumer awareness and information campaign, supported by national legislation, to promote the sorting of bio-waste at its sources (in the household and in businesses). The public should be informed that to recover nutrients from organic waste and extract economic benefits from it, the waste should be uncontaminated, and that this is simple to achieve.

A large share of municipal waste in Lebanon (over 50%) is bio-waste. This includes food waste, nearly all of which is sent to landfills. Very little to no energy is recovered from them. In fact, it is estimated that Lebanon emits more than 1840 Gg CO_2eq from landfills.[10] This is comparable to France, which emits 1871 Gg CO_2eq, despite having ten times the population of Lebanon. In this context, it is imperative to consider proper management of bio-waste systems, to recover useful energy.

Lebanon emits 1840 Gg CO2eq from landfills.

This is comparable to France, which emits 1871 Gg CO2eq with ten times the population.

There are obstacles to producing compost from bio-waste, even in the EU, which is only able to recycle 25%, where the logistics of waste recovery are more effective and viable compared to Lebanon.

Although biodegradable substances can be extracted from mixed waste, this is a complex process and produces a contaminated product. To divert biodegradable waste away from landfill and make composting or biogas production viable, it is essential to sort bio-waste at its source.

There have been some attempts to convert bio-waste into compost in Lebanon. Initiatives such as Compost Baladi have set up bio-waste collection streams, as have several Municipalities. However, almost all such initiatives have failed, leading to a material loss estimated conservatively at USD 100 million in unused energy and nutrients. These failures occur for several reasons.

The first is the low quality of compost resulting from food waste. Several informants whom ACTED interviewed, including several farmers, indicated that locally-made compost had a bad smell, and also did not have standard NPK ratios, which causes chemical imbalance in soil. Secondly, ACTED's KIIs revealed that locally-made compost was often contaminated with plastics and other non-biological debris, due to inadequate household-level sorting of organic waste. Thirdly and most seriously, the relatively small Lebanese agricultural market is currently saturated with imported compost, coming mainly from the EU. Even though imported soil was estimated to cost almost double the price of locally-produced compost, Lebanese agri-business currently prefers imported products, for several key reasons. The first is brand loyalty: most farmers recognize and trust imported brands, but avoid unbranded locally-produced compost. The second is the lack of regulation or testing of locally-produced compost. Farmers indicated that NPK ratios are often not specified for local compost, which reduces their trust in these products. The third is a general preference for compost made from animal waste manure rather than kitchen waste, as animal-waste compost is perceived to be of higher quality.

Estimated USD 100 million lost per year in unused energy and nutrients in organic waste.

Biogas production in Lebanon is more successful than composting. Some small decentralized facilities, such as those in Bikfaya and Qassim in Jezzine, are enjoying some initial success. These facilities use anaerobic digesters – that is, organic chemical plants that enable bacteria to break down waste without needing oxygen – which produce significantly less odor than composting. Furthermore, bio-digesters require much less space than composting equipment, which reduces the cost of investment and installation. At present, bio-digesters installed by Lebanese businesses mainly produce liquid fertilizer, which is given away for free. The methane gas produced is generally burnt off in summer, but is used in winter to heat the water that is fed into the digester. Such schemes are highly dependent on adequate household-level sorting. They require a fully engaged Municipality, capable of maintaining an effective feedback loop to households that do not sort effectively.

Anaerobic bio-digesters, installed under the conditions described in the case study below, have huge market potential in Lebanon. They are cost-effective and would yield substantial revenue for business.

Biodigestors

A biodigestor, in its simplest form, consists of a sealed chamber which has an inlet for organic materials such as kitchen waste and animal dung. This is usually mixed with water to form a slurry, in which the total amount of slurry is kept under 15%. Some biodigestors can also be built to take up to 40% solids and thus reduce the need for water. These are then allowed to ferment in a gas-tight chamber. Anerobic digestion means that this process takes place without oxygen. Microorganisms break down the organic matter. This process produces a mixture of gases which can be used for heating or generation of electricity, and a liquid digestate which can be used as a fertilizer.

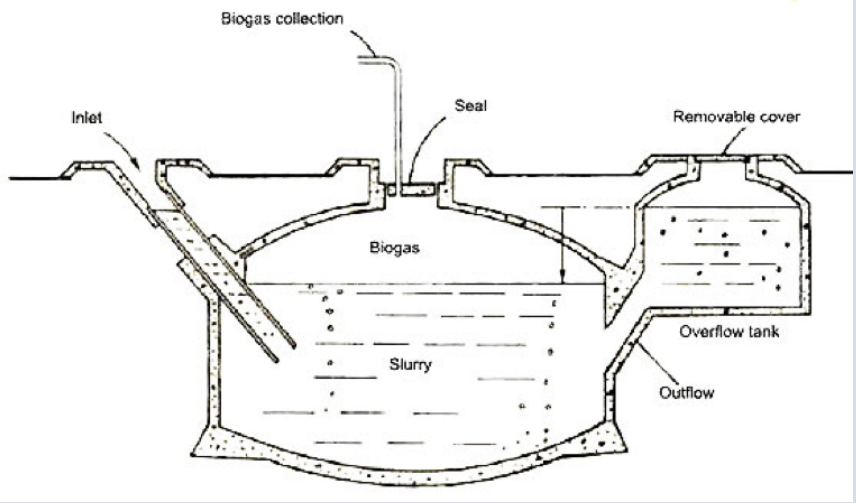


Figure 12: A Simple Biodigestor

However, there are two key constraints in the Lebanese market that need to be addressed to make bio-digesters locally viable.

Firstly, **the quality of the liquid fertilizer and gas produced depends on the quality of the organic raw materials fed into them.** Bio-waste that is mixed with plastics or other materials can fatally compromise the quality of the end products. As is evident from the pilot projects in Bikfaya and Qassem, this can only be achieved with a high level of Municipal engagement, to ensure household-level sorting.

The second major constraint is competition with imported fertilizers. ACTED's KIIs indicated that Lebanese farmers are loyal to imported brands and do not trust locally-produced products. In order to overcome this obstacle, **locally-produced liquid fertilizer must have a recognizable brand and marketing support.** Product labels should include testing results to show NPK concentrations, to ensure farmers are able to make informed choices. **One key market where these products could be tested at a low level of risk is the landscaping market.** Landscaping companies that ACTED assessed indicated that they are open to testing such products, particularly as they do not smell strongly, unlike compost.

In addition to composting and biogas systems, ACTED assessed the existing market for recovering used cooking oil for biodiesel production. Dumping of cooking oil into water systems causes oxygen levels to drop dramatically. At the same time, recycling used cooking oils reduces the consumption of fossil fuels in the transport sector, and limits greenhouse gas (GHG) emissions. One liter of oil recycled into biofuel avoids the emission of 3 kg of CO_2, a reduction of 92% compared to diesel fuel.[11] Biofuels made from waste vegetable oils can also be used for home heating.

ACTED's KIIs revealed that used cooking oil recovery schemes are quite robust in Lebanon. There are many informal actors who collect cooking oil, mainly from restaurants. They then sell it to wholesalers, who usually ship it to the EU and other markets for biofuel production. ACTED's KIIs indicated that this market is getting crowded, with many actors working on recovery schemes from these larger outlets. As a result, restaurants have started charging recyclers for selling them their oil, leading recyclers to sell the oil at a premium price in international markets. **This business model is highly effective in maintaining market incentives, which keeps the value-chain viable.** Collection of used cooking oil from households is still a challenge. ACTED's KIIs indicated that the cost of the logistics of collection from individual households, compared to the volume of oil produced, made such schemes non-viable. Therefore, **Municipalities with existing logistics systems for waste collection should consider expanding operations to recover cooking oil from households.** This can be achieved at minimal additional cost, providing an important source of cost recovery for municipal services. One project piloted by IPT, in partnership with USEK University, aims to collect used cooking oil from the households of students and neighbouring communities to run a bio-diesel generator. Although this project is yet to be launched, such decentralized initiatives would offer end markets for used cooking oil from households.

3.3.2 Reuse: Agricultural Waste

Improving National Systems and Regulations

- Develop regulatory frameworks/tax incentives related to environmental management systems and standards, such as ISO 14001.

Improving Industrial Systems

- Support agricultural cooperatives and small enterprises to create value-added products from produce waste, including through dehydration and making processed food products.
- Support cooperatives and community enterprises to access export markets, including training on GLOBAL GAP and obtaining Organic certifications.

Improving Consumer Awareness

- Conduct a consumer awareness campaign to alter public perceptions of food aesthetics and waste. Unrealistic expectations that produce should be consistently shaped and sized with consistent colouring is one of the major causes of waste, as many growers are forced to throw out produce that doesn't look appealing. Consumer awareness campaigns should focus on the negative effects of such waste and seek to influence consumption patterns.

ACTED's KIIs revealed a large degree of waste in several key produce value-chains, including fruits, vegetables and dairy. Each value chain has a specific waste challenge. This report focuses on the apple value-chain, as an example which illustrates several causes of agricultural waste in Lebanon. The agricultural sector needs to be studied in greater depth to illustrate the constraints affecting other value-chains and causing unsustainable wastage. The common recommendation that emerged from KIIs in this sector, however, is that **agricultural waste offers a substantial market opportunity for processed food products.**

Lebanon has suffered from an apple crisis for the past few years. A large percentage of apple produce has been thrown away due to low market uptake. Many factors have contributed to this,

including low quality of production, low market value of apple varieties grown locally, outdated production techniques and illegal imports from Syria. One key factor affecting the apple market is climate change. A drop in the number of months with snowfall and the consequent decline in meltwater led to increased stresses on apple trees, making them more prone to disease and reducing the quality of their fruit. Another key factor is a high level of pesticide residues, especially derivatives from chlorinated pesticides that are capable of bioaccumulation; when these were found in Lebanese apples, most Gulf countries imposed bans on imports. As a result, most Lebanese apple farmers have been unable to export to Gulf markets for several years. An estimated 40% of apples produced in 2018 were wasted.[12]

As a first step, it is recommended that farmers be supported to reduce waste through improved production techniques. This would require trainings for farmers and technology investments to improve quality of production, as well as introduction of new apple varieties with high level of demand in the markets. KIIs revealed that significant gains can be made from investments in certified organic produce due to high demand for such products in the export markets, particularly in the Gulf countries.

As a second step, remaining waste should be converted into useful products to take to market. There have been several initiatives to use up apple waste locally, such as Cesar Cider, a start-up producing apple cider from wasted apples. Several other opportunities exist to transform apple waste into useful products, including apple leather and vinegar, which would result in significant income gains not only for farmers but also agro-food processing enterprises.

In addition, support must be provided to agri-food industries to improve waste management through establishing national standards such as ISO 14001. KIIs indicated that agri-business in Lebanon mainly focus on standards related to safety and quality (such as ISO 9001) while there are no incentives to adopt environmental standards such as ISO 14001. Firstly, there are no national regulations that make it mandatory. Moreover, as these standards do not influence customer purchase, including in the export markets, other financial incentives must be provided to industries such as tax benefits for establishing improved environmental management systems.

Dried fruits are of particular market value. Dried fruits and nuts, pre-prepared sauces and condiments, and milk and cream were identified as Lebanese agro-food products with high potential for growth, given their export trend data. Exports of dried fruits and nuts registered a CAGR of 43% between 2009 and 2017 while sauces increased by 29% and milk and cream by 23%.[13] IDAL also found that the top three exported agro-food products in 2018 included dried fruits and nuts at 8.3%, followed by processed chocolate (8.1%) and sauces and condiments (7%).

The chart overleaf illustrates the export market potential for Lebanon as identified by ITC. As can be seen, apples represent a large potential for export, as do prepared food groups. Investing in these value chains to reduce waste and improve production quality would therefore represent both economic and environmental gains for the products.

ACTED has also identified substantial market potential for valorized waste products from the dairy industry. Dairy processing facilities that produce cheese often also produce whey as a waste

product. ACTED's KIIs revealed that whey is often dumped, especially in the Litani river. Worldwide, whey production is estimated at around 180 to 190×10^6 ton/year. Of this amount, only 50% is processed and transformed into various foods and feed products.[14] Whey alters the pH of water, which seriously destabilizes ecosystems, and industrial waste water-treatment plants to treat water containing whey are costly. An economical alternative is to reuse the whey, to produce a low-cost alternative to liquid feed for animals; this product is also fit for human consumption.

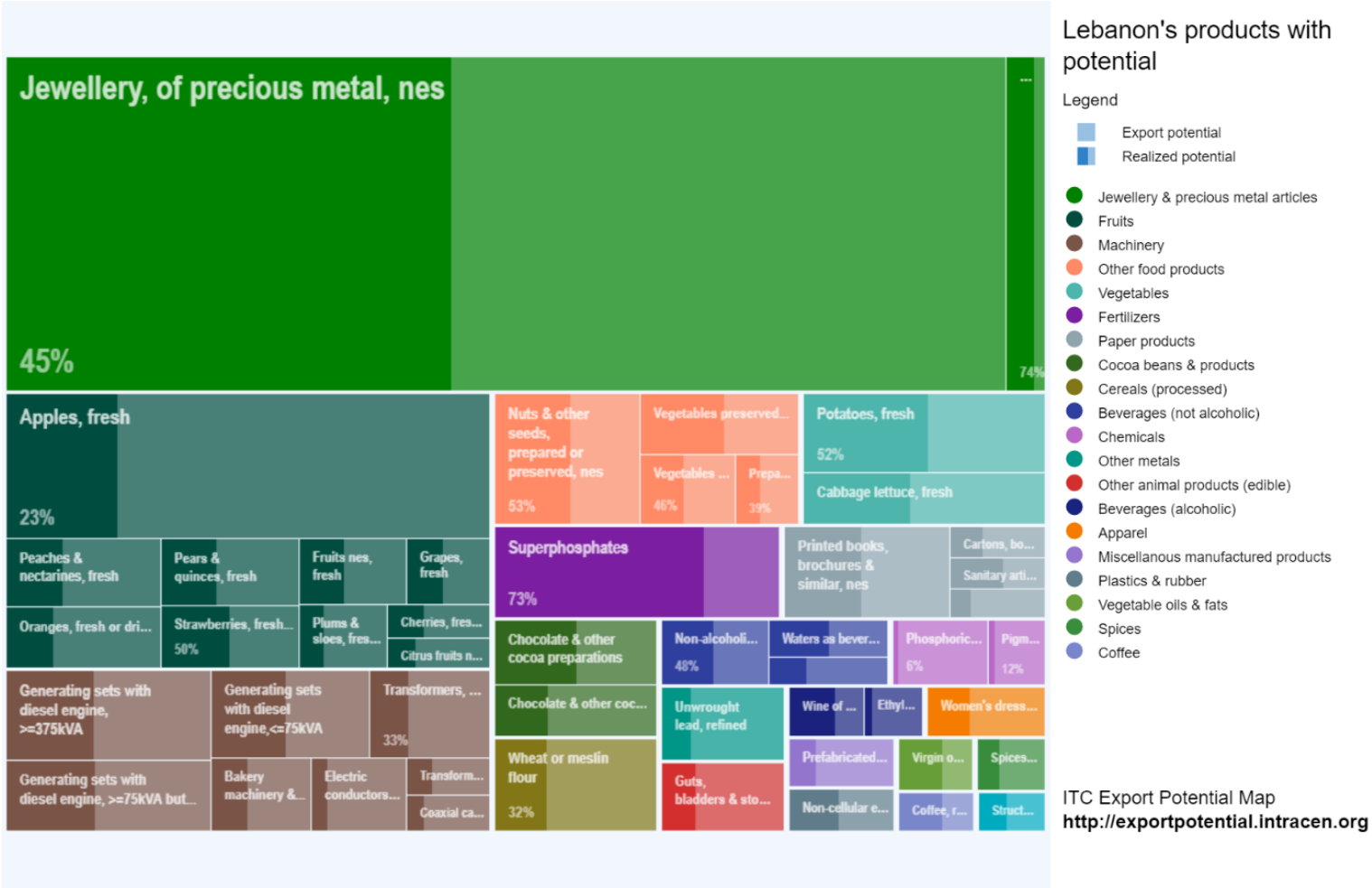


Figure 13: Lebanon Export Potential Map

3.3.3 Reduce: Improved Farm Management Systems

Improving National Systems and Regulations

- Urgently improve regulation and certification of organic produce and farming methods, to support the Organic sector towards meeting its very large market potential.
- Urgently improve regulation of organic inputs, such as biopesticides and biofertilizers and beneficial insects.
- Support universities and institutions such as LARI in research and development of organic inputs.
- Enforce penalties against suppliers who add misleading labels on their products, which creates unfair competition for farmers and producers who comply with organic standards.
- Establish a national marketplace system to track and recommend prices for organic produce, to prevent wholesalers from setting prices that do not reflect market realities.

Improving Industrial Systems

- Support farmers with active organic certification, as well as other interested farmers, to make the transition into organic production without compromising the quality, health or productivity of their farms.
- Support farmers' access to organic inputs such as biopesticides and biostimulants.
- Support farmers and cooperatives to access storage technologies, to reduce post-harvest waste.
- Train farmers in negotiating contracts with suppliers and wholesalers well ahead of the harvest season, to ensure they are able to plan accurately and reduce post-harvest waste.

Improving Consumer Awareness

- Develop and introduce a national label for certified organic produce, to enhance consumer awareness, inform consumer decisions and build consumer trust in organic produce.
- Conduct a consumer awareness campaign to educate consumers about organic certification and labelling. Focus on clarifying the meaning and economic benefits of organic produce, and resolving confusion over common terms such as 'baladi' and

In addition to recycling and reusing agricultural produce to reduce waste, circular bio-cycles should also focus on reducing resource use in production systems.

Organic production is one solution often implemented in agriculture, to reduce resource use and waste in production bio-cycles. Organic agriculture adapts production to local ecological processes, biodiversity and mineral and chemical cycles, and avoiding practices which would damage the wider natural environment. Rather than using resource-intensive and chemically destructive fertilizers, pesticides and soil amendments, organic farmers typically rely on inputs obtained from the waste of other industries, such as animal waste manure.

Moreover, organic product has large market potential in Lebanon. KIIs have indicated that the two largest distributors of organic products in Lebanon currently only meet 30% of the market demand. This is reflected in the steady increase in total cultivated area and number of organic operators that can be seen in Lebanon. Between 2016 – 2017 alone, the total cultivated area for organic agriculture increased from 1,275 ha in 2016 to 1,353 ha in 2017, which represents a 10% increase[15].

In Lebanon at present, there is only one certification for organic production systems (Controllo e Certificazione, CCPB), which consequently holds a monopoly in the sector. CCPB is a private certification body headquartered in Italy but registered with the Ministry of Agriculture in Lebanon. To obtain certification of organic production from CCPB, the registration fee is an estimated 460 USD per year. CCPB also charge an additional fee of 350 USD per sample of produce. For conventional farmers who want to convert to organic production, the conversion period typically lasts 1.5 to 3 years. In order to reduce the conversion period, CCPB charge an additional 300 USD. In total, a farmer could end up paying between 750 USD (3-year conversation period) and 1,100 USD (accelerated conversion period) for organic certification. ACTED's KIIs indicated that during the conversion period, farmers receive very little support if they encounter problems such as diseases and pests. KIIs also indicated that biofertilizers and biostimulants are not well marketed or advertised in Lebanon. Indeed, there is a great deal of misinformation surrounding such products, and that the process for registration of such products with the Ministry of Agriculture is complex, resulting in unnecessary delays and administrative difficulties.

As a result, there is little incentive for farmers to obtain organic certification. Enabling more Lebanese farmers to convert to organic production will depend on **more efficient and equitable regulation of organic farming certification – including the establishment of more certification bodies – and improved registration of biostimulants and biopesticides.**

Investment in breeding local beneficial insects would also yield substantial benefits. Mindful of the high value of organic wine products, the Lebanese wine industry has been at the forefront of organic production and has supported several innovative organic solutions to agricultural problems. One successful pilot conducted by LARI saw the introduction of *Cryptolaemus*, a local genus of ladybird, which successfully preyed on and reduced the population of grape mealybugs, a serious pest to grape crops.

ACTED's KIIs indicated that once farmers do convert to organic production, one of the key problems they face is the lack of market diversification for their products. Although there is high

market demand for organic products, the logistics of transporting organic produce from farms to the end consumer is expensive and requires a high level of efficiency, as organic produce has a shorter shelf-life than non-organic produce. At present, the market is dominated by a few wholesalers who control the logistics of the organic sector. These wholesalers own refrigerated trucks and warehouses with temperature-controlled storage units, and are the only secure links between the farmers and the end markets; they have an established brand identity. Farmers have no option but to sell to these wholesalers, who are then able to control market prices. To address this, **the Ministry of Economy and Trade, in partnership with the Ministry of Agriculture, should establish a national marketplace system to track and recommend prices for organic produce, to prevent wholesalers from setting prices that do not reflect market realities.**

Another consistent problem that ACTED identified was a lack of clear grading standards for organic produce. At present, wholesalers are able to set their own grades, which are often arbitrary and vulnerable to individual commercial interests: wholesalers frequently reject produce that would satisfy standards in independently regulated markets. Organic farmers often have no option but to sell rejected produce in the conventional market, which represents a substantial net loss. To address this, **the Ministry of Agriculture should set clear certification standards for high-value organic crops, especially fruits and vegetables, to ensure there are uniform national criteria and to reduce waste in the sector.**

According to CCPB, there are 600 farmers with CCPB basic certifications, of whom 150-200 farmers are estimated to be active (as determined by reactivation of their certificates).

ACTED's KIIs indicated that the greatest problem with the organic produce sector (and indeed the overall agricultural sector) is a lack of extension services from government. There are 31 extension offices of the Ministry of Agriculture but most do not have adequate resources to assist farmers facing technical problems. In order to meet this need, most farmers seek technical support from fertilizer distributers such as Unifert, Debbane, Blue Field and Robinson Agri. These fertilizer distributors effectively step in where MoA centers cannot. Private distributers have a vested interest in this process, as they are incentivized to provide solutions that boost their own profits. When ACTED asked farmers why they preferred imported compost over locally produced compost, they indicated that they usually trusted international branded products, especially imports from Europe, because they believed these were properly tested, and because the support staff at fertilizer distribution companies were able to provide them with technical information.

ACTED collected data from 43 certified organic farmers[16]. As can be seen from the chart below, most certified organic farmers are concentrated in the Mount Lebanon area, particularly around Jbeil, Alay and Chouf. KIIs indicated higher levels of understanding of organic production among farmers in these areas, and greater support from local authorities, resulting in more widespread sustainable practices.

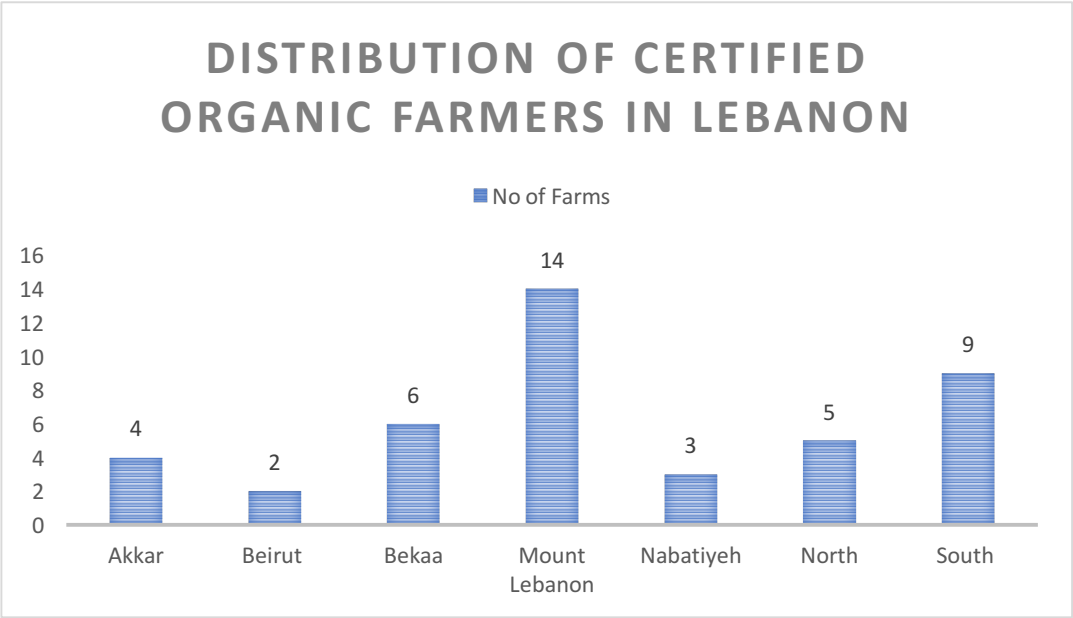


Figure 14: Distribution of geographic location of certified organic farmers in Lebanon

On average, the farms producing certified organic products indicated that they have had certification for an average of 11.5 years.

40% of the farmers assessed had received some type of training on crop diseases, or the uses of fertilizers and pesticides. The breakdown of farmers receiving training per governorate is included in the chart below. The largest share of farmers receiving training was located in the South.

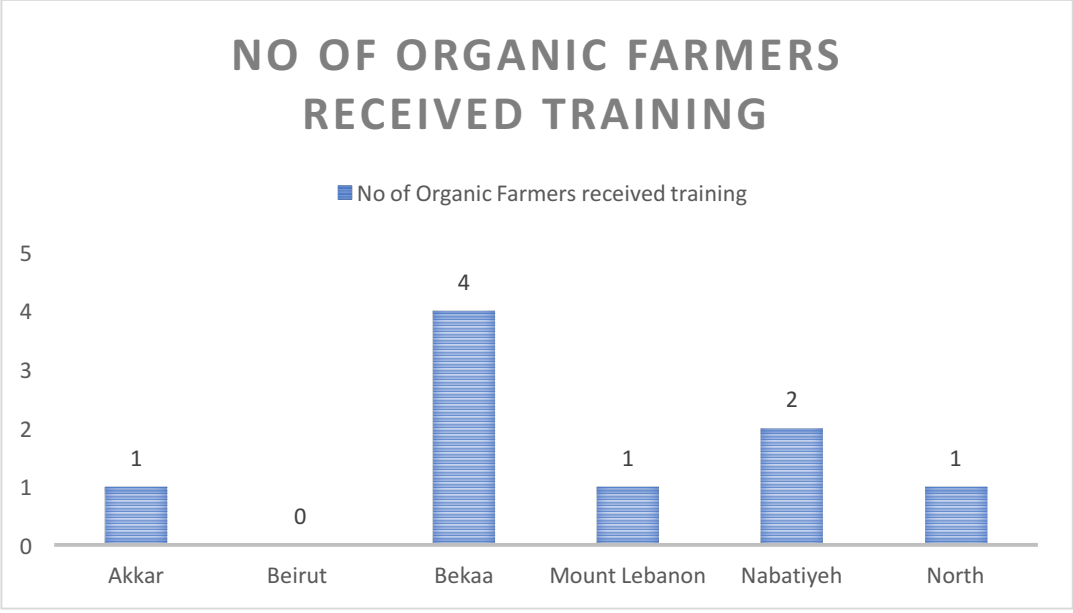


Figure 15: Number of Organic Farmers per Governorate that received trainings; Source: ACTED assessment

Moreover, 67% of assessed farmers depended on agriculture as their main source of income. This means a substantial number of farmers will be economically vulnerable if they cannot prevent contagious diseases from ruining their harvests.

Most of these farmers' organic cultivation was focused on fruits and vegetables, as shown in the next chart:

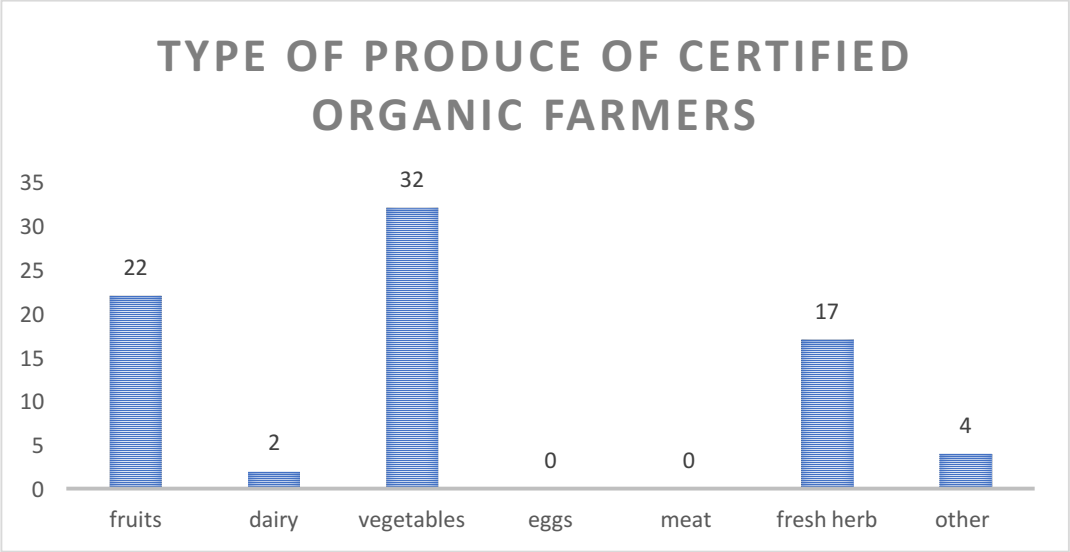


Figure 16: Type of Produce of Certified Organic Farmers; Source: ACTED Assessment

The table below provides the top organic imports and exports from Lebanon. As can be seen, there is overlap between the products grown by certified organic farmers and export demands. However, additional investments in the sector can also be made to replace exports which mainly consist of processed organic foods. Interestingly, KIIs with retail sector actors revealed a low level of confidence in locally processed organic foods mainly due to lack of regulation and consumer perception of the sector. KIIs indicated that as consumers have no trust in product traceability, they are less likely to trust processed foods that contain organic labelling from Lebanon as compared to fresh produce. One the other hand, one retailer of organic products interviewed indicated that consumers tend to trust uncertified organic products produced in areas to which they have family ties. Given the current perceptions and attitudes of consumers around value of local production, it would be interesting to explore how to leverage 'terroir' type labeling for specific products and regions in Lebanon to allow local producers to refer to local identity and cultural heritage in their marketing strategies.

Top Organic Exports	Top Organic Imports
(1) Fresh Fruits and Vegetables (2) Eggs (3) Olive Oil (4) Thyme (5) Seedlings of aromatic plants	(1) Salty snacks (2) Beverages (3) Wine (4) Grains (5) Rice (6) Pastas (7) Jams, honey and syrups (8) Poultry, meat (9) Milk (10) Dairy products (11) Flakes and cereals (12) Canned vegetables (13) Spices and peppers

Figure 17: Top Organic Imports and Exports from Lebanon; Source: BlomInvest Bank

At present, conditions in Lebanon limit the feasibility of farming some of the above products organically. ACTED's KIIs indicated that there is high demand for organic dairy products, eggs and meat, but since certified organic feed is almost completely unavailable, these products are mainly imported. Honey production requires a buffer zone around farms and beehives, where no chemicals can be sprayed. Due to space limitations and the small size of the farms, KIIs indicated that it is very difficult to produce organic honey without contamination.

Citrus fruits, apples and olives are the most popular types of fruits farmers are growing, while tomatoes, cucumbers and eggplants are the most popular types of organic vegetables farmers are growing.

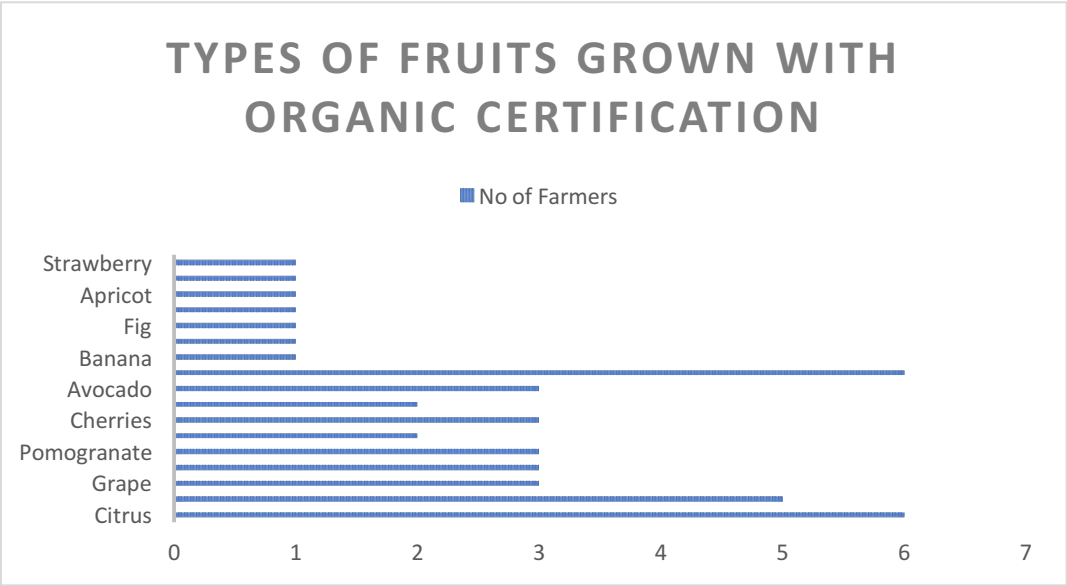


Figure 18: Type of Fruits Grown with Organic Certification; Source: ACTED Assessment

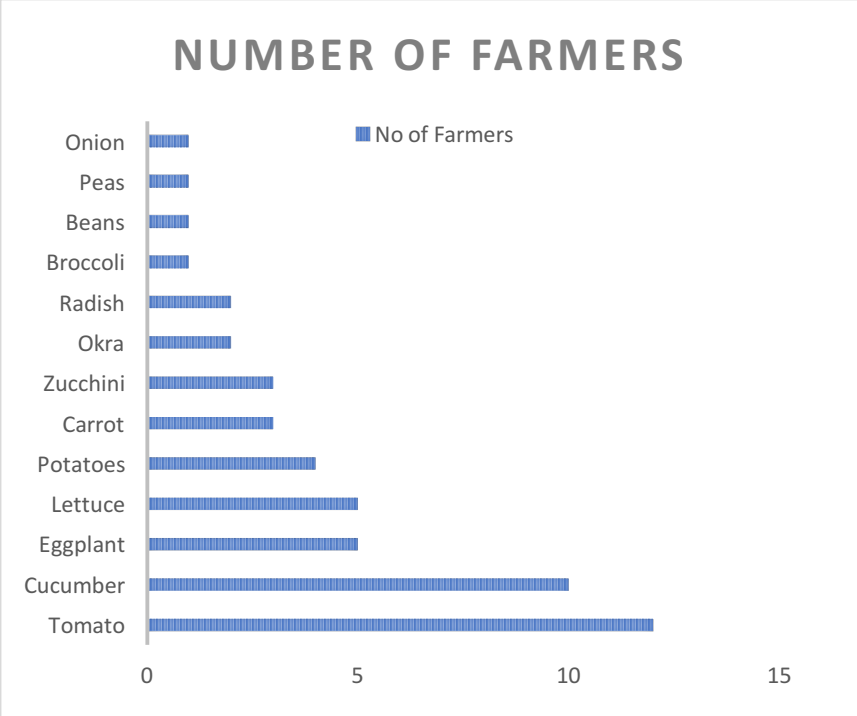


Figure 19: Types of Vegetables Grown with Organic certification

ACTED also asked farmers if organic farms yielded a quantity of produce per dunum of land that is comparable to conventional farms. The following chart illustrates their responses, and it shows that at present, organic farming does not yet match the output of conventional farming. As quantity of produce in organic production decreases, it is imperative that farmers are able to make up the

loss through price corrections. Therefore, retail and wholesale prices set for organic produce must ensure farmers continue to be incentivized to use organic methods.

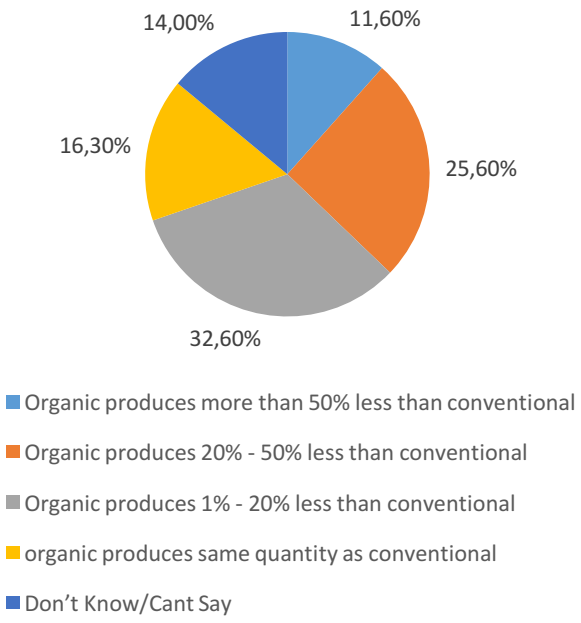


Figure 20: Farmers reported beliefs regarding yields from organic versus conventional production techniques

Concerning agricultural inputs, 81% of farmers ACTED surveyed indicated using bio-stimulants and bio-pesticides on their farms. These included bacillus, Neem Oil, Jenzara, potassium soap, foiling clay, manure and D-comp. 33% of the farmers indicated they used organic soil amendments. All the farmers who indicated using such products stated that they obtained them locally from agricultural shops. ACTED also asked farmers to estimate the cost of inputs per dunum of land. They indicated spending a median value of 3,000,000 LBP per dunum (1,983 USD), and 28% of the farmers indicated that the price of inputs was the greatest challenge they faced in producing organic crops. Farmers were also asked for main points of sale for their crops. The following chart shows a summary of their responses. Most of the farmers had multiple points of sale.

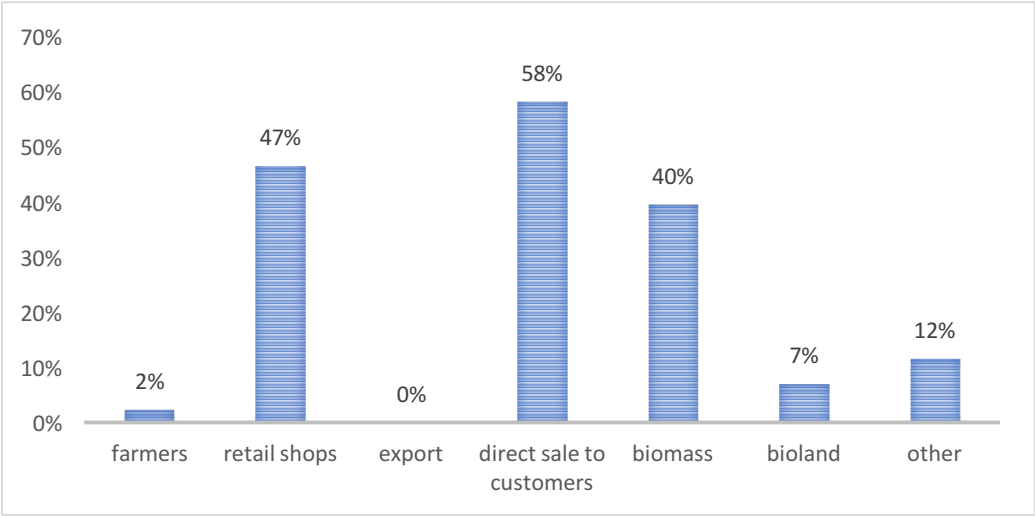


Figure 21: Main Points of Sale for Certified Organic Farmers

When farmers were asked about resources, only 42% indicated that had access to freezers and 44% had access to their own transportation such as trucks. ACTED's KIIs revealed that a lack of access to storage and transport is a major constraint in the growth of organic produce, as this type of produce has shorter shelf-life and spoils relatively quickly.

KII's with large distributors indicated that there is a common perception in Lebanon among farmers that organic farming is unprofitable due to lower yields and higher input costs. However, this assessment revealed that farmers currently working in this sector are able to maintain a net profit.[17] Indeed, although 21% of the farmers that were assessed indicated they did not make any profits or sometimes made a loss, 53% of the farmers indicated that they made a profit between 20-40% of their investment costs.

In summary, while certified organic production has strong market potential in Lebanon, support to organic production should go hand in hand with addressing other sectoral constraints. Support to this sector would not only create additional income gains for vulnerable farmers, but also yield positive results for health and the environment.

Reducing waste is imperative **to optimizing nutrient use on farms**, in addition to **enhancing post-harvest processing, including transport and storage of organic produce**. This includes **improving access to storage facilities, particularly refrigeration units or drying rooms**. Municipalities, cooperatives and small enterprises would all benefit from technical support for developing storage facilities; subsidized prices would incentivize and assist small-scale farmers to do so.

During KIIs, however, ACTED identified that farmers often display an 'intention gap,' which is a *behavioral* problem and also contributes to excessive waste on the farms. Farmers intend to sell all their produce, but do not have pre-signed contracts with distributors or wholesalers. As a result, during the harvest period – which can be quite short – farmers are left with an excess of produce that they are forced to throw out. This is especially true for farmers who do not rely on agriculture

as their main source of income (a large share of farmers in Lebanon). These farmers tend to reach out to markets just before the harvest season, during which time wholesalers have many supply lines and many not always negotiate the best prices, or may have already reached their supply targets. It is therefore necessary to **support wholesalers and distributors to develop harvest calendars and to pre-sign agreements with farmers, to reduce produce waste**.

3.3 E-Waste

While Lebanon does have some industrial assembly lines, where electronic goods are assembled from imported parts (Concord, for example), the vast majority of electrical and electronic equipment is imported.

The total value of imports of electronic and material goods into Lebanon was estimated at 1,878,855.89 USD in 2016.[18] The average quantity of new electronic products on the market in 2012 was 11.5kg per inhabitant, which equates to 46,000 tons.[19] This is comparable to the total number of electronic products on the market in the EU (19.6 Kg per person in 2016). At the same time, the estimated lifetime of new fridges in Lebanon is 8 years. For new air conditioning units, it is 9 years. By 2010, there were 2.5 million refrigerators in stock in Lebanon, which will reach the expiry of their lifespan by 2018-2019.[20] Ensuring the safe collection and disposal of such complex e-waste, which contains high levels of toxic materials by design, represents a significant burden on national systems.

This report considers economic opportunities within recycling of e-waste, the repair/refurbishment economies, and national regulatory reforms needed to reduce the energy loads of electronics in Lebanon. The findings and recommendations are based on the data collected by ACTED in the framework of this assessment, as well as data collected and existing research conducted by OLX.[21] 'E-waste' is an informal term used to describe household or business items with circuitry or electrical components, with power or battery supply, which has entered or could enter the waste stream.

The EU Directive on waste electrical and electronic equipment (WEEE) applies to the following categories of electrical and electronic equipment:[22]

- Large and small household appliances
- IT and telecommunications equipment
- Consumer equipment
- Lighting equipment
- Electrical and electronic tools (with the exception of large-scale stationary industrial tools)
- Toys, leisure and sports equipment
- Medical devices (with the exception of implanted and infected products)
- Monitoring and control instruments
- Automatic dispensers
- Agricultural machinery

E-waste is the fastest-growing waste stream worldwide, with estimates of 4% growth per year.[23] The sheer volume of e-waste globally is illustrated in a UN University report from 2017.[24] The world generated 44.7 million tons of electrical and electronic waste in 2016, or 6.1 kg per person per year — equal to the weight of nearly 4,500 Eiffel Towers. This volume is expected to increase to 52.2 million tons by 2021 (6.8 kg per person). Globally, only 20% of this waste is collected and

recycled. Consumer electronics represents 3% of the waste going to landfill globally.[25] The exact quantity of e-waste in Lebanon, however, is unknown.[26]

3.4.1 Recycle

Improving National Systems and Regulations

- Establish and enforce national regulations to formalize and incentivize the sorting and disposal of e-waste, in the household and at Municipal or other waste collection sites.
- Establish national regulations for safely extracting valuable metals from electronic components.
- Incentivize waste-collection, waste-disposal and recycling companies to include e-waste in their mandates.

Improving Industrial Systems

- Develop industry-wide best practice for safely extracting valuable metals from e-waste, in ways that minimize environmental damage.
- Broaden the mandates of waste-collection, waste-disposal and recycling companies to broaden their mandates to include e-waste.

Improving Consumer Awareness

- Conduct a consumer awareness campaign to increase public understanding of the value of metals contained in e-waste and the economic and environmental benefits of extracting them safely.

ACTED has assessed the value-chain of three common items of e-waste:

1) large and small household appliances

2) IT and telecommunications equipment

3) agricultural machinery

These products were selected based on availability of data on handling and processing of these types of waste from ACTED's KIIs. Other types of e-waste exist in Lebanon, but were not evaluated during this assessment. The principles of recycling these three specific types of e-waste are broadly applicable across the sector.

The value-chain of electronic goods in Lebanon is illustrated in Figure 22. The Circular Economy components of the chain are highlighted in green, and the following sections will discuss opportunities to develop their economic potential.

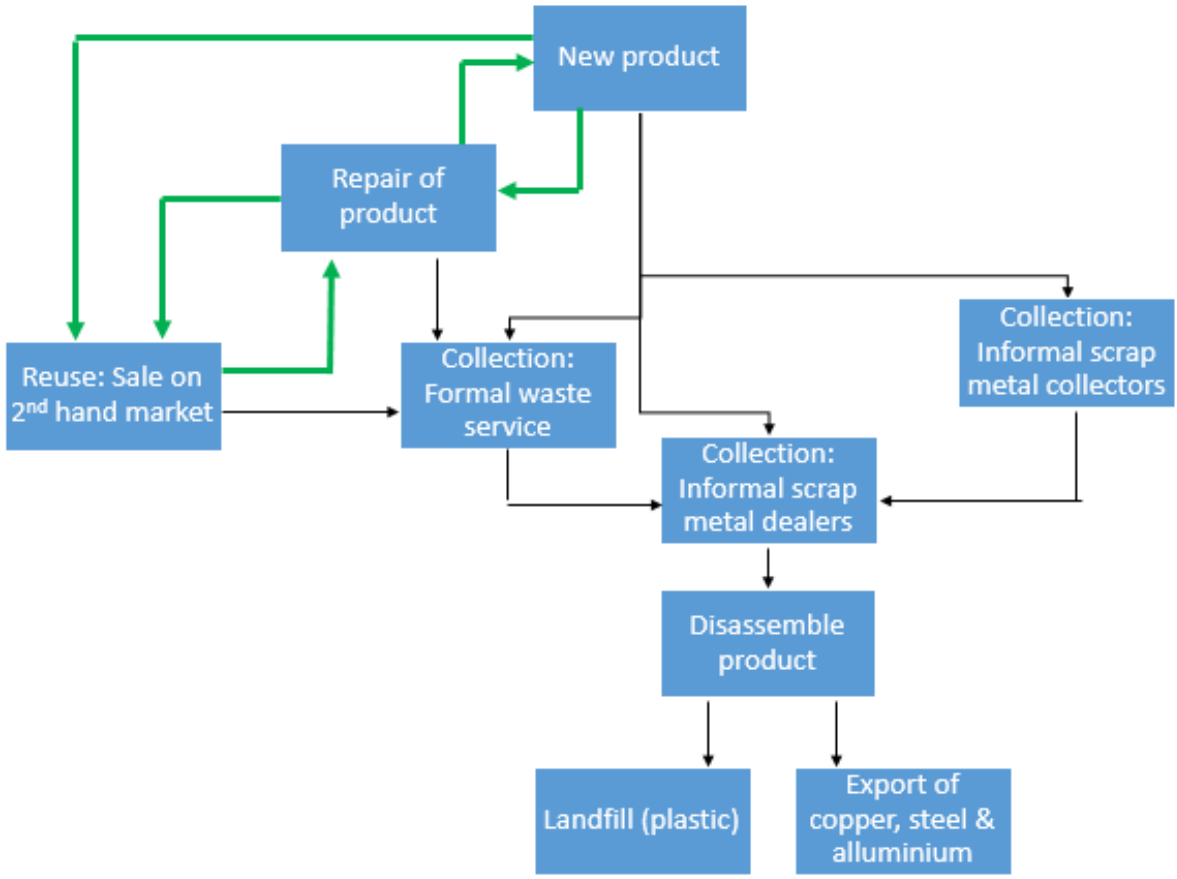


Figure 22. Value chain of electrical goods in Lebanon

One of the most important reasons for recycling e-waste is the fact that it not only contains hazardous substances that should be prevented from entering the environment, but also **highly valuable materials, such as gold, silver, copper, platinum, palladium, iron, aluminium, indium, gallium and rare earth metals, which are present in components such as control circuitry and batteries, and all of which may be recovered.**[27] However, in order to be recycled, e-waste must be treated using complex chemical and heat applications in a suitable integrated facility. E-waste recycling plants should combine specialized equipment for chemical treatment of waste, cement production, incineration conversion to energy, and pyrolosis – and no such

integrated facilities currently exist in Lebanon. As a result, used electric and electronic devices are dumped with Municipal waste in landfills or directly into the natural environment, or are handled by mostly unskilled people in the informal waste market, to recover metal and plastic. There are very few operations dismantling e-waste safely.[28] In the absence of the required equipment for safe extraction of recoverable materials, most e-waste is burned, generating toxic pollution.

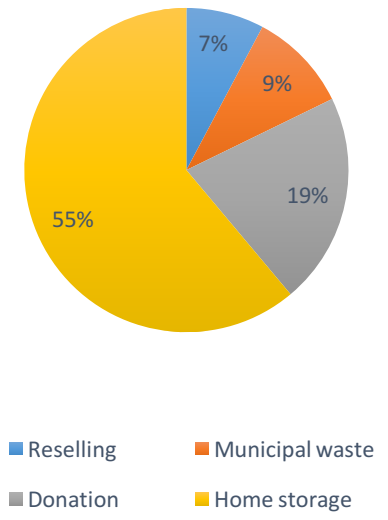


Figure 23: Current Status of E-Waste in Lebanon; Source: Baetoona

Such handling of e-waste represents a significant loss for the Lebanese economy. As stated by the ILO, *"Considering that the recycling of electronic waste and recovery of valuable metals is a major potential growth market internationally, the current haphazard disposal methods applied for e-waste in Lebanon also represent considerable economic losses."*[29] Actors working in the treatment of e-waste in Lebanon have reported that there are two main constraints on the expansion of the sector in Lebanon: **limited capacity for collection and limited consumer awareness**. According to an inquiry carried out by Beeatoona,[30] 65% of Lebanese electronic waste is stored in homes, while 35% is mixed with household garbage, and 65% of Lebanese are not aware of the hazards of e-waste disposal. To overcome the barriers to collection, actors are establishing drop-off points for consumers. To date, however, the two main actors were only able to collect and sell 40 tons (Adtech) and 15 tons (Ecoserv) of the estimated 47,000 tons generated in Lebanon.

Estimated USD 64 million lost per year in material loss from e-waste

The following table captures the cost per ton of specialized e-waste streams in Lebanon, estimated on the basis of ACTED's KIIs. Considering the estimated 47,000 tons of e-waste generated in Lebanon, and an average cost of 1,350 USD per ton, this represents an economic potential of over 64 million USD per year in cost-recovery. This accords with findings by United Nations University, which estimated 44.7 million metric ton of e-waste was generated globally in 2016, with raw material cost per ton of e-waste at 1,230 USD (thus representing ~55 trillion USD of material loss globally).[31]

Product	Data Source	Copper (kg)	Precious metals (kg)	Cost per ton of purchasing recycled e-waste (USD)	Actual end life value per item (USD)	Location of end buyer
Mobile phones	SWEEP-NET : Projected potential prices[32]	130	3.5 (Ag); .034 (Au); .014 (Pd)	15,000	2.5	N/A
E-waste (mixed)	Ad-tech	N/A	N/A	1,750	N/A	Europe
E-waste (mixed)	Eco-serve	N/A	N/A	800 – 1,500	N/A	Dubai

Figure 24. Value chain of electrical goods in Lebanon

Beeatoona has identified that e-waste disposal in Lebanon is ineffective due to five factors:[33]

1) Lack of legislation for disposal of e-waste in Lebanon
2) Waste collection companies not including e-waste in their mandates
3) Collection by informal scrap facilities with no environmental safety measures
4) Burning of e-waste to collect copper and other metals, generating toxic fumes
5) Improper disposal by informal waste collectors

Municipal facilities do not have the capacity to dismantle safely electronic or electrical goods that are sourced locally, and have reported that **the labor cost is too high and the economic incentive for dismantling and selling is too low** for the scale of materials received. Currently, Municipalities that do separate e-waste then provide them to NGOs for further processing. ACTED identified only four formal actors working in the sector, but **there are numerous informal actors who could treat e-waste effectively if they were formally supported and accredited.**

Unlike more developed nations, Lebanon has no way to recycle e-waste. Local actors who are collecting and dismantling e-waste export the recovered metals to Europe and Dubai for recycling and treatment, and send the recovered plastics to local recycling plants. Scrap dealers reportedly send to landfill plastics and other materials that they do not believe have an economic value. Scrap dealers' activities included collecting waste from Municipalities and streets for dismantling and the re-sale of metals. The price of scrap metal sold by Municipalities fluctuates, and as there is a large number of informal scrap dealers in Lebanon, some Municipalities are able to set competitive prices every week, as they can count on receiving several bids from different dealers.

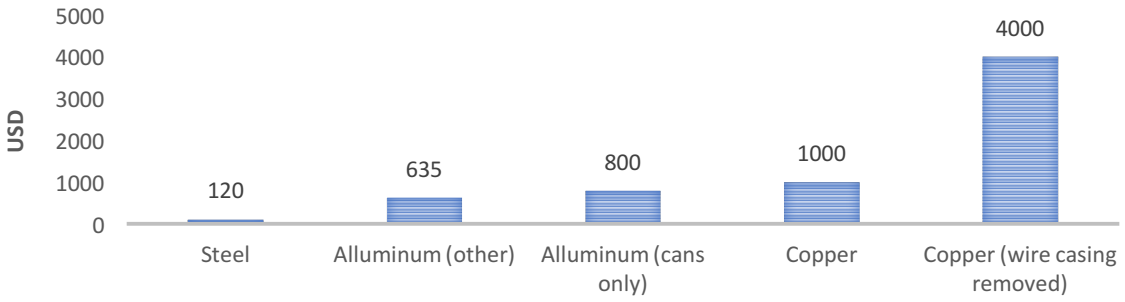


Figure 25: Current Metal Sale Price Per Ton to Scrap Dealers (USD) in August 2019; Source: Estimated based on KIIs

Due to the potential returns from sale of metals, municipalities could focus on metals as a valuable resource for recycling and thus ensure return on investment for their sorting facilities.

ACTED has estimated the end-of-life sale costs for various products, and as the next chart shows, their value reduces drastically from repair and reuse, to recycle; **representing a loss of economic opportunity**. According to the OLX survey, second hand whitegoods are sold in Lebanon for an average of 298 USD, but the value of scrap products is reduced to between 0.12 and 14.40 USD. This analysis does not consider the cost of collecting, treating and landfilling the waste, which further reduces the value of the product.

In summary, although the market for recovery of materials from E-waste is well established in Lebanon, the highly informal nature of this sector poses significant environmental and health hazards. Formalization of this sector would improve livelihoods for vulnerable populations, while ensuring compliance with national regulations and reducing impact on the environment. At the same time, repair and re-use of E-Waste should be prioritized over recycling. Higher material value can be recovered from reusing E-Waste products, while also significantly reducing environmental burdens both of discarding non-recoverable materials from recycling, as well as of importing new electronics and consumer goods into the country. This is discussed in detail in the next section.

3.4.2 Repair and Refurbish

Improving National Systems and Regulations

- Introduce tax incentives for the repair and second-hand economy, to stimulate the sector and reduce e-waste dumping in landfills.
- Support insurance and warranty schemes for the repair economy, to build consumer confidence and increase demand.

Improving Industrial Systems

- Formalize and organize the 'informal' repair economy, implementing standards for accrediting and regulating repair and re-selling activities.
- Provide technical training and business development support to repairers, to improve the quality of repair activities and enable repairers to expand their businesses online.
- Support specialized companies to organize the logistics of whitegoods repair, to ensure items are picked up, serviced and returned to consumers with minimal disruption.

Improving Consumer Awareness

- Support insurance and warranty schemes for repaired goods, especially electronics, to promote public acceptance of second-hand electronics, build consumer confidence and trust, and enable market growth.

In line with the *Joint Mission Statement* prepared by leading environmental actors in Europe,[34] significant economic, social and environmental gains in curbing rapidly increasing e-waste generation can be made by focusing on **reparability and durability** of electronics and other products, and to develop regulations that support reparability and durability. Specifically, the joint statement recommends the following:

> **For the environment:** prolonging the lifespan of products prevents their premature replacement by new products. To reduce the depletion of natural resources, it is crucial to

maximise the utilization of the precious materials already contained in everyday products. Environmentally, it is optimal to give appliances a second life – either by repairing them, reselling them, refurbishing them or at least remanufacturing and recycling the most vital components.

For the economy: finished products have more economic value than the raw materials inside them. By breaking products apart for recycling, this added value is lost. Repair, reuse and remanufacturing maintain, rather than destroy, that economic value. Moreover, maintenance and repair services would provide significant potential for job-creation if labour is taxed less and resource consumption more. Owing to the labour-intensive nature of re-use and repair activities, the potential for job creation in this area is many times higher than recycling. Manufacturers should embrace a more service-oriented approach to their business strategy and enhance their brand reputation as makers of durable products.

For society: consumers would have a better choice of after-sales service providers at more competitive prices, driving down the cost of repair. Easily repairable goods could also be sold on the second-hand market at low prices, especially to low-income groups. Easily repairable products and modular design may also have a marked impact on consumption patterns while boosting innovation in a rejuvenated market for repair, reuse and repurposing.

These conditions also apply to Lebanon, where effort is needed to build up the repair economy, which in turn will create employment opportunities while having significant environmental gains. Through the data collection efforts of this assessment, five primary product categories have been highlighted by key informants as having a functioning market for repair and resale. These are consumer electronics (mobile phones, laptops, desktop computers, etc.), whitegoods (refrigerators, washing machines), agricultural equipment (harvesters, weeders), as well as furniture and clothing which fall outside the e-waste value chain (see section 3.7 for details on the clothing value chain).

Existing repair actors reported that the highest demand for second-hand items in Lebanon was for mobile phones, computers, laptops and consumer whitegoods, as shown in the chart below (Figure 26).

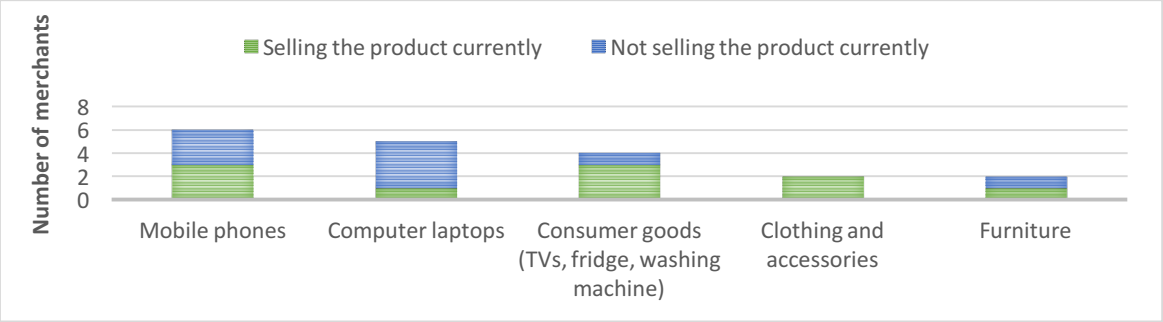


Figure 26: Merchant perception of product with highest consumer demand for repair; Source: Key Informant Interviews

ACTED's KIIs also indicated a large amount of waste related to equipment used in the agricultural sector, such as harvesters. One of the key constraints on the repair of such products is the scarcity of skilled workers. A large proportion of Lebanon's agricultural equipment is imported. No specialized training programs to repair such equipment were identified throughout the course of the assessment. Furthermore, due to the agricultural sector's reliance on international aid, a culture of dependency has resulted in most farmers and cooperatives simply replacing broken parts with new donated machinery. **Specialized training and awareness-building are needed to ensure materials in this sector are captured and reused before being sent to landfills.**

The current repair economy in Lebanon consists mostly of a number of small localized enterprises, typically characterized as 'informal,' which often specialize in the repair of a limited number of products. ACTED found that most operations are very small, with an average of 1.8 staff, and that most hired Syrian laborers.[35] The majority of these actors are interested in expanding their market and repairing and re-selling items they are not currently restoring, but they also noted that lack of capital, market demand and consumer awareness of the benefits of repair are the major barriers to growth in this sector. To overcome these constraints and support growth, **businesses highlighted the need for capital investment and technical training. In fact, 40% highlighted that they needed technical training to expand their market share,** and almost half had never received technical training for repair. Most of these businesses also need **support for marketing their products and services and using online platforms for sourcing and re-sale of items.** At present, internet use among informal repair actors is very low: only one of those interviewed reported sourcing second-hand items for repair on the internet.

ACTED's KIIs also indicated that inconsistent professionalism and inefficient logistics are major constraints on the repair economy.

Collection routes for waste electronics and whitegoods are not well organized and often these items are left to decay in public spaces or the natural environment. As well as increasing pollution,

this represents a missed opportunity to keep repairable products within the economy. None of the merchants ACTED interviewed reported picking up secondhand materials from recycling facilities, Municipalities or landfill or dump sites. **Closer links between repair actors, Municipalities and facilities, and improved collection routes, would keep more repairable products in the economy.**

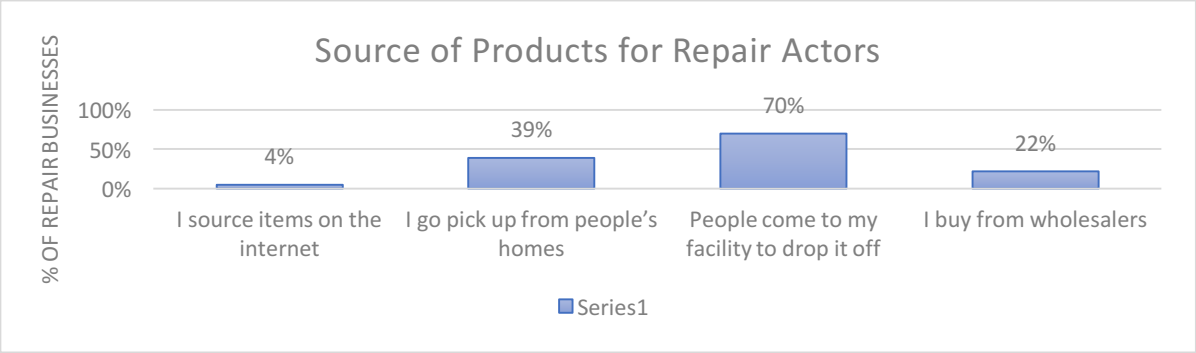


Figure 27: Repair actors source of products for repair; Source: ACTED Assessments

Although some consumers deliver second-hand products to repairers' facilities, more often, repairers pick up items directly from homes, resulting in a heavy resource burden related to collection. For example, most consumers prefer not to have workers repair consumer goods such as washing machines in their homes, as the process is complex and potentially unsanitary. Repairers may also not always have immediate access to spare parts. There is therefore a need for **a level of third-party logistics, to pick up waste goods, transport them to repairers' warehouses and return them once repaired, while also leaving temporary 'stand-in' equipment in consumers' homes to minimize disruption.** Specialized logistics companies are imperative to develop and support the repair sector.

Repair activities can have significant income gains for vulnerable populations. In fact, repairers reported to ACTED that their mark-up on resale of repaired items is between 26% and 275% (Figure 27). In line with a-priori expectations, gains are much higher on more complex products such as laptops, as compared to products such as clothing which require a lower level of skill to repair.

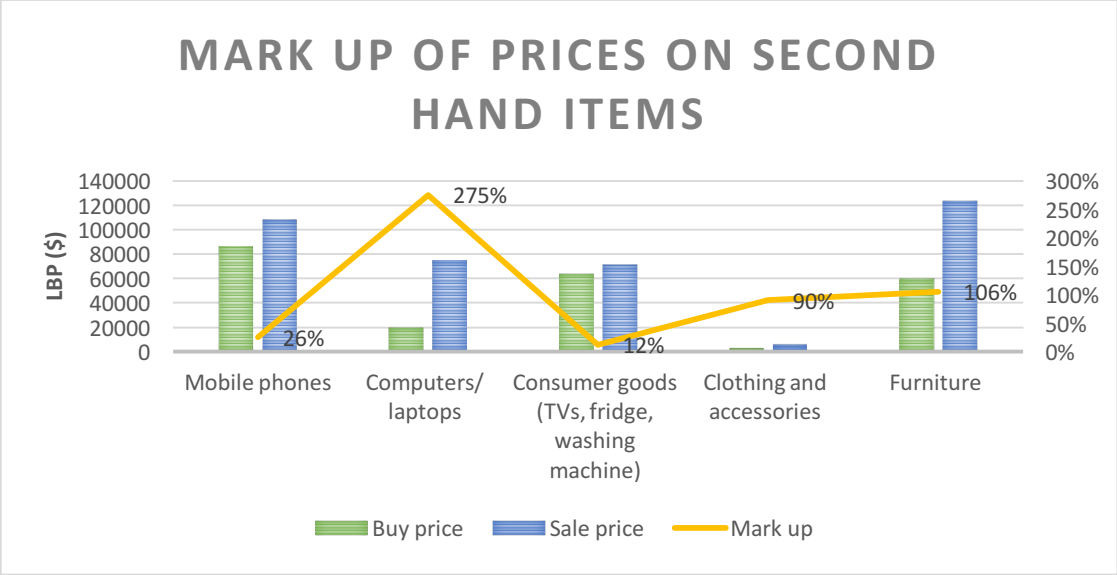


Figure 28: Mark Up on Second Hand Items; Source: KIIs and OLX

However, the average price received for products sold online is much higher than prices obtained in their workshops.[36] This indicates that **if they were better able to access and market their products online, they could increase the mark-up of repaired products** (Figure 28).

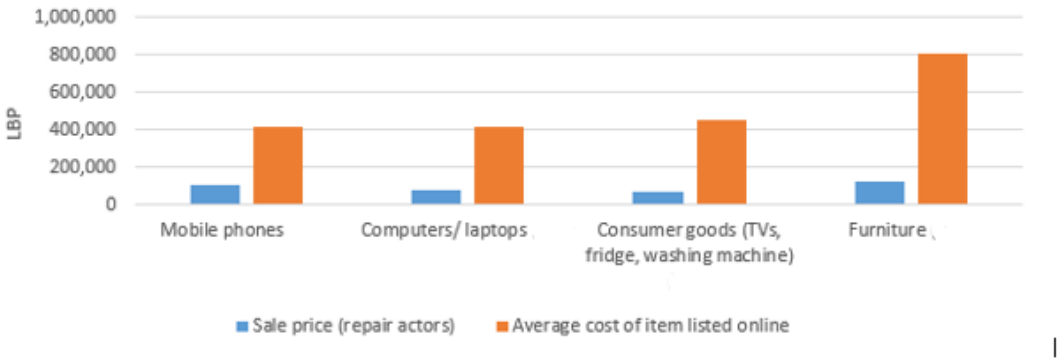


Figure 29: Comparison of second hand prices by informal repair actors and online platform; Source KII and OLX

As illustrated in the volumes of online sales per region in Lebanon,[37] the online market for OLX in Beirut and Mount Lebanon is stronger than in other regions (Figure 30).

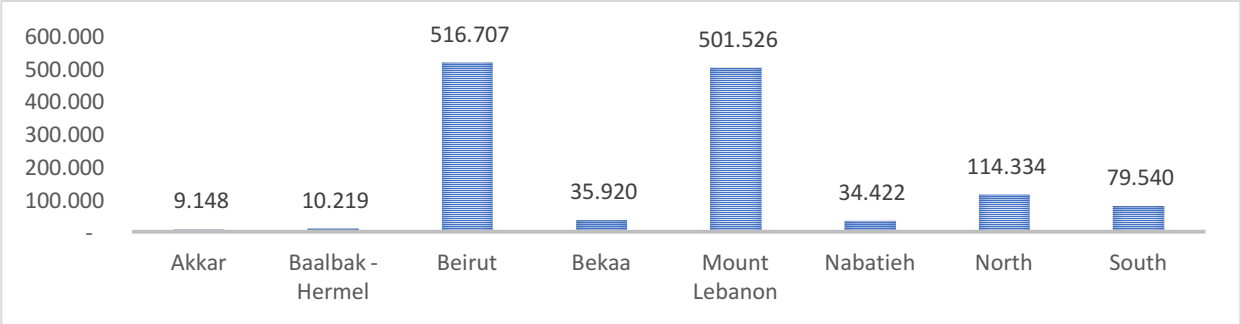


Figure 30: Volume of products posted online per region between August 2017 and August 2019; Source: OLX

The low sales in other regions could be due to a number of reasons (OLX marketing priorities, local preference for other platforms), but these findings indicate that **there is room for growth in marketing second-hand and repaired products online in other regions outside of the capital**.

To determine the barriers to consumers using the online second-hand market in Lebanon, OLX conducted a survey[38] of *usership, perception and behavior*. OLX found that of those not currently using the platform, 62% do not like to buy or sell secondhand items and 15% do not trust buyers or sellers from classified platforms. Lack of refund or guarantee on products (49%) was the greatest deterrent to customers for buying products online, and the second greatest was that 'pictures misrepresent the actual items' (38%). Support should be provided to sellers **to formalize and regulate the second-hand sector, introducing product standards and legally enforceable insurance policies and warranties**. Finally, potential buyers of second-hand items are deterred from buying online as they 'would rather touch or feel' the products before buying. **Establishing local second-hand showrooms**, such as the showroom in Damour managed by Arc en Ciel, linked to online marketing, would allow buyers to make well-informed purchases, encouraging growth in this sector and decreasing the amount of e-waste in landfills.

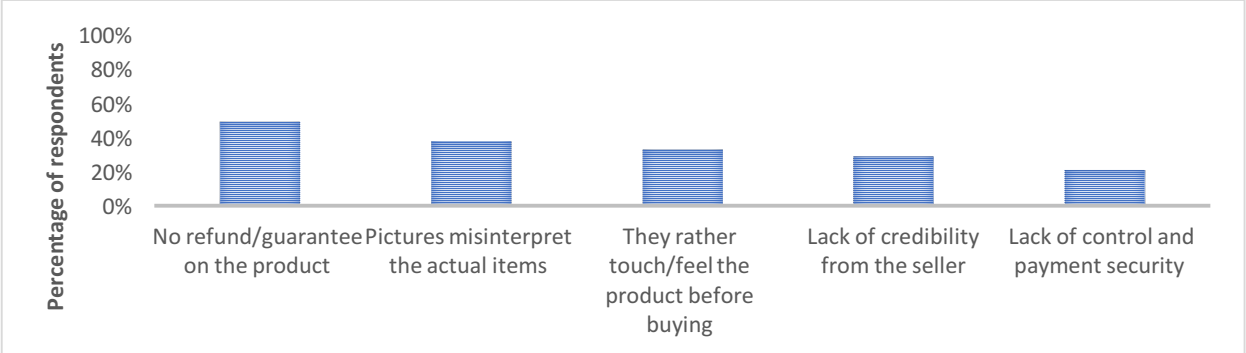


Figure 31: Reported consumer barriers to buying products; Source: OLX

A consumer perception study implemented by ACTED[39] found that consumers' willingness to buy second-hand items varied between geographic areas. Participants in Metn (both men and women) reported that they would not consider buying second-hand items such as used electronics, used furniture or used clothing. One contact reported that doing so represented a 'perception issue' for Lebanese citizens; there appears to be a widespread cultural prejudice against purchasing already-used products. As with the findings of the OLX study, the lack of warranty was also reported as a deterrent against buying second-hand items. Participants in Akkar, on the other hand, reported that they would buy second-hand items, due to their generally lower cost.

All consumers in ACTED's study reported that they would willingly repair items before buying new items, but that the price of repair is a deterrent for many. The informal nature of the market indicates that price point determination is not transparent. Repairers of electronics charge diverse rates for their service, with prices varying widely even for the same product, irrespective of rates charged for spare parts. As at August 2019, there were 224 electronic repair service providers listed on OLX's platform. Figure 32 illustrates the cost distribution of electronic repair services, which can be up to 50 USD per item.

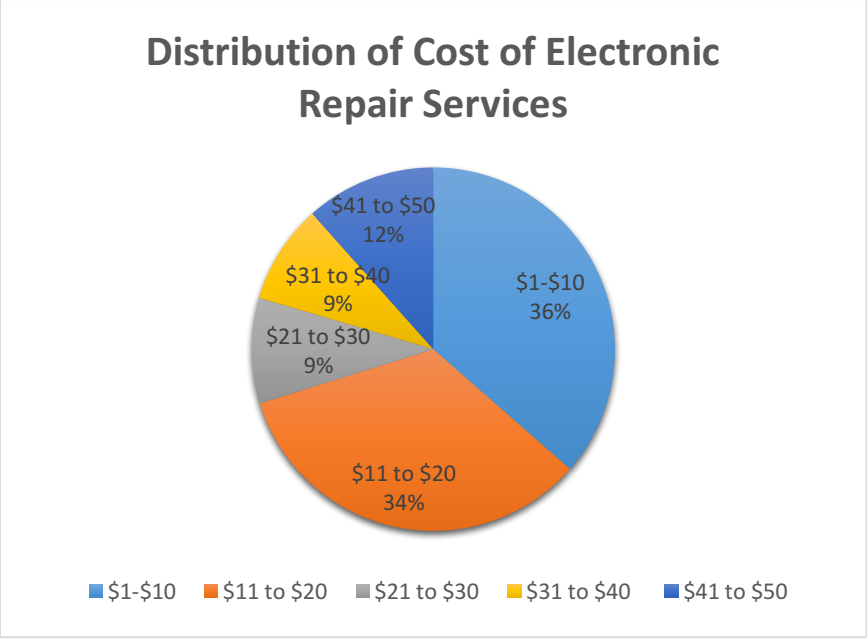


Figure 32: Distribution of cost of electronic repair services; Source; OLX

This accords with findings from ACTED's KIIs. Many informants reported that the Lebanese repair and second-hand product markets place an unfair burden on lower socio-economic classes. Given that the repair economy is characterized by a relatively high degree of informality, with only limited demand and lack of warrantees for repaired items, the market is not able to garner enough of a consumer base to achieve economy of scale and bring down repair costs. Secondly, repair costs have been reported as prohibitive considering lack of assurance of quality of repair. Many

consumers simply cannot afford to purchase repaired or second-hand e-waste which may again be in need of repair soon thereafter, so collectors and dealers have little choice but to send it to landfill or dump it in public spaces. To reduce the volume of e-waste, **consumers should be incentivized to foster the repair of existing products through national awareness campaigns and tax benefits for second-hand products.**

Additional assessment of potential financial mechanisms that could be considered is required, such as lowered taxes on repair service activities and increased taxes on resource-intensive and single-use products instead.

Lebanon's retail service providers sector is not regulated, and ACTED's KIIs indicated that actors in this sector often do not pay VAT. Therefore, providing regulatory incentives for repair will be challenging. Spare parts for brand-named products are also expensive and not always available. For cost efficiency, technicians would require linkages to specific companies, but there is not yet economy of scale for international brands to establish effective repair services in Lebanon.

If products were effectively repaired and resold by the original dealer, it would almost certainly enhance public perceptions and trust of the second-hand market. The major importers of electrical and electronic products would need support, and coordination with the Syndicate of Electrical and Electronic Importers is required. GIZ have identified that **to stimulate the repair economy, technicians require training in general repair of whitegoods, including handling compressors, moving mechanical parts, and replacing electronic circuitry.** Given the large number of imported non-branded whitegoods into Lebanon, there is an opportunity to focus training on these products.

Replacement of refrigerants in air conditioners and fridges, when correctly implemented, can extend the lifetime of the product while also being cost-effective: the average cost of replacing refrigerant is 30 USD.[40] Replacement is a hazardous and specialized activity, however, and currently there is a very limited number of technicians trained in the process. Adding to the risks, Lebanon has no standards for regulating refrigerant replacement or overseeing refrigerant safety.[41] To address this risk, the Ozone Unit in the Ministry of Environment, responsible for coordinating, monitoring and implementing all Montreal Protocol Activities including Ozone Depleting Substances (ODS) Phase-out in Lebanon, has recently launched training[42] in Dekwayne, Beirut, to train 1000 repair technicians on safe replacement of refrigerants in fridges and air-conditioning units. This additionally provides a significant opportunity to keep products in the economy longer.

In summary, critical structural inefficiencies in the repair market for second hand products in Lebanon have resulted in a large number of electronic goods disposed of in scrap yards and unsanitary landfills. Investing in the repair economy could create sustainable livelihood opportunities, in addition to ensuring electronic products have a longer life in the economy, thus closing the loop and achieving environmental benefits. While some initiatives such as the MoE Ozone Unit's technical trainings have created opportunities for increasing skills of labour force, key gaps remain. Thus projects that improve consumer awareness of lifecycle of common electronic products, technical skills development for the labour force engaged in the repair

economy and investments to establish formalized repair workshops that offer effective and reliable repair services to consumers are critical.

3.4.3 Reduce

Improving National Systems and Regulations

- Establish national regulations for rating the energy efficiency of electronic products.
- Incentivize the importation of more efficient models, through tariff and/or tax concessions.
- Revise banking secrecy laws and other security measures, to increase public trust in and use of cloud storage systems and reduce reliance on imported computer hardware.

Improving Industrial Systems

- Coordinate the development and implementation of Minimum Energy Performance Standards (MEPS), as sponsored by the Lebanese Center for Energy Conservation (LCEC).

Improving Consumer Awareness

- Improve public understanding of energy efficiency, and incentivize purchasing of more efficient electronic goods, by introducing clear and easily understood energy efficiency ratings, displayed on labels on all electronic goods.

The global electronics sector is characterized by a generally high product obsolescence rate, as well as rapidly evolving technologies and decreasing prices. In particular, the growth of the internet is leading to a proliferation of IT and telecommunications hardware, even among lower socio-economic sectors. All of these factors are driving consumers to purchase new items more frequently, instead of satisfying themselves with older models or alternatively seeking repair services, which could further stimulate job creation. Moreover, electronic goods are being produced with increasing levels of complexity, required high levels of mechatronics knowledge. Countries like Lebanon suffer from low technical capacity, making repair difficult. Moreover, most branded products use propriety technologies, and repair knowledge is not widely available. Workers in the repair economy are usually trained by individual brands. This is a particular constraint in small markets such as Lebanon where most branded goods are imported through a

few formal import networks, and these are the only ones authorized to repair such branded products. This drives up costs and reduces accessibility for most people.

As technology rapidly evolves, the end-life value of many products is decreasing, thus lowering the opportunity for recycling. This is illustrated by the evolution of washing machine models in the Lebanese market: as new models of washing machines have developed, the value of the scrap metal from discarded washing machines has decreased from 120 USD per ton to 51 USD per ton.[43] With the decreasing profitability of recycling schemes, and increasing inefficiencies in global recycling value-chains, there is an urgent need to focus on reducing consumption of electronics.

Such rapid obsolescence and declining value-extraction highlight the need for improving consumer awareness through communication and advocacy initiatives, to reduce the consumption of electronic goods. Such advocacy initiatives could include improving consumers' understanding of the lifecycle of electronic goods and their impact on the global environment. Furthermore, there is a need to promote energy-efficient products.

ACTED's KIIs have indicated that there is very little awareness among Lebanese consumers regarding energy efficiency ratings for electrical and electronic goods. A study conducted by UNDP in 2018 assessed the efficiency ratings of 5 appliances in the Lebanese Market: Washing Machines, Air Conditioners, Televisions, Light-bulbs and Refrigerators. The study found that of the 630 respondents, 478 (76%) were not aware of energy Labels.[44]

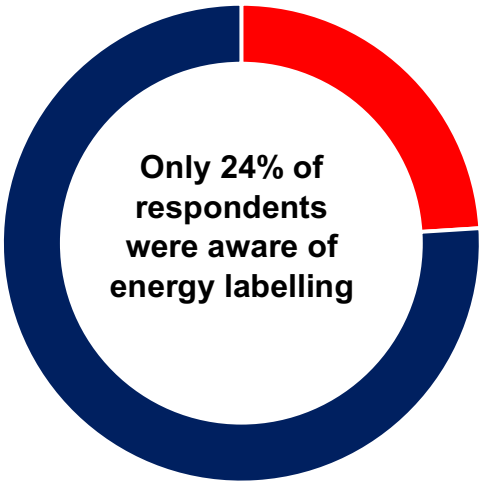


Figure 33: Awareness of energy labels on home appliances

The same report also found that awareness of energy labels varied according to respondents' socio-economic background. 'Middle Class' respondents (from intermediate managerial, administrative or professional occupations) were found to have the highest awareness, while Working Class respondents (semi-skilled and unskilled manual workers) were found to have the lowest awareness. Interestingly, when respondents who were aware of energy ratings were asked about the source of their awareness, the key source they cited was advertising by retailers.

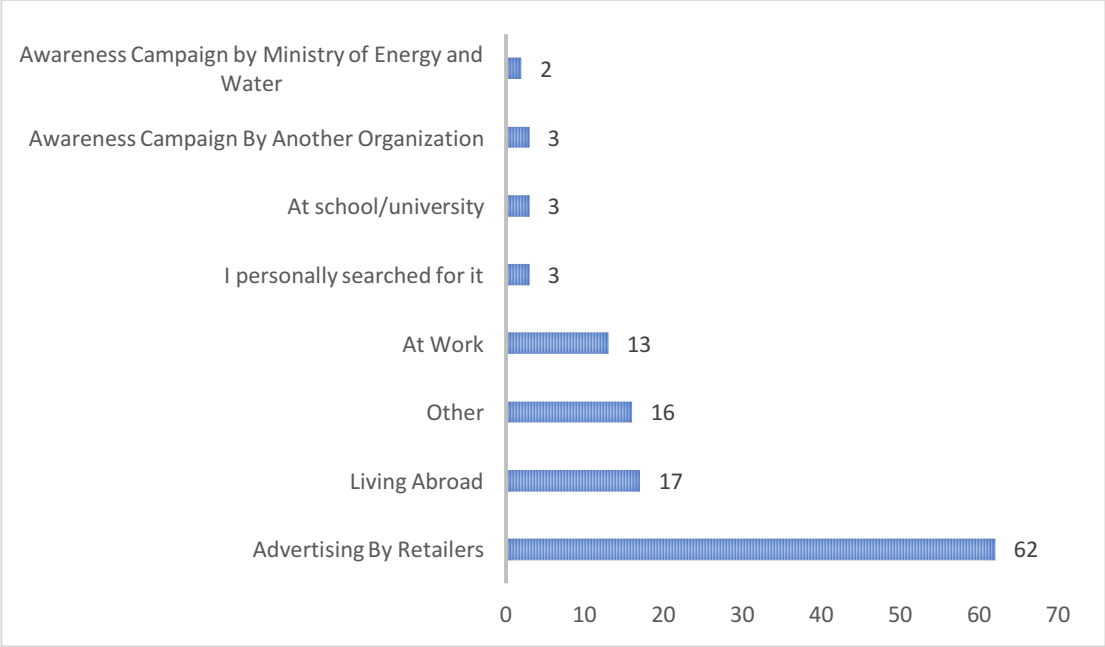


Figure 34: Source of Awareness About Energy Labels; Source: UNDP

Furthermore, 54% of respondents of the survey considered energy labels 'important' and 'very important' in their purchasing decisions. The reasons why are as highlighted in the chart below:

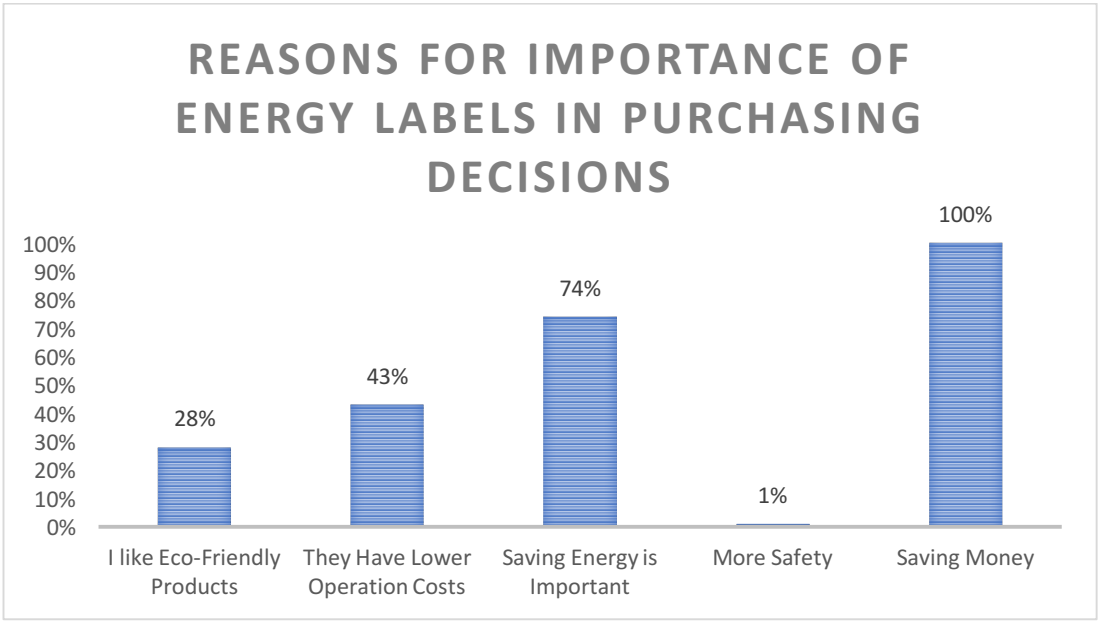


Figure 35: Reasons for the Importance of Energy Labels in Purchasing Decisions; Source: UNDP

This indicates that while most consumers are aware of and care about the importance of energy conservation, they lack labeling literacy and are unable to understand many products' energy ratings. The Lebanese Center for Energy Conservation (LCEC) is currently working on Minimum Energy Performance Standards (MEPS) for the residential sector. These standards will be based on a comparison of international schemes such as the European, the American and the South Korean. The MEPS define the minimum requirements of performance that an appliance or a group of appliances must meet in order to be accepted on the Lebanese market. Products not meeting the MEPS requirements will be banned from entering the market. A technical committee was created by the Lebanese Certification body LIBNOR to work on the energy efficiency indices to be used for the MEPS. In addition, the LCEC is also working on a Lebanese Energy Labelling system for household appliances. The labels will define the annual energy consumption of the equipment. These labels should be complemented with educational campaigns, to improve consumers' labeling literacy.

There are also significant opportunities to reduce material impacts on the environment through virtualizing the economy. Developing technologies, such as cloud storage, offer consumers and industry the opportunity to reduce reliance on hardware electronics as servers and data centers, turning instead to a virtual service, hosted centrally, off-site. Although infrastructure for cloud storage has been established in the UAE, in Lebanon[45] the constraints on the use of cloud storage include:

1) **security**: government regulations on the banking and telecommunications sectors limit the potential for data to be stored overseas

2) **banking secrecy laws** decrease individuals' and companies' trust in the cloud

3) **political instability**, **small market potential** and **high investment costs** have limited opportunities to establish local cloud storage

3.5. Plastics

Plastics pollution is becoming a global issue, with many countries taking initiatives to reduce plastic use and contamination in the natural environment. This is a particular problem in Lebanon due to its high dependence on imported products (making design innovations to reduce plastic use such as in excessive packaging difficult), the nature of its distributed economy (which results in fragmented manufacturing, use and waste generation that lack economy of scale), the large plastic manufacturing industry in the country which contributes positively to the economy and generates employment opportunities, and various macro and micro-economic factors that make recycling of plastics non-viable. As a result of this, plastic pollution has become a particular problem in Lebanon. In fact, it is estimated that Lebanon has the second highest percentage of tap water contaminated with plastic fibers in the world after the United States, with a contamination rate of 93.8%[46].

From a Circular Economy standpoint, reuse of plastics is not an option as this can have health consequences as the plastics break down. Elimination of plastic pollution requires design innovation to reduce the presence of plastics in products and packaging, improve the recyclability of plastics, reduce leakages in recycling systems, and improve plastic designs to remove hazardous additives and chemicals. But most importantly, manufacturers should phase out plastics that are technical nutrients, obtained from finite resources, and replace them with renewable feedstocks (biological nutrients) that are obtained from sustainable managed sources. This report considers the key opportunities and bottlenecks that constrain plastics recycling in Lebanon, and the regulatory reforms that are necessary for improving plastic design and increasing plastic recyclability. Moreover, the section concerning the paper value-chain considers opportunities for replacing plastic products currently made in Lebanon with paper-based feedstocks obtained from recycled paper.

3.5.1 Plastic Recycling

Improving National Systems and Regulations

- Increase customs and taxes on new ('virgin') plastics imported into Lebanon, to make the cost of locally recycled plastics competitive.
- Set national standards for grading, sorting and baling plastic recyclates.
- Integrate advanced technology – such as Near Infrared (NIR) Sorting – into sorting facilities, to reduce errors in sorting plastics.

Improving Industrial Systems

- Enable a cheaper and more reliable electricity supply for plastic recycling industries, to keep the costs of melting and moulding plastic recyclates competitive, against the low cost of plastic manufacturing in neighbouring countries.
- Improve industries' capacity to integrate and absorb recyclable plastics, by providing expert technical advisory services to recycling and manufacturing industries, and by subsidizing testing for quality control of plastic life-cycles and recycled plastic products.
- Introduce a national system of inspection and certification to regulate post-industrial waste.
- Establish looped waste management systems in smaller geographical areas, so that recycling industries can source post-consumer waste from local Municipalities and co-operate meaningfully with local populations.

Improving Consumer Awareness

- Introduce a national system of inspection and certification to regulate post-consumer waste.

- Implement a public information program to improve consumers' understanding of recycling value-chains, recognition of recyclable materials and awareness of the benefits of recycling, and to incentivize consumer participation in recycling programs.
- To incentivize industries to reuse plastic recyclates, consumer campaigns should also highlight products that contain recyclates and increase demand for them.

Lebanon has a robust plastic manufacturing industry, with 306 registered manufacturers making products of varying degrees of complexity. With reconstruction works in Syria expected to increase market opportunities, KIIs revealed that plastic manufacturing is expected to increase in Lebanon, particularly for products such as PVC pipes and electrical cables used in building. In addition, there are several industrial manufacturing companies that produce disposable tableware and packaging for the Food and Beverages industry.

All of these sectors have the potential to absorb locally recycled plastics, and thus to increase the sustainability of the system. However, as shown in the following sections, the plastics value-chain would likely require subsidies in order to remain viable. **Plastic does not allow robust cost recovery for municipal sorting facilities or private recycling companies**. Investments in the re-use of plastic are most relevant for environmental outcomes rather than economic development outcomes.

Type of Plastic Product	Type of Material Used
Food Packaging: Plastic cups, salad boxes, plastic cutlery	Polyethylene terephthalate (PET), Low density Polyethylene (LDPE), Polypropylene (PP), Polystyrene (PS)
Containers and Bottles: water bottles, detergents, water containers	High Density Polyethylene (HDPE)
Pipes	PVC Polyvinyl chloride
Home Furniture	PVC Polyvinyl chloride
Agricultural Materials	PVC Polyvinyl chloride, Low density Polyethylene (LDPE)
Bags	Low density Polyethylene (LDPE)
Hospital Materials	High Density Polyethylene (HDPE)

Figure 36: Product Segmentation and Types of Materials Used in Plastic Industries in Lebanon

Plastic production in Lebanon is highly competitive. Start-up costs for plastic manufacturing industries are relatively low, a fact which may explain the large number of actors in this sector. In 2015, a report by Blominvest on the plastic industry in Lebanon found that **plastic-recycling machinery is highly affordable and averages 15,000 USD.**[47] Furthermore, plastic as a raw

material does not expire, allowing industries to stock up on raw plastic when prices dip and to store it until prices rise again, to attain better price points for their products. Finally, plastic is an extremely inelastic product with very few alternative materials available to consumers.

While all of these factors have encouraged plastic production in Lebanon, they greatly reduce the economic incentives for recycling and increase dependence on imported virgin materials. In 2015 alone, Lebanon imported USD 695 million worth of plastic as a raw material.[48] At the same time, waste collection schemes in Lebanon are collecting large volumes of plastic, most of which is not recycled but sent to landfill.

Plastic waste comes from two sources: industry and consumers. If Lebanese manufacturers use recycled plastic in their production processes, it is overwhelmingly drawn from post-industrial plastic waste. Of the key informants who participated in ACTED's assessment, only two were using recycled plastics, and then it was only post-industrial waste. None of ACTED's KIIs indicated that Lebanese manufacturers or recyclers are using plastic drawn from post-consumer waste.

The key reason given was the low level of cleanliness of post-consumer waste in Lebanon. KIIs revealed that even the smallest particulate contamination in recycled plastics (one informant cited a single banana peel in a 500kg plastic bale) could damage their equipment by clogging feeds and conveyor belts, causing temperature and melt-flow variations, and blow-outs of hot molten plastic. Contamination is very hard to detect and requires trust in the source of recycled plastics. Increasing the supply of clean post-consumer recyclable plastics, however, can yield substantial commercial rewards.

The global plastic markets have important lessons learnt for the Lebanese plastic industry. In countries such as the United States and Europe, the cost of recycled plastics has been declining which encourages manufacturers to use recycled plastics over virgin plastics in their products. Some governments have provided additional incentives such as tax benefits for manufacturers who use larger share of recyclates in their products. This is largely made possible by low cost of recyclates, which have comparable or lower prices than virgin plastic, thus incentivizing manufacturing industries to use larger share of recyclates.

As can be seen from the two charts below, the cost of post-consumer plastics is comparable or even cheaper than the cost of virgin feedstocks in the EU. Such competitive prices have easily allowed plastic industries in Europe to substitute virgin plastic with blends containing recycled plastic, without affecting their bottom line.

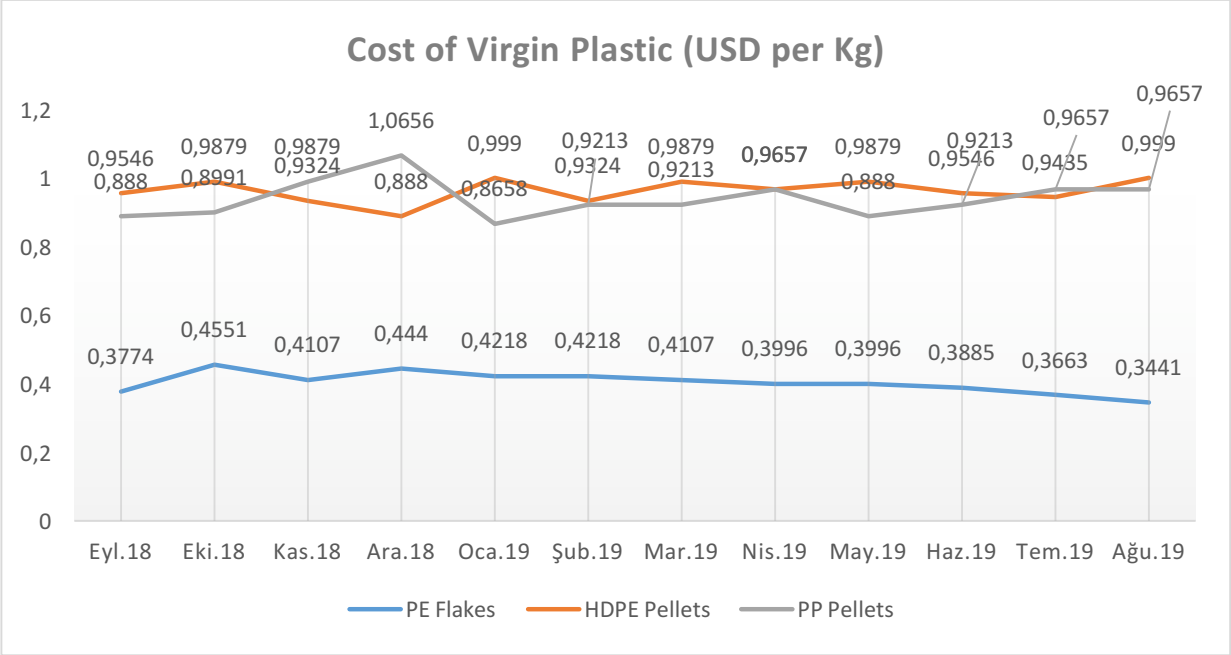


Figure 37: Cost of Virgin Plastic; Source:www.plasticticker.de

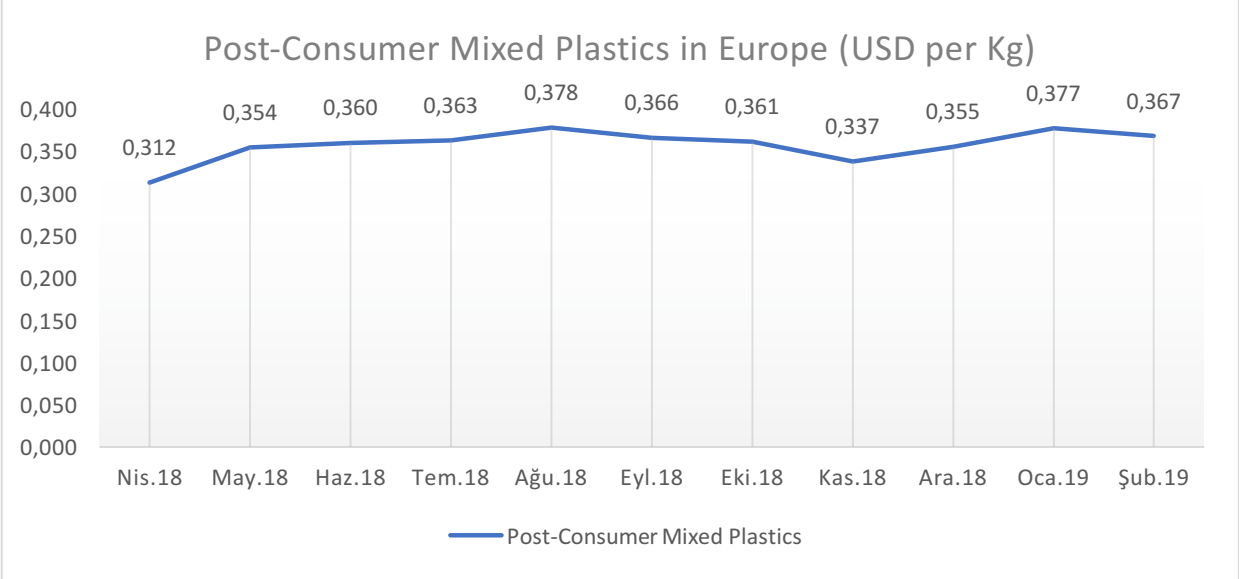


Figure 38:Post-consumer Plastic Prices (USD per Kg); Source: Foreign Trade Statistics

In Lebanon at present, the situation is different, as recyclable plastics pose substantial costs. However, some straightforward and limited policy adjustments can unlock their full commercial potential.

The high cost of post-consumer recyclable plastics in Lebanon has reduced their profitability. At the same time, Lebanon's strategic location, the low tariffs and duties at its ports, and its international relationships and trade agreements have lowered the cost of virgin plastic. In fact, the prices for virgin plastic provided to ACTED by key informants were much lower than prices in Europe. The prices provided for PP ranged from 0.25 USD/kg to 0.500 USD per Kg (as compared to the range of 0.865 USD/kg to 1.0656 USD/Kg in Europe) and for HDPE ranged from 0.1 USD/Kg to 0.2 USD per Kg (compared to 0.888 USD/Kg to 0.999 USD/Kg in Europe). Such low prices have increased the profitability of plastic industries, but have reduced incentives for recycling.

In order for plastic recyclate to be absorbed effectively into local industries, measures should be taken to:

1) reduce the cost of post-consumer waste, through improving economy of scale and efficiency of logistics of the waste collection and sorting; and,

2) increase prices of virgin plastics through taxes and customs.

In order to incentivize the valorization of plastic waste, it is vital to support the value-chain at a certain level of robustness and efficiency, so that sale prices are high enough to ensure some cost-recovery for sorting facilities, but keep the costs of source recyclable plastics competitive with virgin plastic. In the EU, the circular material use rate, which measures the percentage of material resources that come from recycled materials, is only 11.2% in 2017.[49] This is a complex market and ensuring the right price incentives requires continual, careful analysis. As this example scenario shows, the key to success is **economy of scale.**

Example Scenario for cost Recovery for Municipalities in Lebanon from Plastic Sales

The average waste collected per Municipality is 77 tons per month. If we assume that 50% of recyclables are recovered, on average a municipal sorting facility would be able to recover 38.5 tons of waste. This would provide an estimated return of 14,899 USD per month. Comparing to the average municipal expenditure a month (ranging between -9,212 to over -22, 141), this is a clear indication that cost recovery for municipal facilities in Lebanon is only realistic if they achieve economy of scale.

Weight of Recyclables collected per month (Ton)	Estimated Cost recovery per month (estimated at 0.378 USD/Kg)
1	378
5	1,890
10	3,780
20	7,560
50	18,900
100	37,800
200	75,600

For sorting facilities that do achieve scale, higher levels of cost recovery are possible, especially if the facility is fully or semi-automated and is able to have high level of compliance while reducing the any errors.

The most practical way of reducing costs to industry is to ensure that recyclable plastics are properly sorted. ACTED's KIIs identified that improper sorting of plastics causes one of the most serious burdens on industries' bottom lines. Manufacturers who bought plastic recyclates stated that if the recycled plastics were pre-sorted in accordance with their requirements, then they cost less than virgin pellets and were cost effective. Specific suppliers, such as Arc En Ciel and Roky Plast, which have built an effective model for sorting and processing plastics, were able to offer recyclates at highly competitive prices.

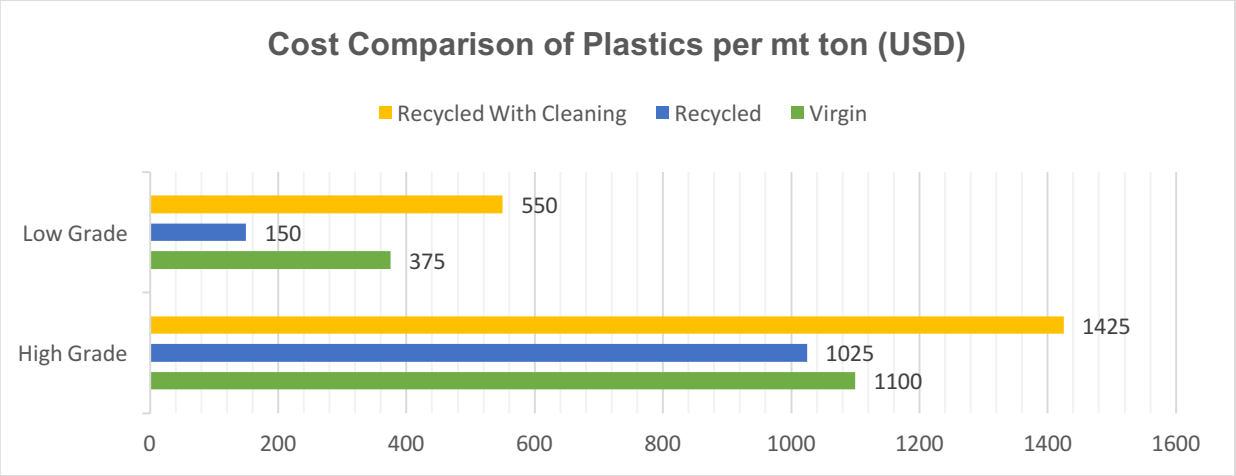


Figure 39: Average Cost of plastics per mt ton in the Lebanese Market

Based on the current market segmentation in Lebanon, and ACTED's KIIs, and in light of EU standards for the sorting of plastics, **the following method of sorting is recommended.** At the first stage, PE, PP and other film should be removed, followed by PS, PP, PE-HD/PE-LD and PET at the second stage. PET should be further separated into bottles vs other products, and bottles further separated by colour.

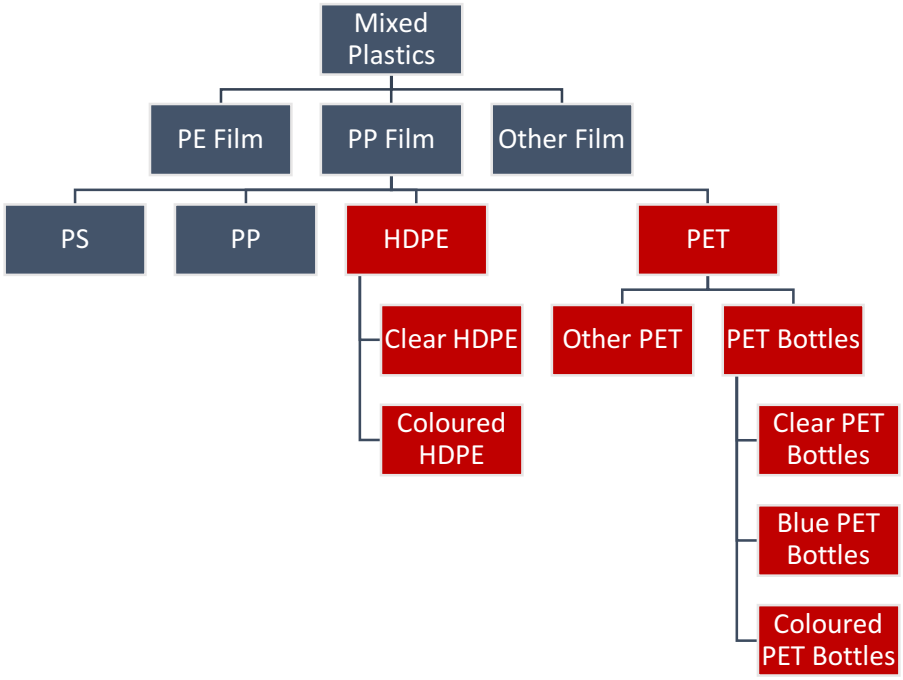


Figure 40: Proposed method for sorting for improved valorization of waste

In terms of profitability, in line with global trends, KIIs indicated that PE-HD, PE-LD and PET have the greatest market demand in Lebanon. Therefore, ACTED recommends that at the first stage, the focus should be on setting national guidelines for sorting and baling of these plastics in particular.

Improving the **efficiency of sorting** is critical. Certain types of plastic have to be separated from others, in order to guarantee the chemical integrity of recycling processes and thus the quality of recycled products. Most plastic recycling in Lebanon employs mechanical processes. Shredding, for instance, allows plastics to be reused without changing their basic chemistry. Used plastics can also be melted down with virgin plastics to create polymers. However, mechanical processes only work for pure plastic types, such as PE, PET, PP and PS. If, due to sorting errors, other more complex plastic types are allowed to mix with these pure types, they will almost certainly degrade the quality of the recycled polymers.

The appearances of plastics can be deceiving. Consider the *Tide* brand of detergent, which comes in two containers of an identical colour. These containers look similar to the human eye. However**, the container on the lef is made of HDPE, while the one on the right is made of PET.** The containers need to be recycled separately, if the final recycled plastic output is to achieve maximum value.

In melting, the ratio of virgin to recycled materials must be kept exactly the same from lot to lot, as minor variations in the ratio may cause temperature variations and inconsistent melt flow, which damages the final products. Such errors carry severe costs for industrial systems. Unfortunately, sorting errors in plastic recycling are common in Lebanon, which decreases the value of its recycled plastic products.

ACTED therefore recommends that **Lebanon introduce Near-Infrared (NIR) sorting, which is the most advanced system currently used in EU and the US.**

In NIR Sorting, plastic waste is spread out on a conveyor belt and fed beneath an identification sensor. This sensor uses an infrared beam to identify plastic types, by analyzing the intensity of reflected light, which is unique to each polymer. NIR sorting is capable of identifying PP, PE, PET, PS and PVC, and can also be programmed to identify biopolymers, carton board and metals. In Europe, NIR sorting has been tested and found to have very low error margins, as shown here:

Polymer	PP	PE	PET	PS	PVS	PLA
Purity Achieved	96%	94%	94%	87%	93%	97%

Figure 41: % purity achieved through NIR sorting in Europe

NIR Sorting is only one of many opportunities that recycling technology offers to train Lebanese workers in advanced technical skills and applied knowledge of industrial chemistry. Such technical capacity is far from uniform at a national level. Several actors in Lebanon's plastic industry indicated to ACTED that in the field of integrating recycled plastics, there is a major gap in technical ability. **Redressing the knowledge gap through a sustained program of technical training, advice and exchanges of expertise would significantly increase the recyclability, and thus the future value, of Lebanese plastics, and equip workers with skills that are highly transferable across the industry.**

The greatest constraint on Lebanon's plastics manufacturing and recycling industries is energy. Plastic production and recycling are energy-intensive. All the industry members that ACTED assessed produce thermoplastics, that is, they import plastic in the form of pellets or flakes, melt them in high-temperature furnaces, and use moulds to shape, cool and solidify the final products. Almost universally, these processes require large amounts of electricity – and all of the industry members that ACTED assessed pay very large sums in generation fees, which greatly reduce the profitability of their products. **A reduction in energy costs is therefore critical to incentivizing plastic recycling.**

3.5.2 Reduce: C2C Design For Plastic Products

Improving National Systems and Regulations

- Develop and enforce national standards for additives and bio-based contents in plastics, especially in the packaging industry, to improve recyclability.
- Establish a national trade association for recycling and an online marketplace/database to monitor trade prices.

Improving Industrial Systems

- Develop financial instruments to assist plastic manufacturing industries in adopting optimal manufacturing processes and improving product design, to ensure compliance with standards for recyclability.
- Provide cash support, rebates or tax incentives to industries – particularly packaging manufacturers – to acquire machinery and develop processes to integrate recyclates into their products.

Improving Consumer Awareness

- Develop clear, nationally standardized labels for plastics – especially on plastic packaging – to enhance recycling literacy among consumers and guide them in handing on plastic waste to recyclers. Labels should display simple, easily-recognized logos for bio-degradable, compostable, recyclable and recycled plastics.
- Develop and conduct consumer awareness campaigns, to guide consumer purchasing and waste disposal decisions.

Design innovation in Lebanon's plastic sector should focus on improving the recyclability of its products. The most effective policy tools in this regard will be the regulation of additives, the introduction of bio-based content standards, and the improvement of packaging design, especially in the agro-food sector.

Additives

ACTED's research – both KIIs and a review of existing LIBNOR standards – has shown that one of the key legislative reforms that would foster a Circular Economy would be to regulate additives in plastics.

Additives are chemical substances that are mixed into plastics or inks during production, to enhance their properties and prolong their lives. To recycle plastics that contain additives requires specialized facilities and techniques for capturing waste outflows, to prevent contamination of the environment and hazards for human health. Some additives also make specific products non-recyclable. Regulation is the key to ensuring that negative outcomes are avoided and that plastics containing additives can still be recycled to commercial advantage.

Plastic additives can be broadly classified into the following categories:

1. **Functional additives** (stabilisers, antistatic agents, flame retardants, plasticizers, lubricants, slip agents, curing agents, foaming agents, biocides)
2. **Colorants** (pigments, soluble azocolorants)
3. **Fillers** (mica, talc, kaolin, clay, calcium carbonate, barium sulphate)
4. **Reinforcements** (for example, glass fibers, carbon fibers).

It is difficult to assess the presence or use of additives in Lebanon, due to a lack of reliable data and transparency in the plastic manufacturing sector. Even so, one of the key trends that emerged from KIIs in the plastics value chain is that most actors were unaware of additives present in the plastics they were handling. In particular, of the 54 Municipalities assessed, not one had any knowledge of additives in plastics. Manufacturers that made new plastic products were aware of some additives such as dyes and d2w additives used in oxo-biodegradable plastics, but were largely unable to identify other additives present in their products or their effect on the products' recyclability.

ACTED therefore recommends that **a national registry be established, to map the use of additives in Lebanon's plastic industry.** Drawing on the information assembled in this register, **an expert technical committee should then be formed to declare and enforce the appropriate use of additives and thus improve the recyclability of plastics.** A number of design guidelines are available from other countries that can be adapted to local needs in Lebanon.

Bio-based Content Standards:

In addition to plastic additives, KIIs also revealed that there is virtually no understanding of bio-based contents in Lebanon's plastic industry. Many plastic products, particularly bags, are being sold as "biodegradable" or "compostable" without having been credibly tested. ACTED therefore recommends that **a certification scheme be established, to ensure that plastics with bio-based contents are appropriately assessed, labelled, marketed and recycled**. Private Standards Agencies such as DIN-Geprüft and OK Compost based in the EU have robust guidelines to regulate and certify bio-degradable plastics. Their methods make clear distinctions

between plastics that are compostable in industrial conditions, home composting, bio-degradation in soil and bio-degradation in marine environments.

Furthermore, ACTED's KIIs indicated that Lebanon has seen a surge in both demand and supply for oxo-biodegradable plastics (that is, plastics that contain d2w additives). There has been strong opposition to the use of these plastics in the EU, as their bio-degradability has not been proven scientifically. In a report in 2018, the European Commission stated, "No conclusive evidence is currently available to confirm that the fragmentation [*of oxo-biodegrable plastics]* is sufficiently rapid and leads to a reduced molecular weight that allows subsequent biodegradation taking place within a reasonable time-frame.[50]" ACTED therefore recommends that **such d2w additives should be further researched in Lebanon, to inform a decision on whether to permit their local use.**

Innovations in Plastic Packaging:

The printing industry, including packaging and 3-D printing, is among the largest industries in Lebanon. According to the Investment Development Authority of Lebanon (IDAL), there are an estimated 305 registered printing industries in Lebanon. An IDAL report from 2016 stated that there are currently 62 companies producing plastic food packaging.[51] According to the same report, "*The Lebanese market is witnessing a trend towards adopting plastic as raw material in the packaging industry, instead of metal and glass. This trend is also seen on a regional scale as packaging activity is projected to grow at a CAGR of 5.0% between 2014 and 2019 in the MENA region (compared to a global 4%), going from USD35.4 billion to USD 45.2 billion.*"[52] Unrecycled plastic packaging makes up a major proportion of the solid waste that pollutes Lebanon's environment on a daily basis. If Lebanon is to resolve its solid waste management crisis, urgent innovation is needed in its plastic packaging industry, to ensure the improved recyclability of its products.

Given the large spread of the agro-food industry in Lebanon, and the competitive advantage of this sector to promote exports, changes to packaging design will improve environmental gains not just for Lebanon but also in the end markets. Further, given the trends in zero-waste products internationally and changing consumer preferences, improve eco-packaging in Lebanon's agro-food industry could help access niche markets abroad, and therefore income returns for vulnerable populations involved in the sector.

Supporting the retail sector to transition to eco-friendly products

Lebanon has a diffused retail network with a large number of micro- and small groceries, convenience stores and supermarket chains.

In order to ensure integration of zero-waste and eco-friendly products in local markets, existing retail shops should be supported to make the transition and new retail shops incentivized to sell zero-waste products. Although a few shops are emerging that do focus on zero-waste products, consumer Focus Groups Discussions have indicated that one of the disadvantages of such shops is a lack of diversity in their product lines. Customers have no option but to spread their grocery shopping between several shops, allocating extra time and incurring extra transportation costs. Existing shops should therefore be supported to make modest and practical changes in their product lines, to reduce the burden of waste before collection by Municipalities. **Such changes include expanding the range of products on sale, offering customers certified zero-waste products, installing bulk dispensers for dry food, replacing single-use plastic with sustainable**

3.6 Paper

3.6.1 Recycling of paper

Improving National Systems and Regulations

- Invest in a national reporting scheme to quantify the amount paper imported into Lebanon, assess the amount of paper waste generated, and track its post-consumer and post-industrial uses. Lack of reliable national-level statistics are a major constraint on regulation in this sector.
- Establish a national standard for grading paper waste, as well as a robust inspection and certification system to regulate post-consumer paper waste.
- Establish looped waste management systems in smaller geographical areas, so that recycling industries can source post-consumer waste from local Municipalities and co-operate meaningfully with local populations.
- Train Municipal workers to enhance sorting processes, to focus on the quality of paper recyclate. NIR spectroscopy could improve the accuracy of sorting by identifying any plastic contamination in paper waste. Automatic microwave sensors can assess moisture content.

Improving Industrial Systems

- Support industries to switch from coal to green energy sources, such as biomass. This will substantially reduce energy costs for recycling industries, create additional jobs in the biomass production chain and contribute substantially to greenhouse gas reduction.

Improving Consumer Awareness

- Conduct consumer awareness campaigns to improve public understanding of paper recycling processes and how involvement in recycling benefits individuals and communities. KIIs indicated that consumer perception relating to cleanliness of recycled paper was a major constraint for growth of this industry.

The paper and cardboard industry presents one of the most promising opportunities for the Circular Economy in Lebanon. There are an estimated 338 firms engaged in the paper, paper-product and printing industries in Lebanon.[53] Lebanon is also a net exporter of printed materials, which account for 3% of total exports.[54] This industry therefore has the capacity to absorb recycled paper locally. The product segmentation of the printing industry is as shown below.

Type of Paper Product	Type of Material Used
Personal Care products	Facial tissues, toilet tissues, hygiene products
Packaging and Labelling	Largest segment of industries using a large quantity of paper. Mainly focused on agro-food packaging
Kraft Paper	Sandwich wrappers, paper bags, other paper packaging in contact with foods.
Disposable Tableware	Paper cups, plates, napkins, towels

Figure 42: Product segmentation in printing industry

Paper-based alternatives are becoming the accepted replacements for single-use plastics, as more consumers become aware of environmental issues. However, paper and paper pulp are produced from forests and their harvesting can often be unsustainable if not properly regulated. In Lebanon, there are no large forests and so the paper industry cannot produce its own pulp. Paper pulp is mainly imported from countries in Latin America, including Brazil (mainly eucalyptus-based pulp), Scandinavian countries (for pine and spruce) and Europe (birch). As at early 2019, Lebanon was importing 17.11 million USD of paper, paperboard and pulp.

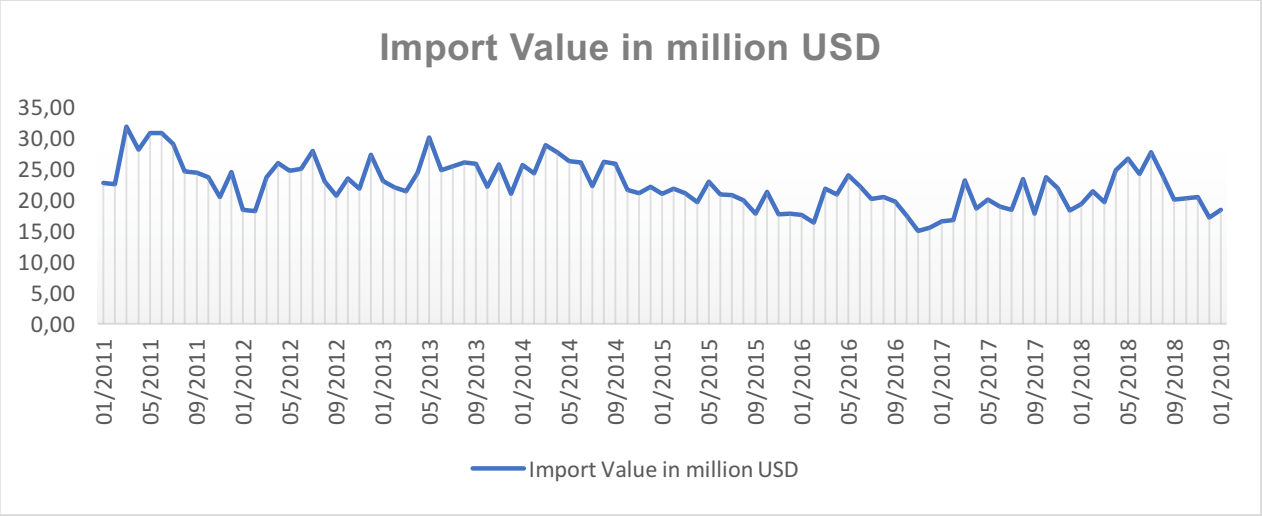


Figure 43: USD value of Paper, Paperboard and Paper Pulp Imports to Lebanon SOURCE: Retrieved from BRITE

The EU funded *Environmental Governance* report estimated Lebanon's paper imports to total 90,000 tons. The total yearly quantity of paper sorted and sold was estimated by this assessment as 110,160 tons, based on self-reported value from 15 actors.[55] The price paid for sorted paper was estimated to be 29 USD per ton –198 USD per ton, depending on quality and grade.[56] This represents an economic gain of USD 2.6 million (lower bound) to USD 21.81 million from material recovery in the paper value chain.

USD 2.6-21.81 million economic potential per year in material recovery from paper waste

In this scenario, recycled paper has the potential to replace imported virgin paper pulp and form a closed-loop system locally. As with the process for recycling plastic, recycling paper requires additional equipment. The various steps involved in paper recycling are shown on the next page.

As can be seen from the diagram, this process is water-intensive and therefore needs to be carefully managed to reduce leakages and ensure efficiency. Moreover, as the process releases dyes and other chemicals as effluents, regulating the overall printing industry (as discussed in the next section) could have significant benefits for improving paper recycling in Lebanon.

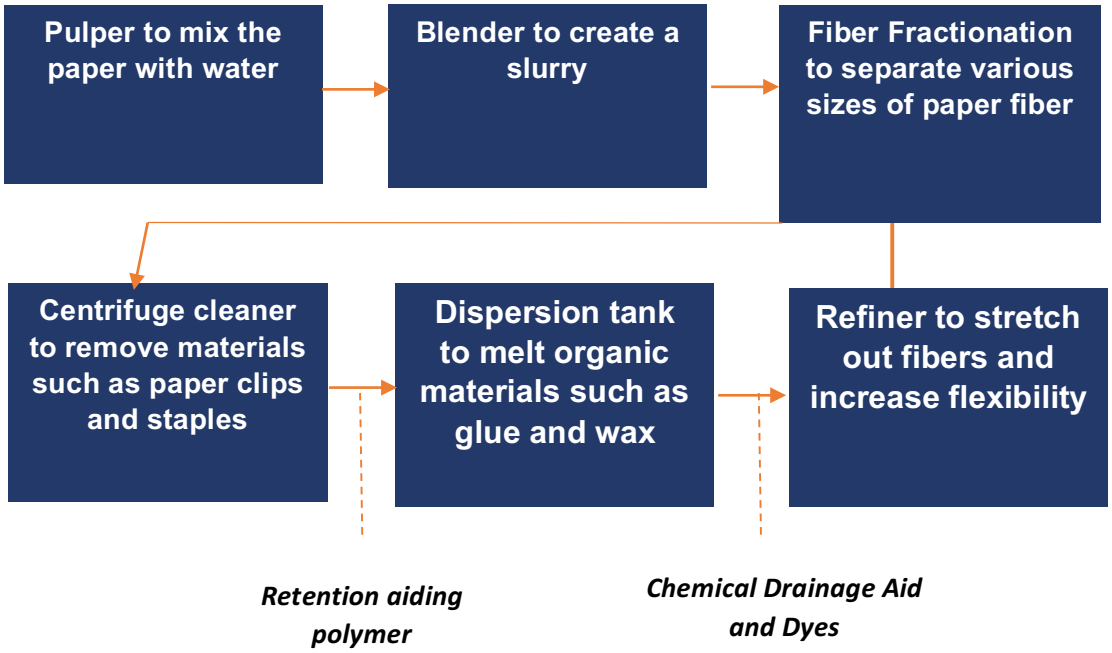


Figure 44: Process flow for paper recycling

As with plastic, in order for paper recycling to be viable, the cost of post-consumer recyclate must be competitive when compared to cost of virgin pulp. The following chart shows the cost of post-consumer mixed paper in Europe, as compared to cost of virgin wood-pulp. As can be seen, the cost of pulp is considerably higher than recyclates, which makes paper recycling cost-viable.

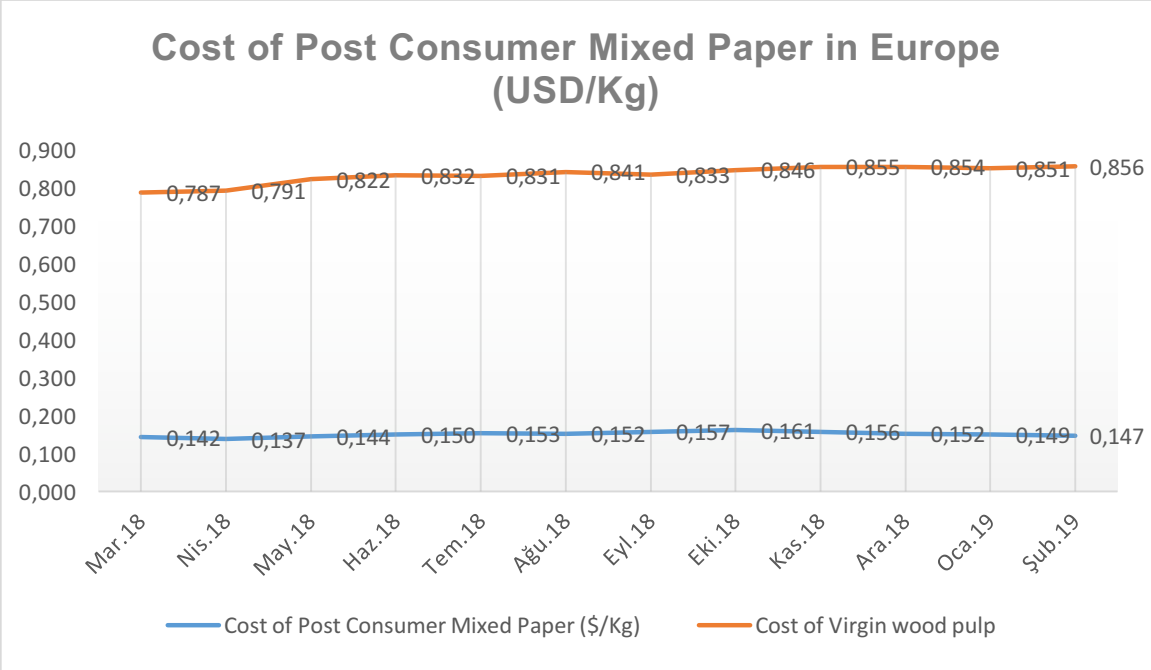


Figure 45: Cost of post-consumer mixed paper in Europe

In Lebanon, the high cost of waste recovery in general has made paper collection and recycling unprofitable. Even so – although no national data is available on the cost of virgin pulp – ACTED's key informants indicated that the costs of virgin paper/pulp (including shipping costs) were comparable to the costs of recycled paper, and in some cases were more expensive than recycled paper, meaning that there is a viable market for expansion of recycled paper use.[57]

This is mainly due to the fact that Lebanon relies on costly imports of imported woody pulp, the price of which is driven up by shipping costs from distant sources such as Brazil. While at least making use of the available paper sources in country could bring costs down, the quality of recyclates was cited as the main constraint on incorporating them into production systems.

While the 3 largest mills in Lebanon (that mainly make personal care products) import virgin paper in the form of pulp, most of the smaller industries that produce paper bags and other packaging imported the materials in the form of paper rolls (both virgin and recycled paper rolls). The following table shows a breakdown of cost estimates for shipping virgin paper rolls into the country.

Category	One paper roll (4 ft wide, 6 ft tall)	Cost of Shipping container 40 ft wide (including tax) containing 50 rolls	Taxes
Cost	1500 USD	3500 USD Approx. cost per roll: 70 USD	12% VAT for paper from Europe. 12% VAT plus 30% customs for paper from other countries.

Figure 46: Cost estimates for shipping virgin paper rolls into Lebanon

KIIs have revealed that the current market shares of recycled paper products in Lebanon ranges from 5-50%. Personal care products such as toilet paper rolls made from recycled paper only comprise 25% of the total market on average. ACTED assessed one large paper mill that indicated that **tissues made from recycled product were on average 20% cheaper than tissues made from imported pulp.** This is mainly due to the fact that imported pulp, being wet, is heavy and therefore carries a high transportation cost – and, as before, the greater the distance of transport, the greater the cost.

Paper packaging, including paper bags, represents another key area of local production that could use recycled paper as a primary material. However, at present, only a small percentage of local production of paper bags (estimated at less than 10%) uses recycled paper.

Several factors in the value-chain discourage manufacturers from using recycled material (or even switching from single-use plastic bags to paper bags at all). Plastic bags are much cheaper than paper bags made from both virgin and recycled paper, thus pricing the latter out. KIIs indicated that in order for paper to become a viable alternative, additional taxes need to be imposed on plastic bags. The industries that ACTED consulted indicated that the recycled paper that they received, especially from post-consumer waste, is often mixed with large amounts of organic and other forms of waste, which make it difficult and expensive to recycle. Mistrust of sanitary conditions in recycling facilities is widespread. However, KIIs revealed that the main limiting factor at present is the cost:

Material	Estimated Cost per Bag
Plastic	0.11 USD
Virgin Paper (Imported)	0.25 USD
Recycled paper (imported)	0.20 USD

Figure 47: Cost estimates per volume for various materials

Manufacturers usually import rolls of virgin paper or recycled paper from the EU and remake them into bags locally. As such, despite the large volume of recycled paper collected in Lebanon, manufacturers rely on imports due to structural constraints such as poor sorting, contamination and price disincentives as described below. The manufacturers ACTED assessed also had their own printing presses for adding the logos of companies on to the bags. KIIs revealed that manufacturers prefer to use water-based paints, as they are perceived to be non-toxic. However, water-based paints make paper very difficult and expensive to recycle.

Despite all these problems, this industry still offers high potential for absorbing recycled paper. But in order to be competitive, small- and large-scale producers need to reach economy of scale and bring down prices, and so stimulate demand. This can be achieved through **building consumer support to replace both plastic and virgin paper (which is resource-intensive) with recycled paper bags. In addition, clear labelling will help consumers differentiate between recycled paper and virgin paper.**

As the quality of paper recyclate is one of the major constraints to absorbing this material into the current market, ACTED recommends that a national grading system be established for paper recylate. This could be built or modelled on existing standards, such as **the EN 643, a European Standard that lists grades of paper and board for recycling, designed for use by industries and recycling actors across the EU.** This standard has helped various market actors in buying and selling paper and paperboard waste for recycling in a coordinated fashion. The EN 643 system has five groups of standard grades for paper and board for recycling, and also defines clear de-inking grades for paper.

As well as grades for sorting paper, Lebanon should **establish standard bale sizes for ease of transport and logistical efficiency.** Finally and most importantly, Lebanon should set **a national standard for the moisture content of paper.** This can be achieved with the use of an automatic microwave sensor. This sensor provides highly reliable measurements of the moisture present in bales of recycled paper, and allows sorters to screen out impurities from the production line. This would greatly enhance the cleanliness and efficiency of the recycling process, as well as gaining the trust of paper manufacturers and making recycled paper an attractive manufacturing material. Introducing automatic microwave sensors into paper recycling plants would also involve equipping staff with technical skills that are highly valuable and transferrable across recycling industries.

3.6.2 Reduce: C2C Design for Paper-based Products

Improving National Systems and Regulations

- Establish a national committee to design, implement and enforce standards for paper recycling, especially de-inkability standards.

Improving Industrial Systems

- Support small-scale manufacturing to absorb paper recyclates and use them to produce products for valuable niche market sectors. Focus on building business-to-business relationships: recycler to manufacturer, manufacturer to producer.
- Support industries to enhance resource efficiency. Reducing energy and water consumption would both reduce these industries' carbon footprint and make their products more competitive.

Improving Consumer Awareness

- Introduce a clear labelling system to show consumers how best to recycle paper, and to demonstrate that recycled paper products can be clean, useful and economically beneficial.
- Conduct a consumer awareness campaign to promote locally-made recycled goods. The Ministry of Industry's "Buy Lebanon" campaign offers an opportunity to promote products in this sector.

ACTED's KIIs indicated that, at present, most of the paper-based packaging and disposable tableware used in Lebanon is produced from Kraft paper. Kraft paper is usually produced from paper pulp through the Kraft process, which is a special pulping process. Kraft paper is much stronger than paper produced from other pulping processes and it can draw on a wider range of fiber sources. All types of wood, including very resinous types such as southern pine, and non-wood species like bamboo and kenaf, can be used in the Kraft process. Kraft paper can also contain up to 10% recycled paper, and used Kraft paper itself can be 100% recyclable. It is a highly competitive option for paper manufacturers interested in recycling.

Currently, several small paper manufacturers in Lebanon produce or import Kraft paper for the Food and Beverages sector. As it is stronger than either types of paper, Kraft paper can also be used to make bags for flour, cement, food packaging, grocery bags, wrapping for flower bouquets and other purposes that demand resilient materials. Unbleached Kraft paper (which is usually brown) can also be composted safely.

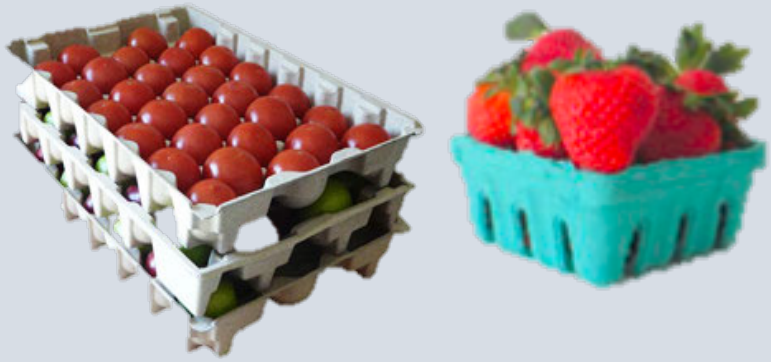
This type of paper therefore represents a significant opportunity to replace single-use plastic packaging in a range of sectors. However, because of its dependence on virgin pulp, this type of paper can also have a larger carbon footprint. Introducing Kraft paper market into the current paper market therefore poses significant environmental challenges and must be handled carefully.

One of the key problems constraining the design of paper products in Lebanon is the lack of standards regulating de-inkability and the removal of glues and adhesives.

De-inkability is the chemical process of removing ink or toner from a printed product, restoring the paper to its unprinted appearance. Degrees of de-inkability can vary greatly depending on ink type, paper type and processing conditions. For example, water-soluble inks may discolour or darken the recovered pulp fibers, thus reducing the quality of final recycled paper. ACTED's KIIs revealed that Lebanon has no national standards to regulate the de-inkability of paper. Furthermore, there are very few de-inking plants in Lebanon, forcing many manufacturers of paper-based products to import recycled paper from Europe. The lack of national regulatory standards also means that the quality of these important cannot be guaranteed. Improving the de-inkability standards of paper will greatly enhance local capacity to recycle paper independently and at a lower cost to industry.

Paper-based products, especially packaging and disposable tableware, have high potential in Lebanon if they are appropriately branded and marketed. Many of these products can be produced through small-enterprises or cooperatives with low-tech production lines, meaning that promoting local manufacture will create low-skilled jobs in Lebanon. Indeed, this sector is globally well-developed. Pre-fabricated production lines can be purchased from reliable suppliers, with various moulds designed to produce different products.

Paper bags made from recycled paper have market potential in Lebanon, especially if targeted at niche customer bases, such as environmentally-conscious brands. Give the increasing global awareness of the harmful environmental impacts of single use plastic, alternative paper packaging could offer strategic alternatives. ACTED's KIIs revealed potential for **making specialty items such as egg trays from recycled paper.** Currently, egg trays are mostly made from plastic, although there are small-scale production facilities for carton production. **A small production facility producing 2,500 trays per hour can employ around 7-8 people, in addition to people employed in collection and sorting of waste.** The same machines can also be used to make cartons for storing and transporting fruits and vegetables, entirely replacing plastic cartons currently in use in the market.



Products with high market potential that can be made under these conditions include recycled paper bags, greeting cards, cardboard and paperboard, which in turn can be used for making boxes for cereals or other foodstuffs. Another high-potential market is for paper napkins used in restaurants and bars. Some chains, such as Starbucks, already use recycled paper napkins, but additional market opportunities exist on a global scale.

ACTED's KIIs revealed there is unmet demand is many such areas of the market in Lebanon. If competitive cost can be achieved, recycled paper will become an exceptionally competitive and commercially advantageous manufacturing material. Products made from recycled paper have the potential to create additional jobs through the creation of new industries, while providing an opportunity to use recycled paper locally and reduce waste.

3.7. Fabrics (Clothing and Textiles)

While the term 'clothing' refers mainly to articles that can be worn, the textile industry produces a much wider range of goods, including home linen, such as curtains, bed covers and table cloths. Almost all of these can be profitably recycled.

The global clothing industry has been growing sharply, with serious environmental and economic impacts. Globally, more than USD 500 billion of value is lost every year due to the under-use of clothing and a lack of recycling.[58]

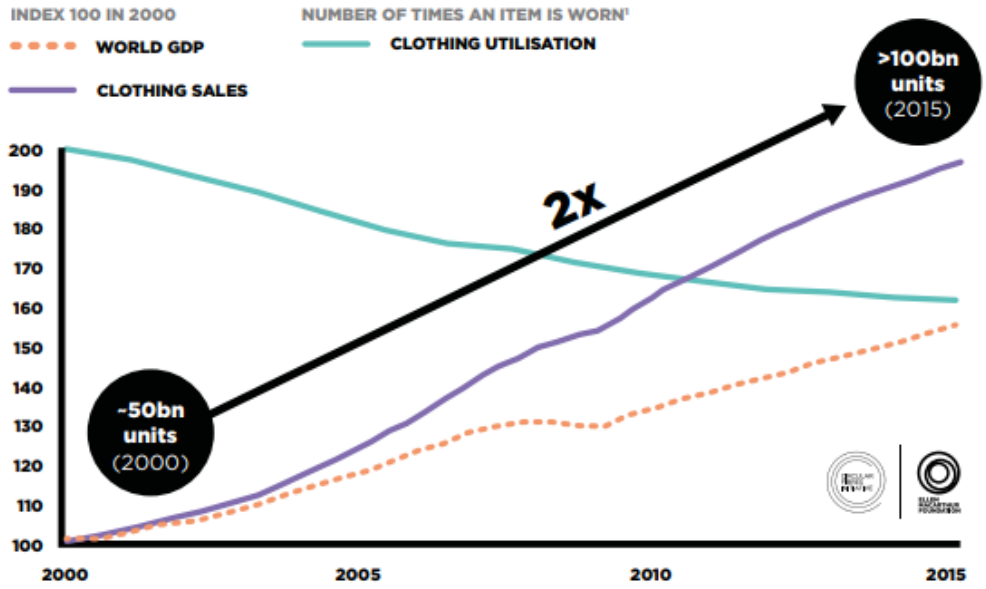


Figure 48: Growth of Clothing Sales and Decline in Clothing Utilization Since 2000; Source: Ellen McArthur Foundation

The chart above illustrates the growth of clothing sales and the decline in clothing utilization since 2000 globally.

As can be seen, more and more items of clothing with shorter and shorter lifespans are being produced, a growing phenomenon known as 'fast-fashion.' At the same time, the global material flows of clothing lead to very high levels of waste. As the next chart shows, at least 73% of fabric globally is incinerated or sent to landfill.

There is no data available on textile composition of waste generated from households in Lebanon, though some localized waste categorization studies are currently underway. The Global Consumption Database, which tracks household-level consumption for a range of goods, does not include datasets for Lebanon.

Even so, data gathered by Lebanon's Ministry of Industry (MoI) since the 1990s has allowed ACTED to model the potential for fabric recycling realistically. (See the diagram on the next page.)

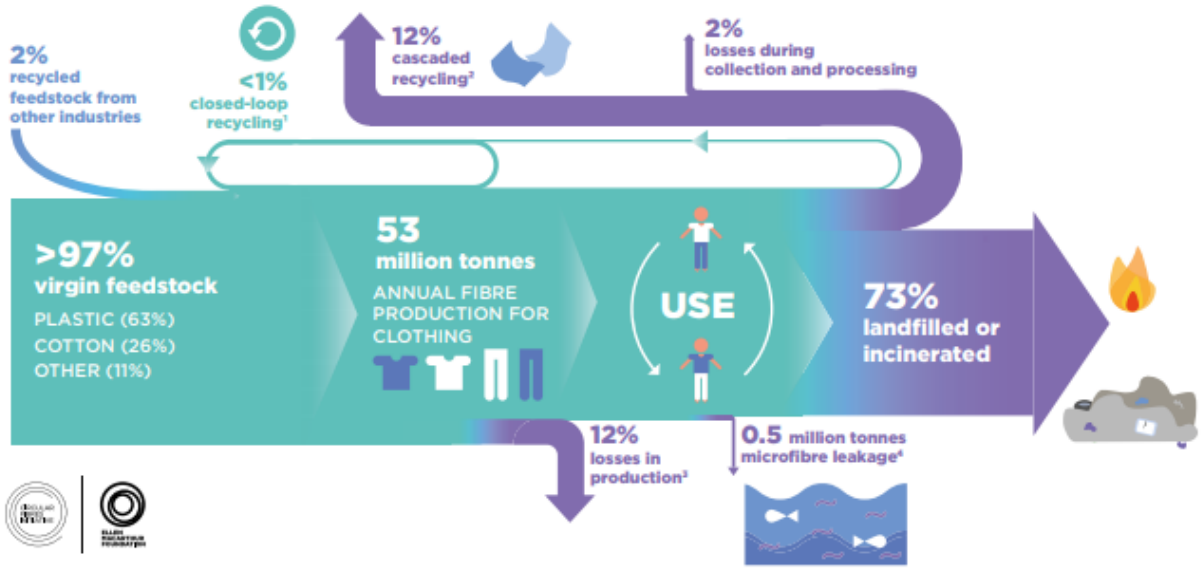


Figure 49: Global Material Flows for Clothing in 2015. Source: Ellen McArthur Foundation

In 1994, there were an estimated 3,004 clothing and textile factories in Lebanon, employing an estimated 17,820 workers.[59] In the mid- to late 1990s, the Government of Lebanon removed tariffs on fabrics, and added taxes (mainly VAT) to the products produced by local industries. Combined with the weak state of infrastructure in Lebanon, primarily in the electricity sector, this drove up the cost of local production while the market was flooded with cheap imports from China, Turkey and Bangladesh. This led to a decline in the local Lebanese fabric manufacturing industry. Today, the number of clothing and textile factories has declined to 237 factories, and the estimated composition of their industrial activity is as shown in figure 50 below.

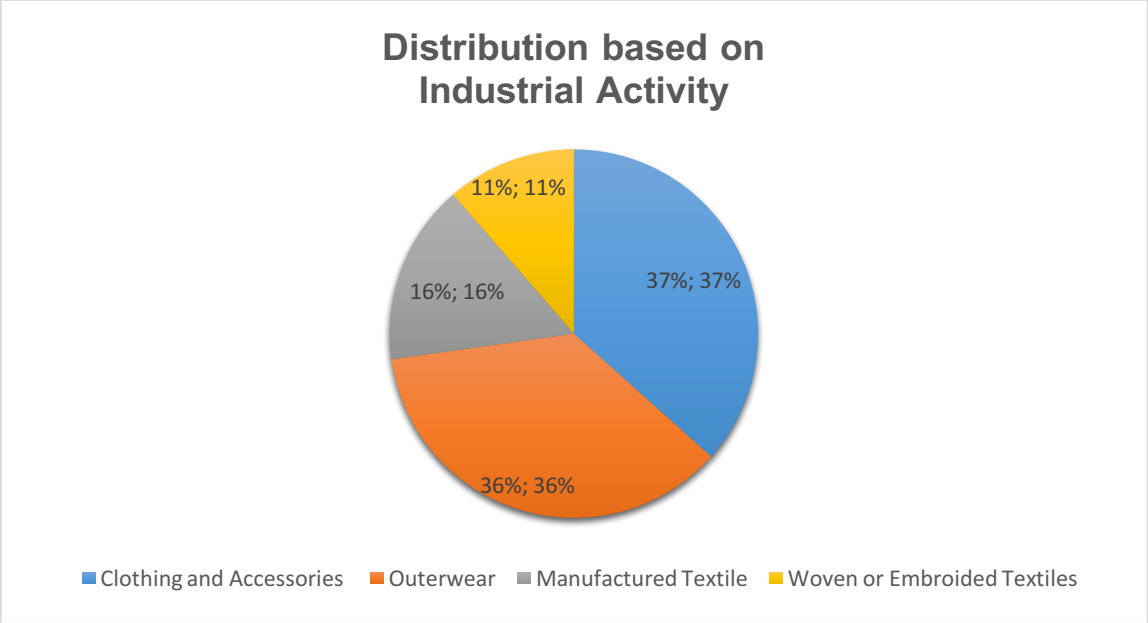


Figure 50: Distribution of Fabric and Textile Industries based on Industrial Activity; Source: MoI

ACTED's KIIs indicated that local manufacturing is small-scale and mainly targets export markets. Despite its small size, this industry does generate employment for Lebanese workers. The MoI estimates that the average industrial output per factory is approximately 1.2 million USD and that the number of permanent workers per factory was 24 workers on average, of whom 72% were Lebanese. According to MoI data, 75% of outputs from these factories were exported and only 25% were sold locally in Lebanon.

Unregulated clothing imports are a major constraint on profitable fabric recycling. According to MoI estimates, a total of 572.8 million USD worth of clothing was imported into Lebanon in 2017. A large volume of new clothing is imported illicitly in the guise of 'used' clothing, which is not taxed in Lebanon. This has resulted in loss of revenue for the Lebanese government, but also, crucially, a higher cost burden on consumers.

The next chart shows the import of textiles and clothing into Lebanon in 2016. The top 5 importers in USD value are shown below. The chart also includes the AHS Weighted Average (or Effectively Applied Average), which measures the lowest available tariff for that country. As can be seen, the effective tariff rates are relatively low for some of the highest importers by volume.

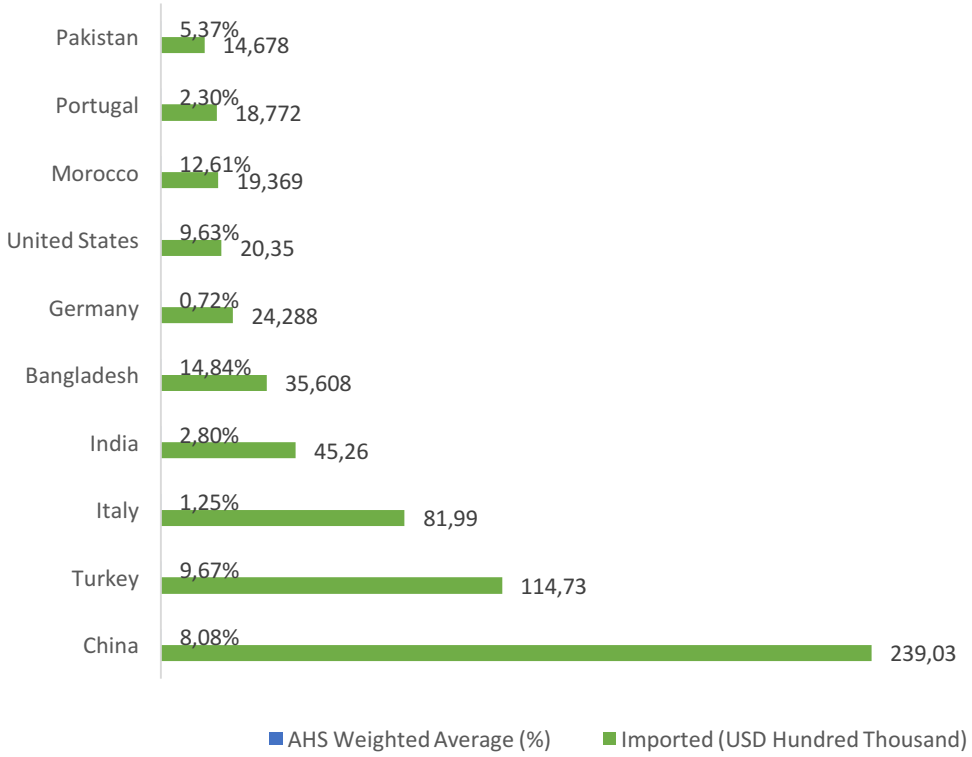


Figure 51: Top Import Partners of Lebanon for Clothing and Textile Industry; Source: World Integrated Trade Solutions

At the same time, as can be seen from the next chart, the sub-index for clothing and footwear increased at a higher rate than the consumer price index, indicating rapid expansion in this sector. In fact, prices in the clothing and footwear sector in Lebanon increased by over 51% between 2017 and 2019, which in turn increased the cost burden on consumers.

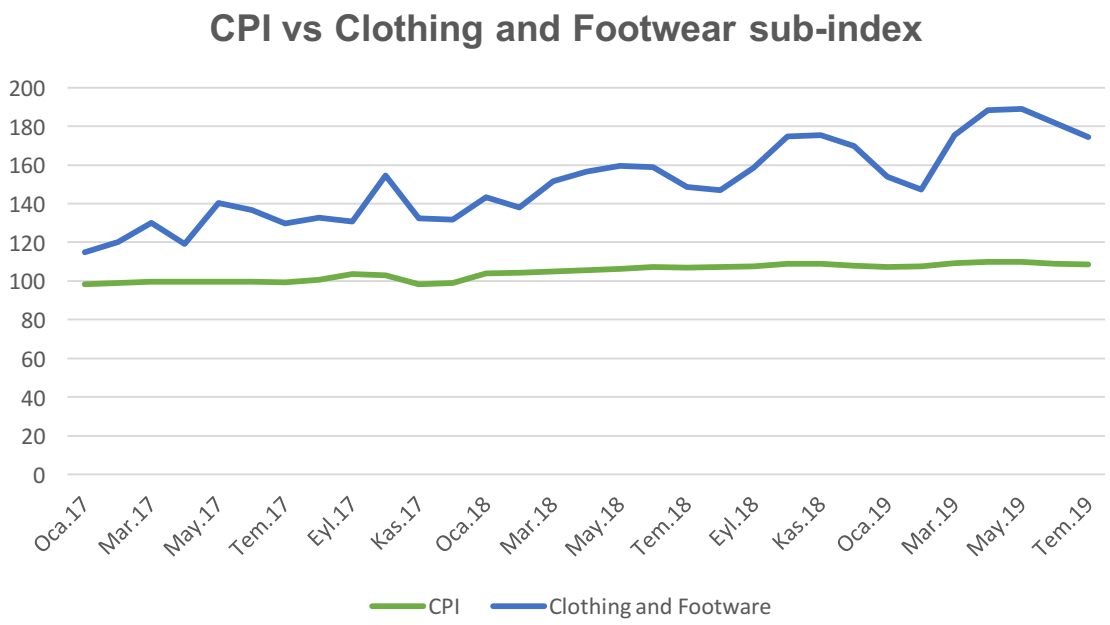


Figure 52: Comparison of consumer price index to clothing and footwear sub-index over time

In summary, the triple constraints of unregulated clothing imports, energy costs and a drop in available labour have led to a decline in clothing and textile manufacture in Lebanon, while imports have increased both in volume and monetary value. Add inflation to these already debilitating problems, and the result is a heavily increased cost burden for consumers.

3.7.1 Recycling of Fabrics

Improving National Systems and Regulations

- Invest in a national reporting scheme to provide reliable statistics, to guide the regulation of fabric waste.
- Train Municipal workers in sorting different types of fabric. Introduce NIR spectroscopy to improve the accuracy of sorting and enhance the efficiency of the value-chain.
- Establish separate waste collection for clothing and textile waste, to improve the recyclability of clothing and support existing initiatives to achieve economy of scale.

Improving Industrial Systems

- Enhance the efficiency of the logistics of collecting fabric waste, especially delivery bins and washing facilities.

Improving Consumer Awareness

- Conduct a public awareness campaign, to demonstrate to consumers the easy actions they can take to support the recycling of fabric and textile waste. Focus on encouraging consumers to buy mainly unblended fabrics and clothing made from recycled fabrics.
- Introduce a clear system of labels for different types of fabric (organic cotton, BCorp Certification, etc.), so that consumers can understand products' recyclability and dispose of fabric products in appropriate ways.

As mentioned, fabric recycling has faced technical constraints globally. In this environment, while fabric re-use has immediate market potential, fabric recycling could only be a competitive cost-effective alternative if the existing recycling schemes could reach economy of scale, which would consequently have benefits for the wider economy.

The EU report on Environmental Governance, of 2016, estimated that 219 tons of fabric were recycled in Lebanon in 2015.[60]. ACTED identified very few initiatives for recycling fabric. The principal actors are Arc En Ciel, Cedar Environmental, FabricAid and Green Globe. FabricAid estimated that it recycled around 35 tons of waste in 2018, but the other initiatives indicated that the volume recycled or 'upcycled' was too small to track. Almost all of the fabric these organizations collected for recycling was exported to countries such as Turkey, which possess large recycling facilities. Some very small-scale initiatives do exist in Lebanon for 'upcycling fabric,' that is, using it to stuff restored furniture.

Recycling clothing is often highly resource-intensive and success depends on the materials from which items of clothing are made. For example, recovering leather from existing clothing for re-use is relatively simple, as leather can be cut into virtually any shape desired for assembling new garments. However, ACTED's KIIs indicated that removing of zippers from leather (and the labour cost involved in doing so) has made it unprofitable to collect leather for recycling in Lebanon. Recycling textiles involves shredding or pulling cloth, to unravel and separate individual threads, which can then be cleaned and re-spun into yarn. This process may compromise the quality of certain fabrics. Cotton, for instance, cannot be recycled to make new cotton clothing, as the recycled fiber is not of sufficient quality. However, cotton can be converted into high quality paper products or used as industrial rags. Recycled material can be produced from synthetic fibers such as nylon and polyester, but mixed fabrics that contain more than one type of fiber are harder to recycle.

ACTED's KIIs determined that the first step towards improving fabric recycling in Lebanon is to improve the collection and sorting of post-consumer waste, based on quality, reusability and fabric types. Initiatives such as FabricAid – which re-sell high-quality second-hand clothing that does not have wear and tear – have estimated the purchase price of post-consumer waste fabrics to be around 0.50 USD per Kg. Lower-quality fabric which cannot be recycled can be sold for around 0.10 USD. However, ACTED's KIIs indicated that at present the high cost of transporting waste fabric to factories in Turkey, Egypt and other countries is the main factor preventing the recycling of clothing in Lebanon. In order to make such long-distance transport viable, recycling initiatives would have to achieve economy of scale. This requires improved collection and sorting at Municipal facilities.

In order to enhance the sorting of fabric and textiles, Near Infra-red (NIR) Sorting technology should be introduced. As with plastic waste, **NIR spectroscopy is capable of identifying textile materials quickly and accurately, based on their characteristic spectra. This would save considerable effort and labour (and therefore expenditure) in sorting clothing and textile waste, and permit the appropriate use of a wide range of fibers.** Identifying textiles with pure fibers and separating out those with blended fibers, which are more difficult to recycle, greatly enhances the efficiency of the recycling process.

One of the key points that ACTED's KIIs revealed is the fact that waste clothing is often cleaned by consumers themselves. That is, most consumers throw out clothing that has already cleaned and stored in their households; unwashed waste clothing is relatively rare. This is especially true for seasonal clothing: consumers often throw out clothing from the previous year at the beginning of the season, but they are likely to wash or otherwise clean it before disposing of it. However, as Lebanon generally lacks separate collection streams, consumers are forced to throw out these clean clothes with other recyclables, which often causes the clothing to absorb moisture and smell bad. KIIs revealed that it is especially important that clothing is not mixed with other recyclates, including plastic containers and food or bio-waste, as this almost always reduces their reusability. **Establishing separate collection streams for fabric, either within or outside existing Municipal schemes, is the best way to improve the recyclability of clothing.**

3.7.2 Repair, Reuse and Sharing of Fabrics

Improving National Systems and Regulations

- Improve access to quality infrastructure for second-hand markets. This would help create additional jobs and boost the economy, by creating user-friendly conditions for community entrepreneurship and expanding access to high-quality clothing for vulnerable Lebanese. Such infrastructure would also add value to the tourism sector.

Improving Industrial Systems

- Provide business development support – including guidance in branding and marketing, to ensure customer buy-in – to the micro-enterprises and small retail shops that dominate Lebanon's market for repair and resale of clothing.
- Support up and coming initiatives that promote the sharing economy through clothing rental.

Improving Consumer Awareness

- Publicly promote small-scale designers, micro-enterprises and retail shops that are working to reduce fabric waste, in order to improve consumer awareness and foster acceptance of second-hand clothing.

ACTED's KIIs have indicated that the repair and reuse of fabrics offer the greatest potential for improving the circularity of the overall fabric value chain.

At present, there are two type of markets that sell second-hand clothing in Lebanon. The lower-end markets usually source second hand clothing in bulk through imports, usually from countries in Africa, including Egypt, but also from Turkey and Europe. Importers pay for the clothing in bulk and sell it unsorted, mainly targeting lower socio-economic market segments. However, ACTED's KIIs have indicated that most of these importers actually bring in mainly new clothing, and that only a small percentage of their clothing is truly second-hand. There is also a repair economy in this market, albeit a very small one, which deals in repairs of lower-end clothing. KIIs have indicated that when these repairers resell second-hand clothing, the resell value is sometimes between 2,000 LBP to 5,000 LBP per piece, which usually represents a profit margin of between 30% and 50%. However, the demand for these clothing items is low and most customers prefer to buy new clothing, which is also usually imported in bulk.

The second type of market is focused on high-end designer brands. This is still an emerging market in Lebanon. Small projects such as Chances Showroom in Gemmayze and 'fashion show,' managed by FabricAid, target higher-end customers with second-hand clothing. These initiatives also reported to ACTED that customers who tend to purchase second-hand clothing at a premium price (as compared to the lower-end markets discussed above) tend to keep the clothing for longer, thus reducing its impact on the environment and extracting more value from it. There are also emerging fashion designers and showrooms such as Emergency Room in Achrafiye and Roni Helou, which use 'dead stock fabric,' that is, fabric that is otherwise wasted in the studios of fashion designers, to make new clothing and thus reducing the amount of waste sent to landfills.

In addition to the second-hand market, the sharing economy could also be promoted. Some small-scale initiatives have emerged already. These include shops such as Designer-24, which provide rental services for high-end clothing from top designers.

Scaling up initiatives such as these will not only reduce the waste load on landfills, but also reduce the carbon footprint of clothing and improve outcomes for Lebanon's environment.

One of the key opportunities that ACTED's KIIs revealed was a concept, supported by several key actors in Lebanon's recycled clothing industry, of creating the infrastructure for pop-up or permanent second-hand markets.

Currently, markets for second-hand clothing are concentrated either in areas of higher socio-economic status or in extremely vulnerable areas. Improving market infrastructure in middle-income areas would yield higher socio-economic returns to vulnerable communities, while at the same time benefiting the environment. For example, the proposed plan by UN Habitat to rehabilitate Arax street in Borj Hammoud could include specific infrastructure for second-hand clothing markets, including physical assets such as workshops designed to sort, repair and clean second-hand clothing, as well as 'softer' support such as guidance in branding and marketing.

Virtualizing businesses for improving circularity

One of the core principles of the Circular Economy model is virtualizing the economy. As outlined in the McKinsey report on the Circular Economy, virtualization involves "delivering utility virtually—books or music, online shopping, fleets of autonomous vehicles, and virtual offices."[1] Virtualizing businesses could have several key economic, social and environmental benefits. Firstly, given the prohibitively high cost of real-estate in Lebanon, especially in urban and peri-urban areas with high business concentrations, virtualizing business is likely to mean huge cost-reductions for businesses. E-commerce services such as warehousing, delivery, pickup and virtual stock management services are being developed through companies such as Wakilini. These could benefit small businesses in key sectors such as retail and agro-food, which depend heavily on business-to-consumer models. Such centralized services for E-commerce could create the core infrastructure for a virtualized system becomes cost-effective through economy of scale. However, virtualized systems also have carbon footprints due to energy requirements for data storage and management. These will have to be carefully monitored to ensure such business models are regenerative and reduce their impacts on the environment.

The key bottleneck for growth of this sector in Lebanon, as identified in KIIs, is a lack of consumer awareness. A perception that second-hand clothing is unclean somewhat restricts this market. Improving infrastructure and designing markets with less alienating features, however, may help to dispel this prejudice. Currently, lower-end markets lack infrastructure and often do not sort or clean the clothes they sell, while high-end markets are not well developed and charge premium prices. Rehabilitating infrastructure and adjusting prices in the middle-market segment, so that shops are able to clean, sort and sell second hand-clothing in easy-access shopfronts, would foster more positive consumer perceptions.

3.8. Glass

The largest glass factory in Lebanon was bombed during the 2006 war and has not been rebuilt. Although efforts are underway to rebuild glass factories elsewhere in the country, Lebanon mainly relies on cheap imports of glass, the source of which can be seen in figure 32. It is estimated that Lebanon consumes around 71 million colored bottles a year, most of which are used by the beverages industry.[61] All of these bottles are used once only, and then sent straight to landfills.

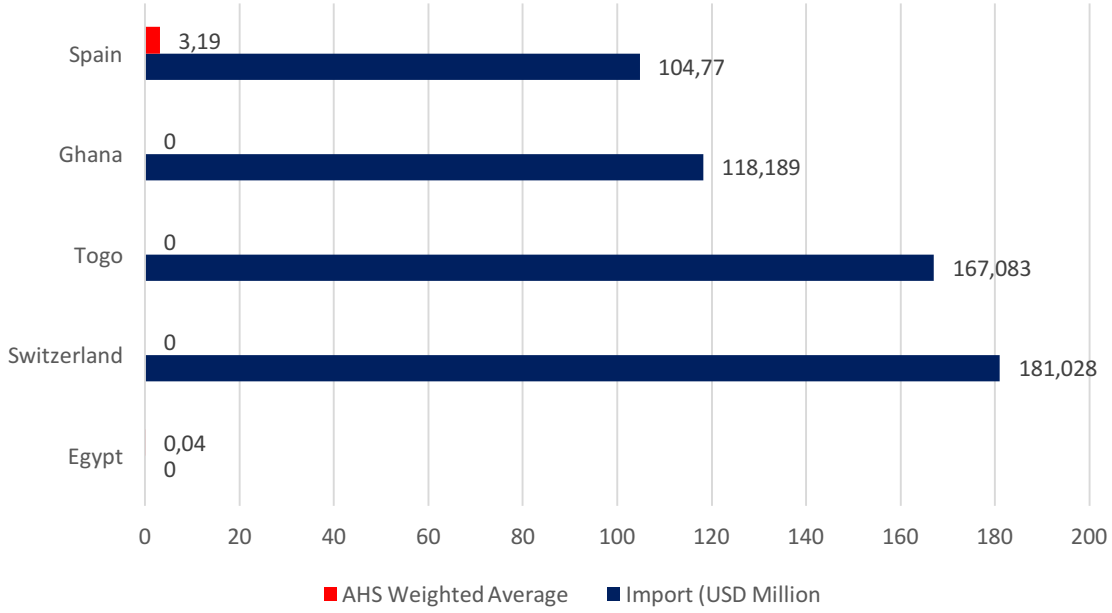


Figure 53: Lebanon Stone and Glass Imports By Country 2016; Source: WITS

Indeed, follow up interviews with key informants in April/May 2020 indicated that the import of glass into Lebanon has declined drastically due to the ongoing currency crisis and Covid-19-related shutdowns. As such, imports of glass to Lebanon declined by 57.44% in March 2020 compared to previous years. This has driven up the cost of glass containers, particularly for the agro-food sector. As a result, an emerging market for re-used glass offers strong potential for integrating circular logistics within local markets and promoting absorption of this infinitely recyclable material.

Within a Circular Economy model, glass has great potential for material recovery and job-creation. Globally, glass reuse has been held up as an exemplary recycling practice, due to its strong economic results. Moreover, glass is 100% recyclable and offers the unique potential to ensure circular material flows with no leakages. In considering opportunities for glass recycling and reuse in Lebanon, this report considers mainly glass used in the food and beverages (FNB) sector. Glass used in the construction and automobile sectors offers additional opportunities and should be considered in future assessments.

3.8.1 Recycle

Improving National Systems and Regulations

- Provide incentives such as tax benefits for promoting glass reuse in the construction sector.
- Establish separated collection systems to reduce leakages in glass recycling. Achieve economy of scale in glass recycling by establishing clearly demarcated service areas, in order to reduce logistics costs for collection of glass waste.

Improving Industrial Systems

- Support the construction sector to use crushed glass in concrete.

Improving Consumer Awareness

- Conduct campaigns to help consumers understand the Circular Economy potential of glass and improve recycling rates.

Glass recycling involves two principal stages: crushing and re-melting. When glass is collected from post-consumer waste, there is an additional stage of cleaning. Since glass retains its colour after recycling, most recyclers first sort glass products by colour and recycle similar colours together. This adds to the cost of recycling glass. Therefore, recycling schemes for glass need to invest in infrastructure to properly collect, clean and sort glass by colour.

Since glass is infinitely recyclable, it is an ideal product for the Circular Economy. Moreover, re-melting crushed glass consumes significantly less energy than the process of producing new glass. It is estimated that for every 10% of recycled glass added to the mixture, an energy saving of 2-3% can be achieved. Glass can also be crushed and used as an aggregate in concrete.

Across Lebanon, ACTED identified mostly small-scale initiatives for recycling glass, such as the Green Glass Recycling Initiative of Cedar Environmental, which reuses glass in several projects, including re-melting it for making artisanal hand-blown glassware in Sarafand. Mdwar, an artisanal glass 'upcycling' initiative, also cuts glass bottles to make artisanal containers. However, these initiatives are resource-intensive. They are only able to process less than 1% of colored glass waste produced nationally each year. Establishing a processing facility to accept coloured glass at scale would require a large upfront investment, as well as an enhanced specialized collection scheme to ensure only colored glass waste reaches this facility. Furthermore, given the energy crisis in Lebanon, such a facility must make significant investments in renewable energy and energy-efficient technologies to be viable.

Glass has high potential for recycling into sand, especially for use in construction. It is estimated that 30,000 metric tons of sand are needed for 1 km of road. According to figures issued by the Surfrider Foundation, between 75% and 90% of the world's beaches are receding. This global trend can also be seen in Lebanon, as beaches degrade and large quantities of sand are extracted from sensitive ecosystems. Recycling glass to make sand has the potential to solve two related issues: reducing the costs of waste management and meeting the demand for high-quality sand in the construction sector.

Estimated USD 550,000 lost per year in unused materials in beer bottles alone.

Each standard beer bottle produces approximately 200 grams of sand substitute. Considering an estimate of 88 million bottles manufactured or sold in Lebanon each year,[62] this would produce around 17,600 tons (11,000m^3) of sand substitute. Compared to the average price of construction sand in the market today, this would be valued at around 550,000 USD in material cost per year. This material cost is derived only from the number of bottles produced for the beer market. Additional cost recovery can also be achieved with glass waste from the construction sector, automobiles, and other glass used in the food and beverages sector. The final value of cost savings therefore is likely to be much higher than the cost estimated here.

As indicated by KIIs, the main constraint for glass recycling in Lebanon is the high cost involved in the logistics of collection and separation. One of the key reasons for this is the distributed nature of the economy in Lebanon, which drives up the cost of collection and sorting. Moreover, as discussed in sections above, municipal recycling schemes in Lebanon service small areas and therefore cannot achieve economy of scale. This further drives up the cost of collation and recycling, making post-consumer glass unprofitable.

Investments in improving the economics of waste recovery would help the glass industry overall by reducing cost of post-consumer glass. Investments also need to be made in a crushing facility that can produce crushed glass of different colours. One such facility currently exists within the warehouse of Recycle Beirut, which has produced small protypes of concrete tiles containing

crushed glass. Such models should be built upon and expanded to recycle glass more effectively for use in the construction sector.

KIIs also indicated preliminary plans for establishing a glass factory in the Bekaa. If such a factory is established, this will provide further opportunities for recycling glass to create glass cullet. This cullet can be used to produce new glass containers.

3.8.2 Reuse

Improving National Systems and Regulations

- Advocate recycling over reuse, as current conditions are not conducive to reuse.
- Encourage industries to seek opportunities to share common models to make reuse feasible.

Improving Industrial Systems

- Explore feasibility of future opportunities to gain sufficient scale within industries which could share bottle shapes/sizes.

Improving Consumer Awareness

- Encourage users to reuse glass bottles at home where feasible.

KIIs indicated that one of the key reasons why glass is not reused in Lebanon is the small size of the market, which makes it impossible to achieve economy of scale. Moreover, the high cost of waste recovery makes the logistics of glass collection and reuse uneconomical, particularly when compared to cheap imports.

As discussed previously, the cost of waste recovery in Lebanon has been estimated to be approximately 169 USD per ton. Assuming a similar value for glass collection, it can be roughly

estimated that collection and transportation of 1 ton of glass would cost approximately 169 USD. Moreover, in order to clean the bottles, remove labels and any adhesives left on the bottles, separate them by colour and remove any defective bottles (cracked, chipped, etc.), large-scale investments in labour, machinery and energy are required. All of this are likely to add to the cost of post-consumer glass. ACTED estimates that the cost of importing virgin glass bottles into Lebanon is approximately 500 USD per ton (1 ton = approx. 2500 bottles), including customs and taxes. This number is lower if larger volumes are imported.

While reuse is a comparatively less resource-intensive solution, it would require a certain economy of scale. Some initiatives have been introduced in the United States, for example by one company in Oregon, to provide standardized beer bottles to be used by various craft brewers.[63] This will ensure they can be cleaned and sorted mechanically through machines that only take one standard size of bottles. However, given the small size of the Lebanese market and its heavy dependence on imports, this is not a viable solution. Therefore, at present, glass recycling is more feasible and should be promoted over reuse. Moreover, consumer campaigns to promote reuse of glass within homes should also be conducted. These should promote key messages about the costs to municipal waste systems of collecting and sorting glass, which can be greatly reduced if the glass is kept in use longer within the economy before being discarded. As most types of glass can be safely reused, unlike plastics, reuse will result in large resource and cost savings for Lebanon.

3.9 Resource Use Efficiency

3.9.1 Energy Use Efficiency

Improving National Systems and Regulations

- Subsidize the costs of energy audits for businesses and industry, to encourage the private sector to seek advice on reducing energy usage and increasing efficiency.
- Introduce Energy Performance Contracting (EPC), a funding scheme that allows energy-use reduction to be funded from the cost savings it generates.
- Implement laws to promote private sector engagement in sustainable energy production and management, including: updating and passing of Law 462, implementing wheeling laws.

Improving Industrial Systems

- Improve industry knowledge of energy audits, management systems and ESCO services.
- Promote energy efficiency and renewable energy use in Industrial systems to reduce dependence on diesel generators.
- Introduce certification schemes to improve product labelling, and thus promote energy efficient products in the markets.

Improving Consumer Awareness

- Improve consumer awareness of emergency efficient products through labelling literacy.
- Conduct consumer campaigns to improve understanding of energy efficiency and renewable energy technologies available in the Lebanese Markets.

As several sections of this report have mentioned, ACTED's KIIs revealed that energy availability is considered one of the major constraints on industrial growth and economic development in Lebanon. The overall effectiveness of the Circular Economy also depends on access to clean and sustainable energy, especially for the manufacturing and recycling sectors. The country's electricity utility company EDL is burdened with a deficit of 800 million USD a year.[64] The energy sector relies heavily on petroleum products to generate electricity, which has a detrimental effect on the environment: this sector is the largest contributor of carbon emissions in Lebanon, generating 56% of total national greenhouse gas (GHG) emissions.[65]

The current status of energy production in Lebanon imposes particular constraints on the industrial sector. As outlined in the National Energy Efficiency Action Plan (NEEAP) developed by the Lebanese Center for Energy Conservation (LCEC), the industrial sector comprises 4,033 factories, employing on average 5 workers or more, and with a power subscription higher than 10kVA. The NEEAP also found that the industrial sector used 20% of final national energy consumption in 2006. Interestingly, the document also found that almost 61% of the sector's energy consumption comes from self-generation, which is aligned with findings from ACTED's assessment, as the following chart shows.

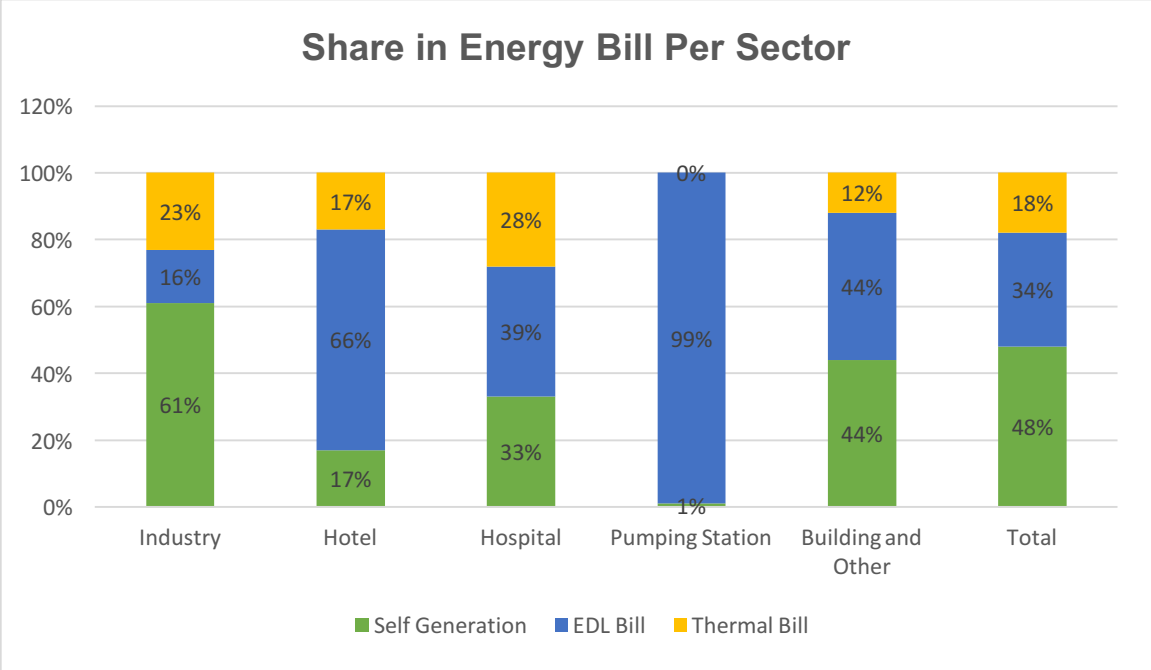


Figure 54: Share in Energy Bill Per Sector; Source: NEEAP

ACTED's KIIs indicated that larger industries have adapted their own energy-production solutions inside their own facilities, due to economy of scale. For example, Unipak Tissue Mill, which produces tissues sold under the brand name "Sanita," reported using biofuel briquettes for heating their production lines. Overall, the Mill reported using 900 tons of husk in their boiler per month, meeting most of their heating needs. Similarly, Sicomo, which is one of Lebanon's largest paper recycling facilities, reported using a built-in incinerator to convert residual plastic waste into

energy. The mill used up 300 tons of residue per day, which met 80% of their energy needs, and reduced the use of diesel in generators from 17,000 liters per month to 3,000 liters per month.

Despite such adaptations, large industries are still experiencing an energy crisis. Large manufacturers still depend on diesel generators to meet their energy needs, but the volatility of the diesel prices is extremely disruptive, as it prevents industries from predicting and maintaining stable manufacturing costs. This can have serious economic consequences. Uniceramic, which declared bankruptcy in 2008, attributed its losses to high energy costs and laid off over 450 staff. Other factories, such as UniPak Tissue Mill, reported having moved some of their more energy-intensive operations abroad, due to high energy costs locally.

Small and medium-sized enterprises are forced to rely on expensive private diesel generators to meet their energy needs. This drives up their costs and reduces their competitiveness. For example, one plastic manufacturer in the south that ACTED surveyed paid 200,000 USD in 2018 for generator costs to meet production targets. The same company also indicated that they were unable to increase the final price of their product due to increasing competition from Jordanian imports, and therefore had to absorb the loss from the energy costs. This has resulted in reduction of targets for 2019, thereby also leading to job losses within the industry.

Another key constraint that ACTED identified is a lack of proper energy management systems within the industrial sector. Although several projects have been initiated, notably with technical support from the Lebanese Center for Energy Conservation (LCEC) located in the Ministry of Energy and Water, none of the entities ACTED interviewed had a systematic energy audit or management system. The Lebanese market for Energy Service Companies (ESCOs) is well developed, but the entities ACTED interviewed stated that they did not believe ESCOs could help them reduce their energy costs, as costs were too high in all sectors. At the same time, most of those interviewed indicated that they had never contacted an ESCO or were not even aware of registered ESCOs. When asked if they would pay for an ESCO to conduct an energy audit, key informants indicated that they did not find such services useful. In fact, ACTED found that they mainly tracked their energy use through monthly bill payments, and seldom, if ever, had a plan for future energy demand increases and supply shortages.

ACTED also consulted several ESCOs and found that their services are most often sought by large building contractors and shopping malls. Financial incentives, such as subsidized green loans, also seemed to have been used mostly for green construction, with very little awareness of such instruments among small and medium-sized enterprises. One of the prohibiting factors also seems to be the high cost of energy audits. ESCOs indicated that energy audit costs started at 7,000- 10,000 USD and increased depending on the size of the industry and the complexity of the production line. Whereas the industry actors that ACTED assessed stated that they were unwilling to pay these costs for ESCOs, in the event that the energy savings from the measures proposed did not yield a good return on investment.

One way to overcome this bottleneck would be to subsidize the cost of energy audits. Such subsidies were provided by LCEC in 2006. ESCOs indicated that around 200 free audits were

conducted. But there was no follow-up, due to a lack of funding. The main recommendations are therefore:

(1) Improve industry knowledge of energy audits, management systems and ESCO services

(2) Subsidize the cost of energy audits and improve industry access to energy management services

Another key recommendation that emerged from ACTED's KIIs, and that is also identified in the National Energy Efficiency Action Plans for Lebanon, is to **establish innovative financing arrangements and repayment plans, such as Energy Performance Contracts**. Energy Performance Contracting (EPC) is a form of 'creative financing' for capital improvement which allows energy upgrades to be funded from cost reductions. Under an EPC arrangement, an external organization (an ESCO) implements a project to deliver energy efficiency, or a renewable energy project, and uses the stream of income from the cost savings, or the renewable energy produced, to repay the costs of the project, including the costs of the investment. Essentially, the ESCO will not receive its payment unless the project delivers energy savings as expected. Industry experts whom ACTED interviewed indicated that if such contracts were made available, this would improve their capacity to invest in sustainable energy systems.

3.9.2 Water Use Efficiency

Improving National Systems and Regulations

- Transition from linear to systems-based water resource management in urban and river basin catchments.
- Implement a water tariff policy across all sectors.
- Increase permeable ground cover to decrease the likelihood of flash floods, enhance groundwater recharge and protect waterways.
- Promote treated waste water and harvesting rainwater for reuse for domestic, agricultural and industrial purposes.

Improving Industrial Systems

- Improve industry knowledge and offer incentives to industries to conduct water audits.
- Financial support should be prioritized for industries to introduce water-saving technologies to replace older and less efficient mechanisms.
- Improve water storage and water-use practices on farms, as well as investment in upgrading and monitoring irrigation water channels to generate major water savings.

Improving Consumer Awareness

- Install water meters on all residential properties and implement volumetric water pricing.
- Incentivize rainwater harvesting, greywater reuse and water-efficient household fixtures.

Water-use efficiency in Lebanon could be the subject of an entirely separate study. Indeed, several studies have already been published on the shortfalls of national water management and have offered recommendations. This section highlights the role of water within the Circular

Economy, and how taking a systems approach to water management can enhance initiatives and recommendations made by others.

To date, human-managed water in Lebanon has not been considered holistically. As can be seen from the water sector value-chain produced by the Ministry of Energy and Water (Figure 55), there is considerable over-reliance on the 'linear' approach of 'taking, consuming and discarding.'

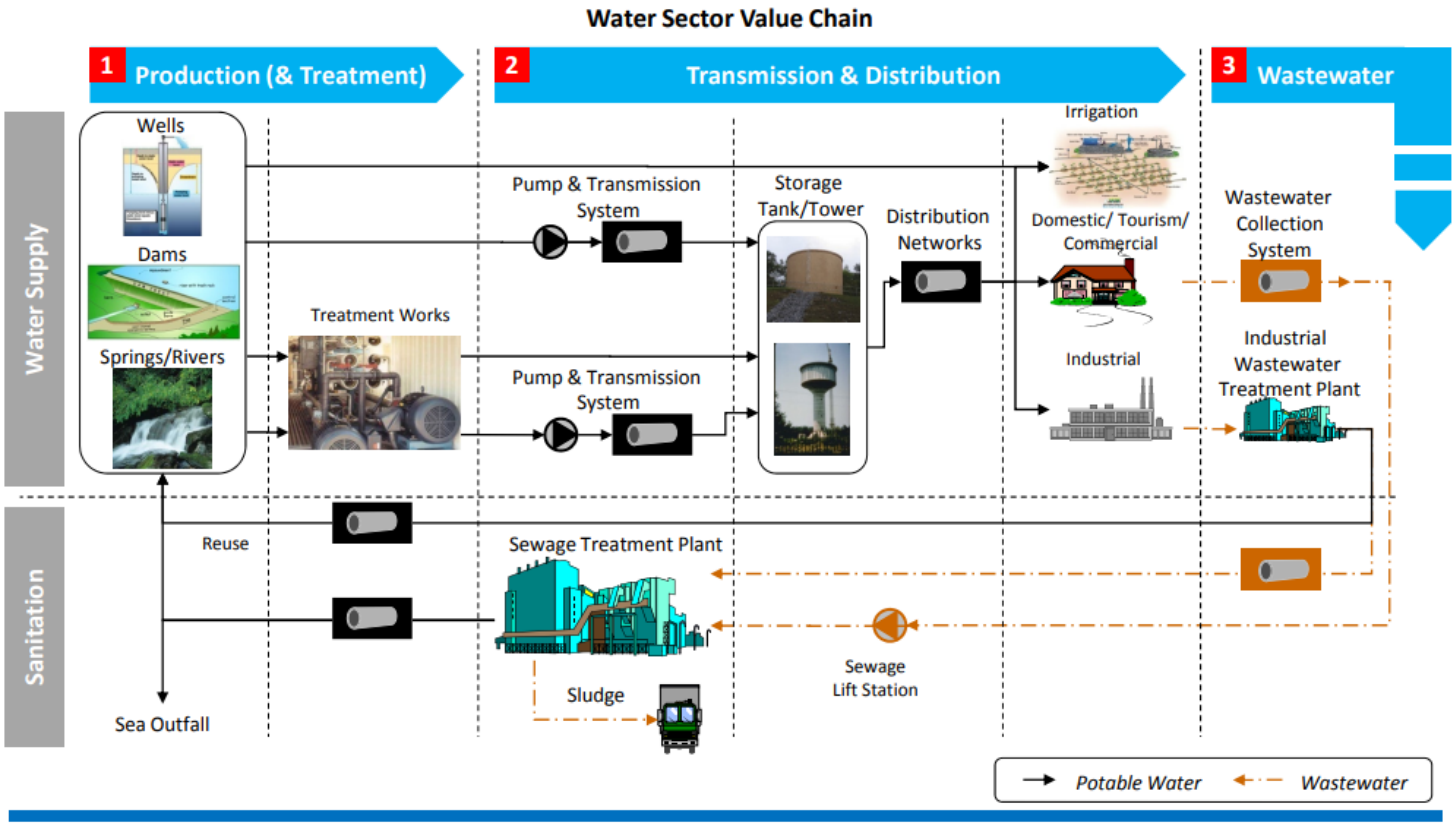


Figure 55. Water sector value chain in Lebanon, Ministry of Energy and Water National Water Sector Strategy 2010-2020

This 'linear' approach to water management omits many opportunities to capitalize on Lebanon's relatively rich water resources, and has led to polluted water sources, high salinity in groundwater, local flooding, urban water scarcity, increased costs for industry, and ultimately degradation of the 'nature-managed' components of the system (see Figure 56, next page).

There are positive initiatives underway in relation to water and the Circular Economy. In its updated National Strategy,[66] the Ministry of Energy and Water is proposing that water management in Lebanon should mimic natural systems, and will require all river basins in Lebanon to consider management at basin scale.

Applying a Circular Economy approach to water management, by assessing the needs and demands of multiple stakeholders across each basin – agricultural, urban, industrial and the environment – and designing and implementing programs to ensure water demand is met sustainably for each is essential to optimizing circularity of water management. Introducing measures for water conservation, water reuse and pollution control, which are developed on the basis of an assessment of the physical distribution of water resources, measuring water demand, supply sources and major pollution risks, are essential in establishing circular systems. It is encouraged to borrow lessons from the program of measures for the Nahr El-Kelb River Basin,[67] as determined through water balance modelling and multi-stakeholder level meetings, included introducing domestic water savings, increasing irrigation efficiency, promoting rainwater harvesting (both in residential areas and in storage lakes) and waste-water reuse.

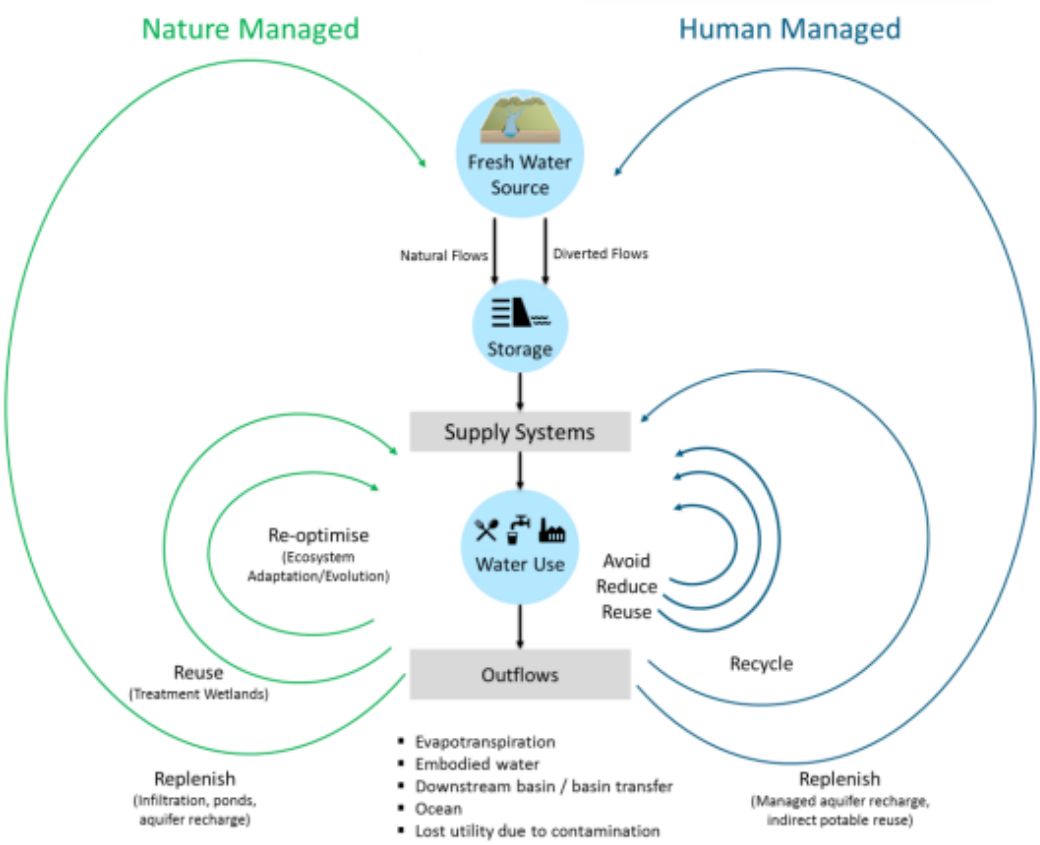


Figure 56. Water and the Circular Economy, Ellen Mac Arthur Foundation

A study by Fransabank in 2018,[68] among many others, showed that Lebanon is expected to experience an increasingly serious water shortage in coming years, due to growing demand and stagnant supply. It is estimated that demand for water will jump from 1.5 billion cubic meters in 2015 to 1.8 billion cubic meters in 2035, pushing up the water deficit from 291 to 610 million cubic meters.

Compounding the likelihood of water scarcity are the competing demands for water across four major areas (Figure 57): domestic, industry, agriculture and the environment. Applying the principles of the Circular Economy would mitigate the effects of scarcity across each area.

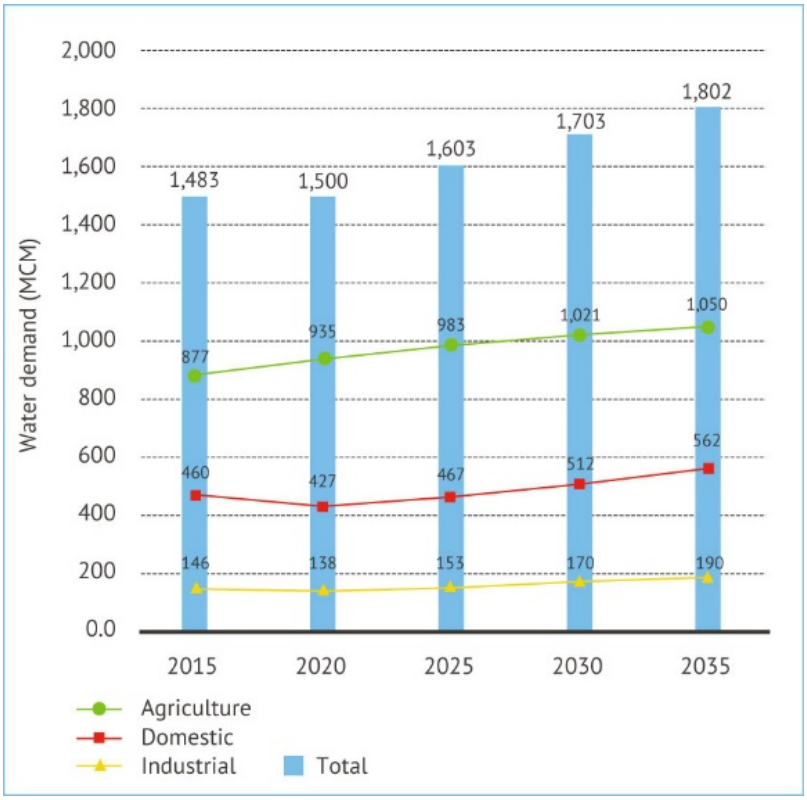


Figure 57: Estimated annual water demand by sector 2015-2035 (MCM) for three sectors, environmental demands not included.

ACTED proposes that **a water tariff policy** is urgently needed across all sectors. Benefits of this policy would include inducing efficient water production, management and consumption behavior, while opening opportunities for business.[69] Existing municipal water systems are often inefficient. From catchment to consumer and back to catchment, water is lost, polluted, wasted and misused.[70] In Lebanon, efforts are being made to upgrade infrastructure in order to convey water to citizens more effectively, yet little effort is being made to 'close the loop' of the water system. To optimize water use in Lebanon effectively, efforts are required to **measure water use and incentivize conservation (reduce use) and efficiency (reduce waste)**.

Water use can reach up to 600m³ per day for large industries.[71] In the industrial sector, **introducing water usage quality standards** would force the manufacturing managers to re-circulate their water, substantially decreasing water demand. Given the significance of efficiency gains that can be made within industry, and the impact this would have on overall water availability, **financial support should be prioritized for industries to introduce water-saving technologies to replace older and less efficient mechanisms**. Although costly in the short term, it would result in both water conservation and resource preservation in the long term.[72]

A well-documented statistic is that the agricultural sector accounts for 60% of water consumed nationally. **Improved water storage and water-use practices on farms, as well as investment in upgrading and monitoring irrigation water channels, would generate major water savings**. One study[73] suggests that investments in 'virtual water' – a process by which water-scarce nations shift their resources and investments towards importing water-rich products instead of growing them domestically and consuming valuable water resources – could be applied successfully to Lebanon. Regions could receive larger or smaller 'virtual water' flows according to comparative land productivity.

The Circular Economy extends the past reduction of use and waste, to promote water harvesting (reuse), treatment (recycling) and fit-for-purpose water supply across all sectors. The water value-chain should be developed as a closed-loop system, with the different grades of water quality put to appropriate uses.[74] Within a Circular Economy system, drinkable water from any source should *only* be used for drinking, while industrial, municipal and agricultural water demands can be met either by harvested rainwater or treated grey, industrial or black water. For example, drinkable water should not be used for municipal irrigation in urban areas, toilet flushing in residential buildings or cleaning of industrial machinery; it could be replaced with harvested rainwater, to reallocate this water for the higher need of human ingestion. Figure 58, produced by the International Water Association,[75] demonstrates the opportunities for using water of different quality among the different elements of the economy. In Lebanon at present, with the exception of some farmers who use untreated wastewater for irrigation, the majority of water users rely on drinkable water for all functions.

Lebanon receives between 600 and 1100mm of rainfall per year. **Rainwater harvesting** presents a good opportunity for water reuse. If widely adopted in Lebanon, this technique could help in:

(1) Collecting around 23 MCM (70 % of the current deficit in the domestic water supply) of rainwater and thus increasing the available water per m^2 of building by 0.4 m^3 per year

(2) Saving around 7% of the amount of electricity usually needed to pump water from an aquifer well, groundwater or underground tank

(3) Considerably reducing the rate of surface runoff of rainwater in coastal zones where rainwater is not captured at all and flows directly into the sea[76]

Rainwater harvesting also helps in reducing soil erosion and the contamination of surface water with pesticides and fertilizers in stormwater runoff. Larger bodies of water, such as reservoirs and lakes, are cleaner as a result. Although rainwater harvesting requires only simple technology, there is a general lack of awareness among consumers, and the cost of installation is a financial barrier for users.

Of the total renewable water resources in Lebanon per year (4.1BCM per year), 2.7BCM per year is returned to the environment (groundwater or surface water) and 0.4BCM per year is lost to human and natural systems as it flows into the sea.[77] The role of the natural environment in

providing water services is well understood in Lebanon, but is undervalued. It is nonetheless possible to **unlock the significant water-management potential of the natural environment, for example, by filtering water through wetlands and marshes, storing treated water by artificially recharging aquifers, and deriving livelihoods and recreational benefits from healthy natural waterways**.

The need for holistic water systems is becoming more pertinent. The UN predicts that 68% of the global population will live in urban centers by 2050. Cities will need to become water-wise to accommodate localized demands on the water system. To prepare for this, many cities globally are integrating their water management and adapting their cities to mimic natural systems: **increasing permeable ground cover to decrease the likelihood of flash floods, increasing groundwater recharge and protecting waterways, and utilizing treated waste water and harvesting rainwater for reuse for domestic, agricultural and industrial purposes.**

5. Conclusion

There is specific market potential for a Circular Economy in Lebanon. The concept offers opportunities for expansion of new local market opportunities, which will lead to immediate job-creation while improving waste management systems and reducing environmental degradation. In all six waste streams assessed by ACTED (Bio-waste, E-waste, Plastic, Paper, Fabric, Glass) there are opportunities for design innovation and manufacturing of new products, repair and reuse economies and recycling systems. Meaningful action can be taken in every sector of Lebanese society: in national administration and government services, in the private sector and industrial manufacturing, and among consumers.

In the bio-waste value-chain, while most household-level composting systems are not currently viable, there are opportunities in the agro-business and manufacturing sectors to introduce anaerobic digesters to produce liquid fertilizer and biogas. Cost-recovery is possible if economy of scale can be achieved, and if the fertilizers produced are branded and marketed to compete with imports. Installing biodigesters and equipping industry with the technical skills to use them will have the dual benefits of reducing agricultural waste and branding it as a valuable resource. Supporting cooperatives and smaller enterprises to recycle agricultural waste and create value-added products, both for local consumption and export, would benefit the environment while creating employment opportunities, especially in the dairy, fruit and vegetable sectors. Finally, there is considerable market potential for local production of certified organic produce, in particular for fruits and vegetables, including potential for export. Market demand is currently unable to be met, while farming remains an important industry for Lebanon which can provide income generating opportunities to both poor Syrians and Lebanese farmers.

The potential for extracting value from e-waste is becoming better understood. Market opportunities exist to expand the repair economy for specific items. Emphasizing the benefits of repair over disposal, increasing the prominence of repairers, facilitating consumer access to repair services, and improving reliability and warranty through regulatory reform will enable this market to expand, creating opportunities for employment requiring technical training and establishment of new service provider interfaces which can better engage with customers.

ACTED has found that the plastics value-chain in Lebanon reflects global trends and is highly distorted. In order to enable cost recovery from plastic recycling, several national regulatory reforms are needed. Investments are also needed to support private sector manufacturing in innovating product design and improving production processes.

Paper, on the other hand, offers immediate opportunities for employment creation. In order to make this value-chain viable, it is necessary to support the improvement of waste collection systems and sorting, allowing more efficient extraction of paper products from waste systems. There are many niche opportunities for making biodegradable or compostable packaging in Lebanon, particularly for use in the agro-food industry, which represents a significant portion of the local economy and has been highlighted as a key sector for growth and job-creation. In order

to ensure sustainability, national standards on de-inkability need to be applied to the local printing industry.

In the fabric value-chain, ACTED found that the complexity of the recycling process combined with the high cost of technology makes recycling non-viable. However, there are clear market opportunities for repair and resale of second-hand clothing, with potential niche opportunities for reusing fabric – for example, as insulation – which would generate jobs while reducing the burden of fabric and textile waste on landfills.

In the glass value-chain, while reuse is not a viable option due to the high cost of water and energy and stringent regulation of sterilization, there remains a major opportunity to facilitate specialized collection and recycling of glass waste into viable products. Local actors are currently performing this transformation at a small scale and these initiatives have considerable potential for expansion. Economy of scale in this sector would greatly reduce Lebanon's burden of glass waste.

Circular Economy principles and design offer Lebanon major opportunities for improving resource productivity, stimulating job-creation and improving competitiveness in the global market. This can only be achieved through investments in technology and legislative change, but these represent a few straightforward actions. They will have sustainable, multiplying effects on larger systems related to waste management, resource protection, and market growth.

Governmental stakeholders should invest in regulatory reforms identified throughout this report to stimulate the Circular Economy. This includes establishment of standards for various material such as plastics and inks, as well as policy incentives such as tax incentives and subsidies for industries to improve their efficiency of material flows and reduce leakages. These would be important first steps to catalyze change within industries and open up opportunities for production of new eco-friendly products and for creation of waste valorization processes.

Private Sector stakeholders should be supported to **transition** to circular approaches to improve their profitability, viability and reduce their impacts on the environment. This could include technology transfers and technical training as well as networking to improve overall material flows. As the main actors who will actually implement change in how waste is produced and transformed, it is essential to ensure private-sector buy-in on reforms and commitment to the opportunities identified.

Large investments are also needed in improving **consumer awareness** regarding the material flows assessed in this report (bio-waste, e-waste, plastic, paper, fabric and glass). Consumer preferences can have significant influence in changing industry behaviour and setting up regulatory frameworks. Therefore, it is important that clear key messaging regarding consumer actions be disseminated.

In order for Lebanon to reap the economic, environmental and social benefits from the Circular Economy, what is needed is a normative shift in how materials are perceived. Circular Economy

thinking should be incentivized through policy change and awareness campaigns, but most importantly changes in the local market to ensure alternatives are available for consumers and industries.

ANNEX 1 – List of Stakeholders

These are key informants whom ACTED interviewed for this report. This list does not include all respondents – a larger number were surveyed in quantitative assessments – but stakeholders who informed high-level strategic aspects of this report.

Public Sector Stakeholders:
Ministry of Environment
Ministry of Environment – Ozone Unit
Ministry of Industry
Ministry of Economy and Trade
Ministry of Interior and Municipality
Ministry of Energy and Water
Lebanese Center for Energy Conservation
Litany River Authority
LIBNOR

Municipalities:
Bekaa
Bar Elias
Ferzoul
Massa
Qaroun
Sohmour
Taaneyel
Yohmor
Mount Lebanon:
Aachkout
Aalmat
Afqa
Aindara
Baadran
Beyet merry
Bickfaya - Mohayedase
Boroj al barjneh
CHARTOUN
Eti7ad sewayejene
Hareit hreik
Mazraat al seyed
Moukhtara
Mristi
Niha
Qartaba
Qlaiaat
Qmatiyeh
Raifoun
Nabatiye:
Deir ntar
Insar
Kfar sir
Nabatiyeh
Rachaya al fokhar
Saksakiyeh
North:
Batroumine
Bebnine
Bechmizzine
Berbara
Bezbina
Btermaz
Heri
Hrar
Kbar habou
Kfar aqqa
Mach7a
Machta hasan
Majdel koura
Majdla
Mechmech
Mounjez
South:
Aanqoun
Ain baal
Beit Lif
Bnaafoul
Kfarhoune
Toura

Brands/Retail
Kassatly (Beirut Beer)
Al Rifai
Zaatar W Zeit
LUSH
Jars and Co
A New Earth
La Familie Eco
Recycle Lebanon/EcoSouk
Concord
Unipack
Sicomo
MasterPack
ChidiacPlast
PlastiLab
3M Plast
Rocky Plast
Mazar Plast
Film Recycling Works
International Sal
Micro Epsilon
Robinson Agri
Biomass
Bioland
Biogaz Lebanon
Unifert
FabricAid
OLX

Packaging:
Dubble
Eat A Plate
Bag It
LibanPack
Polaver
EcoTrade

Others:
Global Environment Financing Facility/GEFF
Environment Core Lab (EVL) AUB
Nature Conservancy Center – AUB
USEK University
CSR Lebanon
FransaBank

ANNEX 2 – Methodology and Limitations

The diagram below presents the framework which ACTED designed to structure research inquiry, guide KIIs and analyze findings. ACTED's research aimed to assess the potential 'wins' arising from Circular Economy initiatives in three main areas: Environmental wins, Social wins and Economic wins. The methodology was designed to consider the material inflows (inputs) and outflows (output) of each value-chain and to identify 'wins' as they related to the transformation of waste materials.

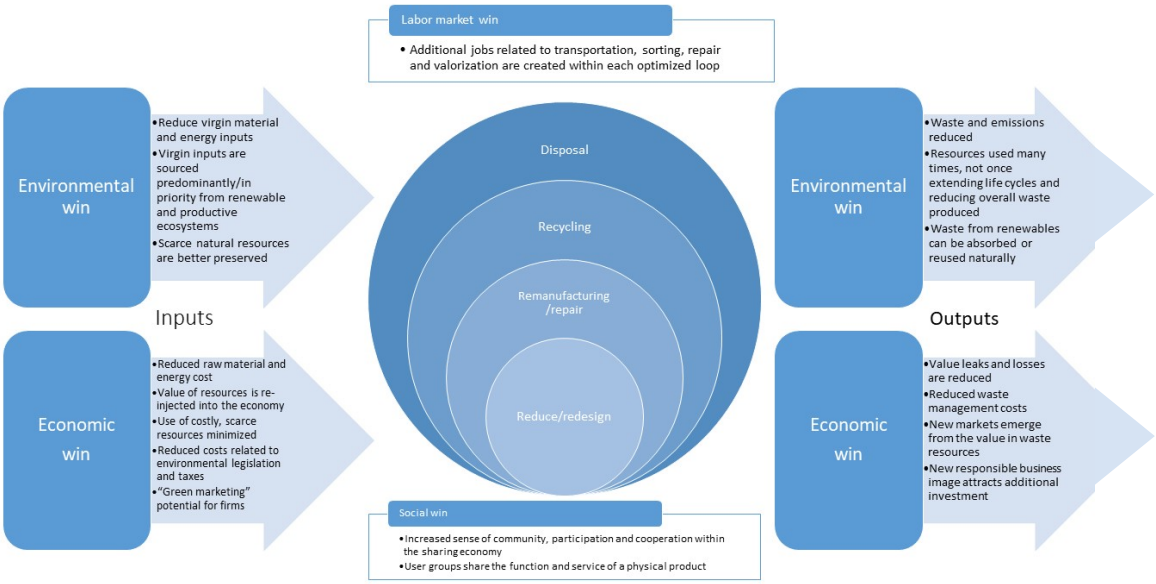


Figure 58: Conceptual Framework for Circular Economy Wins Assessed; Source: Adapted from Korhonen et al. (2018) See also Figure 1.

ACTED's research aimed to improve public understanding of the Circular Economy as a sustainable development pathway. Analysis and findings drew on existing small-scale pilots, policies and advocacy efforts that are currently underway in Lebanon. The main goal was to identify case studies, best practices and specific opportunities for innovation that could facilitate closed-loop systems.

A2.1 Methodology

ACTED's approach to answering its key research questions (see Section 1) involved primary and secondary data-collection. Preliminary research on context, as well as a literature review, identified the main stakeholders and international Circular Economy models that could be feasibly replicated in Lebanon. Following this, primary data was collected in three phases:

- **Phase 1:** Semi-structured Key Informant Interviews (KIIs), in a format that ACTED designed for this project, were used to guide consultations with key private-sector stakeholders. These included representatives of large industries, trade associations and retail shops. The purpose of these KIIs was to understand the market for a Circular Economy in Lebanon and to identify specific value-chains with potential for sustainable development. The KIIs exercise also sought out case studies to illustrate market potential for specific initiatives. The qualitative data collected through the KIIs, as well as the literature review, was synthesized into an initial draft report to identify data gaps.

- **Phase 2:** Taking guidance from the data gaps identified through KIIs, structured interview guides were developed and coded on ODK (Open Data Kit, an online resource for organizing and processing data in resource-constrained environments). These consisted mainly of close-ended questions. Four questionnaires were developed:
    - 1) For the recycling/upcycling industry, mainly comprising actors collecting, sorting and selling waste, or repurposing the waste without large-scale industrial processing
    - 2) repair and resale actors, mainly comprising actors repairing or selling second-hand goods
    - 3) Municipalities engaged in waste collection or sorting
    - 4) Farmers with active organic certification.

  Focus Group Discussions were also held with consumers, to gain understanding of their purchasing habits and preferences for specific product categories.

- **Phase 3:** A validation exercise was conducted with key ministerial and governmental actors, to understand opportunities and constraints within existing and planned national policies. Discussions were held with key Ministry actors on the legislative measures deemed necessary during stakeholder consultations, and their potential to develop a Circular Economy nationally.

In total, 240 respondents were contacted, and 213 responses were received, in addition to 4 focus group discussions. The numbers of responses are as follows:

Municipalities	Structured KII	54
Recycling & Repair Actors	Structured KIIs	41
Farmers	Structured KIIs	43
Others (Government actors, retail shops, manufacturing industries etc)	Semi-Structured KIIs	75

A2.2 Limitations

ACTED's survey considered economic opportunities within various industries. The goal was to understand opportunities for either reducing waste entering the economy, or supporting downstream actors in the recycling value-chain, to ensure that waste collected and sorted can be valorized in the market. Due to a general absence of robust data at the national level, complex data-collection methods and modelling calculations were necessary to arrive at these results. As

large parts of this assessment depended on KIIs, there is potential for bias in information, particularly regarding pricing, due to a frequent perception that investments from aid community might be forthcoming. Regarding private sector KIIs, the industries willing to engage with ACTED were mainly those that are compliant with Lebanese national laws. Therefore, the results may not provide a completely accurate picture of the industrial sector, as the practices of informal or unregistered enterprises are not recorded.

As mentioned at several points in this report, a lack of national-level data on waste management one of the major constraints on the development of a Circular Economy in Lebanon. The missing but necessary datasets can be described in three categories:

- 1) **Waste characterization data** is imperative to understand the volume of waste generated, sorted and recovered. Most actors that participated in this assessment were unwilling or unable to track and share the volume of specific types of waste. This means it is impossible to calculate monetary value of unrecovered waste being sent to landfills. ACTED's research suggests that the material value for these waste streams is high, and that it can be valorized and contribute substantially to national GDP. However, the first step towards recovering this value would be to understand the exact quantities and types of waste involved. Previous research efforts, such as the EU funded report "Support to Reforms – Environmental Governance, Beirut, Lebanon" and the GIZ SWEEP Net report, have attempted to develop waste characterization profiles through extrapolation and calculation, but no accurate or comprehensive accounting system exists.

- 2) **Pricing data** is required not only to understand material value lost by landfilling waste, but also to allow market actors to trade effectively in national and international markets. As highlighted at several points in this report, ACTED made estimates, extrapolations and calculations to establish gross monetary value for waste streams, relying particularly on self-reported data from KIIs. A key recommendation to ensure the robustness of future assessments is to develop a national marketplace that can track such data effectively.

- 3) **Consumption data:** In several sections of this report, ACTED treats imports as a proxy for consumption. While some data is available on material imports into Lebanon, there is very little reliable information on the national manufacturing sector. KIIs have indicated that data on imports is likely to be unreliable, due to incomplete or improper reporting by importers in order to avoid payment of customs and taxes. During KIIs, most industries could not share resource use data, as they themselves were not tracking such data systematically. There is no national accounting system to monitor energy or water use in the agricultural or manufacturing sectors. This greatly limits evidence-based decision making.

Finally, while this report provides specific recommendations for improving product space in the Circular Economy, it does not assess feasibility, in terms of the production costs or resource consumption relating to specific products. For example, some types of alternative packaging are energy-intensive to manufacture and may not be the most economically viable solutions in some

sectors. Further research is needed to understand such products' market viability and environmental sustainability.

In order to ensure the recommendations are widely applicable and can be implemented in an effective manner, robust data collection strategies must be implemented on a national scale. This will require a high level of transparency and coordination among the relevant stakeholders, including Ministerial departments.

Notes

[1] As defined by Ellen McArthur Foundation.
[2] http://www.dailystar.com.lb/News/Lebanon-News/2019/Nov-06/495062-activists-set-up-model-sustainable-village-in-martyrs-square.ashx
[3] Yale, Web, https://e360.yale.edu/features/piling-up-how-chinas-ban-on-importing-waste-has-stalled-global-recycling
[4] Kaza, Silpa; Yao, Lisa C.; Bhada-Tata, Perinaz; Van Woerden, Frank. 2018. What a Waste 2.0 : A Global Snapshot of Solid Waste Management to 2050. Urban Development;. Washington, DC: World Bank https://openknowledge.worldbank.org/handle/10986/30317
[5] During the course of the study, municipalities use the terms "landfilling," meaning disposing in authorized landfills while adhering to environmental and sanitary regulations, and "dumping," meaning disposing of waste illegally or not according to the appropriate standards, interchangeably, so the study was not able to distinguish between these two reported means of disposing of waste.
[6] Bar Elias municipality was the only exception, and reported collecting 2700 tons of waste a month. It is important to highlight that this assessment did not consider Beirut, Tripoli and Saida municipalities, which are some of the biggest waste generators. However, a 2016 report funded through the EU, *Support to Reforms – Environmental Governance*, sourced secondary data for these municipalities.
[7] Costs were basing the average cost of 30,000 LBP per day per laborer based on the exchange rate applicable at time of data collection of 1,500 LBP per USD.
[8] As part of a program funded by the EU MADAD Trust Fund, ACTED launched a SWM hotline to improve linkages to existing solid waste management services for all stakeholders in the waste ecosystem
[9] A factory in Nabatiye collected 2100 tons of mixed plastics a month and could not provide a breakdown per type of plastic. It is therefore not included in this table.
[10] Lebanon's Second National Communication to the UNFCCC, Ministry of Environment, 2011
[11] Veolia, web, accessed July 2019 https://www.veolia.com/en/newsroom/thematic-reports/veolia-committed-climate/our-climate-solutions/biofuels-waste-recovery
[12] Al Bawaba, How an Apple Crisis in Lebanon Is Turning Into Riches for Farmers, October 29th, 2018
[13] IDAL, https://investinlebanon.gov.lb/en/sectors_in_focus/agro_industry
[14] Baldasso C, Barros TC, Tessaro IC. Concentration and purification of whey proteins by ultrafiltration. Desalination. 2011;278:381–386.
[15] BlomInvest Bank, "Lebanon's Organic Food Industry: A Growth Opportunity"
[16] A list of 148 registered organic farmers was obtained from the Ministry of Agriculture, of which 58 were contacted and responses received from 44 which represents a confidence level of 95% and a confidence interval of 12.5.
[17] This assessment was conducted prior to the economic crisis in Lebanon that culminated in the protests during October 2019 and the subsequent devaluation in the currency.
[18] World Integrated Trade Statistics (WITS)
[19] UNU-IAS SCYCLE-2015, referenced in EcoServ company presentation 2019
[20] Interview with National Ozone Unit, Ministry of Environment: results from. Draft 'National Cooling Plan Report', August 2019
[21] OLX Group is a global product and tech company which operates a network of market-leading trading platforms in five continents. With more than 350 million monthly users worldwide, OLX Group makes it fast and easy to buy and sell almost anything online, such as household goods, phones, cars and houses. Through consumer brands including Avito, dubizzle, letgo, OLX and many others, we estimate that 17 million things are exchanged on our apps and platforms every single month. The company is powered by a team of 5,000 people, operating from 35+ countries across five continents. OLX Group is part of Naspers, a global internet group and one of the largest technology investors in the world. Around a fifth of the world's population improve their daily lives using the products and services of companies that Naspers operates and invests in. For more information, please visit www.olxgroup.com and www.naspers.com

[22] Sweepnet report
[23] Sweepnet report
[24]Balde, Cornelis P., Forti, Vanessa, Gray, Vanessa, Kuehr, Ruediger and Stegmann, Paul, The Global E-waste Monitor 2017: Quantities, Flows and Resources, (Bonn, Geneva, and Vienna: United Nations University, International Telecommunication Union, and International Solid Waste Association, 2017).
[25] Ecoserv
[26] Seitz, Joseph, Consultant for SWEEP-Net, *Analysis of Existing E-Waste Practices in MENA Countries*, January 2014
[27] SWEEP-NET0 report
[28] ACTED identified three organizations safely dismantling e-waste in Lebanon during this assessment : Adtech, Ecoserv and Beeatoona
[29] ILO, UNDP (2011): Green jobs assessment in Lebanon – preliminary assessment waste management.
[30] A local NGO operating in electronic waste collection in Lebanon since 2012
[31] The Global E-Waste Monitor 2017, United Nations University
[32] SWEEP-NET report, e-waste in the MENA region
[33] Beeatoona presentation, available online at https://www.aub.edu.lb/Neighborhood/Documents/Ecoserv%20Brief.pdf
[34] http://www.rreuse.org/wp-content/uploads/Joint-Mission-Statement-on-Product-Repair-and-Durability-2.pdf
[35] ACTED assessment of repair actors. 23 repair and resale merchants between June and August 2019: Bir Hasan (1), Borj Hammoud (1), Borj Al Barajneh (1), Cite Sportive (4), Ghoberie (1), Sabra (10), Tarik Jdedeh (3), Zahle (1), Babilyeh (1)
[36] OLX Lebanon (2019). OLX CountryData: Aug 29th 2017 until Aug 20th 2019
[37] OLX Lebanon (2019). OLX CountryData: Aug 29th 2017 until Aug 20th 2019
[38] Survey conducted by OLX online in 2017 with IPSOS
[39] Focus group discussions (4) conducted by ACTED in Bikfaya and Akkar in July 2019
[40] Interview with repair actor, August 2019
[41] Interview with Ozone Unit, Ministry of Environment
[42] Led by The National Ozone Unit, a unit within the Ministry of Environment established in 1998 to implement the commitments of the Montreal Protocol
[43] Data collected in key informant interview with scrap metal dealer in Tripoli Lebanon in August 2019 and represent value paid to municipality waste facilities for each product
[44] Energy Efficient Home Appliances: Perspectives for Lebanese Consumers, UNDP, August 2018
[45] Interview with Oracle
[46] According to data compiled by Orb Media in 2017. Retrieved from https://orbmedia.org/stories/Invisibles_plastics/
[47] Blominvest Bank, The Lebanese Plastic Industry: Leveraging its Strengths Locally and Abroad, 2015
[48] *Ibid*
[49] EUROSTAT, Accessed March 2020. https://ec.europa.eu/eurostat/web/products-eurostat-news/-/DDN-20200312-1
[50] EU, REPORT FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT AND THE COUNCIL on the impact of the use of oxo-degradable plastic, including oxo-degradable plastic carrier bags, on the environment, https://ec.europa.eu/environment/circular-economy/pdf/oxo-plastics.pdf
[51] IDAL, Chemical Industry Factbook, 2016
[52] *Ibid/*
[53] IDAL, Printing Industry Factbook, 2016
[54] *Ibid*
[55] Fifteen recycling companies responded to the survey, but are not representative of the national value. No actual national level data exists on total volume of paper waste collected.
[56] Based on self-reported value from 15 recycling companies.
[57] Sorted paper waste before recycling was sold at costs ranging from USD 0.029 –0.198/kg. This assessment was unable to estimate the final price of paper recycled locally, but KIIs indicated that it was comparable or higher to imported virgin paper due to high energy and infrastructure costs.
[58] A New Textiles Economy: Redesigning Fashion's Future, Ellen McArthur Foundation
[59] Ministry of Industry

[60] Support to Reforms – Environmental Governance Beirut, Lebanon, March 2016
[61] Cedar Environmental Interview in Lebanon Traveler, 18 March 2016
[62] An estimated 29 million liters of beer, with a standard bottle size of 330 ml are produced and sold in Lebanon each year (source: BLOM Bank). This amounts to approximately 88 million bottles a year.
[63] https://www.fastcompany.com/90239092/this-reusable-beer-bottle-could-change-the-way-america-drinks
[64] https://lb.boell.org/en/2019/03/01/renewable-energy-lebanon-can-country-embrace-its-resources-sustainably
[65] Ministry of Environment, http://climatechange.moe.gov.lb/energy
[66] Expected to be released early 2020
[67] Developed through the EU funded SWIM-H2020 SM project in close collaboration with the General Directorate for Hydraulic and Electrical Resources – Ministry of Energy and Water and in a consultation with stakeholders
[68] "The Policies and Actions Needed to Face the Growing Water Security Challenges in Lebanon", Fransabank, 2018
[69] Melki, Roger (2014) Tariff strategy in the water sector in Lebanon, available online: https://www.riob.org/en/file/280448/download?token=HGLN8LKc
[70] https://iwa-network.org/water-utility-pathways-circular-economy-charting-course-sustainability/
[71] Ministry of Energy and Water National Water Sector Strategy 2010-2020
[72] http://www.afedonline.org/afedreport/english/book5.pdf
[73] http://www.afedonline.org/afedreport/english/book5.pdf
[74] International Water Association,
[75] Water Utility Pathways in a Circular Economy, International Water Association, 2016
[76] Appl Water Sci (2017) 7:769–775, DOI 10.1007/s13201-015-0289-8
[77] National Water Sector Strategy, MoEW 2010-2020