KPMG

skd Türkiye

Preliminary Research On Circularity Potential Of Five Sectors In Turkey

2022

AFD
AGENCE FRANÇAISE DE DÉVELOPPEMENT

Contents

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1. Acronyms

ACEA – European Automobile Manufacturers' Association

AEEE – Atık Elektrikli ve Elektronik Eşyalar (Waste from Electrical and Electronic Equipment - WEEE)

AFD – Agence Française de Développement (Fransız Kalkınma Ajansı)

CAPEX – Capital Expenditure

CBAM - Carbon Border Adjustment Mechanism

CGRi – Circularity Gap Reporting Initiative (CGRi)

CTCN - Climate Technology Center and Network

CTI – Circular Transition Indicator

DİS – Depozito İade Sistemi

EBRD –European Bank for Reconstruction and Investment

EC – European Commission

ELT – End of Life Tyres

ELV – End-of-Life Vehicle

EPD – Environmental Product Declaration

EV – Electric Vehicle

EU – European Union

ÇEVKO - Çevre Koruma ve Ambalaj Atıklarını Değerlendirme Vakfı (Environment Protection and Packaging Waste Recovery)

DİS – Depozito İade Sistemi (Deposit Refund System)

HDV – Heavy Duty Vehicle

HORECA – Hotel Restaurant Café

GDP – Gross Domestic Product

GHG – Greenhouse Gas

ICE - Internal Combustion Engine

İBB – İstanbul Büyükşehir Belediyesi (Istanbul Metropolitan Municipality)

İMSAD - İnşaat Malzemesi Sanayicileri Derneği (Association of Construction Material Producers)

IP – Intellectual Property

İPG - İş Dünyası Plastik Girişim

İSTAÇ - İstanbul Çevre Yönetimi Sanayi ve Ticaret Anonim Şirketi (Istanbul Environmental Management Industry and Trade Corporation)

İTÜ – İstanbul Teknik Üniversitesi (İstanbul Technical University)

KDV – Katma Değer Vergisi (Value Added Tax)

LCA – Life Cycle Assessment

MaaS – Mobility as a Service

OECD - Organisation for Economic Co-operation and Development

OSD – Otomotiv Sanayii Sanayicileri Derneği (Automotive Industry Association)

PAGEV - Türk Plastik Sanayicileri Araştırma Geliştirme ve Eğitim Vakfı (Turkish Plastics Industry Foundation)

PU or PUR – Polyurethane

R&D – Research and Development

RCS – Recycled Claim Standard

SDG – Sustainable Development Goals

SKD Türkiye – İş Dünyası ve Sürdürülebilir Kalkınma Derneği (Business Council for Sustainable Development Turkey)

STEM – Science, Technology, Engineering and Mathematics

TMM – Turkey Materials Marketplace

TOFAŞ – Türk Otomobil Fabrikası A.Ş. (Turkish Automobile Factory Corporation)

TOGG - Türkiye'nin Otomobili Girişim Grubu Sanayi ve Ticaret A.Ş. (Turkey's Automobile Joint Venture Group Inc.)

TÜİK - Türkiye İstatistik Kurumu (Turkish Statistical Institute)

TÜBİTAK - Türkiye Bilimsel ve Teknolojik Araştırma Kurumu (The Scientific and Technological Research Council of Turkey)

TTGV - Türkiye Teknoloji Geliştirme Vakfı (Technology Development Foundation of Turkey)

TURKSTAT - Turkish Statistical Institute

VAT – Value Added Tax

VECTO - Vehicle Energy Consumption Calculation Tool

VOC – Volatile Organic Compound

WBCSD – World Business Council for Sustainable Development

WEEE – Waste from Electrical and Electronic Equipment

WEF – World Economic Forum

WIPO – World Intellectual Property Organization

2. Executive Summary

Circularity is an all-encompassing framework, extending beyond simple material recovery to transform material and product design, strategies, systems and business models. The most recent Circularity Gap Report, published in 2022, calculated the global circularity rate as 8.6%.[1] While circularity rates remain quite low globally, the European Union has set the topic on top of its political agenda, notably with its EU Taxonomy for sustainable activities. Restructuring the economy will result in the emergence of new businesses while obviating some others; this transition is expected to generate 700,000 green jobs in the EU alone by 2030.[2]

Turkey's economy has been severely impacted by the COVID-19 pandemic, and its investment space lacks a dedicated circularity focus, despite an investment plan devised with the World Bank. A national circular economy roadmap has not been devised yet in Turkey to date; however, "Green Deal Action Plan" announced in July 2021 by the Ministry of Industry and Trade, has considered the implementation of circularity principles in Turkey. As part of Turkey's efforts to integrate the European Union, legal harmonization has been undertaken to match the EU's current legislative frame on waste and circularity issues. WEEE(1), ELV(2) and Batteries Regulation(3) are just some of the regulations that were matched in Turkey. Current efforts such as regulations, education, innovative practices and a zero-waste project have nevertheless led to improve cyclical material flows in the country. Adopting such directives in Turkey has been the primary reason of higher recovery rates in the Automotive and Home Appliances sectors.

Funded by AFD, a preliminary research was conducted between 2020-2021 on the circularity potential in five sectors of Turkey, with the collaboration of Business Council for Sustainable Development Turkey (SKD), KPMG Turkey and KPMG France. Plastic packaging, textile, home appliances, automotive and construction industries were the five sectors selected for this research, due to their importance in the Turkish economy, their resource-intensive nature, and their strategic imperative in regard to circularity related initiatives such as the Circular Economy Action Plan.

This is a research report, in which limited publicly available qualitative and quantitative data from five sectors, complemented by information provided by volunteer companies and academicians, were compiled and assessed. Due to the low quality of the publicly available nation-wide data, sampling studies were carried out with limited amount of information; hence, varying results on circularity potential of the sectors and products were presented in the report. The most important reasons for the dearth of the studies in the field of circularity were determined as lack of regulations, data, policies and awareness. Other reasons for the absence of circular practices include insufficient industry-wide schemes, deficient infrastructure and lack of data and information transparency. While individual firms have started to research and invest into circular technologies and innovations, most companies are still at a nascent stage.

On the other hand, one of the most important reasons for boosting circularity in Turkey has been trade. Companies that sell in other markets, particularly Europe, have invested more in circular strategies due to European regulations and competition. As a result, some Turkish companies in the Home Appliances market have become pioneers in the global markets with their intensive R&D investments.

The supply chain and customers can either accelerate the transition to a circular economy or impede it and boundaries set by these stakeholders are pivotal. For instance, an organization cannot track or increase the circularity of its products, if the supply chain does not provide necessary data or circular input. As for clients, they tend to impose restrictions derived from a linear consumption model, which limits manufacturers' circularity performance. Thus, while some markets and clients can advance circular initiatives (e.g. European market), some may have the opposite effect. Raising awareness, improving regulations in favour of circularity and building labour capacity throughout the value chain is necessary to truly achieve circularity.

[1] Atık Elektrikli ve Elektronik Eşyaların Kontrolü Yönetmeliği (AEEE) in Turkey
[2] Ömrünü Tamamlamış Araçların Kontorlü Hakkında Yönetmelik in Turkey
[3] Atık Pil ve Akümülatörlerin Kontrolü Yönetmeliği in Turkey

The use of circular input remains low in most sectors. Lack of certified recycled materials in Turkey plays a big role. Companies avoid uncertified recycled materials due to regulations and quality standards that ensure durability, safety and hygiene. Automotive, Home Appliances, Construction and Plastic Packaging (for food) sectors are strictly regulated in that respect. Similar restraints imposed by lack of certified recycled materials rise in the Home Appliances sector too, since it is integral to use quality materials to manufacture durable goods that can withstand extreme temperatures. If the market has a steady and ample supply of certified recycled materials at a competitive rate, boosting the circularity of input will be possible in many sectors. As for bioplastics, their lack of durability and resilience under certain conditions limit their utility in most sectors and challenges the substitution of traditional plastics.

Despite important data limitations in terms of available funding, it appears that development banks continue to play an important role as catalysts. Additionally, manufacturers, conglomerates, commercial banks and funds are also shaping the Turkish investment landscape currently. International partnerships with EU Countries and the EBRD (European Bank for Reconstruction and Development) have contributed to advancing circularity awareness and topics in Turkey, with the Turkey Materials Marketplace and Turkey Circular Economy Platform being one of the most promising projects conducted to date. Funds and financial incentives will aid industries and organizations in overcoming the financial barriers in an evolving economy.

Elevating the growth of a circular ecosystem and working towards a Net-Zero Carbon nation will require the collaboration of companies, industries, NGOs, regulators, municipalities, consumers and academic institutions. Circular practices have demonstrated their effectiveness in limiting emissions which makes them an essential component for nations and organizations' Net-Zero Carbon goals. From capacity building and evolving regulations to awareness campaigns and R&D, a joint initiative and a sweeping roadmap to transform consumption will be integral for limiting GHG emissions.

This report details possible easily implemented criteria to assess the circularity potential of a financed project and presents a summary of current actions and identification of possible trends/gaps for future actions. 29 companies from 5 different sectors participated via surveys; additionally, meetings were held with 15 different companies to evaluate the circularity potential of these 5 industries. The circularity calculation methodology was applied on 2 industries and 4 companies from 3 sectors. The circularity ratios, which exclude energy and water cycles, were calculated based on a derivative method that was inspired by the CTI framework methodology developed by WBCSD. It should be noted that the official tool was not utilized for this study since the scope of the tool and the scope of the circularity calculations carried out for this study were not the same. We estimated the average circularity of the inputs as around 7% and output as around 13% for the plastic packaging sector while in the textile sector, circularity of inputs was around 16% and outputs was around 23% based on the information received from volunteering companies. More industry players would need to contribute to such studies in order to analyse opportunities and barriers in more detail. We hope that this report will serve as a forerunner for future studies regarding circularity in Turkey and encourage more companies to participate in them.

3. Foreword

For decades now, we have been feeling the ever-growing side effects of our linear economy in our day to day lives, and more recently, our politics and economics. As the human population grew, life expectancies increased and consumption levels rose, we demanded more resources without a consideration of the finite capacity of the planet. Whether it be lakes drying up, species going extinct, water-levels rising, air pollution increasing or extended periods of drought, our environment holds all the evidence that we need to take the initiative to change how we live.

Despite the palpable warnings of unsustainable levels of consumption and the pressure put on natural resources, it was not until recent years that nations came together to take a stand in unity. The Sustainable Development Goals set during the Paris Agreement in 2015 laid out the focus areas of an overarching approach for social, environmental and governance sustainability. Turkey has ratified this agreement on October 2021 and set 2053 as the target year for achieving Net Zero Emissions.

This shift in Turkey's position reflects the importance of supporting sustainability initiatives – not just for environmental and social motivations but for international affairs as well. In a world defined by the globalization of economies, countries that fall behind in integrating sustainability measures in their policies will surely face major losses in trades and stakeholder relationships. With an expanding network of firms and countries joining initiatives and pledges triggered by developments such as those in COP26, Paris Agreement and the EU Green Deal, major changes in how we consume is on its way. Most recent commitments from COP26 include pledges regarding deforestation, methane, coal, cement, EVs and finance and are bound to transform industries as we know them.

In the light of such transformation, circularity principles hold a strategic importance in forsaking linear consumption, combating climate change and eliminating biodiversity loss. Majority of the emissions come from material handling and use-of-products phases; thus, when materials, products and services' consumption decreases, so will waste and GHG emissions.

This project, funded by l'Agence Française de Développement[4] and supported by SKD[5], aims to conduct a preliminary research study of circularity potential by focusing on five major industries in Turkey. During the study, interviews and meetings were held with industry leaders, companies and researchers alongside consulting renowned publications to evaluate and determine risks and opportunities germane to each industry in Turkey. This study consists of two phases, in which sector level research and company level circularity calculations were conducted in order to present a few examples, focusing on associated materials flow and physical waste-streams, excluding water and energy cycles.

[4] AFD, French Development Agency
[5] Business World and Sustainable Development Association, *İş Dünyası ve Sürdürülebilir Kalkınma Derneği*

Many KPIs have been developed over time to assess governance, social and environmental performances – but all-in-one circularity indicators are a relatively novel concept. To quantify companies and industries' circularity performance that will assist them with adopting a cradle-to-cradle approach, we have adopted the circularity calculation methodology developed by KPMG Netherlands which was inspired by WBCSD's CTI Framework[6]. With this approach, companies can track how circular their operations and products are and evaluate the impact of their sustainability strategies over the years. As it will be later demonstrated on this report, we have conducted this study both on a sector and company level, utilizing the limited information that was available.

The consensus of our investigation was that circularity concepts are unbeknownst to majority and sustainability practices are mainly limited to recycling, which are also some of the reasons of nation and company wide data limitations. We need to widen the scope of circularity practices to encompass the entire value chain and product life cycle to tackle climate change and biodiversity loss. We hope that this preliminary study will not only introduce companies, leaders, investors and consumers to circular economy principles and the potential of circularity strategies in Turkey, but will also enhance organizations' awareness regarding circularity practices and highlight the importance of data for tracking to supplant cradle-to-grave with cradle-to-cradle.

[6] World Business Council for Sustainable Development

4. About this Report

The report covers the following sections:

Table 1: Table of Contents

#	Section	Overview
	Disclaimer	
1	Acronyms	
2	Executive Summary	This section summarizes the conclusions drawn from this report.
3	Foreword	This section is the preface of the report.
4	About this Report	This section explains the project scope, aims and methodology.
5	Introduction	This section provides an overview of circularity trends internationally and in Turkey.
6	Leading Sectors Analysis	This section provides a summary overview of the sectors covered by the report, namely: - Plastic Packaging - Textiles - Automotive - Home Appliances - Construction Services
7	Areas of Collaboration Between France and Turkey	This section outlines joint initiatives that can be undertaken by different parties in Turkey and France.
8	Barriers and Opportunities	This section elaborates on the barriers and opportunities in the Turkish market
9	Acknowledgements	This section has the names of companies, associations and names of experts who have contributed.
10	Appendices	This section includes explanations of the terms and frameworks used in the report.
11	References	This section lists the references and links for information used on this report in the order they appear in the text.

This report summarizes the findings from a circularity project undertaken by an international collaborative effort, led by experts from KPMG Turkey, KPMG France, SKD[7] and AFD[8] and the international network.

The study focused on the following industries in order to assess the circularity of key sectors within the Turkish economy:

- Plastic Packaging
- Textiles
- Automotive
- Home Appliances
- Construction Services

These sectors were selected as the focus of this study for their vital presence in the Turkish economy, strategic importance in Turkey's economy, resource intensity and circularity potential.

The project has been carried out in 2 main phases. The results presented below are not representative of the entire sector. As a result of the limited number of sources that were available for consultation for the sectoral study, quantitative projections cannot be made with the information provided below. Due to lack of data, study was applied to a portion of the sector and results are based on estimation from volunteer companies and publicly available sources.

Phase 1:

Following the selection of the sectors, work moved onto extensive research that included the following main activities:

- Identified, collected and analysed the publicly available data needed to measure circularity performance on a national level via the circularity calculation methodology. Sources consulted included Turkish companies, sector associations, academia, Ministries and online research of reports.
- Due to lack of public data, extensive stakeholder consultation was conducted through meetings, interviews and surveys with leading companies, start-ups, experts, industry associations and the Turkish Ministry of Environment, Urbanization and Climate Change to obtain more circularity data and verify and cross-validate information. Further macro level analysis is needed to enrich the methodology, underlying data and improve the circular economy performance levels of sectors in Turkey.
- Data covered a yearlong span.
- A total of 29 organizations and researchers from 5 sectors contributed to the research and data validation during phase 1.
- While the circularity calculation methodology was used to calculate the circularity of all five sectors, the results of only two (Plastic Packaging and Textiles) have been disclosed in this report due to the low quality of data. Details of phase 1 study are summarized in the sections of each sector.
- During Phase 1, circularity calculation methodology results were deemed low-quality for some sectors due to lack of data.

[7] Business Council for Sustainable Development Turkey, *İş Dünyası ve Sürdürülebilir Kalkınma Derneği,*
[8] Agence Française de Développement

Phase 2:

- In order to enrich the data collected in Phase 1 study, which will be detailed further in later sections, the scope of the Phase 2 study was changed to calculate circularity rates at company level. Meetings were held with 15 companies from five sectors and four companies from plastics packaging, textile and construction sectors volunteered to participate in this project. Each participating company had the option to choose which product, project or plant circularity they wanted to evaluate and circularity calculation methodology was used to calculate circularity rates.
- For plastic packaging and textile sectors, data covered yearlong production of selected product lines. For construction sector, data was collected for a single project and the time frame was the start and end date of that project, which was longer than a year. The reason for scope variance is due to the nature of operations and products; while the plastic packaging and textile manufacturing sectors usually have a continuous product stream, construction companies work on a project-basis. Additionally, it was decided that a product or project focused approach instead of a company-wide one would be more useful for the participating companies to better understand their own performance. Circularity of inputs and outputs vary vastly from output to output, even within the same company.
- Details of phase 2 study are summarized in the sections of each sector.

The methodology followed on this project has inspired by the methodology developed by WBCSD's Circular Transition Indicator (CTI) Framework. Hereinafter, the method used in this report will be referred to as 'circularity calculation methodology'.

Circularity calculation methodology uses the following definitions to evaluate circularity in which weight and % composition are primarily evaluated:

% circular input

This ratio assesses the circularity rate of input materials. Input materials are the sum of non-renewable, renewable and secondary materials used in production, as classified based on the following definitions:

Non-renewable materials (tonnes): This is the weight of input that has neither been previously used or consumed (virgin) nor is it renewable. Therefore, for these materials, circularity is 0%.

Renewable materials (tonnes): Renewable input is the weight of sustainably managed resource that is replenished/regrown after extraction. Input can consist of either fully or partially of renewable content. Thus, in this case, % circularity input is the % renewable material content.

Secondary materials (tonnes): Secondary material is the weight of previously recovered non-virgin or secondary (reused, refurbished, remanufactured or recycled) materials. Input can consist of either fully or partially of renewable content. Hence, in this case, % circularity input is the % recovered content.

In the event input is both renewable and secondary, it is counted only once in the input in order to prevent double counting.

% circular output

This ratio assesses the circularity rate of output materials. Output materials are the sum of products, by-products and waste generated during and after production and are as classified based on following definitions:

Product (tonnes): These are the weight of the target output of the manufacturing activities.

By-product (tonnes): In some sectors and companies, weight of by-products were included in calculations if data was available.

Waste (tonnes): These are the weight of outputs of the manufacturing activities that, based on a linear model, no longer have economic utility.

% Potential ratio of recovery: This is the potential recoverability rate of outputs based on how they were designed and treated in a way that they can be recovered on a technical, material level at end of life. Recovery design solutions can include disassembly, repairability and recyclability. Recovery potential refers to material recovery but does not include energy recovery.

% Actual recovery: This is the realized recovery rate of outputs that leave the organization and actually find their way back into the value chain (either the same or a different value chain) and covers products, by-products, and waste). Recovery is different from collection. After collection, materials can still end up in landfill or incinerated. For this reason, this indicator is not based on estimates but requires actual data and in case no data is available the actual recovery is deemed to be 0%.

The aggregated weight of products, by-products and wastes yielded the weight of the total output.

The analysis for this report focused on the production and manufacturing phases; energy and water cycles alongside extraction of materials, transportation and end-of-life phases of products were excluded from the scope of the circularity calculation methodology. Only associated materials flow and physical waste-streams were considered for the selected sectors, products and project. Waste streams covered in the calculations include packaging wastes, hazardous wastes, paint-dye sludge, wastewater treatment sludge, by-products and scraps. Domestic wastes are excluded in this study. Additionally, construction, excavation and demolition wastes are excluded in the calculations except for the construction sector phase 2 study calculations. Here, it is important to note that in order to have an in depth understanding of circularity performance, the entire life cycle should be considered – which means performing the circularity study on the entire value chain.

It was decided that a product or project focused approach instead of a company-wide one would be more useful for the participating companies to better understand their own performance. Circularity of inputs and outputs vary greatly from output to output, even within the same company; regulations, clients, environment, infrastructure, availability of resources and a product's function are just some of the variables that affect the circularity potential. Due to this, companies that produce a range of products may prefer to track their circularity performance over the years for the same or similar product lines and instead of assessing all activities at once. Finally, a product-based approach also allows companies to better evaluate their costs per unit.

This report is a first attempt to assess the current state of circularity in some of the largest sectors in Turkey. It aims to raise awareness of circular economy principles and accelerate the transition away from a linear economy.

The report covers circular best practices mostly from France and Turkey to highlight opportunities for scaling up circular solutions more broadly across the sectors studied. In addition, it has also determined current gaps in data, technical and regulatory obstacles and untapped potential and opportunities. Work was undertaken over December '19 - December '21; the dates of the company's circularity calculation methodology data covered 01.01 2021 – 31.12.2021 for plastics packaging and textiles sectors while it covered the entire duration of the project for the construction sector. The data for the sectoral study covered the year 2020.

5. Introduction

Circular economy is a cradle-to-cradle approach that focuses on regenerative design. It aims to optimize the value of materials, both environmentally and economically, by circulating resources, products, parts and materials continuously. Innovative business models that prioritize quality, durability, versatility, re-use, refurbishment, remanufacturing, repurposing, recycling, renewability, and biodegradation are the pillars of a circular economy. Through circular designs and sustainable consumption, waste generation will fall concomitantly with lower demand on raw materials. For these principles to become the norm, a full-scale intervention in the value chain by the participation and contribution of all consumers and institutions is necessary.

While traditional linear models have been proven to be profitable up until recently, such business activities and profits cannot be sustained in a world where planetary boundaries are being challenged. As environmental risks' grip on world economy and policies tightens, companies that do not rejoinder will eventually face regulatory, operational, business, market and stakeholder risks. A circular business case can act as a defence mechanism against these risks while increasing resource efficiency and reducing long-term costs.

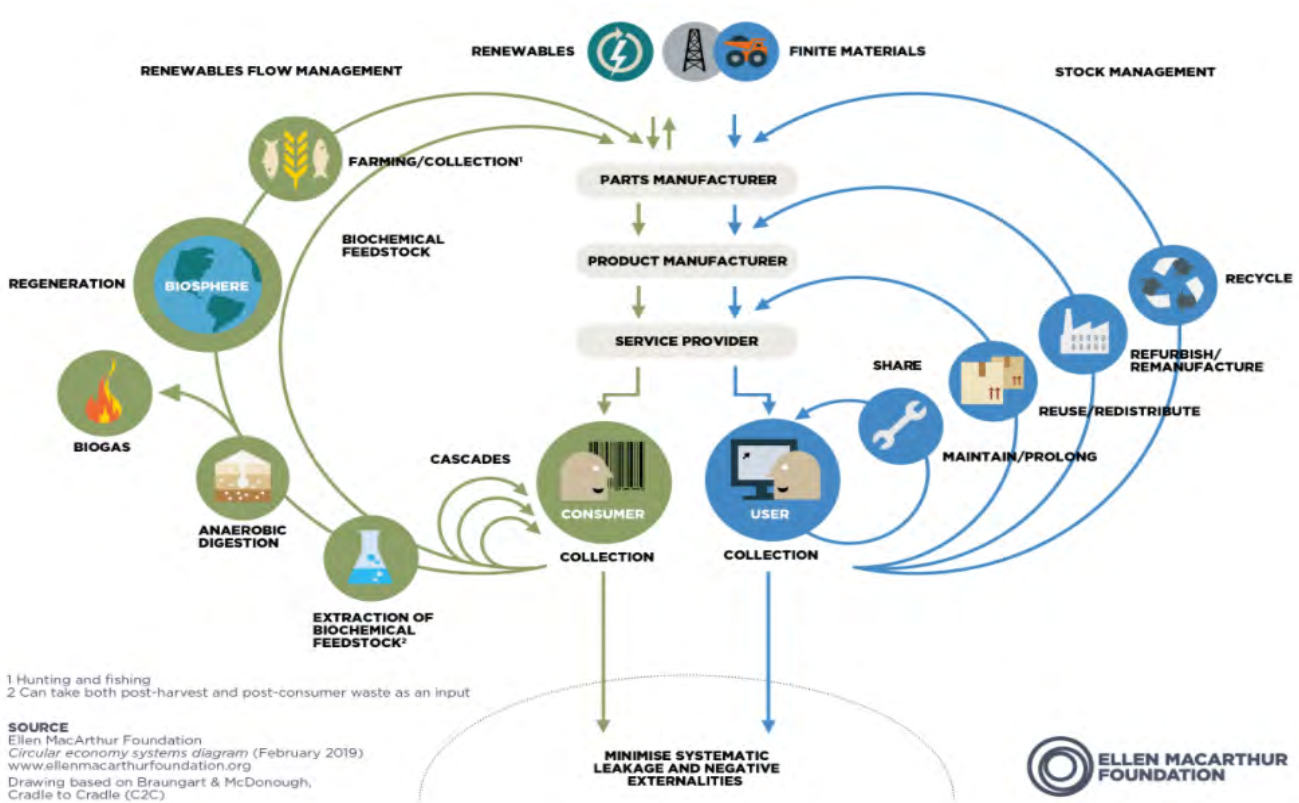
Principles of circular economy rely on re-thinking and re-designing every aspect of how we produce, consume and discard as we move away from a linear economy that is defined by the take-make-waste model.[3] Ellen MacArthur Foundation, one of the leading organizations on the study and application of circular economy model, has outlined three circular economy pillars:

1. Eliminate Waste and Pollution
2. Circulate Products and Materials
3. Regenerate Nature[4]

Circular economy pillars define waste and pollution as design flaws instead of unavoidable by-products, which means that they can be removed from the equation by changing product, service and process designs. To ensure that fewer resources are used, products will need to be designed for durability. For consumption to be circular, waste needs to circulate back into the economy and landfills utilized only as a last resort. Finally, while using fewer resources will put less stress on the environment, natural systems will still have to be further supported through restoring, nourishing and growing processes.

Decoupling value creation, production and consumption from systematic reliance on raw materials and waste pilling-up is at the heart of the concept of a circular economy. In this respect, a circular economy is not simply focused on minimising the use of materials and wastes but looks more broadly at the overall amount of water consumed, wastewater recycled/reused and emissions reduced alongside materials and wastes' levels of purity and toxicity; thus, it also insists on reducing consumption of energy, water and pollutants while shifting towards renewable energy. The economic and environmental rationale behind the circular economy is clear-cut as several value creation levers drive its mechanics: the amount of materials used is minimised compared to a linear production system; material reuse is maximised both through time and through the number of reuses; reuses can be diversified across the whole value chain; and finally, materials' purity reinforces efficiencies in collection and redistribution.

Adopting a circular approach for resource consumption imitates the processes of natural systems. In the natural environment, everything returns to nature and is absorbed by the environment. A circular approach to materials management follows the same philosophy, working to reduce and avoid waste throughout the lifecycle.[5]



Circular Economy Systems Diagram

The butterfly diagram constructed by the Ellen MacArthur Foundation illustrates two main material flows in a circular economy: biological cycle and technical cycle. It depicts the main strategies for optimizing natural resource consumption and extending products and materials' lifetimes. The order of the loops signifies the importance of the strategies, with inner loops prioritized. The graph also highlights the roles different participants play in the economy, emphasizing that achieving circularity relies on maximizing participation.[6]

The European Commission has categorized circular economy strategies under the 9R Framework, which was initially developed by Potting et. al :

0. Refuse. Make product redundant by abandoning its function or by offering the same function by a radically different (e.g. digital) product or service.

1. Rethink. Make product use more intensive (e.g. through product-as-a-service, reuse and sharing models or by putting multi-functional products on the market).

2. Reduce. Increase efficiency in product manufacture or use by consuming fewer natural resources and materials.

3. Re-use. Re-use of a product which is still in good condition and fulfils its original function (and is not waste) for the same purpose for which it was conceived.

4. Repair. Repair and maintenance of defective product so it can be used with its original function.

5. Refurbish. Restore an old product and bring it up to date (to specified quality level).

6. Remanufacture. Use parts of a discarded product in a new product with the same function (and as-new-condition).

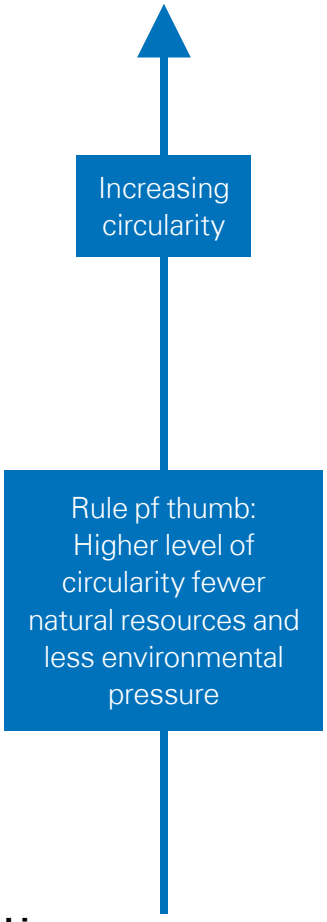
7. Repurpose. Use a redundant product or its parts in a new product with different function.

8. Recycle. Recover materials from waste to be reprocessed into new products, materials or substances whether for the original or other purposes. It includes the reprocessing of organic material but does not include energy recovery and the reprocessing into materials that are to be used as fuels or for backfilling operations.

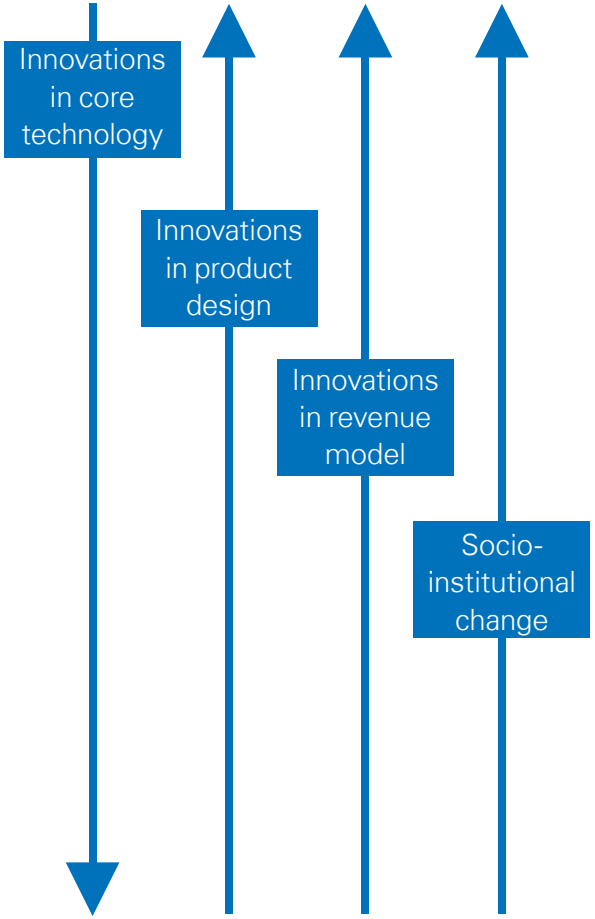
9. Recover. Incinerate waste for energy production

Figure 2: Circularity Strategies (Source: Adapted from Potting et al. (2017, p.5)[7]

Circularity strategies within the production chain, in order priority



Strategies		
Smarter product use and manifacture	R_0 Refuse	Make product redundant by abandonings its fuction or by offering the same function with a radically different product
	R_1 Rethink	Make product use more intensive (e.g. through sharing products, or by putting multi-functional products on the marker)
	R_2 Reduce	Increase efficiency in product manufacture or use by consuming fewer natural resources and materials
Extend lifespan of product and its parts	R_3 Re-use	Re-use by another consumer of discarded product which is still in good condition and fulfils its original function
	R_4 Repair	Repair and maintance of defective product so it can be used with its original function
	R_5 Refurbish	Restore and old product and bring it up to date
	R_6 Remanufacture	Use parts of discarted product ot its parts in a new product with a same function
	R_7 Repurpose	Use parts of discarted product ot its parts in a new product with a different function
Useful application of materials	R_8 Recycle	Process materials to obtaion the same (high grade) or lower (low grade) quality
	R_9 Recover	Incineration of materials with energy recovery



Source: RLI 2015: edited by PBL

Circularity principles aim to phase out waste or minimise at the very least, as demonstrated by the 9R framework adapted from Potting et al. It is important to note that the strategies have been listed sequentially. Circular practices need to start with refusing first, which does not require any energy or resource, and then continue with other items where recovery is dictated as a last resort. To support this principle, countries like Norway and Denmark have an incineration tax.[9] Similar prioritization is also emphasized in the butterfly diagram from Ellen MacArthur foundation, shown earlier in this section, where recycling is the final loop in the technical cycle. Additionally, only when all strategies have been exhausted, should recovery and other waste management systems be utilized.

This enumeration from the 9R Framework stresses that recycling and recovery, which are more pervasive in our existing sustainability practices despite being more energy intensive processes compared to other strategies, are to be treated as final resorts to circulate materials and resources.

These strategies are applicable for all players of the economy; responsibility falls on consumers, producers, financial institutions and legal entities alike for its implementation. For instance, consumers can "refuse" to lower their demand for certain goods and services, while producers can "refuse" to use to less sustainable resources and regulators can 'refuse' by limiting or banning certain practices. Similarly, regulators will have to implement the technology and systems to collect and 'recycle' while producers and consumers will have to participate by methodically discarding materials and equipment that are no longer usable.

This transition comes with a very high price tag, though, it is less than the cost of an environmental failure, and the overarching responsibility of financing these ambitions falls on financial institutions. However, finance sector revolves around data and data pertaining to ESG performance is a relatively young study. Organizations have become adept in monitoring and reporting their financial assets; yet, reporting of non-financials remains insufficient and sporadic. Impact of environmental risks are growing and are now becoming more intertwined with economic and political risks; thus, organizations need to assess their investments, operations and value chains by quantifying and integrating such factors to reduce the risk of a default.

One way to do so will be applying circularity principles into data aggregation. The methodology in this report, which will be elucidated in the later sections further, attempts to assess a business's dependence and impact on non-circular and circular resources alongside the utility and recoverability of its outputs.

Another key aspect of circularity is communication.[10] For this system to work with all its intended participants, awareness needs to be established and information shared accordingly. Knowledge of circularity needs to be communicated with a clear and concise language to reach an audience from all backgrounds, which is also one of the goals of this report. Communication also means inclusion and connection; industrial symbiosis projects and collaborations increase participation and optimize the flow of materials. Joint ventures enable different minds and resources to come together to unlock new knowledge, grow networks, share information and accelerate innovation.

This aspect of circularity also highlights the controversy of intellectual property and patents. While organizations such as WIPO(9) incentivize innovation and secure profits through licensing, such competitiveness can also hinder sustainable development.(10) In a capitalist economy, innovations are used to create a competitive advantage in the industry instead of advancing circularity in the whole industry.

When Volvo opened up the patent for its 3-point seat belts designed by Nils Bohlin, it did so because it valued safety over profits.[11] This allowed other automakers to immediately replicate and implement that design, which has saved countless lives and averted serious damage for its users. Similarly, when Simon Velez and Marcelo Villegas designed durable bamboo houses as a means of affordable housing, they made their designs publicly available and never patented them. They also invested their time to educate the illiterate workers on the techniques they developed to spread their knowledge. Now, their sustainable houses can be found in thousands worldwide, which shows the power of communication in increasing impact.[12]

A study by WEF found that patent protection loss increases subsequent innovations by 50%, although this value varied across environments. Patent loss fuelled further innovations especially in the electronics industry while cumulative innovation was not seen in pharmaceuticals at the same rate.[13] This reaffirms that licenses, while promoting creative solutions, can slow down the global progress towards a circular economy in specific sectors.

[9] WIPO – World Intellectual Property Organization
[10] United Nations Sustainable Development Goals

5.1 Global Circularity Outlook

As households and communities' living conditions improve, their demand for resources and products grow, too – in a linear economic model, that is. Thus, to ensure the long-terms success of SDGs set by the United Nations, changing designs, behaviour and consumption is of paramount importance.

According to the CGRi[11], the global economy is now consuming more than 100 billion tonnes of materials annually for the first time; yet, the current level of circularity is very limited and has even started to falter.[14] The latest annual Circularity Gap Report, launched in 2022, estimated that the world is only 8.6% circular, representing a reduction from 9.1% in the past 2 years.[15] Globally, approximately 37% of waste is disposed in a landfill, 33% is discharged into open areas, 19% is recycled, and 11% is treated with modern incineration.[16] This break down of waste treatment alone shows the lack of circularity practices across industries, since the only circularity strategy that is tracked is recycling.

Many of the top risks facing the economy are now sustainability-related systemic risks such as climate action failure, extreme weather conditions and biodiversity loss. For instance, for the last 2 years, the World Economic Forum has rated majority of the top risks as environment related.[17] On the other hand, circularity solutions offer great potential for accelerating decarbonization, decreasing pollution, limiting biodiversity loss and mitigating water related risks by reducing our demand on virgin raw materials.

In light of growing resource scarcity issues and the accelerating global climate crisis, circular solutions offer many other potential benefits. Collateral benefits can include greater efficiency and profitability, reduced waste and cost, better innovation and enhanced customer relationships. Research has demonstrated that the circular economy presents huge opportunities for businesses, with one recent study suggesting that in Europe, adopting circular principles could generate net economic benefit of EU€1.8 trillion (USD 2 trillion) and 700,000 new jobs by 2030.[18] [19]

Circular approach is not simply limited to environmental considerations but also encompasses social aspects such as economic prosperity, job creation and social equity. Sustainable development thus constitutes a key driver of a circular economy and both reinforce each other as circularity works towards "a more resource-aligned" and "people-centric future".[20]

5.2 Circularity in the EU

The Circular Economy is a key pillar in the EU Green Deal, its new growth strategy to transform the union into a modern, resource-efficient, competitive economy where there are no net emissions of greenhouse gases by 2050, where economic growth is decoupled from resource use and where no person and no place is left behind. A key building block of the European Green Deal is the CEAP[12], which was published in 2015, adopted by the European Commission in 2020. Moving to a Circular Economy is crucial to achieving the Green Deal as it will reduce pressure on natural resources, halt biodiversity loss and help EU achieve climate neutrality by 2050.

Measures that will be introduced under the new action plan aim to;

- make sustainable products the norm in the EU
- empower consumers and public buyers
- focus on the sectors that use most resources and where the potential for circularity is high such as: electronics and ICT, batteries and vehicles, packaging, plastics, textiles, construction and buildings, food, water and nutrients
- ensure less waste
- make circularity work for people, regions and cities
- and lead global efforts on circular economy"[21]

[11] Circularity Gap Reporting Initiative
[12] Circular Economy Action Plan

In March 2020, The EU Expert Group on Circular Economy Financing identified four high level types of circular business models: (1) "value recovery" business models where value is recaptured in the products' end of life, (2) "circular design" business models where products' design intentionally aims for material retention and product durability, (3) "optimal use" business models where repair and remanufacturing services increase products' usage, and (4) "circular support" business models where advisory services and enabling activities support other circular business models.

The EU Taxonomy for sustainable activities, which was based on these business models, has identified activities deemed sustainable through specific performance criteria. It has a specific objective dedicated to the transition to a circular economy, with specific quantitative milestones to be reached such as a reduction of the EU27 material footprint of 50% by 2030 and 75% by 2050 (2015 baseline) and an increase in the average circular material use rate for all materials of 25% at least by 2030.[22] This taxonomy will also limit "green-washing"[13] by elucidating what actions and activities can be classified as sustainable.

These new ways of doing business highlight the importance of behavioural change in shifting towards a circular economy as this change will unlock a decrease in demand for new goods and the expansion of sharing and service economies. With such focus on usage rather than ownership, usage is prolonged through reuse, repair, refurbish, remanufacture and repurpose, to give a second life to materials, parts and products, reused to develop new ones or remanufactured to be put back in the economy.

Europe's circularity and sustainability journey has played a key role in guiding the ecosystem in Turkey, too. Since Turkey is a major exporter of goods and services to Europe, it needs to adjust its regulations parallel to standards set in Europe to remain competitive in the market there. From EU ELV Directive[14] and energy labels to EU REACH[15] and EU RoHS[16] Directives, many of these practices have been adopted by the Turkish government or companies that trade with that region.

[13] Giving false impression or misleading the public about how environmentally friendly a product, service or company is
[14] European Union End-of-Life Vehicles Directive 2000/53/EC
[15] European Union Registration, Evaluation, Authorisation and Restriction of Chemicals Directive (1907/2006)
[16] Restriction of Hazardous Substances Directive 2011/65/EU

Table 2: Concordance Table Between The EU And Turkey's Most Relevant Circularity Legal Frameworks

Themes	Directive	Topic	Transcription	Publication Date	Corresponding Directive/Directory Name	Turkish Name of the Directive
Material Safety and Traceability	Dir. 2012/19/EU	Electronic Material Restrictions	YES	RG:22.05.2012-28300	Waste from Electrical and Electronic Equipment (WEEE) Directive	*Atık Elektrikli ve Elektronik Eşyaların Kontrolü Yönetmeliği*
	REACh	Product Transparency	Partially*	RG:11.12.2013-28848	Testing Methodology for Substances and Mixtures' Physicochemical, Toxicological and Ecotoxicological Properties Directive	*Maddelerin ve Karışımların Fiziko-kimyasal, Toksikolojik ve Ekotoksikolojik Özelliklerinin Belirlenmesinde Uygulanacak Test Yöntemleri Hakkında Yönetmelik - Ekler*
				R.G:13.12.2014-29204	Directive on Fact Sheets Regarding Dangerous Substances and Mixtures	*Zararlı Maddeler ve Karışımlara İlişkin Güvenlik Bilgi Formları Hakkında Yönetmelik*
	CLP	Product Labelling	Partially*	RG:11.12.2013-28848	Directive on Classification, Labeling and Packaging of Substances and Mixtures	*Maddelerin ve Karışımların Sınıflandırılması, Etiketlenmesi ve Ambalajlanması Hakkında Yönetmelik-Konsolide - Ekler*
	RBP	Biocides Manufacturing	Partially*	2012	Directory on Industrial Hazardous Waste	*Tehlikeli Atıkların Sınıflandırılması Kılavuzu*
	CMD &CAD	Reduction of Carcinogenic Substances	Partially*	R.G:23.06.2017-30105	Directive on Registration, Evaluation, and Restrictions of Chemicals	*Kimyasalların Kaydı, Değerlendirilmesi, İzni ve Kısıtlanması Hakkında Yönetmelik*
	POP	Persistent Organic Pollutants	Partially*	R.G:14.11.2018-30595	Directive on Permanent Organic Pollutants	*Kalıcı Organik Kirleticiler Hakkında Yönetmelik - Konsolide - Ekler*
Mandatory Extended Producer Responsibility Schemes	Dir. 94/62/EC	Packaging	Yes	RG:26.06.2021-31523	Packaging Waste Management Directive	*Ambalaj Atıklarının Kontrolü Yönetmeliği - Ekler*
	Dir. 2009/125/EC	Ecodesign	Yes	RG: 7/10/2010 - 27722	Ecodesign Directive	*Enerji İle İlgili Ürünlerin Çevreye Duyarlı Tasarımına İlişkin Yönetmelik*
	Dir. 2006/66/EC	Industrial Batteries and Accumulators	Yes	RG:31.08.2004-25569	Batteries Regulation	*Atık Pil ve Akümülatörlerin Kontrolü Yönetmeliği*
	Dir. 2012/19/EC	Electrical & Electronic Equipment	Yes	RG:22.05.2012-28300	Waste from Electrical and Electronic Equipment (WEEE) Directive	*Atık Elektrikli ve Elektronik Eşyaların Kontrolü Yönetmeliği*
	Dir. 2000/53/EC	Vehicles	Yes	RG:30.12.2009-27448	End of Life Vehicles Directive	*Ömrünü Tamamlamış Araçların Kontrolü Hakkında Yönetmelik*
	Dir. 2010/31/EU	Construction	Yes	RG: 23.12.2017-30279	Energy Performance of Buildings Directive	*Binalar ile Yerleşmeler İçin Yeşil Sertifika Yönetmeliği*
	Dir. 2012/27/EU		Yes			
	Dir. 2004/35/EC		Yes	RG: 02.03.2021-31411	Energy Efficiency Directive	*Enerji Etiketlemesi Çerçeve Yönetmeliği*
					Environmental Liability	
Waste Management	2008/98/CE	The Waste Directive	Yes	RG:02.04.2015-29314	Waste Management Directive	*Atık Yönetimi Yönetmeliği*

5.3 Circularity in Turkey

Briefing on Turkish Economic Climate

Turkish Gross Domestic Product (GDP) had known a steady growth since the end of WWII, and economic boom since the turn of the century. However, national growth slowed after a peak witnessed in 2011 and, since COVID-19, has declined further similar to most other nation's economies globally.

In order to contain the negative social aftermath of the global lock-down, the government issued bill n°31102 in 2020, preventing the enforcement of bankruptcy proceedings and enforcements, freezing work contract termination procedures, extending the duration of mandatory unpaid leaves, etc. Additionally, economic recovery was promoted through a USD 15 billion stimulus package.[23]

Unsustainable urbanization, increasing inflation and limiting waste and pollution without compromising quality standards have become important development challenges for Turkey. The concept of the circular economy has started to attract interest and importance in Turkey and companies are now implementing pilot projects. Examples from some of these companies are included later in this report.

Before the pandemic, Turkey had devised a dedicated investment plan with the World Bank, which appears to be one of the leading actors for sustainable investment in the country. This partnership was focused around 4 high-level investment areas, among which environmental concerns were clearly identified[23]:

1) Innovative Production, Stable and High Growth;

2) Qualified Individuals and Strong Society;

3) Liveable Places and Sustainable Environment;

4) International Cooperation for Development.

While facing the COVID-19 pandemic, the World Bank reiterated its commitment to invest in the country's industrial transition towards a high-technology country, namely through 3 programs[24]:

1) The Organized Industrial Zones (OIZ) program, aimed at helping OIZs become more efficient, environmentally sustainable, and competitive,

2) The Turkey Resilient Landscape Integration Project (TULIP), focused on improving green infrastructures of the Bolaman River Basin and aimed at developing sustainable infrastructures and guaranteeing sustainable livelihoods;

3) The Turkey's Seismic Resilience and Energy Efficiency in Public Buildings Project, a loan program issued to restore public infrastructure (schools, hospitals, government buildings, etc.) for better protection against earthquakes and improved energy performance.

Though a dedicated COVID-19 recovery roadmap has not been issued by the Turkish government, possibilities for a more circular and sustainable post-pandemic investment landscape remain present and are likely to represent a valuable path for collaboration between the EU and Turkey.

6th of October marked a turning point in Turkey's international and national policies regarding sustainability as the Parliament finally ratified the Paris Agreement, more than five years after signing the treaty.[25] The country has long contended that nations should provide finances based on historical emissions and argued against being listed as a developed country, the Annex-II countries, despite being a part of the OECD.[17]

The Paris Agreement was adopted at the UNFCCC's 21st Conference of the Parties[18] held in Paris in 2015 and entered into force on 4 November 2016. The long-term goal of the agreement is to keep the global temperature rise below 2°C as much as possible and limiting it by 1.5°C if possible. Thus, emphasis on the use of renewable energy sources and limiting fossil fuel consumption has become the goal of all parties. In order to determine which nations will contribute to the fund designated for sustainable growth in developing countries, the convention grouped nations based on how developed their economies were.

Turkey has committed to reduce its emission increase by 21% by 2030 and become net-zero by 2053 under the Paris agreement. Turkey's Climate Change Strategy and National Contribution Statement will be updated accordingly. Some sustainability projects are already under way or have been completed. The Green Deal Action Plan 2021[19] – the first major publication regarding harmonization with the European Green Deal and acknowledging the importance of circular principles - was published in July '21[26] The Emissions Trading System infrastructure is being built to support investments in climate-friendly and clean production technologies.

In its 11th Development Plan[20] and 2021 Presidency's Annual Program[21], the Presidency of Strategy and Budget[22] listed targets for economic development for most major sectors and subsectors. The Development Plan highlighted strategies for economic growth, but the scope of the plan was not comprehensive enough with some major omissions like the plastics industry. It presented limited objectives regarding circular economy principles and environmental measures. The plan noted that the presence of traditional products and production methods in manufacturing industries remain resilient but requirements for competitiveness are changing due to new trade and industrial standards introduced by the European Green Deal.

"An Overall Assessment of the Potential of Turkey in the Context of Transition to Circular Economy Project" under the Environmental Management for Sustainable Development was kicked off in February '22, which is the third action of the IPA II period Environment and Climate Action Sector Operational Program. This was co-funded by the European Union and the Republic of Turkey with the end beneficiary set as the General Directorate of Environmental Management of the Ministry of Environment, Urbanization and Climate Change. The budget allocated to the project, which will last for 36 months, is approximately 3,2 million Euros; 85% of this is EU contribution and 15% is national contribution. The project aims to enhance the institutional and technical capacity of Turkey in accordance with the EU Circular Economy Package, especially regarding waste management and transition to circular economy.[27]

There are several other initiatives in Turkey, both registered and unregistered, that have been inadvertently contributing to the circular economy model. Prior to 2017, perhaps the most important contributors to recycling were the unregistered labour (street waste collectors) who collected and sorted domestic wastes to earn money. They accounted for most of the 9.2% of the waste recycling schemes in Turkey.[28] Then, in 2018, the Turkish government announced its 'Zero Waste' policy to improve waste management and increase public awareness about waste treatment. Within the scope of the Zero Waste Policy, all municipalities and public private organizations are required to achieve a certain rate of waste recycling per area. The Policy's aim is to increase the recycling rate of domestic solid waste up to 35% by 2023, while 2019 domestic waste recycling rate has increased to 11,5% in Turkey.[29] Following this initiative, some improvements have been made regarding waste separation and treatment. For example, the İBB[23] has started a project on reverse vending machines through which citizens can hand in plastic bottles and cans in exchange for public transport credits. Currently, only 9 such vending machines have been installed in metro stations and schools. This public awareness campaign about waste management also emphasizes the value of residual materials.[24] Additionally, the Turkish Government introduced a fee on plastic bags to reduce their consumption. This initiative accentuated the awareness campaign regarding plastic waste while reducing plastic bag consumption by 75%.[30]

[17] Organisation for Economic Co-operation and Development
[18] COP 21
[19] *Yeşil Mutabakat Eylem Planı 2021*
[20] *11.Kalkınma Planı*
[21] *2021 Yılı Cumhurbaşkanlığı Yıllık Programı*
[22] *Strateji ve Bütçe Başkanlığı*
[23] Istanbul Metropolitan Municipality, *İstanbul Büyükşehir Belediyesi*

Table 3: Overview of Turkey's Zero Waste Project

Area	Overview
Scope	The following areas and locations are included: • Municipalities, buildings, campuses, shopping malls, business centres, plazas, airports, train and bus terminals, OIZs and industrial enterprises, educational institutions, HORECA[25], health institutions, households and sites. • Industrial process wastes are excluded from the scope of the regulation.
Obligations	• To take measures to collect waste separately and to reduce waste generation • To obtain a qualified Zero Waste Certificate, covering 4 categories (basic, silver, platinum and gold) • To reduce waste generation with the minimum requirement being at least 15% • To achieve a countrywide Total Recycling Target of 35% by 2023.

GEKAP[26]

GEKAP is another initiative that has been introduced by the Turkish Government to tackle waste management. It is an Extended Producer Responsibility that was initiated in January 2020 and brings additional financial obligations for manufacturers, importers and consumers of products detrimental to the environment. It aims to support waste prevention while increasing reusability, recovery and recycling potentials.[31]

Scope: Companies that sell tires, batteries, accumulators, electronic equipment, mineral and vegetable oils, medicines or packaging (plastic, glass, composite, metal, wood) in the Turkish market.

Obligations: Impacted companies are required to pay a contribution fee towards recycling: contribution rates vary based on the type of product as stipulated by the Environmental Law ANNEX 1 List.

The Deposit Refund System[27]

The deposit system is expected to start on January 1st 2023, aiming to support the Zero-Waste initiative and boost Turkey's actual recovery and recycling rates for packaging waste. Operational barriers are expected during its first terms, as evident in similar systems' early performances in other countries; regardless, the auspicious project will make Turkey's "Zero-Waste" initiative more inclusive and raise nation-wide awareness. The system will allow the consumer to collect a refund or get shopping credit, equal to the deposit fee, for the packaging waste they return to markets and other designated spots. Through this collection scheme that utilizes monetary incentives and highlights the intrinsic value of waste, packaging wastes will be reintroduced into the economy via increased end-user participation. It is estimated that 1 million tons of recyclable materials will be saved from going to the landfills every year will result with plastic packaging wastes reduction which will contribute to prevention of plastic pollution. Turkish Environmental Agency will determine which packages are recoverable based on the Management of Packaging Waste Directive. Annually, this system is projected to generate 4 billion TL alongside new job opportunities. The refund system's expected performance is detailed on the following page:[32]

[25] Hotel/Restaurant/Café
[26] Recycling Contribution Fee - *Geri Kazanım Katılım Payı*
[27] *Depozito Iade Sistemi* (DİS)

Tables 4-5: Deposit Refund System's Performance Projections

Years	Total Recovery Rate (%)	Total Recycling Rate (%)
2021 -2025	60	55
2026 -2030	-	65
2031 and Later	-	70

	Annual Recycling Rates For Materials (%)				
Years	Glass	Plastic	Metals	Paper	Wood
Until 2026	70	55	60	75	25
Until 2031	75	55	70	85	30
After 2031	75	55	70	85	30

In waste management, responsibility falls heavily on municipalities, which do not always have the technical or financial capacity to collect, sort and distribute the waste to appropriate channels. For instance, Environment Cleaning Taxes[28] intend to make the polluter pay a fee based on facility type and water consumption; however, the previous rates were viewed as inadequate to finance all the operations.[33] In 2021, these rates were increased by 9.11%, in hopes to alleviate some of the pressure on the local governments.[34]

ÇEVKO[29] foundation, which started its journey in 1991 with 14 members, was announced to be an Authorized Organization by the Turkish Republic Ministry of Environment and Urbanization within the framework of the "Regulation on the Control of Packaging and Packaging Waste" published in 2005 during the harmonization process of Turkey to the EU. As of the year 2005, companies selling packaged products in the Turkish market have been transferring their recovery obligations to ÇEVKO Foundation for the recovery of packaging waste.

The Foundation has fulfilled its obligations in accordance with the "Regulation on the Control of Packaging Waste" which was re-enacted in August 2011. ÇEVKO Foundation carries out activities regarding communication, awareness-raising and training for the performance of the liabilities it has assumed. The authorized organization develops activities regarding the separate collection of packaging waste at the source in cooperation with municipal administrations and licensed companies on behalf of the packaging producers and economic operators which put packaging on to the market it represents.

ÇEVKO Foundation, having taken over the recovery responsibilities of the industry, carries out its activities on contractual basis with many economic operators. Such corporations include domestic or foreign ones active in Turkey as fillers, packaging producers, packing recyclers with private labels, big scale shopping malls and chain stores from food, consumption, medicine, chemistry and oil, etc. sectors using glass, metal, plastic, paper and composite packaging.[35]

Waste management responsibility should not only fall on municipalities and organizations. Currently, there are no penalties associated with improper waste separation and disposal for domestic consumers in Turkey. Waste segregation at end-user level should be regulated to ensure end-users segregate their wastes correctly, send their wastes and used products to right channels and these wastes should be collected by the municipalities and recycled in the collection, sorting and recycling centres. There are regulations regarding the disposal of electronics but only a few consumers are aware of them due to lack of effective communication.

[28] *Çevre Temizlik Vergisi*
[29] *ÇEVKO: Çevre Koruma ve Ambalaj Atıkları Değerlendirme Vakfı*

As seen in the above examples, circularity practices in Turkey in most of the sectors concern the recycling/recovery phase; however, the 9Rs hierarchy categorizes these methods as last resorts since they are more capital and energy intensive processes and result in a greater loss of intrinsic value. Currently, the focus is more on the end of the lifecycle when in fact, it should be addressing the bigger picture to increase circularity.

For instance, enforcing stricter regulations without comprehensive financial incentives and instruments could hinder economic growth and drive-up prices by pushing companies to invest in CAPEX. The government would need to invest in infrastructure, facilities and systems that complement the new regulations as well. Timing of such expenses would be important, especially during a period when the exchange rates are not in Turkish Lira's favour and interest rates are low.

Many Turkish companies have developed innovative circularity solutions that make them competitive on a global scale. This is due to a vast portion of their operations and clients being linked to the European market. As the global market enforces more stringent regulations, more companies in Turkey will have to invest in circularity strategies. Thus, one of the ambitions of this report is to highlight practices of circularity, other than recycling and energy recovery, to maximize the value of materials in the economy primarily through eliminating waste and pollution, optimizing the utility of materials and products and regenerating natural systems. By highlighting the vitality and benefits of circular economy practices and featuring some leading examples from Turkish producers, this report intends to encourage companies, consumers and regulators to focus more on implementing circular economy principles.

Turkey Circular Economy Platform

In order to promote the active engagement of industrial companies located in Turkey with waste minimization practices and more broadly with the Circular Economy, the BCSD Turkey (SKD Türkiye) and EBRD[30] have been collaboratively running a Circular Economy (CE) platform (previously referred to as Turkey Materials Marketplace, TMM) in Turkey since February 2016. Through the CE platform, companies are part of the largest business network in Turkey that is focusing on the Circular Economy. As of January 2022, the platform has more than 204 member companies.

The Platform includes a knowledge hub, an e-commerce platform and measurement tools, in addition to offering training, technical assistance and consultancy services for companies that are looking to accelerate their circular transition.

Circular Vouchers

Since 2018, Turkey Circular Economy Platform has been offering a technical assistance program called "The Circular Vouchers" to provide consultancy services for platform members' circular economy projects and connect them with international technical expertise. Through the Circular Vouchers, which also include short term consultancies called desk-based studies, members can identify and implement circular economy practices in their businesses. This supporting package has been developed by EBRD to support companies in identifying viable circular investments (e.g. technological options available to introduce alternative raw materials in the production process and/or transforming by-products), adopt circular business models and introduce circular elements in their governance model.[36]

As of 2021, 38 companies benefited from this grant, with a total budget of EUR 800,000, in order to become more circular.

[30] European Bank for Reconstruction and Development

6. Analysis of Five Sectors

6.1 Plastic Packaging Sector

Plastic Sector Overview

Market Structure: around 1,450 plastic packaging[37] and 5,000 plastic processing companies[38]

Production: 4.1 million tons (Plastic Packaging)[39] and 9.5 million tons (Plastics End Products)[40]

Revenue: total plastic industry exports exceeded USD 5 billion in 2020[41]

Employment: more than 160,000 people[42]

At present, globally and in Turkey, plastic packaging material flows are mainly linear. These inputs can be divided into 3 categories: non-renewable virgin content (fossil-based - oil or gas), renewable content (organic, bio-based) and recycled content (non-virgin content).[43] Most input materials for plastic packaging production are made from the first category, non-renewable virgin, which can take up to 500 years to decompose in nature.[44] As for biobased plastics, regardless of the nature of their raw materials, not all are biodegradable; biodegradability is an add-on property for some plastic types.[45] At the end of their life, plastic materials are important resources that can be used in a new form. Their usage as secondary raw materials avoids or reduces demand on virgin raw materials, which helps avoid associated energy consumption, arable land usage and greenhouse gas emissions.

PE plastic packaging is the most common source of plastic consumption and many of them are single use items. During the COVID-19 lockdown, the consumption of single-use plastic products such as hygiene items, takeaway packages and utensils has increased dramatically.

There are 2 types of plastics; thermoplastics and thermosets. The main difference between thermoplastic and thermoset plastic is that thermoplastic materials have low melting points, which means they can be reconstructed or recycled by heat exposure. The former is used more frequently in the packaging industry. The most common thermoplastics and thermoset plastics are shown in the following table.

Table 6: Types Of Thermoplastic And Thermoset Plastics[46]

Type of Thermoplastic	Overview	Packaging Applications
Polyethylene Terephthalate (PET)	• Used in fibres for clothing, containers for liquids and foods and in combination with glass fibre for engineering resins	• Plastic bottles for soft drinks, water, juice, sports drinks, beer, mouthwash • Food jars • Microwavable food trays
Polypropylene (PP)	• Used for flexible and rigid packaging	• Containers for yogurt, takeaway meals and deli food • Medicine bottles • Bottle caps and closures
Polystyrene (PS)	• Used typically for protective packaging, food service packaging, bottles, and food containers	• Food service items such as cups, plates, bowls, cutlery and rigid food containers.
High Density Polyethylene (HDPE)	• Most common plastic that is used to make bottles, containers, household and industrial chemicals such as detergents and bleach.	• Bottles for milk, water, juice, cosmetic, shampoo, detergents • Retail Bags • Grocery Bags
Low Density Polyethylene (LDPE)	• Used mainly in film applications due to its toughness and flexibility, making it popular where heat sealing is necessary.	• Bags for dry cleaning, bread, frozen foods, and household garbage • Stretch film • Beverage cups • Squeezable bottles
Polyvinyl Chloride (PVC)	• Used for its chemical resistance, clarity and high impact strength.	• Bedding • Medical Products • Deli Wrap
Type of Thermoset Plastics	**Overview**	**Applications**
Epoxy resin	• A hard and brittle material that usually requires reinforcement.	• Adhesives • Bonding of Materials
Melamine formaldehyde	• A hard and strong material, that is chemical and water resistant,	• Surface Lamination • Tableware • Electrical insulation
Polyester resin	• A hard, stiff and brittle material when in unlaminated state.	• Encapsulation • Bonding • Casting
Urea formaldehyde	• A hard, stiff, strong and brittle used mostly for its insulation properties.	• Adhesives • Coating • Lamination • Electrical devices
Polyurethane	• A hard, strong and durable material.	• Paints • Insulating foam • Footwear • Automotive • Adhesives • Sealants
Phenol formaldehyde resin (PF)	• A strong, heat and electrical-resistant material.	• Electrical items • Sockets and plugs • Automotive • Cookware • Industrial equipment

According to data from PAGDER[35], per capita plastic consumption in Turkey, which was 80.8 kilograms in 2015, increased by 11.5% in 3 years and reached 90.1 kilograms in 2018. Plastic raw material production was around 1 million tons in 2020 which constitutes 42% of the Turkish packaging industry production. The relative production of different types of plastic materials was as follows:

Figure 3: Plastic packaging materials in Turkey in 2020[47]

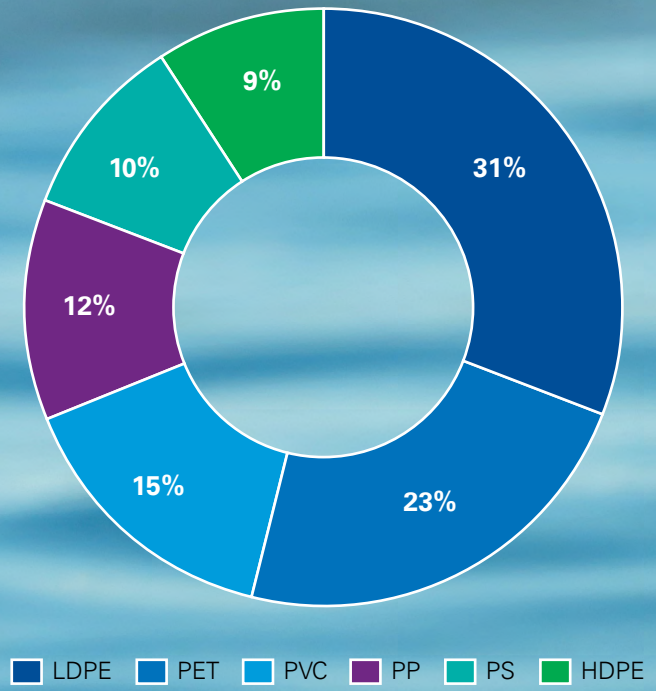


Figure 3: Relative Production of Plastic Types

Internationally, and in Turkey, a lot of plastic waste recycling is done by small local businesses. Between 1950 and 2015, around 6,300 million tonnes of plastic waste were generated; only 9% was recycled, 12% was incinerated, and the remaining 80% was dumped into landfills or the natural environment.[48] On the other hand, there is a growing demand for recycled material; thus, boosting the recycling ratio and certifying it for quality standards will be essential for increasing circularity in the industry. For example, Nestlé has claimed that they are willing to spend more than USD 2 billion and even pay above the market rate, if they can find suitable recycled materials.[49]

[35] Plastics Industrialists' Association in Turkey – Plastik Sanayicileri Derneği

Plastic Waste Exports

Over recent years, many developed countries have exported their plastic waste to emerging countries due to following neoliberal economic policy. After China restricted waste imports in 2018, plastic waste imports shifted more towards other countries, including Turkey. According to research by Greenpeace Mediterranean, Turkey is the country that received the most plastic waste from Europe in 2020, importing a total of 659,960 tons from the EU and the UK in 2020.[50] Similarly, according to Eurostat[31], Turkey is the largest importer of waste from Europe, receiving 13.7 million tons out of a total of 32.7 million tons of annual waste from the EU.[51]

The Greenpeace Mediterranean report also claimed that the imported materials were not processed in recycling facilities; instead, they were dumped on roadsides and beaches or burnt. Following a backlash from the public after this publication, Turkey enforced a ban on certain plastic imports starting in July 2021. Turkey repealed this ban upon pressure from the plastics industry; industry leaders stressed that such a ban would cripple the plastics recycling industry and thus, the ban was substituted with stricter regulations and monitoring.[52]

Main Obstacles and Corresponding Strategies

Even though recycling is viewed as a less prioritized circular economy strategy, for the plastic packaging sector, it is a strategy harder to avoid due to their utility in the food sector. Thus, keeping plastics away from waste-streams and directing them to recycling stations is key in circularizing these materials. Participation from both individual and industrial consumers is required; however, lack of awareness, weak policies and a narrow network for waste collection keep participation levels low. There is also public dissent regarding the efficiency of recycling set-ups with some believing that the collected waste is sent to dumpsters; this is how consumers validate their lack of contribution to the recycling cycle. Awareness of recycling, faith in the system and frequency of collection dumpsters need to be increased to boost participation.

Plastic recycling is also problematic on a more technical level. First off, not all plastics can be recycled. Plastic packages' physical and chemical properties make some of these materials technically challenging to recycle. Most packages used in the FMCG industry are multi-material plastic packages where some can have around seven layers of different subcomponents and recycling is harder when materials are not in a pure form. Another major issue is contamination, such as food waste; recycling centres need to sort out relevant materials which is not only time and labour intensive but also creates a health hazard for workers who do the sorting since they may get exposed to hazardous waste. It should be duly noted that some of this contamination is a result of good-intentioned consumers; however, 'aspirational recycling' or 'wish cycling'[32] increases inefficiencies in recycling streams by reducing the quality of the recycled materials and increasing maintenance costs.[53] In order to reduce contamination, consumers need to be educated on the recycling process and sorting criteria; to further incentivize consumers, appropriate penalties should be enforced.

The recycling process demands energy too, and not just when the plastic is broken down. If there is no sustainable network to transport material to and from recycling stations, then the LCA[33] of the recycled materials will yield poorer results. Supply chains need to be kept short and 'low-carbon' to avoid high emissions from logistics while achieving economies of scale in transportation and recycling facilities. Due to the energy, effort and system required to recycle plastics, recycled materials price is not always competitive against traditional raw materials, nor is the supply reliable. Financial incentives given to researchers, the recycling industry and the companies who contribute to the recycling ecosystem would need to be increased to boost recycled materials' supply and demand.

[31] European Union Statistics Office
[32] 'Aspirational Recycling' and 'Wish cycling' is when a consumer throws an item into the recycling bin even when they are unsure about its recovery potential
[33] Life Cycle Assessment

Plastic packages are also problematic due to lack of durability. For instance, plastic containers for food are not always dishwasher friendly and they tend to lose their form under heat. Their reusability needs to be improved to keep them away from landfills and recycling centres.

Rise of bioplastics made from virgin materials has been met with scepticism. In 2020, 2.3 billion people – 30% of global population did not have year-round access to adequate food, and 811 million people were undernourished[54] ; using arable land to replace plastics instead of mitigating the hunger crises is a trade-off that many oppose. In addition to that, bioplastics have the potential to contaminate other plastic recycling streams; since they are not easy to distinguish, they are not easy to sort. Bioplastics can also generate more emissions if they are not discarded properly; when bioplastics are incinerated in landfills and without oxygen, they may release methane, a GHG 23 times more potent than carbon dioxide.[55] To avoid such outcomes, direct responsibility once again falls on consumers who need to become more conscious while obtaining and disposing of their waste.

When using recycled materials, concerns regarding hygiene are raised in the food industry. Plastic packages are widely used for containing food and they play a key role in preserving nutrients. Even though they are not environment-friendly materials, their function in the food industry is critical for reducing food waste. Since they are in direct contact with edible items, there are certain health standards that have to be met, which are included in the Turkish Food Codex Legislation. Health standards, understandably, slow down the development of sustainable substitute materials that serve the same purpose as plastic packages.

Finally, the plastics sector has been excluded from Turkey's 11th Development Plan, even though the plan covers almost all other industries in Turkey.[57] Besides a mention of bioplastics in the report, there has not been any strategies laid out for plastic packaging or any of its subsectors. To develop and implement industry-wide action plans and roadmaps, it is integral for a resource and waste-intensive industry to be evaluated on a macro level and be integrated into national strategies.

Key Circular Strategies

For each of the sectors covered by this study, key strategies that can be applied within Turkey's context were selected. Strategies were aligned with the material flows at three key intervention points as defined by the Circularity calculation methodology and as outlined below. Material flows can include nutrients, compounds, materials, parts, components or even products. By analysing these flows, an organization can determine its ability and ambition to minimize resource extraction and waste material.

Circular Inputs:

- Eliminate problematic and unnecessary plastics, single-use plastics (with an exception on health sector-related products) and packaging
- Lightweight plastics to reduce the amount of inputs
- Maximize recycled content of plastics
- If virgin inputs are used, move towards renewable feedstock
- Opt for food waste for bioplastic production, instead of fresh crops

Recovery Potential:

- Ensure the plastics are technically recoverable at the design phase
- Innovate plastics to be reusable, recyclable, recoverable or compostable
- Incentivize consumers to reuse plastic products and keep these items away from waste streams
- Educate consumers on the recovery potential of different types of plastic waste and waste sorting processes
- Develop and promote non-plastic substitute products
- Keep supply chains short by strategically stationing recycling facilities and developing efficient transportation modes

Actual Recovery:

- Ensure plastics are reused, remanufactured, recycled, recovered or composted in practice
- Set up recovery stations and networks to collect plastic waste
- Audit recycling and waste treatment centres to ensure the right practices are used
- Install systems in factories that prevent the release of microplastics into the environment
- Regulate plastic waste imports to align international inputs with facility capacities
- Regulate plastic waste exports to ensure countries with comprehensive systems are taking in the waste

Table 7: Main Sources Of Information Used For The Plastic Packaging Sector

Plastic Packaging			
Consulted Organizations	Interview	Main Research Materials	Sector Validation
• Coca-Cola İçecek A.Ş.(CCI) • Sarten Ambalaj • Larplast (SEPA) • Beno Plastik • Unilever • 2 plastic packaging companies which preferred to stay anonymous	• Academic sector experts from Turkey	• Online research on Turkish and international websites • Sustainability Reports and Integrated Reports for sector companies • Websites for sector companies • PAGEV: Plastics Sector Overview Report 2020[34] • WWF: Transparent 2020 Report[56]	• Coca-Cola İçecek A.Ş. • Sarten Ambalaj • Bell Holding • Plastic Move (Case Study only) • Ersem Plastik (Case Study only)

Tables 8-9: Input And Output Dashboard For Data Collected From Plastic Packaging Sector In 2020 In Turkey*[35]

Circular Inputs					
7%					
Input	**Total inputs weights (tons)**	**Non-renewable Virgin Content (%)**	**Renewable Content (%)**	**Non-virgin Content (%)**	**Weight circular inputs (tons)**
PET – Polyethylene terephthalate	741,345[58]	91[59]	1[60]	8[61]	66,721
HDPE – High Density Polyethylene	290,092[62]	91[63]	1[64]	8[65]	26,108
PVC – Polyvinyl Chloride*	483,486[66]	100[67]	0	0[68]	0
LDPE – Low Density Polyethylene	999,205[69]	91[70]	1[71]	8[72]	89,928
PP – Polypropylene	386,789[73]	91[74]	1[75]	8[76]	34,811
PS – Polystyrene*	322,324[77]	100[78]	0	0[79]	0
Total	3,223,241	94%	1%	5%	217,569

Circular Output				
13%				
Output	**Weights (tons)**	**Recovery Potential (%)**	**Actual Recovery (%)**	**Weight Circular Output (tons)**
Plastic Packaging	3,250,885	88[80]	13[81]	429,116

*These values are average estimates.

[34] PAGEV is one of the leading non-governmental organizations in the plastics industry in Turkey. With nearly 750 current trustees and 1,750 related companies, it represents more than the 88% of the plastics industry in Turkey. PAGEV publishes an annual sector report, which was used to determine the values in the report such as inflow and outflow weights.
[35] This table shows the circularity data that was collected for the sector in Turkey. The data points are KPIs, which are based on the CTI Framework, and are as defined in the glossary included in Appendix 2. These KPIs are used to calculate circular performance demonstrated on the following table.

Calculations

Weight of circular input (tons) = weight of renewable input + weight of secondary (non-virgin) input

% Circularity rate of input = (weight of renewable input + weight of secondary (non-virgin) input) / total weight of all input x100

Weight of circular output (tons) = Total weight of output x % recovery potential x % actual recovery

% Circularity rate of output = Weight of circular output/ Total weight of output x 100

% Actual Recovery = Weight of actual recovered output/ Weight of output x 100

% Recovery Potential = Weight of potentially recoverable output / total weight of output x 100 (ranging from 0% if not recoverable, to 100% if fully recoverable)[36]

% Circularity Results for Plastic Packaging Sector*

circular input	circular output	
7%	13%	
	recovery potential	**actual recovery**
	88%	13%

*These values are average estimates.

[36] Recoverable indicates that the contents are renewable and/ or nonvirgin and each is counted only once.

Table 10: List Of Omissions

Category	Reason for Omission
Import and export amounts	Due to lack of data for import and export weights, data collection and analysis had to focus on production data for Turkey.
Omission of less common types of plastic	Plastic packaging inflow materials had to be limited to the most common types. As a result, Poly Carbonate (PC), Expanded Polystyrene (EPS) and Bioplastics had to be excluded. Whilst, as an outflow, only the plastic packaging production has considered.
Omission of Plastic Packaging Waste during production	Waste occurring during production could not be calculated due to insufficient data regarding the amount of waste generated per material. Some data points could be sourced from an industry report from PAGEV but there were no other resources available for validation.

Analysis of Circularity Calculation Results

Based on the data that was analysed for companies in the Plastic Packaging sector in Turkey, the circularity of input performance was estimated to be 7%. Boosting this performance will depend on introducing new regulations that increasing the usage of circular materials during production, such as setting a minimum requirement for recycled and renewable content % or providing tax breaks for companies who reach a certain level of circularity input. Regulations will need to be supported by complementing initiatives, such as increasing the supply of certified recycled materials and manufacturing high quality circular materials. Ensuring quality through certification will also support the increasing number of companies that are committing to establish a more sustainable supply chain. In cases where health and quality standards pose as an obstacle for changing the composition of the plastic package, supporting R&D that complements this goal will be necessary.

The circularity of output was determined as 13%, while recovery potential[37] and actual recovery were deduced to have a huge gap, 88% vs. 13%. This gap can be reduced after addressing issues in areas of collection, transportation and separation of the waste through designing new policies that increase participation (both for industries and end-users), educating consumers on the process to reduce contamination and improving the network for collecting and sorting materials.

In the past few years, Turkey has focused more on excelling in the global plastic waste imports market. After China removed itself from the scene in 2017, this created an opportunity for Turkey to capitalize the market. In the past 15 years, plastic waste imports increased by 173 folds, with a major spike coming after 2016. To keep the input of such waste high, barriers to enter and stay in the market were kept low, with financial incentives like tax exemptions.[82] As a result of this spike in capacity, certain data was never tracked or made public. Issues regarding data availability are expected to improve with new regulations, which will in turn help with keeping track of the circularity performance in the plastics sector. One way the regulators will be addressing the issue of traceability is through the MOTAT[38] which will be tracking wastes via chips from port to factory.[83]

Consequently, the limited data availability introduces uncertainty in the calculations from the sector. To complement the findings from a macro-scope, the circular calculation methodology was also tabulated 2 Turkish companies.

[37] Recovery potential ratio is based on an environment where logistical and operational limits are at a minimum
[38] Mobile Waste Tracking System - Mobil Atık Takip Sistemi

Circularity Calculation Results for Company X*[39]

circular input	circular output	
8%	16%	
	recovery potential	actual recovery
	92%	16%

Calculation Outputs (based on the circularity calculation methodology)

Calculations have been completed based on one-year production data.

- The circularity rate for the inputs has been determined to be 8%. The inputs materials such as PET, HDPE, PP, PS, PC etc., metals and renewable materials entered production in this manufacturing facility.
- The circularity rate for the outputs was determined to be 16%; this rate is 92% for potential recovery and 16% for actual recovery. Soma packaging products and materials are recycled in this facility. By-products and wastes have been included in the calculations in this example. Recovery potential rates are estimated figures based on research conducted on publicly available sources and estimations of company experts.

Circularity Calculation Results for Company Y*[40]

circular input	circular output	
11%	8%	
	recovery potential	actual recovery
	99%	8%

Calculation Outputs (based on the circularity calculation methodology)

Calculations completed for only one product (base) data. You can find the details of improvement opportunities in Barriers and Opportunities section.

- The circularity rate for the inputs has been determined to be 11%. Plastic materials, solvent and dye enter manufacturing facility as input materials in this example. Recovery potential rates are estimated figures based on research conducted on publicly available sources and estimations of company experts.
- Using solvent and low-density polyethylene type plastic obtained from non-virgin content as raw materials has increased the circularity rate for the inputs.
- The circularity rate for the outputs was determined to be 8%; this rate is 99% for potential recovery and 8% for actual recovery. The packaging product ,by-product and dye sludge datas are given as output.

The biggest reason for the difference between potential and actual recovery rates is the lack of circular inputs; if inputs that are recyclable or recoverable are used, actual recovery would be higher for Company X and Y. The recovery potential in this example is very high which means that the products are recoverable. The main reason of this difference between the recovery potential and actual recovery is the insufficient end of life products collection and recovery practices. The recovery potential is an estimated value given by the company experts.

*These values are average estimates.

[39] Company referred to as X has requested anonymity
[40] Company referred to as Y has requested anonymity

Drivers of Circular Economy Growth Potential in the Plastic Packaging Sector

For each sector section of this report, we have included an analysis that summarizes the potential for circular economy growth internationally and in Turkey with the format being aligned with the Ellen MacArthur Foundation in terms of the drivers and international context and then tailored to Turkey.[81]

Table 11: Drivers Of Circular Economy Growth Potential In The Plastic Packaging Sector Internationally And In Turkey (1/2)

Driver	Example	International	Turkey
Innovation & Corporate Action	Industry Action	Plastics commitments by large FMCGs and retailers are increasing. For example, more than 850 organizations have focused on a circular economy for plastics, with the New Plastics Economy Global Commitment signatories representing more than 20% of the plastics value chain[85]	The corporate members of PAGEV's makeup 88% of plastics revenue in Turkey.x One example of a project implemented by PAGEV members to help tackle plastic pollution include is 'Operation Clean Sweep'[86], which focuses on reducing micro plastics from factories. Business Plastics Initiative (İPG)[41], which was established under cooperation of Global Compact Turkey, SKD Turkey and TUSIAD, aims to prevent plastic waste pollution and encourage companies to provide joint solutions to mitigate plastic pollution. 34 companies have formed the İPG to trace their plastics footprint and evaluate their consumption through the IPG Tool.[87]
	Demand for Recycled Materials	Globally, demand for recycled plastic is increasing with growth of 17% reported between 2012 and 2016[88] There is an increased interest in recycling from plastic producers, evidenced by major M&A activity (e.g. Borealis)[89]	Following Turkey's short-lived ban on plastic waste imports, which was later converted to stricter regulations, demand for domestic plastic waste is expected to rise even though some experts argue that domestic input will not meet the sector's demand[90]. On the other hand, still allowing certain waste imports will help Turkey become a key player in the global recycling market, especially after the Chinese government's ban on waste imports.[91]
	Innovation	Circularity innovation is occurring across the value chain with examples including increased uptake of models for reuse, the development of renewable feedstocks, chemical recycling and packages with more recycled content or reusability, recyclability and compost ability potentials.	Many companies internationally and in Turkey are recycling plastics, using recycled materials and producing lightweight products to lower their demand for raw materials, upcycling waste, reducing cost, reducing emissions and supporting the ecosystem. Waste from one industry becomes an input in another, supporting the circular model across industries: Mavi Jeans manufactured a t-shirt line[92]. Detergent containers[93,94] and İKMİB[42] is supporting an initiative to build dog[95] out of plastic waste. Waste has been transformed into an input stream for bioplastics. Wastespresso, A Turkish start-up, collects, composts, and dries coffee waste, mostly collected from restaurants, hotels, and cafés to generate raw bioplastic materials.[96] Coca-Cola İçecek A.Ş. uses bio-based materials in Damla 330 ml Plantbottle. Aghita Group PSJC produced the first 100% recyclable plant water bottle in 2019. Some plastic packaging manufacturers are developing recyclable flexible packaging by designing out polyester and polyamide, which are non-recyclable, and creating a novel formula with 95% polyethylene. These products have been tested for compatibility with customers and certified for recyclability. Korozo Packaging developed and produced recyclable flexible packaging, designing out polyester and polyamide which are non-recyclable, focused on mono material solutions. Advanced technologies were used for production and resulting products certified as recyclable. Korozo is in full alignment with its business partners with respect to packaging line performance of regarding products.

[41] İPG – Business Plastic Initiative, *İş Dünyası Plastik Girişimi,* was found by the members of Global Compact Turkey, Business World, and Sustainable Development Association, and TUSIAD
[42] İstanbul Chemicals and Chemical Products Exporters' Association - *İstanbul Kimyevi Maddeler ve Mamulleri İhracatçıları Birliği*

Table 11: Drivers Of Circular Economy Growth Potential In The Plastic Packaging Sector Internationally And In Turkey (2/2)

Driver	Example	International	Turkey
Policies & Regulation	Increasing Policies and Regulation	Bans on single-use plastics items have been announced in many countries across Asia, Africa and Latin America but also by the EU (e.g. via the EU's Single-Use Plastics Directive, which seeks to tackle the 10 single-use plastic items most commonly found on Europe's beaches from 2021)[97]. " As of 2018, 63 countries had EPR[43] measures in force[98], with mechanisms including the following: Product take-back schemes, Deposit return systems (e.g. Australia's 'Return and Earn' scheme)[99] The EU EPR schemes for certain single-use plastic products[100] There has been an increase in the number of basic requirements for packaging and landfill taxes. (e.g. recycled content mandates for beverage containers in California)[101] National recycling targets such as the EU target for Member States of achieving plastic packaging recycling targets for 2025 of 50 % and 55 % by 2030[102].	Ban on Polyethylene imports was replaced with increased monitoring and regulations.[103] Since Turkey banned the provision of complementary plastic bags in 2019, meaning that plastic bags at checkout came with a price tag, their consumption has decreased by 77%.[104] Turkey published amendments to its Environment Law no. 2872 ("Amending Law") on 10.12.2018 and brought additional financial obligations in the form of a GEKAP. Companies and stores are mandated to report their plastic consumption as a result.[105] Minimum recycled content ratio for plastic packages has been increased to 8% in 2020 by the Turkish authorities.[106]
	Incentives	Incentives include Circular Economy Regulations such as the EU Circular Economy Action Plan[107] and EU Packaging and Packaging Waste Directive[108] Subsidies and support for innovation through projects such as Smart Sustainable Plastic Packaging Challenge, which will fund up to £60 million to support academic-led research on investigating solutions to tackling plastic packaging waste.[109]	To promote proper waste disposal methods, charities and municipalities are placing plastic disposal 'vending machines' in schools, shopping malls and public spaces around Turkey. Some of these smart disposal machines in İstanbul give out credit compatible with the city's transportation cards, Istanbul kart[110]. A similar initiative, Pugedon, gives out pet food instead, and this project has expanded to other countries too.[111] Tax reductions, increased tax returns and lower interest rates are some of the incentives given to companies investing in or running recycling and disposal facilities.[112] Deposit Refund System is a recently established collection scheme that will be complementing the Zero-Waste initiative. It aims to augment the recovery potential of certain domestic wastes, including plastics, with monetary rewards.
Customer Preferences and Macrotrends	Changing Preferences and Behaviour	Customer demand has been increasing to tackle plastic pollution due to high-profile documentaries and media attention. Customer preferences are now changing due to concerns over plastics, with reusables now being preferred over single-use products.[113]	Due to the COVID-19 pandemic, there has been a surge in demand in Turkey and globally for single-use plastics such as surgical masks, disinfectant containers and utensils.[114] As many consumers in Turkey demand more environmentally friendly products, manufacturers have been switching to bamboos or wood as a plastic substitute.
	Climate Change and Global Challenges	Reducing plastic waste and increasing the reuse and recycling of plastics can contribute significantly to decarbonization. One recent study estimated that GHG emissions from plastics production and end-of-life processing could be reduced by 56% in a circular scenario by 2050.[115]	The new restrictions on plastic imports announced in Turkey may push other nations to seek out new flow routes for their waste.[116] This development has also led some other nations to reconsider their policies when exporting waste to other nations.[117]

[43] Extended Producer Responsibility

Table 12: Circular Good Practice Examples From France

Company Profile	Project Profile	Details on Innovation & Circular Economy Practice	Impact
Name: Surfilm Packaging **Size:** SME (Small and medium sized company) *Recyclable and Reusable Package Manufactur*	**Product Name:** Recyclable Plastic Bag **Circular Economy Strategy:** Reduce, Reuse, Recycle **EU Circular Economy Model:** Circular Design and Production	Defective materials and scraps are recycled in-house Extrusion[44] process allows to integrate more recycled materials into production Materials are reinforced to be more durable and reusable Economic method set to recover packages from customers Innovation through bio-sourced packaging Re-using and sharing CPR pallets through the network sustained by PRS[45]	Lowering demand for new inputs materials Keeping waste away from landfills by connecting with end-users for package recovery Making products with longer lifespans Creating bio-degradable or compostable waste to reduce the waste's environmental impact Lower prices since products with recycling contents above 50% get 50% discount on their CITEO tax in France Earned the PRS Green Label[46] which certifies companies' efforts for reducing their environmental impact.

Circular Good Practice Examples from Turkey

Company: *Coca-Cola İçecek (CCI) A.Ş.*

Type of Circular Strategy	
Refuse	
Rethink	
Reduce	X
Re-use	X
Repair	
Refurbish	
Remanufacture	
Repurpose	
Recycle	X

Type of Circular Project	
Circular Design and Production Model	X
Circular Use Model	X
Circular Value Recovery Model	X
Circular Support	

Sources for Circular Case Study Information

- Website of Coca-Cola İçecek A.Ş. (CCI)
- Annual Reports of CCI
- Websites for organizations and companies in the CCI ecosystem (Ambalaj Ay Yıldızları, Mavi Jeans, Kollekt App)
- Interview with CCI experts

[44] High volume manufacturing process where the plastic is melted into a continuous profile
[45] PRS Pooling System lets companies rent CPR pallets in Europe.
[46] PRS Green Label is given to active participants of the PRS program.

CCI is the sixth-largest bottler in the Coca-Cola system in terms of sales volume. *CCI*, head-quartered in Turkey, has operations in 10 countries including Turkey, Pakistan, Kazakhstan, Iraq, Azerbaijan, Turkmenistan, Kyrgyzstan, Tajikistan, Uzbekistan and Jordan.[118]

CCI has 3 focus areas in their sustainability and circularity efforts: energy management, sustainable packages and water management. As a company that recognizes its impact on the environment, *CCI* has been increasing its efforts on finding sustainable solutions, especially with a focus on the plastic packaging sector.

Through their Operational Excellence (OE) projects they managed to save 330 million MJ of energy, 45,000 tons of CO_2 e emissions and 104,000 m^3 of water in 2020.

CCI's Recycled PET (r-PET) project also highlights the company's circular initiatives. Through chemical recycling, 32% of plastic packaging in 2020 contained 25% r-PET content. *CCI* collaborated with *Etapak Baskı Ambalaj Sanayi ve Ticaret A.Ş.*, and they were awarded the Gold Award in *'Ambalaj Ay Yıldızları 2020'* competition.[119]

Another reduction strategy has been improving the packages' designs and compositions using a range of methods. One approach has been light weighting in 2008, this started by shortening the neck of the bottles in Turkey. After that, factories in different countries started looking into ways to make the bottles lighter by design and material changes; in 2015, all participants shared their findings to choose and implement the most efficient method.

In 2020, the light weighting efforts helped *CCI* reduce its input by a total of 411.4 tons in resin production and 534 tons in glass production in 9 countries including Turkey.

Glass bottle can be implemented as a substitute for plastics. In 2020, both in Turkey and Pakistan, *CCI* initiated the returnable glass bottles project to extend the life cycle of their products which lowered the company's energy and resource consumption in bottle production. These bottles can be re-used up to 8 times, which is estimated to have reduced their CO_2 emissions by 67,590 tons, which is similar to the CO_2 intake of 5.6 million mature trees[47].

In order to integrate the consumer more into circularity projects, *CCI* developed an app called '*Kollekt*' in partnership with DKM[48] and UNDP. Since local governments cannot effectively collect all the plastic waste, consumers need to participate in the disposal process. The pilot project was conducted in Antalya's Kemer region and it connected the app user with either the nearest disposal station or the municipality to report the trash location. The plastic bottles that were collected with this app were recycled as fabric in *Mavi's* t-shirt collection.

[47] This comparative calculation used trees of at least 15 years of age that could absorb 12kg of CO2 annually from the atmosphere.
[48] The Nature Conservation Centre

Company: *PlasticMove*

Type of Circular Strategy	
Refuse	X
Rethink	
Reduce	X
Re-use	
Repair	
Refurbish	
Remanufacture	
Repurpose	
Recycle	X

Type of Circular Project	
Circular Design and Production Model	X
Circular Use Model	
Circular Value Recovery Model	X
Circular Support	

Sources for Circular Case Study Information

- Company website of PlasticMove
- Information provided by PlasticMove
- Discussion with Plastic Move experts
- Turkish Grain Board reports[49]
- TÜSİAD's start-up competition's website[50]
- Egirişim's YouTube Channel[51]

In Turkey, on a daily basis, 95 million pieces of bread are consumed but 6 million pieces are wasted. The monetary value of the 2.1 billion pieces of bread that are wasted in Turkey in a year is estimated as 1.5 billion TL. Turkey's annual economic loss due to bread waste is equivalent to the income the country receives from flour exports, where Turkey ranks first in the world.

PlasticMove, one of the finalists in TÜSİAD's "*Bu Gençlikte İş Var 2020*" start-up competition, offers a solution to this problem based on the circular economy model and regains this waste stream into the economy for further use in the plastic industry. The İstanbul based start-up was inspired by technologies that use corn starch to produce bioplastics, but that method relies on resources that could be used to combat hunger while 690 million people go hungry every day. Instead, *PlasticMove*'s approach covers various SDGs and focuses on recycling starch-based agricultural and food waste to produce biopolymers without directly relying on the farming industry.[123] [124]

The biopolymer was developed by working with companies in FMCG and automotive industries, which are characterized by high levels of plastic consumption; their packaging partners enable these companies to reduce their use of plastic by up to 20%. By reducing their plastic usage, these firms aim to reduce their carbon emissions and reach their environmental targets faster.

For every kilogram of bread, PlasticMove can make 1.3 kg of bioplastic and for every kilogram of bioplastic they produce, they prevent at least 6 kg of CO_2 emissions.

As a new company in the industry, they are currently more focused on integrating their materials as a fraction of their partners' products. PlasticMove's plastic substitute is compatible with 2 types of common plastics: polypropylene and polyethylene. While testing this material at KordSA's facilities, they found that the products were compatible with these plastic types and yielded the same quality when 10% of it was substituted with biopolymer. The start-up just landed its first partnership with Evyap and Sarten where their materials will be used as a part of plastic bottle caps. This project will not only redirect waste streams but also reduce the demand for fossil resources which are the basis of traditional plastic products. In 2021, *PlasticMove* plans to finish product validations with 8 customers that operate in FMCG and the automotive industry and receive purchase contracts from these customers to further initiate the mass production stage in 2022.[125]

[49] Turkish Grain Board - *T. C. Toprak Mahsülleri Ofisi Genel Müdürlüğü*, is the government office that ensures agricultural commodity markets are operating lawfully and within reasonable prices
[50] Turkish Industry and Business Association – *Türk Sanayicileri ve İş İnsanları Derneği*, is one of the top business organizations in Turkey.
[51] A channel dedicated to the start-up ecosystem in Turkey

6.2 Textile Sector

Textile Sector Overview

Market Structure: The number of textile companies operating is approximately 53,318[126]

Revenue: Turkey's total textile sector exports was Euro 9.8 billion in 2020[127]

Employment: 1.58 million people[128]

In 2019, the industry attained a significant importance in the Turkish economy, reaching 3% of national Gross Domestic Product (GDP) and becoming the 7th largest exporter worldwide after China, Vietnam, Bangladesh, India, UK and Indonesia. The industry accounts for 10.1% of national exports, for a total amount of USD 14.8 billion.

Textile is more than the clothes we wear. It is an all-encompassing industry, which makes changing demand and supply patterns in favour of sustainability across the entire industry a challenge. Some examples of textile components outside of the fashion industry include home textiles, seat belts, industrial filters, face masks and even road materials. Each has a unique purpose and composition; so, setting standards and regulations and establishing sweeping circular economy targets is complex.

The utilization rate of clothing items decreases as household income increases.[130] Over the years, the textile industry has seen a rise in inefficient consumption, especially in the clothing sector. While the household's demand for garments increases, the utilization rate of such products has decreased. Compared to 15 years ago, the number of times textiles are worn before being discarded has decreased by 36%. This pattern in consumption highlights the importance of consumers 'refusing' in order to lower their demand and 'reusing' to increase the circularity of goods.

McKinsey Fashion Scenarios suggest that global fashion sales will reach 96-101% of 2019 levels in 2021 and 103-108% in 2022. Still, while sales are expected to make a recovery in the following year, performance will vary across geographies; growth will most likely be driven by the US and China, while the European market diminishes consumption.[130] In response, many companies will recalibrate their retail footprints, even amid uncertainty as to whether these pandemic-induced behavior shifts will stick.

The industry includes resource-intensive processes. It ranks 2nd among production industries for water consumption during production, and 5th amongst agricultural activities of cotton and the crops that consume the most water. In 2015, the global market consumed around 98 million tonnes of resources including oil to make synthetic fibres, fertilizers and pesticides to grow crops and chemicals to dye and finish fibres. 97% of its inputs were virgin feedstocks, plastic and cotton.[131] However, there is potential to make textiles, and subsequently the food industry, more sustainable; by making the transition to the use of recycled cotton, recent studies have indicated that 17% of agricultural land in Turkey, equivalent to an area of 766,390 hectares, can be freed up.[132] Using this land to grow crops for food would drive down domestic food prices and increase the gains from exported agricultural products.

If the industry continues to embrace current decarbonisation initiatives at the ongoing pace, emissions will be capped at around 2.1 billion tonnes a year by 2030, which is around the same as they are now. This would leave levels at nearly double the maximum required to stay on the 1.5-degree pathway. To align with the 1.5-degree pathway over the next 10 years, the fashion industry needs to intensify its efforts. In practice, that means embracing accelerated abatement, which is estimated to reduce annual emissions to around 1.1 billion tonnes, about half of today's figure.[133]

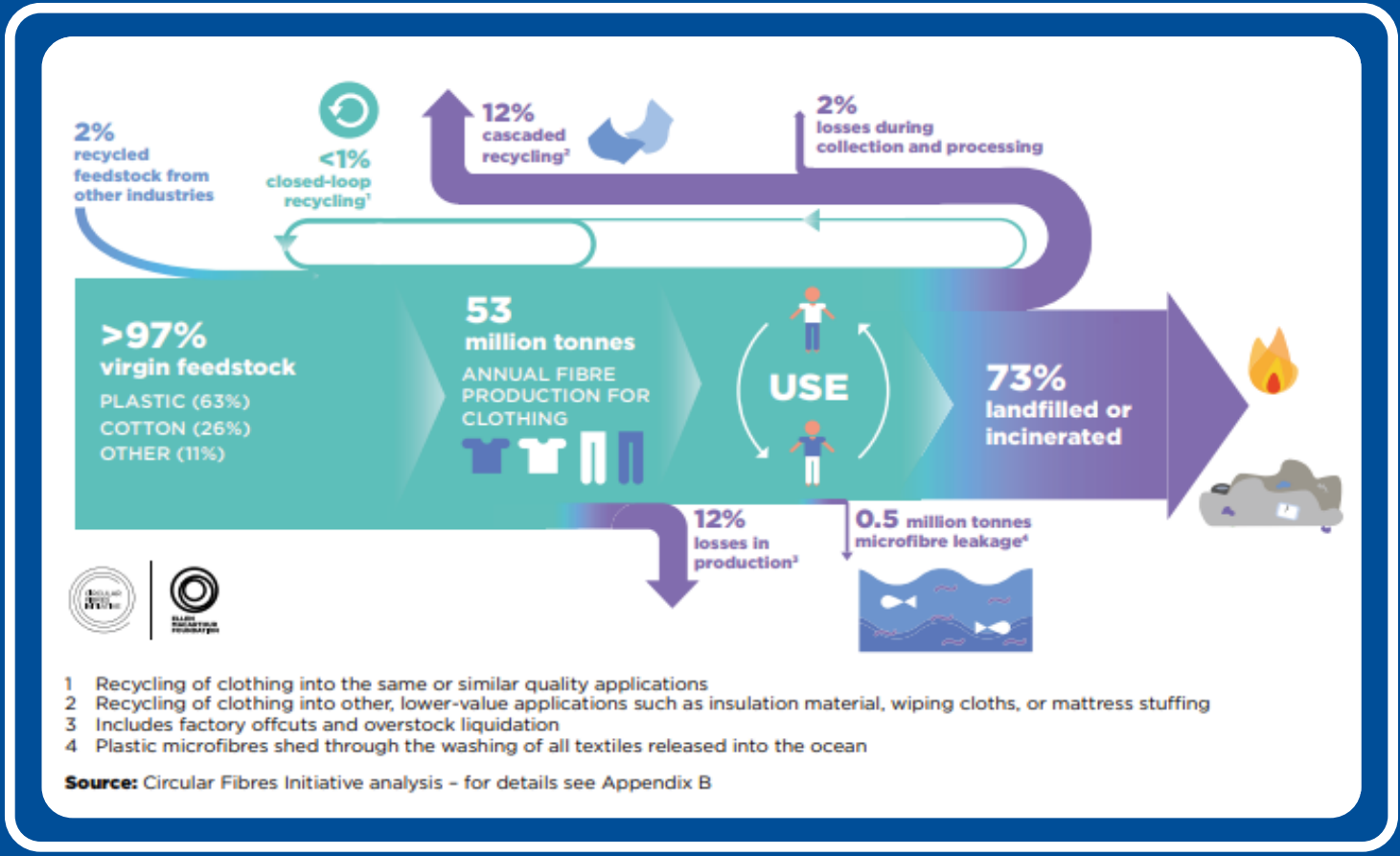
According to the data of the European Union Commission, the textile sector is the 3rd largest sector contributing to GHG emissions globally. Considering only the energy consumption during the production process, approximately 10% of global GHG emissions arise from this sector alone, which exceeds the combined contribution (pre-COVID-19) of international aviation and shipping. Hence, by transitioning to renewable energy, the textile sector can have a significant impact in terms of decarbonizing the global economy.[134]

"Textile production, one of the industries with the highest pollution rate, produces 1.2 billion tons of CO_2 per year. More than 60% of textiles are used in the apparel industry, and it is stated that about 5% of global emissions come from the fashion industry. Synthetic fibres have had higher production rates in recent years. Polyester is the most used fibre and has replaced cotton at the beginning of the 21st century. Emissions for polyester and other synthetic materials are very high because they are produced from fossil fuels. In 2015, polyester production resulted in 706 billion kg of CO_2. (Rita Kant,2021)"

Textiles' production uses around 93 billion m3 of water annually and globally while discharging high volumes of water containing hazardous chemicals into the environment.[135] In Turkey, studies show that textile production processes account for 15% of the industrial water consumption.[136] In a region that is already inflicted by seasonal draughts and is marked by the growing numbers of dried up lakes, water usage is currently a matter of life and death for some species. With the aggravating effects of climate change, water crises is expected to have a more crippling impact on communities, industries, nature and biodiversity.

During the production phase, a major concern in textiles is the chemical waste that mixes in with the water. It is estimated that 20% of industrial water pollution load is a result of the treatment production of fabrics and fibres. Textiles generate pollution during their usage too. Microplastic pollution caused by the washing of synthetic textiles has recently been assessed as the main source of primary microplastics in the oceans. It has been estimated that every year, around half a million tons of plastic microfibers shed due to washing plastic-based textiles - such as polyester, nylon, and acrylic – and end up in the ocean.[137]

Figure 4: Global material flows for clothing in 2015



Globally, around USD 460 billions of value is lost every year due to consumers throwing away underutilized garments with only less than 1% is recycled in a closed-loop system[52]. About 12% is cascaded recycling[53], in which significant economic value is lost.[139] Thus, a linear consumption does not only waste materials and resources but also economic value too. Increasing circularity in this subsector would have economic gains for consumers and producers alike.

Today's textile sector is mainly linear with the sector using large amounts of resources and being responsible for a range of negative externalities. However, there are also many examples of companies internationally and in Turkey starting to embrace more circular business models.

Main Obstacles and Corresponding Strategies

In a world defined by capitalist motives, it is hard to convince the consumer that more is usually not better. From social media to offices, many environments dictate a certain sense of fashion as appropriate, which challenges the first chain of 9Rs: refuse. Consumers are marketed the idea of 'appropriateness' by not just brands and marketing agencies but also by society. Environments such as restaurants, offices, gyms and schools inadvertently increase demand by enforcing expectations and rules to create a certain ambiance, which pushes consumers to make additional purchases for every occasion. Circularity principles need to apply to societal expectations in order to refuse and reduce the demand for unnecessary goods.

The growth of fast fashion has exasperated the problem that arises from a linear economy. Buying more for less has no just fuelled overconsumption but also increased waste since consumers are more likely to throw away items that hold less economic value. Thus, price of goods and its relativity to disposable income play key roles in controlling demand, waste and 'refuse' culture.

Moving away from clothing, demand for textiles increase via demand for other marketed goods, such as automotive, furniture and buildings. By designing and producing quality goods that are durable, multi-functioning, easy to dismantle and are reusable, goods and materials can circulate in the economy for longer. Textiles complement products in other sectors, which also means that they are discarded as waste when the items they are used in are no longer deemed as useful. Designing textiles that can be dismantled or separated without damaging other components, such as those used in car interiors, would increase the reclaimed materials remanufacturing potential.

A lot of fibre is generated as waste (or by-products if circular principles are applied) in factories; about 12% of the inputs are lost during production. Collecting these fibres for closed-loop recycling can prove very useful for reclaiming value that would have been lost otherwise. The problem regarding quality rises in this sort of application: since these by-products are relatively shorter fibres, it is more challenging to make longer-lasting fabrics. Companies are challenged with the loss of reusability when using production waste; thus, they can only mix in a certain ratio of reclaimed threads into their fabrics.

Keeping valuable goods out of landfills requires consumer participation and brands have been implementing systems to incentivize post-consumer textile waste collection. While all circular practices are encouraged, some recycling incentives also generate more demand. For instance, brands sell new items at discounted prices if old clothes are dropped off for recycling at the store. While there are benefits to such actions, it should be noted that this strategy can still induce overconsumption.

Not all textiles are recyclable. Especially in the garment industry, certain dyes, pigments, patterns and prints reduce the recovery potential of the fabric. Additionally, textiles are harder to recycle when the variance in its composition increase. For instance, a 100% cotton shirt can still include sewing threads or labels made from other materials such as polyester. Accessories like zippers, buttons, beads make the separation process very labour intensive and it requires a skilled workforce. Separating materials is a tedious process, but there is potential of growing employment in this sector. Low-income communities can be targeted which would generate more income and employment opportunities for less educated people.

[52] Closed Loop Recycling: materials are recycled into same or similar applications
[53] Cascaded recycling is downcycling. Garments are recycled into lower-value applications such as mattress stuffing and insulation material.

Besides these general issues regarding textile circularity, the industry in Turkey faces several other challenges that come in the form of regulations and taxation. Producers are taxed for almost all items that are taken out of stock under the VAT[54] Regulations[55]; this means that even if a company wants to give away its deformed or unsold goods for charity or research, the company will still need to pay VAT for these goods. However, products such as textile scraps and fabric fabrics are exceptions. Therefore, these products are included in the scrap textile waste category and are evaluated with 0% VAT.

The only way to avoid such payment would be to bury it or burn it. Such taxes deter companies from engaging in circularity strategies and hinders the potential of circularity innovations in the textile industry.

Sun Tekstil sends the waste generated as a result of production activities to licensed waste collection facilities for recycling. They primarily redesign the products remaining in stock. If it is still unsold, they wait for the period specified by the brands and sell it to the personnel with a symbolic fee. Products that cannot be kept in stocks are converted into scrap and sent to licensed waste facilities. These wastes are converted into products such as yarn, felt and filling materials at the facilities. The products that cannot be recycled are sent to energy recovery or landfill. Taxes on unsold goods need to be lifted in order to encourage companies to recycle, remanufacture, share and donate. Further incentives can be implemented by lowering VAT on finished goods that were manufactured with a certain rate of circular inputs.

Most textile wastes are also among the list of banned imports. While this ruling can be perceived as an obstacle in increasing recycled content production in a country where there is no efficient collecting and sorting scheme, it is also in line with ensuring that Turkey is not pressured with other countries wastes and supply chains are kept short. As for the exports of textiles scraps, manufacturers can do so as long as they have permits[56] from the government.

[54] VAT – Value Added Taxes, *Katma Değer Vergisi (KDV)*
[55] VAT Regulations, *Katma Değer Vergisi Genel Tebliği*
[56] *Dahilde İşleme İzin Belgesi*

Key Circular Strategies

Key Circular Economy Strategies for the Textile Sector can include the following strategies, which are considered in terms of the 3 Circular levers: Circular input, Recovery Potential and Actual Recovery, which are defined in the Appendix.

Circular Input

- Adopt new business models to increase utilization through resale or rental
- Extend useful life through reuse and repair
- Opting for organic dyes instead of synthetic ones
- Ensure clothes are made from safe and renewable or recycled materials
- Ensure textiles are collected, sorted, and reused or recycled
- Develop cleaner production techniques and technologies that will benefit in terms of raw materials, energy, water savings and, wastewater management.

Recovery Potential

- Design products with fibres and accessories that are easy to separate
- Design and manufacture biodegradable or mono-material products
- Create materials that do not pollute water ways when washed
- Set up recycling and donation containers for textiles in residential areas
- Promote products that support circular initiatives on brand websites
- Develop energy labels that promote circular practices throughout the lifecycle
- Enforce stricter regulations to incentivize companies to invest in technologies, such as membrane processes like reverse osmosis, that will reduce water withdrawals and consumption
- Increase water recovery rates by investing in wastewater recovery and reuse technologies
- Eliminate taxes on deformed or unsold goods and by-products
- Raise consumer awareness on textile sector's environmental impact

Actual Recovery

- Extend useful life through reuse and repair
- Ensure textiles are collected, sorted, and reused or recycled
- Promote thrift stores
- Expand rental cloth platforms
- Install technologies for recycling wastewater
- Install waste management systems in facilities to collect and sort discarded fabrics and threads
- Improve fibre technology to increase efficiency in various energy intensive products such as automotive, airplanes, buildings and energy infrastructure [141]
- Implementation of pollution prevention on-site by cleaner production and circular economy approach.

Table 13: Main sources of information used for the textile sector

Textile			
Consulted Organizations	**Interview**	**Main Research Materials**	**Sector Validation**
Akar Tekstil Away Denim Orta Anadolu SUN Tekstil	TÜBİTAK experts Sector Experts/Academics	Online research on Turkish and international websites Sustainability Reports and Integrated Reports for sector companies Websites for sector companies TÜİK Data Set Ellen MacArthur Foundation: A New Textiles Economy[142]	Orta Anadolu SUN Tekstil EİB[57] SUSEB Prof. Dr. Şule Altun Kurtoğlu Dr. Recep Partal (TÜBİTAK) Zorluteks Textile (Case Study Only)

Table 14-15: Input And Output Dashboard For Data Collected From Textile Sector In Turkey*

% Circular input 16%					
Input	**Weights (tons)**	**Non-renewable Virgin Content (%)**	**Renewable Content (%)**	**Non-virgin Content (%)**	**Weight of circular input (tons)**
Cotton	1,650,656[143]	78[144]	2[145]	20[146]	363,144
Wool	51,545[147]	93[148]	3[149]	4[150]	3,608
Viscose	24,469[151]	68[152]	32[153]	0[154]	7,83
Synthetic Fibres (polyester, nylon, polyamide, polypropylene fibres)	2,353,276[155]	100	0	0	0
Organic Fibres (Other vegetable textile fibres)	9,022[156]	0	100	0	9,022
Total	**4,088,968**	**68%**	**27%**	**5%**	**383,604**

% Circular Output 23%				
Output	**Weights (tons)**	**Recovery Potential (%)**	**Actual Recovery (%)**	**Weight Circular Output**
Textile Products	3,185,924[157]	75[158]	35[159]	836,305
Residual fabric and fibres	375,257[160]	75[161]	35[162]	98,504
Industrial Waste for Textile	346,994[163]	75[164]	35[165]	0
Total	**4,045,127**	**75%**	**35%**	**934,81**

*These values are average estimates.

[57] Aegean Exporters' Association - Ege İhracatçı Birlikleri

% Circularity Calculation Result For Textile Sector*

circular input	circular output	
16%	23%	
	recovery potential	**actual recovery**
	75%	35%

*These values are average estimates.

Table 16: List of omissions

Category	Reason for Omission
Omission of textile wet processing	Textile wet processing uses large amounts of water, dyes and chemicals, and other materials for dyeing, printing, and finishing processes. However, data is not available for these inputs and hence could not be included.

Analysis of Circularity Calculation Results

The scope of the study was the manufacturing phase, where materials are weaved and processed into textiles. The sub-sector that was focused on the circularity calculation methodology data collection was the clothing industry. Primarily, the TÜİK data set was used to determine the total weight numbers, but there were many omissions in their data set, and the reason for such omissions were not indicated. To have an accurate calculation on a macro-level, data transparency is a must.

For the textiles sector in Turkey, the circularity of input was estimated to be around 16% and the output was 23%. However, these figures are calculated according to the assumptions made using the publicly available data, opinion of sector experts and companies which responded the survey. Due to the low number of participants representing large textile companies with good practices, these figures do not represent the average circularity rates of the textile sector and actual figures are estimated as much lower in textile sector in Turkey. The performance of both inputs and outputs can be improved by changing tax regulations regarding the flow of waste, unused materials, scraps and unsaleable goods. This would increase the flow of non-virgin materials between companies. These ratios can be increased by implementing fiscal incentives on finished goods – for instance, a lower tax on circular textile products would stimulate companies to change their designs and material compositions. If the end-of-the-life cycle is considered in the design phase, Circularity calculation methodology performance can be improved further by manufacturers avoiding, mixing materials, designing prints and embellishing fabrics.

Many companies stated that they do not track the number of chemicals used in their processes since it varies vastly. The WWF report has also determined the mass of dyes and chemicals used in the textile industry to vary between 10% and 100% of the mass of the finished good.[166] Due to this wide range, calculations based on assumptions could not be carried out either. On the one hand, it can be deduced that by excluding an integral component of the production process which had a high environmental footprint, the Circularity calculation methodology for the output was calculated to be potentially higher than the actual performance. However, it is also important to note that such exclusion was also partially supported by the framework of the Circularity calculation methodology Module 1 used for this study does not include the water flow and most of the chemicals and dyes used in textile belong in this cycle.

Consequently, the limited data availability introduces uncertainty in the calculations from the sector. To complement the findings from a macro-scope, the Circularity calculation methodology was also tabulated 1 Turkish company.

Despite the low circularity numbers compared with more circular global markets, significant opportunities for improvement were determined. Tables 17 and 18 below show a wide range of circular good practices and recommendations for driving improvement towards a more circular economy.

Table 17: Drivers Of Circular Economy Growth Potential In Textiles Sector Internationally And In Turkey (1/2)

Driver	Example	International	Turkey
Innovation & Corporate Action	Industry Action	Increasingly, fashion brands are moving to more circular business models including reuse and rental models, while focusing on product design aspects such as durability, recyclability, and traceability. For example, more than 70 leading brands, manufacturers, and fabric mills are collaborating on the Jeans Redesign project to create clothes that never become waste and are due to be available on the market during 2021.[167] Inditex, one of the biggest fashion groups in the world, developed a sustainability program to increase their products and supply chains' environmental footprint under the Join Life Program. Companies in their value chain, like the Turkish company Sun Tekstil, also abide to these standards.	Many Turkish textile companies, such as Koton and Orta Anadolu, have joined the Better Cotton Initiative via IPUD[58], the initiative's chapter in Turkey, which is committed to sustainably procuring cotton crops.[168 169 170] Start-up competitions like "Techxtile Start-Up Challenge" promote sustainable innovations through competition.[171] Sun Tekstil plans all business processes based on the circular economy hierarchy. In this direction, as a first step, in order to reduce the use of raw materials at the source, they increase the level of digital transformation at the design stage and makes collection presentations to specific customer groups without producing physical samples. In this way, the amount of sample production in specific customer groups was reduced by 41% and significant level of raw material, energy and workforce savings were achieved. Sun Tekstil is working on a guide to share their CE practices and projects with other textile companies to inspire their sustainability journey. The publicly available report will focus on their business model for their industrial symbiosis project which aims to create value from fabric waste.
	Innovation	Circularity innovation is occurring across the value chain with examples including reuse models, integrating recycled content, designing for reusability and recyclability, development of renewable feedstocks, and chemical recycling.[172] Algae is harvested to make organic dyes and decreases the demand for raw materials such as petroleum.[173]	Major Turkish textile companies such as Aksa Akrilik, Zorluteks Textile, Gama İplik and Sasa Polyester (textile and petrochemistry) have been investing in projects and technologies that support the transition to a circular economy.[viii] These include partnerships for recycling, waste management systems, nanofiltration and reverse osmosis technologies.[175 176 177 178 179] At AKSA Akrilik, reverse osmosis technology has been used to use salt water during production. Their recycled fiber Acrycycle uses post industrial production waste. Some Turkish companies have started re-purposing and up-cycling high-quality textiles across markets; for instance, sails that are no longer in use are being converted into bags.[180] Turkey is one of only a few countries that produces carbon fibre, a material that has a high strength-to-weight ratio and stiffness-to-weight ratio. This fibre supports circular performance by decreasing lifecycle costs, extending a product's lifetime and increasing energy efficiency in areas such as transportation and energy production.[181 182]

[58] Good Cotton Practices Association, İyi Pamuk Uygulamaları Derneği

Table 17: Drivers Of Circular Economy Growth Potential In Textiles Sector Internationally And In Turkey (2/2)

Driver	Example	International	Turkey
Policies & Regulation	Increasing Policies and Regulations	Increasing circularity regulations such as the EU Circular Economy Action Plan and the French Circular Economy Law, enacted in 2020, that bans the destruction of unsold or returned consumer products including products created from textiles such as luxury goods.[183]	Statement on Integrated Pollution Prevention and Control in Textiles Sector[59] is being revised to reflect higher standards.[184] EU's proposal for a CBAM[60] will mean that trading nations and companies will need to align their policies, regulations and operations with the CBAM resolution in order to remain competitive in the European market.
	Political Priorities	There has been growing interest in the circular steps in textile industry, including platforms such as UNEP, UNFCCC and OECD. Policy Hub proposals for green recovery principles that help increase circularity in the Textile, Apparel, and Footwear industry as part of the EU Green Recovery Plan[185]	To help support the competitiveness of Turkish companies internationally and to promote sustainable practices parallel with those in the EU, eco-labels have been developed by the Turkish government in several sectors, including textiles.[186]
Customer Preferences and Macrotrends	Changing Preferences and Behaviour	Increasing customer awareness of the negative impacts from the current fashion system, is fuelling demand for safer chemicals and regenerative sourcing[187] Increased acceptance of buying second-hand and convenience of resale and rental due to increasing ubiquity of digital platforms.[188]	Brands that focus on vintage, upcycled and rental clothing are getting more recognition through media outlets.[189] Brands are adjusting to increasing awareness and demand for sustainable products by expanding their portfolios to include products such as vegan shoes and recycled furniture.[190] Shopping websites are implementing additional filtering tools for collections made from vegan and recycled materials.[191] Rental clothing schemes that promote the circularity of clothing items that are not frequently worn are gaining recognition.[192]

[59] Tekstil Sektöründe Entegre *Kirlilik Önleme ve Kontrol Tebliği*
[60] Carbon Border Adjustment Mechanism – *Sınırda Karbon Düzenleme Mekanizması*

Table 18: Circular good practice examples from France

Company Profile	Project Profile	Details on Innovation & Circular Economy Practice	Impact
Name: La Gentle Factory **Size:** Small Cap Company *Fashion Factory*	**Project Name:** *Gentle Factory* **Circular Economy Strategy**: Recycle **EU Circular Economy Model:** Circular Design & production	They have been using recycled fibres that are certified by Global Recycled Standards and when that is not possible, they opt for organic fibres certified by Global Organic Textile Standards. Production scraps are also recycled via a partnership with "Fier comme un Paon", which manufactures t-shirts. Dyes have been certified by Oekotex[61] and their supplier has set up a rainwater recovery system and treatment plant to reduce water consumption.[193] The sludge from the water plant is 100% recycled and is used by an agricultural fertilizer by a different company; the recycled waste is also certified for traceability. Screen printer and embroiderer have the Imprim'vert label which validates the absence of chemical substances, waste management systems, storage conditions and on-site energy consumption. Customers are provided with a range of information to minimize the number of returns, such as a size guide and explanatory diagrams for taking measurements. Eco-friendly computer servers that utilize 30% air-cooling and 70% water-cooling are used. The server uses its own green energy produced by wind turbines.	Greenhouse gas emissions are reduced by 15%, water consumption by 50% and eutrophication[62] by around 50% compared with conventional manufacturing processes. Prioritizing recycled materials first, and organic fibres second, decreases the company's demand for natural or non-renewable resources. Certification, whether it be to for traceability or for validation of sustainability, is applied to ensure quality and transparency. Communication channels are also used to reduce the impacts of transportation related emissions: customer's access to information and customer satisfaction play a key role in avoiding additional logistics related environmental and economic costs. In the age of digitalization, having an eco-friendly approach that goes beyond the manufacturing phase will lower the company's environmental impact. Using renewable energy to manage servers reduces the company's environmental impact. The company's impacts are indirectly amplified with their choice of suppliers, who also implement circularity in their operations. This ensures that sustainability is practiced, and detrimental impacts are reduced throughout the supply chain.

[61] One of the world's best-known labels for textiles tested for harmful substances. Shows customer confidence and product safety.
[62] the gradual increase in the concentration of phosphorus, nitrogen, and other plant nutrients in an aging aquatic ecosystem

Table 19: Circularity calculation methodology application in textile industry in Turkey

Company Profile	Project Profile	Details on Innovation & Circular Economy Practice	Impact
Name: Sun Tekstil **Size:** Medium Cap Company *Fashion Factory*	**Project Name:** Circularity **Circular Economy Strategy:** Reduce, reuse, remanufacture, recycle **EU Circular Economy Model:** Circular Design & production	SUN Tekstil makes most of its production for Inditex group and is one of Inditex's Join Life suppliers. They have been reporting their CDP since 2012. They also have a sustainability committee that has a working group on sustainable product design and development. Apart from synthetic fibres, plant fibres like cotton, which are certified for quality, are used during production too Since they cannot sell the surplus samples or production wastes, they apply a redesign process. They alter the unsellable products and then re-present them to the markets. Only when they cannot remanufacture, they ensure the remaining products and scraps are recycled.	By incorporating circularity into the manufacturing process, raw materials are consumed more efficiently. They reduce the use of chemicals by influencing their suppliers and ensure sustainability is considered throughout the supply chain. They carry out certification and auditing activities in line with international standards to guarantee quality and transparency. They extend the life cycle of products with reuse, remanufacture and recycling studies. Further projects that pave the way for industrial symbiosis is currently underway.

Circularity Calculation Results – Sun Tekstil*

circular input	circular output	
46%	14%	
	recovery potential	**actual recovery**
	93%	14%

*These values are average estimates.

Calculation Outputs

Calculations have been completed based on one-year production data.

- The circularity rate for the inputs has been determined to be 46%.

Renewable inputs like viscose and cotton, which is BCI certified, increase the circularity rate on the input side while secondary raw materials, which are used at relatively low rates, bring it down.

- The circularity rate for the outputs was determined to be 14%; this rate is 93% for potential recovery and 14% for actual recovery. Recovery potential of this product is very high. This recovery rate is an estimated figure based on the insights of the experts of the company since they know the ingredients of input materials. Actual recoverability rates are estimated by the company experts using the data of recycling facilities and research.

The biggest reason for the difference between potential and actual recovery rates is the fibre mixture in the product, the elastane content and the volume of products made from printed fabrics which affect both the potential and actual recoverability rates. Additionally, there is a lack of adequate regulation and facility infrastructure for collection, recycling, reuse and recycling within the sector.

Circular Good Practice Examples from Turkey

Companies: *Orta Anadolu* and *Gama Recycle Elyaf ve İplik*

Type of Circular Strategy	
Refuse	
Rethink	
Reduce	
Re-use	
Repair	
Refurbish	
Remanufacture	
Repurpose	
Recycle	X

Type of Circular Project	
Circular Design and Production Model	X
Circular Use Model	
Circular Value Recovery Model	X
Circular Support	

Sources for Circular Case Study Information

- Company website for *Orta Anadolu*
- *Orta Anadolu's* Social Media
- Information provided by *Orta Anadolu* experts during this project
- Online articles

To be effective, circular economy models rely on communication and partnership; so, *Gama* and *Orta Anadolu's* project on "closing the loop in denim" project, which is also a part of the global initiative 'Denim Deal' based in Netherlands, sets a great example of what is possible.[194]

Globally, 53 million tons of fibre are produced annually but about 10-15% is lost during production.

Orta Anadolu collects fibres lost during production, mostly during the spinning phase, along with other waste materials that are sorted out during the production stage through a waste management system and these materials are then sent to *Gama*, a company that specializes in recycling pre and post-consumer fibres. Gama has developed a new technic for recycling second-hand garments, in which they manufacture pure recycled cotton from multi blended fabrics. To ensure transparency, they have also established a tracing system for recycled fibers.

The upcycled material is then sent back to *Orta Anadolu* to be used in their new products. A downside of recycled fabric is that the fibre is shorter than others; so, the material is less homogenous and weaker. To compensate for its lack of durability, *Orta Anadolu* has been focusing on improving what they call the "Golden Ratio", the ratio of recycled materials and natural resources to create high quality recycled jeans.

Orta Anadolu used 650,000 kg of recycled materials in 2020 to produce new fabric which accounts for 20% of the product. Collaboration with Gama aims to bring this number up to 1 million kg in 2021 which will equate to 2,800 tons of CO_2 emissions prevented and 1,860,000 m^3 of water conserved at the farming level.

Orta Anadolu has partnered with Levi's to improve the post-consumer recycling process as well. Globally, it is estimated that only 1% of textiles are recycled meaning that more than USD 100 billion worth of materials are lost every year.[195] By using the jeans received from Levi's, *Orta Anadolu* created 4 new types of recycled fabric that uses up to 20% of non-virgin material. This collaboration also aims to empower less developed communities during the recycling process. Post-consumer jeans' waste is sent to a village in Kahramanmaraş where women manually remove metals, labels and seams from discarded jeans; after this manual filtering process, the jeans are sent to the recycling station.[196] [197]

Company: *Zorlu Holding*

Type of Circular Strategy	
Refuse	
Rethink	
Reduce	X
Re-use	
Repair	X
Refurbish	
Remanufacture	
Repurpose	
Recycle	X

Type of Circular Project	
Circular Design and Production Model	X
Circular Use Model	X
Circular Value Recovery Model	X
Circular Support	

Sources for Circular Case Study Information

- *Zorlu Holding* company websites and publications
- *Zorlu Holding* Annual Reports
- Information provided by Zorluteks Textile experts during project
- Partner organization websites

Zorlu Holding has several brands in the textile business including *TAÇ, Linens, Zorluteks Tekstil* and *Korteks* that operate in a range of markets with different sustainability strategies. TAÇ uses innovative fabrics for curtains that clean themselves with light, which reduces the demand for water and energy, while *Korteks* recently invested USD 10 million for a facility that can make recycled polyester thread from plastic bottles.[198] [199]

Each company has a tailored approach to the circular economy and *Zorluteks*'s involves partnerships within Horizion2020 on 3 different projects to accelerate its innovations: Reclaim, ZeroBrine and Oxipro.

"Reclaim" aims to extend the machinery's lifespan while improving productivity and performance. This project harnesses digital analytics, the Internet of Things (IoT)[(63)] [200] and circular economy strategies to improve predictive maintenance and upgrade legacy machines responsibly and effectively. *Zorluteks* aims to develop a dynamic Decision Support Framework for a bleaching machine to produce cotton fabrics with targeted whiteness indices. The goal of this initiative is to extend the lifetime of the equipment by repairing, optimize machine use, reduce resource consumption and minimize environmental impact by decreasing breakdowns by 10% and energy consumption by 10%.[201]

In "ZeroBrine", *Zorluteks* is researching methods to recycle 80% of wastewater in production and recover salt (NaCl) through brine processing. Most textile factories employ membrane processes such as nanofiltration and reverse osmosis to reuse wastewater steam; however, even though this process yields produce high quality water, it also produces brine as waste which is a highly polluted concentrate. The demo project located in Zorluteks Textile's plant in Kırklareli will focus on developing a treatment and recovery system for this brine(concentrate stream) , which can potentially recover about 400 tons of NaCl in a year.3 By recycling wastewater, it is projected that demand for salt will decrease by 40%, water consumption by 15% and GHG emissions by 20% while improving aquatic environments and protecting the soil from salination.[202]

With an interdisciplinary and systemic innovation approach, "OXIPRO" aims to develop environmentally friendly and sustainable products to be used in detergent, textile cosmetics and nutraceuticals (food supplements) sectors. As the only participant from the textile industry, *Zorluteks* is testing the potential of using a single environmentally friendly enzyme instead of 8 traditional ones during bleaching and desizing phases. Bleaching process uses a range of chemicals including hydrogen peroxide, caustic soda, and acetic acid, and switching to new enzymes will reduce their content ratio by 70%. This will contribute to the circular economy approach while reducing costs of operations. Additionally, 2 different manufacturing processes, bleaching and desizing, have been merged for resource and energy efficiency. Overall, energy consumption is expected to halve and water consumption in the bleaching phase to fall by 43% with the OXIPRO project.[203]

[63] a system of interrelated computing devices, mechanical and digital machines, objects, animals or people that are provided with unique identifiers (UIDs) and the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction.

6.3 Automotive Sector

Automotive Sector Overview

Market Structure: Top 3 brands[64] had 54% market share in 2020[204]

Production: 1,485,000 vehicles manufactured[65] [206]

Revenue: 26 billion USD[207]

Employment: 425,000 employed[67] [208]

According to a 2018 Greenpeace report, automotive industry's carbon footprint exceeded EU GHG emissions and equalled 9% of global emissions.[209] With the environmental impact this high, transforming the automotive industry will be imperative for a more sustainable future.

If circular practices are developed further in the automotive industry, vehicles' life cycle carbon emissions can be reduced by up to 75% and resource consumption by up to 80% per passenger per km by 2030.[210]

The automotive industry, internationally and in Turkey, already has a growing focus on circular economy approaches and has implemented numerous sustainability projects aimed at improving circularity and resource efficiency. Considering aspects such as repairability, refurbishment, reusability of components, insurance schemes and production and service waste management standards, automotive sector plays a key role in supporting the circular economy in Turkey.[211]

One method to reduce energy consumption during production is to remanufacture. For example, Renault's re-manufactured gearboxes contains an average of 75% pre-used but tested parts while its engines currently contain 38% pre-used tested parts.[212] Renault's studies also show that giving components a new life requires 88% less water and more than 92% less chemicals. This circular approach can reduce overall waste by 70%.[213] As another example in Turkey, measured the rate of reuse and recycling processes approximately 91% within the scope of the End-of-Life Vehicles Regulation, and this rate does not include energy recovery and disposal processes. In addition, all wastes arising from vehicle production are evaluated as 100% recovery. Additionally, since most metals are easy to recycle, the metal waste generated during production has a high recovery potential. Even though automakers cannot utilize closed-loop recycling of certain materials due to regulations, their waste is still fit to be used in other sectors.

By incorporating pre-used and recyclable materials, the need for virgin raw materials and energy-intensive mining and manufacturing processes can be significantly reduced.

[64] Fiat, Renault and Ford accounted for a majority of sales in Turkey. All 3 of these brands have factories located in Turkey.
[65] 2019 data
[66] 2019 data
[67] Employment number is from 2020 February

Furthermore, the automobile industry does not only contribute to the circular economy by remanufacturing components and reducing waste, but also by prolonging the service life of the vehicles it produces by ensuring that they can be serviced, repaired and maintained. Extending the lifetime of a vehicle is essential to reducing costs for consumers, as well as conserving natural resources and energy.

To impel the development of financial instruments that can support the transition to greener vehicles, Hacettepe University conducted a study that compared the air pollution generated by new and greener vehicles with old ones. They estimated different vehicles' performances for the following 10 years to demonstrate gains from switching to cleaner vehicles; the economic gains from reduced fuel consumption and health-related costs, environmental gains from lower emissions and pollutions alongside the benefits of materials recovered through ELV recycling were compared against the economic cost of new vehicles. It was concluded that the following points would need to be addressed to lower air pollution:[214]

- Establishment of Low Emission Zones
- Promotion of dissemination of low emission vehicles
- Enforcement of stricter exhaust measurements
- Issuance of deterring traffic fines based on stricter standards
- Evaluation and repurposing of ELV scrap
- Increased traffic monitoring
- Implementation of fiscal incentives to boost the production and sale EVs and low-emission vehicles
- Offering financial incentives for dismantling and recycling factories

Another focus area for research and development projects has been smart technology integration; by improving data systems and software, drivers not only benefit from optimized route and lower fuel consumption but can also potentially achieve this without having to purchase a new vehicle. Smart technologies have also been improving the sharing economy, which is globally expected to reach USD 335 billion in 2025. Considering the potential in Turkey, it is expected to grow even faster, especially in the field of mobility as a service, MaaS.(68) According to Statista's survey results from 2021, 16% of users used the services of MaaS businesses in the past 12 months in Turkey. Additionally, a study conducted in 2019 found that the rate of multimodal traveling in Turkey is relatively high compared to Europe and America with 27% of car owners in Turkey regularly benefiting from multiple models of mobility. Istanbul's status as the most populated city in Turkey and the 5th most congested city in the world, makes the city an auspicious ecosystem for MaaS applications. It is estimated that the total revenues of the sharing economy in the automotive sector in Turkey will reach USD 53 million in 2021, and USD 107 million in 2025.

[68] Mobility as a Service

Control of End of Live Vehicles Regulation-30.12.2009 (R.G. 27448) is an instrument that drives circular economy in the automotive industry.

Turkey adopted 2000/53/EC End-of-Life Vehicles Directive and issued "Control of End of Live Vehicles Regulation", which includes requirements regarding lowering hazardous substances consumption, limiting waste generation and recovering used goods to avoid the need to dispose of hazardous waste and reduce negative environmental impacts. According to the regulation; the design and production of new vehicles shall thus "take into full account and facilitate" the dismantling, reuse and recovery of used vehicles as well as increasing quantity of recycled materials in vehicles and other products. In accordance with the ELV Directive and Control of End of Live Vehicles Regulation-30.12.2009, Turkish Automotive Industry has established an infrastructure to meet the below major requirements:

- **Take-Back:** Economic Operators must provide a convenient network of authorised treatment facilities (ATFs), or make acceptable alternative arrangements, offering free take-back for their brands when they become ELVs. For this purpose, 174 licenced take-back facilities have been authorised in 81 cities in Turkey**.
- **Materials and Components:** Materials and components in M1/N1 vehicles shall not contain cadmium, lead, mercury or hexavalent chromium, unless covered by a specific exemption in Annex II of the ELV Directive. To meet these requirements, a material data system called The IMDS (International Material Data System) has been developed by the automobile industry. IMDS is now a global standard used by OEMs[69] to classify their parts and to ensure elimination of heavy metals and other hazardous materials. In Turkish Automobile Industry, all vehicle component producers should meet the IMDS reporting obligations. Certain plastic and rubber parts weighing over 200 grams (apart from tyres) must be marked in accordance with the regulations to promote their recovery, reuse and recycling.
- **Recovery and recycling targets:** Producers shall meet annual targets for their brands, currently 95% for recovery and 85% for recyclability rates for the plastic and metal parts used during manufacturing of vehicles. Details on recovery, reuse and recycling rates are reported to Turkish Ministry of Environment, Urbanisation and Climate Change by dismantling and recycling centers and facilities. In Turkey 119 authorised treatment facilities (in 43 cities) and 24 authorised final metal processing plants have been established.[219]

Although a national regulation replicating the ELV Directive has come into force since 2009 in Turkey, Turkish Automobile Industry ELV infrastructure has still opportunities for improvement. Major problem is the small capacities of treatment and dismantling facilities to achieve feasible management. Annual ELV take-back number in Turkey is around 15,000 where total number of M1/N1 vehicles exceeding 21 years old is 3.5 million.

Regarding circularity principles, some industry experts that contributed to this study also expressed that their focus has been mostly on increasing the recoverability of vehicles at the end of their life. Circularity principles that are applicable to other parts of the life cycle have not been a major focus area for some manufacturers, which is one other reason that circularity innovations are limited.

[69] Original Equipment Manufacturer

Main Obstacles and Corresponding Strategies

Even though the potential of circularity is high in the automotive industry, both the global and local sectors face numerous challenges. Since safety standards and specifications are of paramount importance, approving new materials and technologies can take longer as a result of the need for extensive research, testing and regulatory requirements. Therefore, some car producers are working on the recovery of other materials such as textiles and plastics that compose car accessories.[220]

As the automotive industry utilizes more data and software, and becomes increasingly digitalized, cyber risks associated with these new systems are also increasing. This is leading to concern amongst both internal and external stakeholders; customer are concerned regarding data privacy and the industry is concerned over the prospect of malicious attacks.[221] It is essential to address these concerns and guarantee the safety of personal data and new products.

MaaS applications show great potential for filling in the mobility gaps in cities like İstanbul; however, certain barriers like the taxi lobby pose a threat to new comers. For instance, Uber has had a shaky start in Turkey despite a strong demand to the service; shortly after it started services in Turkey, the mobility service was banned after a harsh backlash from taxi drivers. The ban on the app was recently lifted, but it is once again being legally challenged by Istanbul Taxi Drivers Chamber of Commerce. Despite these obstacles, ride-hailing apps are still thriving and it is estimated that sharing economy in the automotive sector in Turkey will reach 1.1 million users in 2025.[223] Another challenge for the car sharing economy has been the pandemic. For example, Italy recorded a 60-70% drop in car sharing services, which was fuelled both by health concerns and a decrease in user's mobility.[224] Health related concerns would have to be eliminated completely to optimize sharing economies.

Turkish consumers also face economic barriers to switching to more sustainable solutions. Unfavourable exchange rates coupled with high inflation and taxes make many consumers more price conscious than environmentally conscious. 2020 has seen a surge in vehicle taxes; in some cases, the cost of these taxes exceeded the net sales price of the car and EVs[70] are not exempt from these fiscal instruments either.[225] These prices push some drivers to purchase used cars instead of new ones, which means keeping less efficient engines on the roads; on the other hand, even though older engines are associated with higher emissions, opting for used cars also mean that the circularity of materials has increased via reuse. In 2020, of the 772,788 cars sold in Turkey, only 844 were EVs and 16,941 were hybrid vehicles, which shows how demand for these technologies is still at an early phase.[226] Taxes need to be reduced on EVs, hybrid vehicles and older vehicles need to be refurbished with greener technologies for Turkey to reach Net Zero Emissions Goal for 2053.

In addition to the barriers noted above regarding EV purchases, there is also currently an absence of reliable infrastructure for circular and low carbon solutions. Lack of a vast charging station network deters potential buyers. Since Turkey is planning on launching its own EV in 2022, authorities are addressing these concerns by increasing network capacity and updating charging station regulations. For instance, regulations regarding minimum capacities for vehicle charging points in parking lots and shopping malls was recently updated to reflect rising demand.[227] More details on this topic can be found in the case studies section.

While EVs are hailed as a crucial step on the road to decarbonization, it is important to note that they come at a certain price. The World Economic Forum's Global Battery Alliance notes two major challenges in during extraction of minerals: "First, raw materials needed for batteries are extracted at a high human and environmental toll. This includes, for example, child labour, health and safety hazards in informal work, poverty and pollution. Second, a recycling challenge looms over the eleven million tonnes of spent lithium-ion batteries forecast to be discarded by 2030, with few systems in place to enable reuse and recycling in a circular economy for batteries."

[70] Electric Vehicle

EV technology relies on batteries made from metals and minerals such as cobalt and lithium. Mining such materials come with environmental and health problems, but cobalt has additional social costs too. Battery manufacturing now accounts for 60% of the 125,000 tonnes of cobalt mined globally each year. While no country has laws that requires producers to report on their supply chains, two thirds of world's cobalt need are met by the Democratic Republic of the Congo, a region that is associated with many concerns regarding human rights and labour laws.[228] [229]

EV batteries have low recovery potential. Chemicals and construction vary from brand to brand and variance in composition creates barriers for recycling. With such technical challenges, the price of recycled materials exceeds those of raw materials. Some nations and states are setting minimum recycled content requirements but as the demand for batteries increase, maintaining or increasing circularity input will pose a challenge.[230] Since one of the issues regarding recycling is separating components and materials, design can be improved to increase recovery potential.

Sustainably mining metals and minerals for EV batteries can elevate social and environmental problems as more companies and countries switch to EVs.

Producing batteries is also an energy intensive process. Studies have shown that half of the emissions are the result of electricity usage during battery production; thus, using electricity from renewable resources would decrease this environmental impact. For instance, most of lithium-ion battery manufacturing is in China, South Korea and Japan, where the countries are dependent on fossil fuels for electricity generation. Thus, the location of the production site will change the battery's carbon footprint depending on how developed the renewable energy sector in the country of production is.

Key Circularity Strategies

Key Circular Economy Strategies for the Automotive Sector can include the following strategies, which are considered in terms of the 3 Circular levers: Circular Input, Recovery Potential and Actual Recovery.

1. Circular Input

- Use recycled materials including plastics for manufacturing vehicle parts
- Use electricity from renewable sources during car and battery production
- Source renewable energy for charging EVs and hybrid cars
- Set minimum recycled content requirements in vehicles higher

2. Recovery Potential

- Modular design for better repairability
- Ensure availability of spare parts and a wide range of options for repair (access to mechanics and/or instructions for repair)
- Mono-material use in combination with design for disassembly for more reuse, refurbish and recycling options
- Design vehicles for longevity
- Re-design batteries to increase recovery potential
- Increase sharing services such as car-pools and rentals
- Promote short-term and long-term car rentals
- Fund and promote ride-sharing apps
- Improve and increase access to MaaS services

3. Actual Recovery

- Enforce stricter legislations that guarantee recycling and recovery rates at the end of a vehicle's life cycle
- Offer upgrades, fixtures and maintenance at lower costs
- Keep materials in use by remanufacturing and upgrading of parts, vehicles, and infrastructure
- Plan cities and regions to optimize mobility (including freight), and enable effective reverse logistics and resource flows

Table 20: Drivers Of Circular Economy Growth Potential In Automotive Sector Internationally And In Turkey (1/2)

Driver	Example	International	Turkey
Innovation & Corporate Action	Established Circular Practices	Well-established second-hand car market already exists where circularity initiatives such as refurbishing and reselling are commonplace. Car sharing programmes are starting to become available in many areas. For example, the company Launch Mobility in the US offers multiple sharing economy solutions applied to different transportation modes This is important since in a world of personal ownership, most cars sit idle for at least 95% of the time, generating no value.[232]	Second-hand vehicles are being used to improve public transportation systems. Ankara municipality has partnered with its subsidiary BELKA to convert diesel buses into 100% EVs at the end of its life cycle. The lifetime of these vehicles will be extended by 15 years while achieving fuel efficiency.[233] Cab hailing is now being digitalized through apps such as *BiTaksi* that provide MaaS. By matching drivers and customers, there will be significant time and energy efficiencies which will decrease fuel consumption.[234]
	Innovation	Electrification of mobility is increasing support a circular economy by demanding less resources during their usage. Innovations in autonomous driving and connected vehicles are growing. Development and integration of digital technologies in automotive such as Tesla EVs are increasing efficiency.	New smart technologies are being developed by brands like Ford Otosan so that drivers can select the optimal route for efficiency. These digital solutions will be able to take into account factors such as traffic and weather in order to determine the most fuel-efficient route for the driver.[235] 'Driving modes' are being developed for HDV(71) drivers so they can opt to limit their speed for optimal emissions. One example is Eco-Mode and Fleet-Mode developed for HDVs by Ford Otosan.[236] EVs and hybrid vehicles will lower demand for fossil fuels considerably, especially when they use electricity generated by renewable energy.

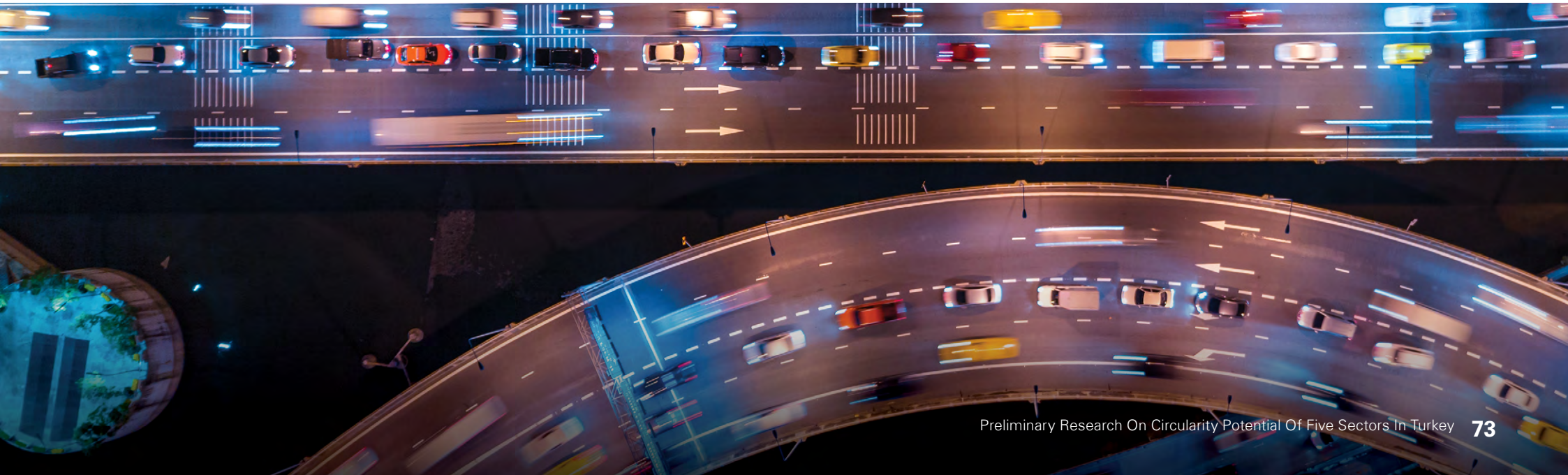


Table 20: Drivers Of Circular Economy Growth Potential In Automotive Sector Internationally And In Turkey (2/2)

Driver	Example	International	Turkey
Policies & Regulation	Increasing Policies and Regulations	Increasing environmental regulation impacting the automotive sector including in terms of: GHG and air emission limits, recycled content, end-of-life vehicle reuse and recycling, rechargeable batteries, product-as-a-service mobility solutions EU Circular Economy Action Plan Reusability, recyclability, and recoverability standards[237]	Turkey is aligning its recovery and recycling rates for the automotive sector with EU regulations. This not only helps support more circular business practices within the Turkish economy but can also help make cars manufactured in Turkey more competitive in the European market.[238] [239]
	Incentives	Incentives for car sharing are starting to become more available. For example, Chinese central government and local municipalities have issued numerous policies to encourage car sharing and this is expected to increase rapidly in China.[240] Urban planning regulations and initiatives aimed at tackling traffic congestion and air pollution are changing approaches to transport in cities. For instance, London's Walking Action Plan will introduce 450km of new Cycleways by 2024[241]. Many cities are restricting car use in central areas and promoting alternatives such as public transport, cycling and walking.	İstanbul has set the goal to be a carbon neutral city by 2050. The city revised its climate action plans in 2021 and one of the main goals will be to increase the metro lines up to 630 km and cycling lanes up to 650 km. The plan also aims to make modes of public transportation 35% of intracity transportation.[242] In accordance with the VAT regulations[(72)], some industrial wastes are exempt for VAT taxes. Lowering the cost of directing waste into other input streams supports circular practices.[243] Companies like Tofaş take advantage of these tax discounts and support circularity principles by sending the appropriate waste to cement factories where they are used as alternative fuels.[244]
Customer Preferences and Macrotrends	Changing Preferences and Behavior	Demand is increasing for electric vehicles in many markets including the 3 largest automotive markets: US, China and the EU. Recent analysis has forecast growth in the global EV market to be 21% annually from 2019 to 2030[245]. Customer preferences are changing with increased acceptance of car sharing. The value of the global car sharing market exceeded USD 2.5 billion in 2019 and growth of 24% annually is forecasted between 2020 and 2026.[246] The latest data revealed by the Confederation of the European Bicycle, E-Bike, Parts & Accessories Industries (CONEBI) confirms what has been announced in several countries in recent months. E-bike and bicycles sales in the EU and the UK shot up a whopping 40% to a 20-year high. As a result of increasing investments in cycling infrastructure and political commitments to a transition to the Green Economy, E-bikes are becoming consumers' preferred choice.[247]	New start-ups are emerging to alleviate the traffic congestions and related air pollution in Istanbul by implementing solutions for short-distance transportation. For example, number of rental electric scooters are increasing, which will lower city-wide fuel consumption.[248] Market for ride-hailing apps are still expanding and it is estimated that sharing economy in the automotive sector in Turkey will reach 1.1 million users and revenues will be USD 107 million by 2025.[249]
	Global Urbanization	Globally, urbanization is increasing rapidly. For the first time in human history, the majority of the world's population now lives in urban centres and this is expected to increase to 68% of the global population by 2050. As a result, shared multimodal public transport will become increasingly viable.[250]	

[72] VAT : Value Added Tax, Katma Değer Vergisi Genel Tebliği (KDV)

Table 21: Circularity Good Practice Examples from France

Company Profile	Project Profile	Details on Innovation & Circular Economy Practice	Impact
Name: Renault **Size:** Large Cap Company *Automobile Manufacturer*	**Circular Economy Strategy:** Reduce, Remanufacture **EU Circular Economy Model:** Circular Use, Circular design & production	Renault has been an active agent in developing circular practices on a global scale. The company is a founding partner of the Ellen MacArthur Foundation and contributes to the foundation's works and events. To increase the value of its products, Renault has been focusing on ways to extend the lifetime of its equipment and preserving valuable materials for further remanufacturing. In 2019, EUR 15.6 million in electric vehicle batteries had been repaired and reused in vehicles or refurbished and resold for second-life applications. Closed-loop recycled materials such as metallic waste from plants and materials extracted from end-of-life vehicles that were reused to produce new vehicles were worth EUR 70.4 million. To optimize this extraction process, the number of fixing points has been reduced in vehicles and recyclable materials have been prioritized during manufacturing. Renault also established the first European factory dedicated to mobility for the circular economy, RE: Factory. By 2030, its factory in Flins, France will have a negative CO_2 balance. The operations will have four focus areas Retrofit, Re-energy, Re-cycle and Re-start. Retrofitting will recondition vehicles and convert thermal vehicles into less carbon intense versions, Re-energy will focus on extending battery life, Re-cycle will be using old vehicles to make new ones and Re-start will focus on other research areas.[252]	One of the defining aspects of the circular economy is its reliance on partnership and communication. Renault's contribution to Ellen MacArthur Foundation, highlights the company's commitment to circularity not just through innovation but by supporting the growth of the network too. The circular economy activities of Groupe Renault and its subsidiary Renault Environment enabled the creation or preservation of EUR 219.8 million in technical and economic value during the 2019 financial year, up EUR 45.7 million compared to 2016. Renault recognizes that to generate waste with utility value at the end of a vehicle's lifetime, products will need to be re-designed with that goal in mind. Thus, by simplifying the dismantling process, materials and equipment can be recovered more easily. By recycling and remanufacturing end-of-life waste like precious metals, polypropylene bumpers and textile scraps, le virgin material content of new products will be reduced. The RE: Factory, dedicated to circular strategies is set to lower energy consumption by 80%, water by 88%, chemical products by 92% and waste generation by 70%. The factory's focus will be on remanufacturing, recycling and researching to extend products and materials' life cycles while reducing the consumption of virgin input.[253]

Table 22: Circularity Good Practice Examples from France

Company Profile	Project Profile	Details on Innovation & Circular Economy Practice	Impact
Name: Michelin **Size:** Large Cap Company *Tyre Manufacturing*	**Project Names:** 4Rs strategy (X-ONE tyres, Regroovable,The BlackCycle Project, The BioButterfly Project) **Circular Economy Strategy:** Rethink, Repair, Recycle & Remanufacture **EU Circular Economy Model:** Circular Use	"The 4 focus areas of 4Rs strategy: 1. Reduce the weight of the tyres, cut the emissions associated with its use and minimize the number of tires required to go anywhere. For instance, "X-ONE" tyres give the same performance as two-dual tyres even though they weigh less. 2. Reuse to extend the life of tyres. Tyres are designed with an under tread that is thick enough to allow high quality regrooving without affecting the strength of the product. "REGROOVABLE" has been moulded on the sidewall to identify these tyres and have regrooving depth indicators act as a guide for the technician who performs the maintenance. 3. Recover materials from tyres that have come to the end of their life cycle for other uses. "The BlackCycle Project", a unique European public-private partnership of 13 organizations, aims at creating, developing, and optimising a full value chain from end of life tyres[73] feedstock to Secondary Raw Materials (SRMs). These SRMs will be used to develop new ranges of passenger car and truck tyres. 4. Renewable materials are to replace fossil-based inputs. "The BioButterfly Project" aims to produce butadiene from biomass (plants) based ethanol in order to produce innovative synthetic rubbers that are more environmentally friendly.	"1. "X-ONE" tyres deliver fuel savings of at least 4%. These tyres increase energy savings due to their lightness which reduces the demand for fuel. 2. When regrooving is performed at a time when the original tread depth has 3 to 4mm remaining, regrooving will restore the tread depth, providing up to 25% greater tyre life. Regrooving also renews the grip of the tyre making the product safer. This process is carried out when the tyre has the lowest rolling resistance due to higher rigidity of the tread pattern, and low rolling resistance means increased fuel efficiency. By adding only 5% additional rubber volume when the tyre is new, these tyres will add up to 25% more kilometers which creates a 16% reduction in raw materials when compared to non-regroovable tyres. Due to having a low cost compared to performance gained, regrooving can lower operators' running costs dramatically. In the long run, fewer new tyres will be purchased. By extending the product's life through repairing and remanufacturing, inputs required for a service are reduced over time. This product also supports the circular economy by establishing a communication line; marking these products and educating the technicians will ensure that the value of the innovation is optimized. 3. "The BlackCycle" value chain has a lower carbon footprint, emitting 0.93 kg/CO_2/kg tyre less and using 0.89 kg fossil/kg ELT less. "BlackCycle" will reduce the export of ELTs since it offers an economically and environmentally viable alternative. By relocating ELT management and transformation within the EU, "BlackCycle" is expected to create sustainable jobs inside the EU while shortening supply chains. 4. Michelin's tyres will composed of 100% bio-sourced or recycled materials by 2050 and 40% by 2030. This will reduce the demand for non-renewable resources.

[73] ELT

Circular Good Practice Examples from Turkey

Emerging National EVs

Type of Circular Strategy	
Refuse	X
Rethink	
Reduce	X
Re-use	
Repair	
Refurbish	
Remanufacture	
Repurpose	
Recycle	

Type of Circular Project	
Circular Design and Production Model	X
Circular Use Model	
Circular Value Recovery Model	
Circular Support	X

Sources of Information for Circular Case Study

- Websites of sector companies from Turkey
- News Articles
- TEHAD[74] publications

We are on the cusp of a major global transition to EVs. Global clean energy and decarbonization goals will not be achievable without innovations in the vehicles industry. Many global companies like Ford, Volvo and Mini have already committed to a complete phase-out of their ICE[75] vehicles while a few companies such as Tesla, the automotive company with the largest market cap globally, are already producing only EVs. The EV transition is accelerating due to drivers such as international political pressure with many major economies committing to more ambitious climate goals - including national net zero commitments - and new initiatives at the sector level which include a complete phase out of new ICE vehicle sales. For example, the UK Government recently announced it was bringing forward the ban of ICE vehicle sales from an initial phase-out date of 2040 to 2030. Phasing out of vehicles that consume carbon-based fuels requires all market players to commit to circular economy strategies, whether it be facilitating incentives, supporting infrastructure or refusing ICE technologies.

An intellectual property of Turkey, Togg is a globally competitive UseCaseMobility® brand. Togg was established on June 25, 2018 as a joint venture of Anadolu Grubu Holding A.Ş., BMC Otomotiv Sanayi ve Ticaret A.Ş., Turkcell İletişim Hizmetleri A.Ş., Zorlu Holding A.Ş. and the Union of Chambers and Commodity Exchanges of Turkey (TOBB). It is due to launch its first vehicle in 2022, followed by 4 more by 2030. Considering how the switch to EVs is yet to take hold in Turkey, Togg's price, which has not been announced yet, and its associated taxes, will be pivotal for the growth of EV markets in Turkey and in turn reducing demand for carbon-based fuels. Togg's production facility in Gemlik, Bursa, has been designed to release less hazardous waste into the environment. Thus, the volatile organic compounds emission is less than 5 gr/m^2 which makes this one ninth of the legal limit in Turkey and one seventh of the legal limit in Europe. This initiative by private industry giants and NGOs will also provide employment for 5,000 people directly and 20,000 in total by 2030, which will propel sustainable economic growth.[255]

As detailed in the previous sections, while EVs are pivotal to reach decarbonization goals all around the world, they also inherently contradict circularity principles by fuelling a new demand for mineral ores and chemical products. There are social and environmental concerns associated with mining these materials too.

Sustainably sourcing virgin materials, primarily lithium and cobalt, and economically recycling EV batteries will be crucial to make EV designs more circular.

[74] Turkey's Electric and Hybrid Vehicles Association, *Elektrikli ve Hibrid Araçlar Derneği*
[75] Internal Combustion Engine

Switching to EVs is essential for decarbonization but scaling up requires the development of an extensive new infrastructure including EV charging stations.

When electric vehicles were initially introduced, a valid concern was how to charge these vehicles – especially when traveling long distances. To promote the sales of these vehicles, countries need to invest in infrastructure and policies that make the charging stations more accessible and frequent. Ministry of Energy and Natural Resources[76] aims to increase its public EV charging points from 2,000 to 250,000 by 2030 to strengthen its network and ensure that there is at least 1 charging point for every 10 vehicles throughout the country.[256] Earlier in 2021, the Turkish Ministry of Environment and Urbanization announced that all new parking lots with more than 20 parking spaces will have at least 5% capacity allotted for EVs, an increase from the previous 2%. By 2023, this rate will increase to 10% for shopping malls and public parking lots.[257]

National brands have already started implementing these solutions; *Eşarj* has almost 500 public charging points installed, which %50 of them are fast DC chargers, and an additional 2500 private ones. In 2020, the company obtained the IREC license for their electricity which guarantees that the electricity *Eşarj* supplies is generated by wind and solar energy.[258] The company's goal is to have avoided 2.5 million tons of GHG emissions by 2030.[259]

Company: Ford Otosan

Type of Circular Strategy	
Refuse	
Rethink	
Reduce	X
Re-use	X
Repair	
Refurbish	
Remanufacture	
Repurpose	
Recycle	X

Type of Circular Project	
Circular Design and Production Model	X
Circular Use Model	
Circular Value Recovery Model	X
Circular Support	X

Sources for Circular Case Study Information

- Ford Otosan's Website and Sustainability Report
- Sector Association Publications
- OptiTruck Project Website
- European Commission Website

[76] Türkiye Cumhuriyeti Enerji ve Tabii Kaynaklar Bakanlığı

Recycle – Reuse – Reduce - are the 3 scopes of Ford Otosan's sustainability initiative ReCube (Re3), which began with their recycled fan hood project that was a finalist in Plastic Recyclers Europe Awards 2020 in the Automotive, Electric & Electronic product category. Fan hoods were initially 70% virgin Polypropylene and 30% glass fibre; since 2019, *Ford Otosan* has been making these materials with 20% virgin Polypropylene, 50% recycled office supplies and 30% glass fibre. By reducing the virgin plastic content, the cost of the fan hood was reduced by 16% and carbon emissions, which were import-related, by 2.2 kg per piece. [262] [263]

In 2019, the EU enforced the VECTO[77] requirement for new HDVs, to better track and evaluate the vehicles' energy performances and their environmental impact.[264] *Ford Otosan*, by signing the ACEA's[78] "Making the Transition to Zero-Emission Mobility", has shown its commitment to manufacturing zero emissions HDVs by 2040.[265] The company has been working towards this objective since 2016 with their participation in the EU's Horizon2020 initiative "OptiTruck", which utilizes cloud computing to increase efficiency.

OptiTruck optimizes "fuel consumption with Predictive Power Train Control and calibration for intelligent trucks" to lower fuel consumption by 21.6%.

Unlike the Re3 project, which is materials-oriented, the aim of OptiTruck is to develop intelligent transport systems for energy efficiency; so, the process is not as resource intensive as Re3. Savings from utilizing new generation navigation systems and data analytics such as traffic and weather predictions, road topography and road network information to assess the optimal route can be increased even further by improving the data on cloud services.[266] [267]

OptiTruck's strategy to minimize emissions highlights the importance of connectivity and flow of information for circular economy practices.

Ford Otosan also initiated the Cataphoresis Line Separation Project[79] to reduce the amount of waste originating from the dyehouse, increase financial savings and lower the pressure on the treatment plant. With the membrane system specially developed for this project, equipment recovery and waste separation from wastewater were achieved; as a result, waste from this process was reduced by 90%. Annual savings from this circularity project was 120,000 TL, which would have been the amount spent on the disposal of, now avoided, 180 tons of waste. They have also designed The Waste Solvent Recycling System to recover 85% of the dirty solvent that is collected while cleaning the paint shop cabinet robots and the paint lines. This project aims to recover 15 tons of solvent which would be worth around 172,000 TL and reduce VOC[80] emissions.[268] Reducing and recovering waste to be re-introduced to the manufacturing process not only supports circularity principles but also provides economic gains.

[77] VECTO is a simulation software developed by the European Commission and stakeholders that measures emissions and fuel consumption of heavy-duty vehicles. It has been a mandatory tool for some of the new trucks manufactured since January 2019.
[78] European Automobile Manufacturers' Association
[79] Cataphoresis Line Separation Project: Kataforez Hattı Ayrıştırma Projesi
[80] Volatile Organic Compound

6.4 Home Appliances Sector

Home Appliances Sector Overview

Market Structure: 3 top companies' market share totals 76%[(81)] [269]

Production: 29.1 million products manufactured in 2020 (globally, second to China)[(82)] [270]

Employment: 600,000 employed (2.1% of the workforce in Turkey)

Annually, the global home appliance industry provides people with billions of products. In the EU, there are almost 8 billion installed products in homes which equals around 30 million tons of steel, 12 million tons of plastics as well as millions of tons of non-ferrous metals and glass.[271] It is projected that 3 billion new users will be added to the market by 2030.[272] Increasing the circularity of these technologies will be crucial to meet this demand without consuming more non-circular materials.

Turkish companies like *Arçelik A.Ş.* and *Vestel A.Ş.* are some of the leading brands in Turkey that also dominate the global markets, both in sales and innovations. Their race for innovations has focused more on efficiency during the products usage – which is an attractive attribute for consumers since efficiencies in energy and water consumption reduce the budget allocated to these products during their use. It is also important to note that compared to other industries evaluated in this report, with the exception of vehicles, the environmental impact of home appliances during their usage is considerably high (ex: washing machines on average use 50 liters of water per use[273]), which justifies prioritizing usage efficiency during R&D. Improving efficiency in these technologies support CE as these products demand less resources (water and electricity primarily, followed by complementing products such as detergents) during their lifetime.

In the EU, industry-led recycling, mainly via take-back schemes set up by the industry, now collect and treat about 1.7 million tons annually across the EU but this is much less than the estimated 5 million tons of discarded appliances annually. Due to increasing resource scarcity and the need to rapidly decarbonize the global economy, the high metal content and intrinsic economic value of large appliances means that rapidly moving to a circular economy is essential for the home appliances industry. Indeed, the sector already has many initiatives in place, examples of which are shown in the following subsections.

Since most home appliances are meant to be consumed over an extended period, EU has been implementing measures to enhance the potential of 'repairability', which will also benefit consumers and smaller businesses in the industry. Right to Repair movement has gained momentum all around the world and the European Commission has addressed this critical component of circular economy by implementing new eco-design measures in 2019.[275] These measures require spare parts to be available for a period of time after purchase, parts to be easily dismantled and repaired with commonly available tools and disclosing professional repair and maintenance information to be disclosed for repairers. Such designs will also help refurbish products too – if products can be upgraded with just small alterations, customers would start to demand new components instead of whole new products.[276] Improving design, guaranteeing spare parts and making necessary knowledge accessible will enable consumers to use the same products for a longer time, empower the consumer and small businesses while avoiding emissions from longer supply chains.

Other countries are implementing similar regulations too. Even though a resembling correspondence has been established in Turkey, the Directive for After-Sales Service Support[(83)] covers a narrower scope which dictates the number of years brands are obliged to provide repairing services after they sell a certain item.[277] There is not a comprehensive law for eco-design established in this sector in Turkey yet – but the fact that most Turkish factories manufacture in accordance with demand and standards in the European market means that Turkish brands are equipped to support more circularity initiatives in the Turkish market.

[81] VECTO is a simulation software developed by the European Commission and stakeholders that measures emissions and fuel consumption of heavy-duty vehicles. It has been a mandatory tool for some of the new trucks manufactured since January 2019.
[82] European Automobile Manufacturers' Association
[83] *Satış Sonrası Hizmetler Yönetmeliği*

Main Obstacles and Corresponding Strategies

Home appliances sector in Turkey is extremely competitive; any information that is disclosed to the public is done so with scrutiny. The major home appliances companies in Turkey also dominate the global markets – and their race for innovation, which is focused more on the efficiency of the products, is marked by their growing number of patents. While such competition drives companies to invest further in R&D, it also creates barriers in the expansion of circularity applications. The importance of discrepancy also affected the quality of this report Companies could not disclose certain circularity data due to confidentially and competition.

Companies have had a slow progress in increasing the circularity of their input, despite intensive R&D efforts. One reason is that replacing traditional plastic materials with bioplastics has been inefficient. Polyurethane (PU or PUR)[84], is favored by the home appliances sector for its versatility, durability and energy efficiency. It takes longer to develop bio-based materials that showcase the same qualities under the same heat conditions for an extended amount of time. Lack of recycled materials to be utilized as inputs is another issue in the industry. Not all recycled plastics can be used in production since the exact chemical composition information is not available for all. Supply of TS EN ISO 15347 standard certified recycled plastics is low, which creates an unsteady supply of circular materials.[278]

For some orders, manufacturers do not have the flexibility to change the composition of the materials they use. Clients can have strict requirements that prevent the manufacturers from switching to more circular inputs; such constraints keep the manufacturers from achieving their circularity potential.

The later steps in the 9Rs strategies – repairing, remanufacturing, refurbishing, repurposing and recycling - require an efficient way of collecting products at the end of their lifecycle. The operational and logistical challenges of reverse logistics prevent companies from directly engaging with consumers to reclaim used products. An industry coalition, or a collection scheme supported by governments and regulations, can alleviate the problems that rise from reverse logistics. Currently, the AEEE Regulation[85] has determined that companies should collect back used electronics from the end-users at the rate of 4 kg/person/year.[279] The Directive should list higher quotas upon setting up a support system for reverse logistics to boost circularity of the materials and products. Companies can use promotions and discounts to incentivize consumers to transport their end-of-life products to factories or collection points, but this carries a risk due to damages these goods can receive during transportation.

Recycling process is not directly handled by home appliances manufacturers, considering how the recycling industry has existed long before AEEE Regulations. Intrinsic economic value of the materials and the high metal content in these products have attracted demand outside of the home appliances industry.[280] This ecosystem needs to be evaluated and optimized to increase the recovery potential of materials and components.

[84] Plastic material
[85] *Atık Elektronik ve Elektrikli Eşya (AEEE) Kontrolü Yönetmeliği RG:22.05.2012-28300*

Key Circularity Strategies

Key Circular Economy Strategies for the Home Appliances Sector including its supply chain can include the following strategies, which are considered in terms of the 3 Circular levers: Circular Input, Recovery Potential and Actual Recovery.

1. Circular Input

- Use recycled materials, including plastics, for production
- Implement 3D printing technology during manufacturing
- Develop durable bioplastics
- Manufacture bioplastics from food waste

2. Recovery Potential

- Modular design for better repairability and refurbishment
- Ensure good availability of spare parts and a wide range of options for repair (access to mechanics and/or instructions for repair)
- Disclose information for dismantling and repairing
- Mono-material use in combination with design for disassembly for more reuse, refurbish and recycling options
- Manufacture longer lasting products
- Improve reverse logistics to make it more feasible and environmental
- Promote rental schemes
- Install sharing economy models such as laundry rooms to increase economies of scale
- Amend patent and IP laws to increase the rate of subsequent innovations without foregoing the benefits of a competitive market

3. Actual Recovery

- Enforce stricter legislations that guarantee reuse, recycling and recovery rates at the product's life cycle
- Offer fixtures and maintenance at lower costs
- Keep materials in use by remanufacturing and upgrading parts
- Innovate for efficient resource consumption during product usage
- Implement sharing economy models to circulate efficient technologies

Table 23: Drivers Of Circular Economy Growth Potential In The Home Appliance Sector Internationally And In Turkey (1/3)

Driver	Example	International	Turkey
Innovation & Corporate Action	Industry Action	At the end of the products' life cycle, buy-back strategies are implemented by companies to recover some of the materials and equipment. This limits the end-user from opting for recycling, which is a less circular approach compared to other R-strategies.[281] By implementing leasing and rental schemes, consumer can make use of a service at a lower cost. Blue Movement and The Papillon Project by Bosch increases circularity while the latter also combats energy poverty in low-income households through long-term leasing.[282]	Home appliance producing giants, *Arçelik A.Ş.* and *Vestel A.Ş.*, are buying back several types of home appliances for remanufacturing, refurbishing and recycling. Small and local shops buy back used appliances with a salvage value to re-sell useful parts. Regulating and monitoring this sector can unlock great potential in achieving circularity in the electronics industry.
	Innovation	Products can be designed to be easily disassembled, re-assembled and repaired. Based in France, Groupe SEB produces 3D spare parts for their products. They also design their products to be easily maintained, repaired and upgraded.[284] To reduce home appliance's demand for water, in-unit recycling technologies are being developed. AquaFresco managed to recover and cleanse 95% of the wastewater generated during a washing machine's cycle to be reused in future cycles and tested its quality with IoT.[285]	Circular material use rate can be increased by using recycled and recovered materials. *Arçelik A.Ş.* using waste fishing nets to supply its plastic needs and producing a washing machine tub made from recycled pet bottles can be given as such examples.

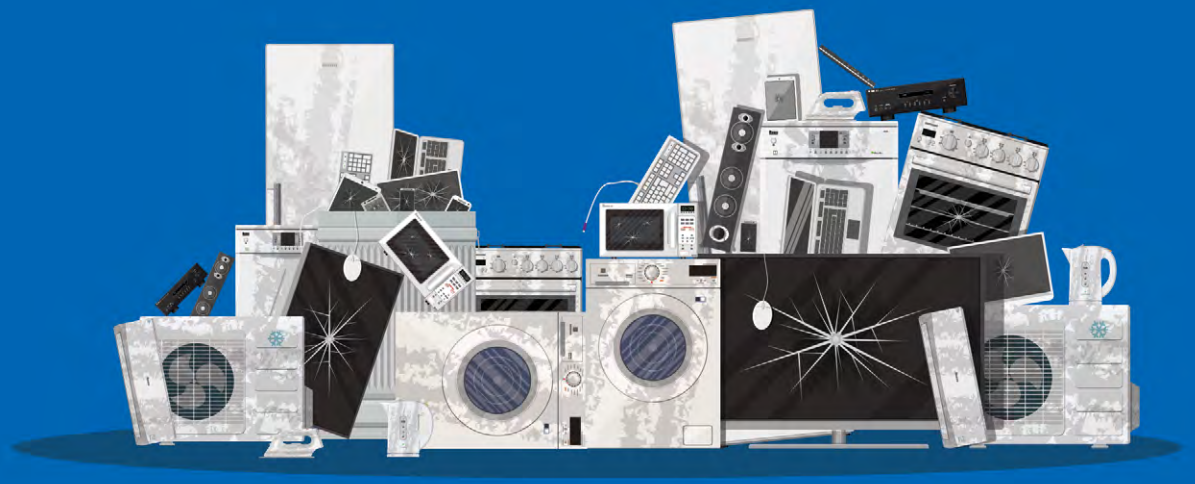


Table 23: Drivers Of Circular Economy Growth Potential In The Home Appliance Sector Internationally And In Turkey (2/3)

Driver	Example	International	Turkey
Policies & Regulation	Increasing Policies and Regulations	Increasing circularity regulations with examples including the EU Circular Economy Action Plan and the France's new Repairability Index represent fundamental steps towards a circular economy.[286] Increasing circularity regulations with examples including the EU Circular Economy Action Plan and the France's new Repairability Index represent fundamental steps towards a circular economy.[286] European Commission published 10 eco-design implementing regulations collocate energy efficiency and other requirements in 2019.[287] To contribute to sustainable production and consumption, the EU has established guidelines for treating electrical and electronic equipment waste under the WEEE Directive.[288]	A draft proposal has been prepared with the appropriate CBAM (Carbon Border Adjustment Mechanism) to remain competitive in energy-intensive industries. AEEE Regulation includes methods for waste management, collection and recycling processes of electrical and electronic equipment. Turkey adopts both the EU WEEE and RoHS-style directives as part of its environmental legislation.[289] The presence of lead (Pb), mercury (Hg), plus hexavalent chromium (Cr6+), polybrominated biphenyls (PBB) and polybromide diphenyl ethers (PBDE) and cadmium (Cd) is prohibited, with exceptions in electrical and electronic goods put on the market within the scope of WEEE regulation.The main goal of this ban is to prevent hazardous chemicals from harming the environment during recycling and disposal processes when the useful life of electrical and electronic equipment is completed.Similarly, there are bans on PCBs according to the Stockholm Convention, Persistent Organic Pollutants regulation and Regulation on the Control of Polychlorinated Biphenyls and Polychlorinated Terphenyls. Therefore, it is mandatory to decontaminate and dispose of PCB-containing equipment by 2025. PCBs have been used in the construction of capacitors and transformers for a long time but were banned after their damage was realized. Thus, it is not found in electrical and electronic goods produced after 1986. It has been used especially in fluorescent type lighting devices, functional power motors and is highly toxic to human health.[290] [291]
	Political Priorities	There is increasing global political interest from platforms such as UNEP and UNFCCC and the OECD. COP26 also addressed topics related with circular economy strategies.	"The Green Deal Action Plan 2021" released by the Ministry of Trade defines one of the goal of the plan as "The regulatory framework that will support the green and circular economy" that "will be strengthened through harmonization with the Sustainable Product Legislation, EU Chemicals Legislation, Eco-Design, and Energy Labeling Legislations to be implemented by the EU".[292]

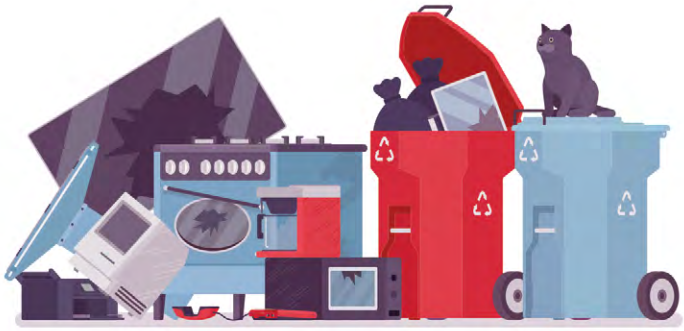


Table 23: Drivers Of Circular Economy Growth Potential In The Home Appliance Sector Internationally And In Turkey (3/3)

Driver	Example	International	Turkey
Customer Preferences and Macrotrends	Changing Preferences and Behaviour	The new generation is interested in circular economy concepts and eco-designs more than the older generations. The increasing customer awareness of the sharing economy and the attention given to the collection of waste products compared to the past are indicators of this movement.[293] According to the 2018 EC Behavioral Study on Consumers' Engagement Report, the majority of survey respondents said they maintain items they own for a long time (93%), discard old belongings (78%), and repair possessions if they break (64%). A smaller but significant percentage of respondents said they are willing to engage in other CE practices such as leasing things or purchasing used goods. Also, one out of every three consumers claim to buy used goods.[294] Right to Repair movement has gained momentum all around the world and countries are accommodating to this movement via new regulations such as eco-design directives.	Circularity highlights the importance of communication with the end-user and raising awareness; in accordance with this, Turkey has adapted the EU Label2020 framework to relay more accurate information to the consumer. Increasing engagement with customers, who prioritize durable goods, has influenced manufacturers and brand to improve goods' repairability. The sharing economy practices have great potential for economic reasons in Turkey, where consumers are becoming more price sensitive due to rising exchange rates and inflation.

Table 24: Circularity Good Practice Examples from France

Company Profile	Project Profile	Details on Innovation & Circular Economy Practice	Impact
Name: SEB **Size:** Big Cap *Small Household Equipment*	**Economy Strategy:** Repair, Rethink, Recycle, Refurbish **EU Circular Economy Model:** Circular support	The Group offers a 10 years long repair package with a single fixed rate for each product category. The consumer is guaranteed to get their product repaired for less than a third of the price of an equivalent new product from the brand, regardless of the malfunction, the spare parts needed or age of the appliance. They have also increased their network of repair centers, with over 6,200 partners world-wide, to make their repair services as accessible as possible. 3D printing of spare parts on demand simplifies inventory management, increases availability and ensures energy and materials are only consumed only when needed. When consumers return products, the Group makes every effort to give them a new life and selling them at bargain prices rather than shipping them off for dismantling or recycling.	Over 90% of electrical appliances have the "10-year repairable product" commitment which aims to extend the products life through guaranteed customer service. By 3D printing spare parts on demand, demand for energy and materials is reduced. Since parts are only created when needed, demand for real estate (storage space) is lowered too. Defected appliances are refurbished and injected back into the economy for further use.

Circular Good Practice Examples from Turkey

The New Energy Labels

Type of Circular Strategy	
Refuse	X
Rethink	X
Reduce	
Re-use	
Repair	
Refurbish	
Remanufacture	
Repurpose	
Recycle	

Type of Circular Project	
Circular Design and Production Model	
Circular Use Model	
Circular Value Recovery Model	
Circular Support	X

Sources for Circular Case Study Information

- Turkey's regulations on eco-labels[86]
- European Commissions' publications on new energy labels
- Sector association publications

[86] *Enerji Etiketlemesi Çevre Yönetmeliği*

Starting in March 2021, the EU switched to new energy labels, Label2020, which was also implemented in Turkey.[295]

Label2020 was funded by the European Commission's Research and Innovation Program, Horizon 2020, to replace outdated environmental standards. These labels also complement the new eco-design directive released by the EU that aims to promote better environmental performance through reparability and recyclability of appliances. Some of these new eco-design measures include making spare parts more easily replaceable and ensuring that key parts and repair and maintenance information are available for users and repairers for at least 7 to 10 years. This new legislation also reinforces the idea that waste is a design flaw; thus, circularity measures need to be taken at the early stages of design in order to minimize waste and prolong products' life spans. Products would not be approved for sale unless they complied with these directives in EU.[296]

According to the Special Eurobarometer 492[87] in 2019, 93% of European consumers recognized the energy labels and 79% considered it when buying new products.[297]

However, these labels lost their performance over time. As new technologies developed and spread, every year more products were qualified as Grade A or above, meaning that existing indicators did not highlight out-performing products. For instance, around two-thirds of refrigerators and washing machines sold in 2006 were labelled as Class A, whereas over 90% of those sold in 2017 were labelled A+, A++ or A+++. To commit to higher levels of efficiency per the Paris Agreement, it was a necessity to rescale the standards and downgrade most of these products. This will also add more heat to the R&D competition within the sector.

Label2020 redefines qualifications to make home appliances more circular. The grading will be done only with letters and '+' will be dropped. A simple alphabetical grading from 'A' to 'G' has been set to illustrate a clearer picture for quality variance. Fridges, freezers, dishwashers, washing machines and televisions have been prioritized in the labeling transition process that started in March of 2021, while other products will be transitioned later.

The new generation labels also highlight the importance of having accessible information; in order to sell in the European markets, producers must upload their products on to the European Product Database for Energy Labelling.[88] Consumers and sellers will be able to pull up this information via the QR codes on the labels; with information at people's fingertips, more conscious purchases can be made. One other change has been reducing the text on the labels and relaying information through symbols and numbers to create a uniform understanding of the grading scale that is not language biased.[298] As circular economy indicates; strong communication networks need to be established to optimize circular practices. Label2020 has been designed to be easily accessible and has eliminated language barriers with the assistance of a strong visual design to ensure information is relayed effectively.

By incorporating novel digital solutions, updating the grading scale to be more legible and competitive, stating requirements for reusability and recyclability for the first time and enforcing the directive on a large scale, the new rulings will not only contribute towards reducing GHG emissions but will also provide economic benefits to consumers and producers alike. The EU legislations for energy labels and eco-design are expected to bring energy savings of around 230 Mtoe by 2030. For households, this translates to average savings of up to EUR 285 per year on their energy bills.

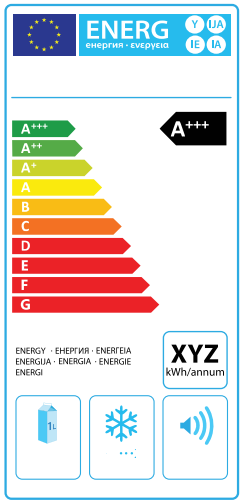
[87] Eurobarometers are surveys to gather the public opinion in the European Union
[88] EPREL

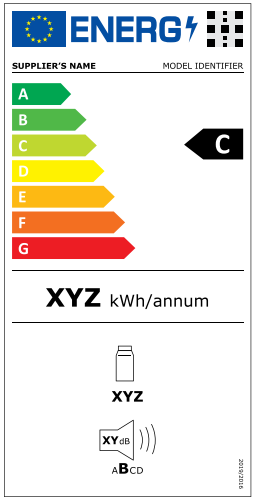
As for European companies, they are estimated to bring in EUR 66 billion in extra revenue through energy efficiency and circularity measures.[299]

Spillover effect of these changes has been the implementation of similar practices in Turkey, a major exporter of home appliances to Europe. In order to remain competitive in the EU market, Turkey and any other EU's trading partners, will have to comply with these directives which shows the impact of trading networks for expanding the application of circular innovations. However, the benefits of this application can only be reaped with conscious shoppers.

Consumers' response to these labels and to what degree their preferences will reflect on them avoiding purchases with lower ratings will determine the effectiveness of this communication.[300]

Figure 5: Differences In Current and New Energy Labels





- **The QR code** gives acces to more information on the model
- **The rescaled energy efficiency class** for this fridge, an A+++ in the previous label
- **The annual energy consumption** of this fridge is calculated with refined methods
- **The volume** of the fridge explressed in liters (L)
- **The noise level** measured in decibels (dB) and using a four classes scale

Company: *Arçelik A.Ş.*

Type of Circular Strategy	
Refuse	
Rethink	X
Reduce	X
Re-use	X
Repair	X
Refurbish	
Remanufacture	
Repurpose	
Recycle	

Type of Circular Project	
Circular Design and Production Model	X
Circular Use Model	X
Circular Value Recovery Model	
Circular Support	X

Sources for Circular Case Study Information

- *Arçelik A.Ş.*'s Website
- *Arçelik A.Ş.*'s Annual Reports
- Horizon 2020 Projects' Websites

Arçelik A.Ş. is one of the top companies in the global home appliances sector and a sector leader in Turkey and Europe.[302] It is the first and only Turkish company to make it to Corporate Knights "Global 100 Most Sustainable Corporations in the World".[303] As one of the key players in the global household appliances sector, *Arçelik A.Ş.* has a major focus on R&D; in building innovative products that will help the company maintain a competitive edge, they have achieved 3,000 patented inventions. The company accounts for one third of all patent applications from Turkey to World Intellectual Property Organization (WIPO).[304 305]

EU has set the minimum rate of recoverability of materials used in home appliances as 80% and *Arçelik A. Ş.* has achieved a range between 83% and 98% in its product portfolio.

Arçelik A.Ş. has not only excelled at recyclability standards but is working towards improving efficiency in its products. By committing to a sustainable future, *Arçelik A.Ş.* has implemented innovations throughout the lifecycle. In order to accelerate their R&D, *Arçelik A.Ş.* has joined several initiatives within the Horizon 2020 scope and partnered with a global network of researchers and scientists as detailed in the following table.[306 307]

Table 25: *Arçelik A.Ş.'s* Horizon 2020 Projects

HORIZON 2020 PROJECT	Innovation	Circularity Approach
Nanohybrids[308]	A new generation of nano porous organic and hybrid aerogels for humidity absorption have been developed to be utilized in dishwashers.	With these aerogels, less heat energy will be used during the drying phase of dishwashers. This will reduce the product's demand for resources during its operation.
BIO4SELF[309]	The most durable and resilient bio polylactic acid (PLA) to date was developed. Egg shells and other organic compost like tomato pulp and coffee grounds were used to make bioplastics.	Besides reducing the demand for non-renewable resources used in traditional plastics, this material also alleviates the waste problem by recycling organic waste in its input.
C-SERVEES[310]	Demo TVs and washing machines will be produced and distributed to customers in Spain and Turkey to study the efficiency of a short-term rental model for achieving circularity. These products will be used for 1 year, returned and repaired, then will be reused for another year. The recycled content of these products has been increased at unprecedented levels in their categories: polycarbonate-acrylonitrile butadiene styrene (PC-ABS) with 30% recycled content has been used on the back of television for the first time while recycled polypropylene (PP) content has been increased for washing machines and has also been used in the inner lid for the first time. They will also experiment with multi-use packaging methods. They have partnered with Circularise, a supply chain traceability software, for this project.	Circular economy requires consumers and businesses to rethink their consumption trends by moving away from ownership status. Utility of products can be maximized if the demand for that product does not cover the entire life cycle but just the time it's needed. Sharing and rental systems can be better utilized if brands guarantee day-one quality through refurbishing. Demand for virgin materials will be reduced via the re-use model and the increased recycled content of these appliances. Furthermore, circularity in this project will be reinforced through communication: manufacturer's communication with the clients until the end of the lifecycle will keep these appliances away from waste streams and the partnership with Circularise will increase the materials traceability.
MAESDOSO[311]	Developed electrochromic devices for domestic ovens that control the transfer and loss of heat through an oven's glass door.	Implementing smart glass into ovens will help EU reach its goal of 60% PJ/a energy savings by 2030. From a circular perspective, increasing efficiency that prevents heat loss will help reduce demand for energy.
PROMETHEUS[312][313]	High power ultra-short pulse lasers have been developed to alter the morphology of the interior surface through precise periodic texturing to change surface functionalities. Its application in dishwashers can change the interior's surface functionality to reduce water particles' adhesion to the surface during the drying process.	This technology will make the drying process more efficient by reducing the demand for energy. It aims to save 26.7 GWh of electrical power and offset 11,000 tones CO_2 per year.

Company: *VESTEL A.Ş.*

Type of Circular Strategy	
Refuse	
Rethink	X
Reduce	X
Re-use	
Repair	
Refurbish	
Remanufacture	
Repurpose	
Recycle	

Type of Circular Project	
Circular Design and Production Model	X
Circular Use Model	
Circular Value Recovery Model	
Circular Support	

Sources for Circular Case Study Information

- Vestel Company's Website
- Vestel's Annual Reports
- News Articles

Vestel A.Ş. has concentrated on increasing energy efficiency and a focus area has been reducing water consumption in its home appliances.

While increasing its household appliances production by 55%, through R&D investments, the company has reduced its water usage by an average of 36% per product.

One of the key innovations *Vestel A.Ş.* has put out in the market is the VegiWash, an additional compartment and washing cycle that comes with their dishwasher, vegetables and fruits can be washed by using less water and energy. It is estimated that 5 liters of water is used each time groceries are hand-washed, which add up to 12 tons of annual water consumption; with this product, water usage can be brought down to 1 liter per wash.[314]

In 2018, *Vestel A.Ş.* received certificates for their Hydro-Charge, Hydro-Boost and PyroJet technologies from Verband Deutscher Elektrotechniker (VDE), one of the most experienced test certification and inspection bodies in Europe.[315]

Hydro-Charge has electrolysis-based technology installed in dishwashers and washing machines which either eliminate the need for a detergent or at least lower it by 50% depending on the product. While this helps reduce consumer's expenses and minimize the chemical waste, it also provides a relief for people who are allergic to chemicals in detergents. Moreover, this product has achieved high levels of efficiency in electricity consumption, saving 30% more energy compared to former A+++ class.

Hydro-boost washing machines decreases the time used to wash clothes by 50% with its technology that sprays water from up to 20 different angles. With record breaking wash time and improved water and detergent penetration, this machine consumes less energy.

PyroJet washing machine has the lowest annual energy and water consumption values on the market, 70% less energy than former A+++ rated products and only 7,700lt/year for machines with 8kg capacity. Based on *Vestel A.Ş.* research, if every household in Turkey switched to this technology, energy costs in Turkey would be reduced by 2.8 billion TL.[316]

Improved technology will not only help the environment but the consumer's budget as well; while quantifying their results, Vestel A.Ş. focuses on translating the environmental benefits to economic ones to further incentivize the consumer and states that households can reduce their electricity bills by 35% if they make more sustainable choices in their daily lives, such as opting for greener innovations.[317]

6.5 Construction Services Sector

Construction Sector Overview

Market Structure: More than 127,050 firms with 486 considered as 'large firms' [318]

Investment amount: ≈ 628,200,000 TL

Employment: 1,748,000 [319] employed (6.4% of the work force in Turkey)

Sector Overview

The trend towards urbanization keeps growing – with most of the world's population already residing in urban centres. The global urban population, currently almost 4 billion out of a total population of around 7.8 billion, is expected to grow to around 6.3 billion by 2050 and comprise 70% of the global population.[320] Due to this, it will be critical for urban planning, construction, and water and waste management projects to address the needs of rapidly increasing urban populations in a sustainable way.

The building and construction industries are inherently resource intensive at present. The industry requires the extraction, manufacturing and assembling of specialized materials and products sourced from natural resources. According to the OECD, every year construction materials and the building sector are responsible for more than one-third of all resource consumption in the world and account for 36% of global final energy use.[321] [322] Buildings also generate excessive levels of waste, comprising around 40% of municipal urban waste in some countries.[323] Enforcing laws and facilitating systems to manage this waste is crucial for establishing sustainable communities.

One focus of the European Commission has been increasing renovation and refurbishment rates. Only 1% of buildings in Europe undergo energy efficiency renovations every year – The Renovation Wave intends to increase that rate to improve buildings while creating new job opportunities.[324] Additionally, the European Commission published Circular Economy Principles for Building Design to guide those in the construction value chain on circular practices; the strategies highlighted on that guide have also influenced the findings of this report. [325]

COP26 reaffirmed the environmental impact of the construction industry. UK, India, Germany, Canada and UAE committed to limiting emissions from the cement and steel industries, which cumulatively account to around 16% of global emissions. Interim targets for 2030 will be set by mid-2022; disclosure of embodied carbon and transition to low-carbon economy will have a big impact on Turkish producers, who are major exporters in both sectors.[326] [327] [328]

Turkey's Annual Presidency Program has set a more economic output-oriented strategy for the cement industry. It highlighted that more sustainable compounds (e.g. fire and earthquake resistant, high heat and moisture resistant, light weight) should be developed primarily to remain competitive in the global industry.[329]

Main Obstacles and Corresponding Strategies

While evaluating the construction industry, it is integral to consider a country's unique urbanization history and seismology.

In Turkey's 50's, the rate of urbanization[89] was 25%. In 2012, this had reached a staggering rate of 77%. Since this transition was not paced, cities lacked the infrastructure to accommodate the input of new residents. As a result, slums, illicit structures and buildings with lower durability standards became long-term housing solutions. On top of this, Turkey also lies on the Alpine-Himalayan seismic belt, one of the most active earthquake zones. 92% of Turkey's land is on a seismic belt and about 95% of the population reside there.[330] In İstanbul alone, of the 1.2 million buildings, 42% do not meet the requirements to withstand an earthquake the size of 7.5 as a result of uncontrolled developments. To avoid a catastrophe, government and private sectors have come together to reconstruct risky buildings while offering sustainable finance modules as a part of the initiative "Urban Renewal". While the aim is to create stable structures for sustainable communities, the price of reconstruction will be higher consumption of raw materials which highlights the importance of durability as a pillar of circularity.

Structures used to outlive their architects but now the opposite is becoming more prevalent. Buildings are being torn down prematurely to make way for new investments which generates an avoidable demand for resources. In October 2021, the government released its first regulation dedicated to demolition, 'Directive on Building Demolition'[90] but there are no laws or regulations that prevent developers from taking down a structure prematurely. Additionally, upgrades should be prioritized over knockdowns via penalties, financial incentives and tax regulations.

COVID-19 served as a good example of the importance of designing versatile buildings. Anticipating changes in demand and culture ensure optimizing the utility of a structure; so, architects and construction companies need to work together to design multi-purpose buildings. While the effect of work-from-home is expected to have long lasting impact on demand for real estate with many offices now downsizing, other social changes are influential too. Women's economic empowerment, delay in marriages and changes in average household size are just some of the social changes that affect the type of real estate that is in demand.

Structures should accommodate different preferences to ensure that they do not lose their utility.

Even if they are not environmentally friendly, demolitions and new developments still provide some social benefits: employment for unskilled labour. Considering the size of the construction industry, their lobby remains as one of the main obstacles in achieving circularity in some regions. In Turkey, of the nearly 27.5 million people employed country wide, more than 1.7 million of them were working in the construction sector in 2020.[331] To avoid a rise in unemployment as a result of slowing down developments, it will be necessary to investment in those workers' skillsets to support the workers' transition to a new sector.

In a circular model, waste is treated as a design flaw, which means that intervention is needed at the earlier stages of production to design out waste and pollution.[332] For the construction industry, this could include a change in the material sourcing criteria and promotion of products with a lower environmental footprint. By integrating recycled content without compromising quality, the use of primary resources can be minimized. Designers should also avoid using materials that contain harmful substances or cause significant pollution in their life cycles. Modular, flexible structures that are easy to assemble or disassemble can help reduce waste and consumption, considering how such structures and materials used in those structures will have higher recovery potentials through recycling, refurbishing, remanufacturing and repairing. Developing durable materials is another aspect of circularity in the building sector. If materials and structures are resilient against external factors such as time, weather, earthquake and fires, buildings and infrastructures values can be preserved for a longer time.

[89] Rate of urbanization: the flow of population from the peripheries to cities
[90] Binaların Yıkılması Hakkında Yönetmelik

Working to regenerate natural systems requires adopting clean and renewable energy sources for design.[333] The industry should also consider returning materials to the natural environment (such as biodegradable products) or using energy generation technologies (including geothermal heat) that limit the depletion of natural sources and energy. Lastly, buildings should be built with a consideration for its location. Focusing on bioclimatic and biophilic design practices will not only bring building occupants closer to the natural environment and provide a healthier indoor climate but also reduce emissions during its use since the design incorporate the elements present in the building's environment.[334]

In Turkey, according to the "Energy Efficiency Law No. 5627" and the "Energy Performance Regulation in Buildings", energy and energy resources need to be consumed efficiently. Energy Performance Certificate - which contains information about a building's energy requirement and energy consumption classification, insulation properties and efficiency of heating and/or cooling systems - is used as a minimum standard, in order to ensure the efficient use of energy, prevention of energy waste and protection of the environment. The energy performance of buildings is evaluated based on different parameters which include building type, net amount of energy consumption, electricity demand for lighting and the energy consumption for heating-cooling and ventilation.[335]

Green Buildings in Turkey[336]

Considering how buildings and construction industry are some of the highest greenhouse gas emitters, redesigning these structures to be more environmentally friendly throughout their lifetimes is essential for achieving global emission reduction goals. According to a study conducted in the US, greener buildings demand 24-50% less energy during its use, emit 33-39% less CO_2, consume 40% less water and generate 70% less waste. International Green Building's Association has asserted that the most effective way to have more sustainable buildings is implementing 'green label's. These standards guide architects and engineers to design and build greener structures. This label also recognizes and validates the ownership's effort to minimize its environmental footprint.

Over the years, many green building standards have been developed across the globe - BREEAM, LEED, IISBE, CASBEE, and DGNB are a few notable examples. B.E.S.T. Certificate, developed by ÇEDBİK[1] for residential and commercial buildings separately, recently joined these ranks. These certification systems evaluate residential and commercial buildings under 9 categories: Integrated Green Project Management, Land Use, Water Efficiency, Energy Efficiency, Health and Wellbeing, Material and Resource Consumption, Residential Life/Life in Commercial Buildings, Operation and Maintenance, and Innovation. Based on these interdisciplinary criteria that determines the buildings environmental performance, B.E.S.T. lists certified buildings under 4 categories.

Key Circular Strategies

Key Circular Economy Strategies for the Construction Sector can include the following strategies, which are considered in terms of the 3 Circular levers: Circular Input, Recovery Potential and Actual Recovery, which are defined in the Appendix.

1. Circular Input:

- Complement the reuse of deconstruction materials by using materials that are renewable, non-toxic, have a high recycled content, and/or are sourced locally
- Opt for recycled materials and source them across sectors
- Design greener buildings through biomimicry
- Mix the aggregates recovered during site demobilization into construction materials to lower costs and emissions related with using virgin materials or any other material that requires transportation
- Optimize the green concrete ratio, a concrete associated with lower emissions as a result of using waste material
- Use materials that can be sourced near the production site to empower local economies and to reduce transportation costs
- Use 3D printing to reduce inputs through precision, lower emissions associated with transportation and utilize more circular materials

2. Recovery potential:

- Design structures that are easy to dismantle without damaging the materials used and make this information accessible for future users
- Make parts of structures easy to access for repairing and replacing
- Design buildings with flexible purposes and the future demand considered
- Create strong networks that communicate input and output data across industries to optimize waste that is reintroduced as an input
- Integrate principles of circularity into curriculums in architecture and engineering schools
- Engineer materials resilient to external factors such as earthquakes and storms

3. Actual recovery:

- Create futures contracts, in which value is tied to the estimated future value of materials in a building when deconstructed, which can be traded on a centralized exchange to enable recovery and reuse of construction materials.
- Implement legislations to collect and sort the waste at the end of the life cycle
- Retrofit existing buildings for alternative uses and design
- Repurpose structures like containers to provide low cost housing, make-shift office spaces or shelters
- Enforce laws that prevent or limit the premature demolition of buildings
- Pay for performance through product-as-a-service subscriptions for building fixtures and fittings (e.g. heating, cooling or lighting-as-a-service)
- Offer existing, underutilized building spaces for short-term use on online platforms to maximize the utilization of existing assets

Drivers Of Circular Economy Growth Potential In Construction Sector In Turkey

Key Circular Economy Strategies for the Construction Sector can include the following strategies, which are considered in terms of the 3 Circular levers: Circular Input, Recovery Potential and Actual Recovery.

Table 26: Drivers Of Circular Economy Growth Potential In The Construction Sector Internationally And In Turkey (1/2)

Driver	Example	International	Turkey
Innovation & Corporate Action	Demand for Finite Resources	Recent studies suggest that due to rapid urbanization, demand for both steel and cement is expected to almost double by 2050.[338] Unmet housing needs mean 1 billion new homes will be required worldwide by 2025.[339]	Turkey is the 6th largest cement producer in the world[iii] and its exports reached 30 million tonnes in 2020 (USD 1 billion) which results in a vast demand for limestone, energy and water. [341] Under the "Urban Renewal" initiative, which rebuilds houses that are deemed unfit for current standards, demand for resources is expected to keep rising.[342]
	Industry Action	Large development projects are being designed with circularity principles. The Triodos Bank HQ in the Netherlands's circularity features include being built with screws to enable disassembly and reuse of materials in addition to being constructed primarily with wood (carbon neutral as CO2 is stored in the materials) rather than emissions-intensive concrete and steel.[343] S&P Global Platts is set to publish new low-carbon metal spreads and ratios to guide industrial producers and consumers.[344]	Cement plants are using waste materials as alternative fuels to help lower emissions and reduce the stress on landfills. From 2016 to 2020, the cement industry in Turkey used 901,000 tonnes of used tires which prevented the release of 865,000 tonnes of CO_2. 67% of these tires were imported since the national supply was not adequate.[345] In a research carried out by İTÜ[(91)] , Turkish contractors were evaluated for their environmental performance through the relative importance index (REI). They exceeded the 60% threshold in topics of Green Supply, Recycled Materials, Certified Materials and Recycled Waste. Excavation soil is being redirected by İSTAÇ[(92)] to fill up mines that are no longer in use. The goal is to restore the landscape to its pre-mining state and facilitate habitat restoration. Developers are investing more in green structures and a growing number of projects in Turkey are getting certified through assessments like LEED, BREEAM and most recently B.E.S.T., which is the first Turkish green building certificate.[347]
	Innovation	Circular business models are being developed. For example, Madaster's platform produces material passports for buildings and tracks the value of materials over time[348] To establish a common language in assessing and reporting on sustainability performance in buildings, European Commission developed Level(s), a European Framework for sustainable buildings. Concrete as a CO2 sink is being tested by researchers at University of Warwick.[349]	Cement and concrete producers are expanding their portfolios, with more environmentally friendly materials like green concrete, to lower virgin content (traditional cement) and thus emissions.[350] Mineral additives and recycled by-products such as furnace slag are used to make up about 70% of the new concrete. Blue Life is the production approach, design attitude and management outlook of Eczacıbaşı Building Products, and with this approach VitrA Tile uses wastewater treatment sludge of VitrA Sanitaryware as raw material to reduce the footprints in the raw material and waste life cycle.

[91] İstanbul Technical University, *İstanbul Teknik Üniversitesi*
[92] İstanbul Environmental Management Industry and Trade Company, *İstanbul Çevre Yönetimi Sanayi ve Ticaret Anonim Şirketi*

Table 26: Drivers Of Circular Economy Growth Potential In The Construction Sector Internationally And In Turkey (2/2)

Driver	Example	International	Turkey
Policies & Regulation	Increasing Policies and Regulation	EU Circular Economy Action Plan includes a focus on material recovery targets for construction and demolition waste and its material-specific fractions.[351] European Waste Framework Directive (2008/98/EC) has a target for 70% of non-hazardous construction and demolition waste to be reused, recycled or recovered by 2020.[352] There is an increasing focus on circularity in urban policies. For example, the New London Plan requires all new developments of a certain size to submit a Circular Economy Statement to help architects embed circular economy principles[353]	Some banks in Turkey have increased their credit capacities for "Urban Renewal" projects to alleviate the financial burden of rebuilding unsafe buildings. With the support of the Ministry of Environment, Urbanization and Climate Change interest rates have been reduced as well. Projects, depending on their size, location, and type, need to get their ÇED (Environmental Impact Assessment)[93] reports approved.[354] Construction Materials Regulation[94] includes clauses regarding the sustainable consumption of natural resources and non-virgin materials, recovery potential, durability and issuance of CE certificates for compatibility with European standards.[355]
Customer Preferences and Macrotrends	Changing Preferences and Behaviour	There is increasing customer demand for renewable energy. According to a study in the UK in 2019, more than 45% of customers said they would be willing to pay more for 100% renewable energy and the study found that renewable energy was now the preferred customer choice for power supply.[356] [357] There is growing interest in decentralized, off-the-grid energy production and storage, which is also being supported by growth in the global EV market. Working patterns are becoming increasingly flexible, a trend accelerated by the COVID-19 pandemic. While urbanization increases demand for properties in cities, houses get abandoned and remain unsold in the peripheries. Ledger saw this as an opportunity in Copenhagen. They use the materials recovered from abandoned homes to build new buildings in the city. They expect to reduce the building's carbon footprint by 70% with this project, "The Resource Rows".[358]	In order to help tackle the housing crisis faced by nearly 4 million refugees, Turkey has implemented sustainable solutions such as upcycling containers for accommodation.[359] Consumers are becoming more aware of the social and environmental impacts of fossil fuels. According to a survey by E3G[95], 86% of Turkish citizens favoured renewable energy investments. The COVID-19 pandemic has resulted in some companies announcing plans for their workforce to work-from-home or move to a hybrid module on a permanent basis. Online shopping trends are jeopardizing the prospects of the brick-and-mortar industry and as a result real estate is losing value and occupancy.[360] Family structures are changing; the number of marriages and the average family size are decreasing while the number of divorces is increasing. This cultural change can be expected to affect the demand for different types of real estate properties.

[93] *Çevresel Etki Değerlendirmesi*
[94] *Yapı Malzemeleri Yönetmeliği*
[95] A climate change think tank

Circularity Calculation Results - *Enka İnşaat ve Sanayi A.Ş.

circular input	circular output	
0%	1%	
	recovery potential	**actual recovery**
	69%	1%

*These values are average estimates.

Calculation Outputs

- *The circularity rate for the inputs has been determined to be 0%.*
- *The circularity rate for the outputs was determined to be 1%; this rate is 69% for potential recovery and 1% for actual recovery.*

In this project, the circularity rate was low since materials were selected according to customer demands and standards. Therefore, the figures in the table do not reflect ENKA's overall circularity rate nor its sustainability efforts. Circularity calculation methodology has been used for a specific project sample data selected due to time constraints in the project. The data used when calculating Recovery Potential is not the recycling potential of this project; it shows the recovery potential of similar products in the market. The recovery potential is provided by the suppliers of the construction company.

[96] Association of Construction Material Producers, *İnşaat Malzemesi Sanayicileri Derneği*
[97] *Türkiye Yapı Sektörü Raporu 2019-20*

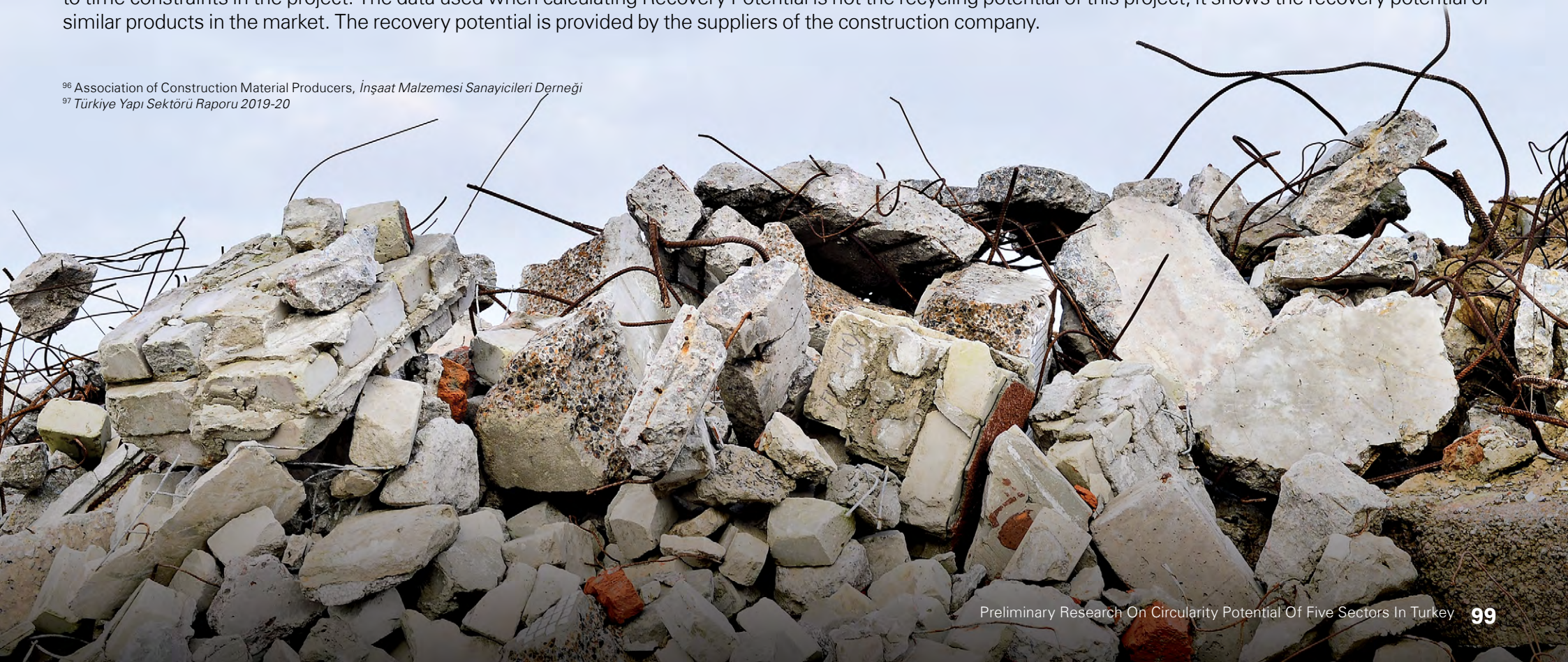


Table 27: Circularity of Good Practice Examples from France

Company Profile	Project Profile	Details on Innovation & Circular Economy Practice	Impact
Name: BOUYGUES **Size:** Large Cap Company *Sustainable construction firm*	**Project Name:** The EDA Project **Circular Economy Strategy:** Repurpose **EU Circular Economy Model:** Circular Use	This is a low-carbon positive energy building design. The Green Office will be built over a storage depot and the office space will include coworking spaces, a bicycle repair shop, a canteen open to the public, and "pick & go" urban logistics spaces. 80% of the four basement levels will be made from timber. Grey water[98] will be reused for watering green spaces and urine will be reprocessed as a natural fertilizer. A Climespace system[99] will be installed in the basement to supply the neighbourhood with cool air and mitigate the heat island effect. Photovoltaic panels and rapeseed oil cogeneration will be used to transform and generate heat. An energy-storage system using recycled car batteries is also planned, for channelling surplus energy into the building during periods of peak consumption or into the grid.	By using timber, 2,700 tonnes of CO_2 can be avoided, reducing carbon emissions by 16% - with conventional concrete production taken as a reference. Priority will be given to sourcing timber in France so that supply chains can be kept short. Once the building is in use, some 660 tonnes of CO_2 emissions will be avoided, due to self-generation of energy. Irrigation systems will reduce the demand for water by recycling conventional and unconventional waste that is generated within the building. The space rethinks the approach to conventional offices by optimizing their use through shared spaces. Including a bicycle repair shop will promote the utility and convenience of zero-emission transportations. The design also allows the community to reap its benefits even if they are not the direct tenants. Circular models have been implemented in this building to not only support the environment but also to instil circular values into its users.

[98] Domestic wastewater
[99] Climespace is a subsidiary of Engie, a French multinational electric utility company, that provides district cooling services.

Table 28: Circularity of Good Practice Examples from France

Company Profile	Project Profile	Details on Innovation & Circular Economy Practice	Impact
Name: Colas **Size:** Large Cap Company *Transportation Infrastructure*	**Circular Economy Strategy:** Recycle & Reuse **EU Circular Economy Model:** Circular Value Recovery	Colas, a subsidiary of Bouygues Group, has been specializing in responsible mobility in transportation infrastructure projects for over 40 years. Currently, there are around 320 Colas sites that recycle aggregates for public works materials with asphalt recycling being one of their specialties. Reclaimed Asphalt Pavement (RAP) comprises of materials recovered from milling or demolition of roadways before new asphalt mix is applied. Since asphalt is traditionally mixed in with bitumen, a non-renewable petroleum based raw material that acts as the liquid binder which holds the asphalt together, this practice has both economic and environmental gains. Colas Ile-de-France Normandie, an affiliate of Colas, has been working on utilizing construction waste recovered from buildings and not just roads. The affiliate has a network of around 40 facilities (recycling platforms, sorting platforms for commercial users, clean waste storage facilities) and its specialized affiliate Premys has been making progress on secondary elements[100] waste. They empty out and selectively remove specialized materials (ferrous and non-ferrous metals, computer room flooring, wooden flooring, wooden beams, false ceilings, furniture, etc.) in buildings due for demolition, and turn them into a source of raw materials or equipment. Moreover, Premys is currently testing solutions for selling products from recovered demolition waste (doors, windows, false ceilings, insulation, etc.) to private individuals and trades people.	Recovered aggregates produced 9.2 million metric tons of recycled materials in 2019, which corresponds to about 10% of the Group's total production from its quarries and gravel pits. Reducing raw material consumption by increasing recycled content ratio yielded savings equivalent to the average production of 47 Colas quarries. As global economies shift away from petroleum and other carbon-based raw materials, bitumen[101] becomes harder to obtain since its supply depends on demand and supply of crude oil. In 2019, 6.2 million metric tons of reclaimed asphalt was reused and 16% of new asphalt mixes had recycled asphalt mixes; savings from this practice was the same as the annual bitumen production of a medium-sized refinery. By reducing and reusing waste, energy savings increase while emissions and cost decrease. At Colas Ile-de-France Normandie, 1.6 million metric tons of materials were recycled including 290,000 metric tons of reclaimed asphalt pavement from the demolition of former road surfaces. In 2019, the company completed the massive project to fully rebuild runway number 3 at Paris Orly airport in only 14 weeks using 300,000 metric tons of recycled materials.

[100] Parts of the building that are not providing loadbearing capacity.
[101] It is a residue obtained from the distillation of crude oil but there are also deposits of naturally occuring bitumen.

Circularity Case Studies from Turkey

Company: *Nural Construction and Trading Co. Inc.*

Type of Circular Strategy	
Refuse	
Rethink	
Reduce	X
Re-use	
Repair	
Refurbish	
Remanufacture	
Repurpose	
Recycle	X

Type of Circular Project	
Circular Design and Production Model	X
Circular Use Model	
Circular Value Recovery Model	X
Circular Support	

Sources for Circular Case Study Information

- Turkey Materials Marketplace Website
- Information provided by *Nural Construction and Trading Co. Inc.*

Nurol İnşaat joined the Turkeys Materials Marketplace (TMM) 23 platform in 2019 and they were paired with Arkım Chemical Substances, the first company in the world to produce patented 100% natural food preservatives. After one of its factories ceased operations, the steel construction parts used in that structure were re-utilized in Arkım Chemical Substances' new facility. Through Turkey's Material Marketplace, Nurol İnşaat also matched its construction waste from demobilization during the Balıkesir Highway Project with other parties and prevented those materials from being discarded in the dumpster.

Company: *Bilecik Demir Çelik San. ve Tic. Inc.*

Type of Circular Strategy	
Refuse	
Rethink	
Reduce	X
Re-use	
Repair	
Refurbish	
Remanufacture	
Repurpose	
Recycle	X

Type of Circular Project	
Circular Design and Production Model	X
Circular Use Model	
Circular Value Recovery Model	X
Circular Support	

Sources for Circular Case Study Information

- Information provided by *Bilecik Demir Çelik San. ve Tic. Inc.* during the project
- Website from organizations in the Company's Ecosystem
- News Articles

Bilecik Demir Çelik San. ve Tic. Inc., an iron and steel company in Turkey, has taken advantage of "The Circular Vouchers" technical support program to produce steel from refractory waste.[361] The company conducted studies focused on optimizing secondary raw material production which yielded positive results for the economy and the environment.

Bilecik Demir Çelik San. ve Tic. Inc. innovation focused on lowering the impact of White Fused Alumina[102] (WFA) (Al_2O_3).[362] This process, which requires heats up to 2,0000C, is water and chemicals intensive and yields red-mud as a by-product which can have hazardous and fatal effects on the environment and humans.[363]

In this project, refractory material containing 85-90% WFA was recycled and which helped the firm halve its waste. Since the company is reliant on WFA, which is 100% imported, this circular method helped them reduce their cost, upstream emissions and demand for raw materials. Their consumption of bauxite decreased by 2,566 tons while 2,291 tons of red mud residue was averted. Reusing operational waste also saved around 3.5 million kWh of electricity and 2,238 tons of CO_2 emissions.

All these environmental benefits from lowering energy usage and demand for raw materials translated into savings of EUR 1,030,838.

Table 29: Results for August 2019 (project start date) – June 2021

	Material Savings (ton)	Economic Gains (€)	Emission Reductions (tCO_2e)	Energy Savings (kWh)	Water (ton)	Red Mud (ton)	Bauxite (ton)	Sodium hydroxide (NaOH) (tonnes)
Savings/Ton	1	1,125	2.44	3,815	2.00	2.50	2.8	1.8
Annual Savings	580	652,5	1,416	2,212,700	1,16	1,45	1,624	1,044
Total	916	1,030,838	2,238	3,495,685	1,833	2,291	2,566	1,649

Company: *Akçansa Cement*

Type of Circular Strategy	
Refuse	
Rethink	
Reduce	X
Re-use	
Repair	
Refurbish	
Remanufacture	X
Repurpose	
Recycle	X

Type of Circular Project	
Circular Design and Production Model	X
Circular Use Model	X
Circular Value Recovery Model	X
Circular Support	

Sources for Circular Case Study Information

- *Akçansa Cement's* Website
- *Betonsa's* Website
- UNIDO News[103]
- Science Daily[364]
- Scientific Papers[365]

[102] White Fused Alumina (WFA) is produced in electric arc furnaces through the fusion of high purity calcined alumina.
[103] United Nations Industrial Development Organization

Producing cement is a thermal energy intensive process that requires heats up to 1,450°C and primarily uses fossil fuels to achieve this.[366] Cement mixed with water and aggregates then yields concrete, the building blocks of today's society.

The industry accounts for 8% of global CO_2 emissions and mitigating these emissions have been viewed as a challenge due to the necessity of the thermal process and the durability of the composite material.[367] The industry accounts for 8% of global CO_2 emissions and mitigating these emissions have been viewed as a challenge due to not only the necessity of the thermal process but also the production process itself.[368] While the clinker, which is the main raw material that makes up the cement, is produced in rotary kilns operating at high temperatures, carbon dioxide is naturally released as a result of the chemical reaction called the calcination reaction of raw materials such as limestone used. However, recent research and innovations have shown that low-carbon solutions are indeed possible for cement and concrete, which will play a key role in the sustainable growth of communities.

Akçansa, the joint venture of Sabancı Holding and Heidelberg Cement and the largest cement producer in Turkey, has been diversifying its portfolio to include more environmentally friendly products and has been awarded for its eco-friendly identity by Istanbul Chamber of Industry.[104] The company's high standards during the production process has also earned them Turkey's first EPD[105] in the cement industry.

Yeşilşap is a new generation "green, light, ready-mixed screed[106]" which has up to 35% smaller CO_2 footprint due to special mineral additives used during production.

It is more resilient against earthquakes as it is air entrained[107] up to 25% with chemical additives, whilst reducing earthquake load with its light weight. This screed reduces construction site traffic and pollution by eliminating the need to transport sand, cement and water to the construction sites separately. It also contributes to thermal insulation, which means that the occupants' heating related energy demands will be lower. It's efficiency during production, transportation and use supports the circular model by lowering emissions during its lifetime and making it more durable against external activities.[370]

Green concrete is an environmentally friendly concrete that uses waste or residual materials like fly ash[108], concrete aggregates from demolished structures and aluminium can fibers in its composition to lower the demand for raw materials and energy.[371]

At Akçansa, A+ Beton is a concrete that uses blast furnace slag[109] up to 70% of the composition. By implementing ground blast furnace cinder (GBFC) as a substitute for virgin inputs, CO_2 emissions can be lowered by up to 153 kg/m^3. Altering the composition of inputs by blending in waste to maximize the non-virgin ratio in concrete means lowering demand for materials with high carbon footprint (cement and clinker) which bolsters Akçansa' s contribution to circular economy.[372]

In low carbon product studies, the use of wastes with high calorific value as fossil fuel substitutes is another emission reduction solution. By using alternative fuels, Akçansa is mitigating emissions caused by the combustion of fuels, while re-introducing wastes to the economy and closing the loop. Akçansa also studies alternative raw materials by evaluating by-products or recycled products of other industries.

[104] Akçansa was initially a cement and clinker producer. After merging with its subsidiaries Betonsa and Agregasa Agrega, it started providing services in the concrete and aggregates industries as well.
[105] Environmental Product Decleration
[106] Screed has less aggregates in its composition which makes it a smoother mix than concrete.
[107] Air Entrainment: intentionally producing a system of small air bubbles with special chemical admixtures during the mixing process. These voids remain after the mixture hardens.
[108] A fine power that is a byproduct of burning pulverized coal in power plants
[109] A byproduct of steel production and can be used to substitute clinker in cement production

7. Areas of collaboration between France and Turkey

One of the aims of this report, supported by the French Development Agency (AFD), has been to advocate circularity initiatives in Turkey by guiding international partnerships. In that light, propositions for circular collaboration strategies between Turkey and France have been presented in this section.

French and Turkish organizations could *develop platforms to share best circular economy practices* such as "designforlongetivity", a platform produced by Global Fashion Agenda as part of the European Clothing Action Plan (ECAP) that aims to drive sustainability throughout the entire lifecycle of clothing via communicating companies' best practices, new innovations and training. Similar platforms already exist, so, to be truly efficient and reach their target audience, this platform should consider the specifics of Turkish sectors. These could include financial incentives that companies could benefit from by implementing circular projects such as green bonds, tax refunds, subsidies and lines of credit in addition to the conditions to fulfil.

French companies could encourage their Turkish suppliers to adopt circular economy practices through the integration of circular economy criteria in the supplier selection process. Standards could be set for % of recycled material used or energy and water management systems. To help Turkish suppliers improve on these criteria and meet the requirements, French companies could also help them build capacity through sharing tools and knowledge.

French companies could *establish collection systems* in the main countries where they sell their products. If consumers are incentivized (e.g. coupons) to bring in their old products back to stores, companies can take these items back to factories for refurbishing or remanufacturing. Assessing the environmental and economic cost of reverse logistics would be crucial to determine the sustainability of such initiatives. Supply chains can be shortened by building local factories or working with local actors to reduce the environmental impact of transporting used goods.

French and Turkish organizations could develop *shared platforms where actors from the whole value chain could connect* and better manage resources avoiding waste. For example, Upcyclea in France has developed a collaborative software of circular resource management in the construction sector. The idea is to transform assets into a digital bank of products and materials that can be reused or upcycled. The business model of these platforms would apply to all sectors.

Turkey could integrate existing *Extended Producer Responsibility (EPR)* at European level (e.g. packaging, electronic waste, batteries). EPR system is based on the "polluter pays" principle in which producers are held responsible of reducing the environmental impact of a product throughout its entire life cycle; thus, they are expected to support during take-back, recycling and final disposal phases. It makes the producer accountable for financing end-of-life cost, providing incentives to producers to prevent waste at the source and design products that are recyclable/reusable. Turkey could improve their EPR standards, following their initiative on Recycling Contribution Fee (GEKAP). Some French organizations such as the French Environment and Energy Management Agency (ADEME) could support countries in the establishment of an EPR approach and the creation of an eco-organism and manage the project with local actors.

Turkey's representatives could *join working groups* to better understand the legislative developments at European level. The European Commission is adopting new action plans (e.g. CEAP) alongside introducing legislative and non-legislative measures targeting sustainable growth and circular economy principles. Although it is led by the European Commission, the EU can only succeed if its efforts drive also the global transition to a just, climate-neutral, resource-efficient and circular economy. There is a growing need to advance discussions on defining a "Safe Operating Space" whereby the use of various natural resources does not exceed certain local, regional or global thresholds and environmental impacts remain within planetary boundaries. For countries with an EU accession perspective like Turkey, the new sustainable models will open up business and employment opportunities, while strengthening the ties with European economic actors. Turkish stakeholders should monitor the upcoming regulations to adopt and update their national strategies, plans and measures in light of European Commission's new ambitions.

8. Barriers and Opportunities

Barriers

Several obstacles, some of which vary from sector to sector, hindered data collection. Most significant barriers are given as follows:

- Data deficiencies
- Confidentiality of relevant data
- Lack of protocols for enforcing circularity principles
- Lack of regulations for mandating reporting
- Low of awareness of circularity principles
- Lack of data for products' LCAs
- Restraints imposed by customers
- Unavailability of certified circular inputs

During Phase 1, which primarily focused on the nation-wide assessment of the production phase, a salient obstacle was *obtaining data*. Information regarding certain materials are not available in some sectors due to confidentiality. The datasets are not always compatible with principles of circularity either. For instance, data is collected within companies and Turkey for recycling, but other circularity strategies are not tracked. Also, companies and nations' datasets focus are more on weight, quantity and economic value – circularity related KPIs need to be monitored as well. It should be noted that plastic packaging and textile sectors had better circularity data publicly available, a sign that circularity principles are being applied. However, considering how most of the data available has come from companies that have initiated circular strategies in their operations, the circularity numbers calculated are assumed to be higher than the industry average.

To remove barriers regarding data availability, in parallel to "An Overall Assessment of the Potential of Turkey in the Context of Transition to Circular Economy Project" led by Ministry of Environment, Urbanization and Climate Change, it would be beneficial to prepare and publish a National Circularity Action Plan which will serve as a guidance for companies and include requirements to establish systems for monitoring and reporting data submitted by companies.

Lack of awareness regarding circularity data is another concern that impedes data collection. While many institutions are impassioned about sustainability, only a few monitor relevant KPIs. Effective management is critical for raising awareness within a company. Our research revealed that most companies' senior managements are still not focusing on circularity strategies; the knowledge of such strategies is still limited with recycling for most departments. Additionally, since circularity principles rely on strong network within the value chain, effective governance that spreads the knowledge of circularity strategies should permeate the entire market.

Safety, hygiene and *quality standards* and *specs*, agreeably, can pace circular economy developments. There are strict standards that have to be met in food packages, automotive, construction and home appliance sectors to ensure that the products are safe, durable and hygienic. These quality standards result in certain restrictions in the design stage, which affects products actual and potential recoverability rates at the end of their lifecycle.

Clients' design expectations, supply chain's capacity, sourcing problems can limit the circularity of products. Some clients' orders have rigid standards, whether it be for clothing, buildings or small electronics, which means that manufacturers cannot change the inflows or designs to make a product more circular. As for the supply chain, if circular inflows are not available in the Turkish market, such as certified recycled textiles or second-hand electrical equipment, manufacturers will not be able to transition to a sustainable supply chain. Obtaining such inflows from different countries can negate some of the environmental benefits of using circular inflows due to emissions from transportation.

Making services, products and operations more circular can be *expensive* in the short run. Many firms, especially manufacturing businesses, face financial barriers when investing in innovative, greener and more resource efficient technologies. Some organizations also do not allocate a high budget for their R&D departments, which can support the development of circular innovations.

Some *fiscal policies* do not consider circular applications. For instance, when textile scraps and by-products are used as secondary inputs in manufacturing operations and these output materials lose their waste feature, the manufacturer has to pay 18% of VAT on delivery of these materials. This law also applies to rubber, paper, metals, plastics and glass.

A *competitive market* has had an equivocal role in the development of circular strategies and the transparency of KPIs. While such market characteristics push companies to invest more in R&D, they also raise barriers in the form of patents that secure the profitability of such investments. Especially in sectors such as home appliances and automotive, companies refrained from participating in the study due to this concern.

Optimizing a Circular Economy

Education will be pivotal for developing circular solutions since such improvements rely on the capacity of the human capital. Educational institutions will need to develop more in-depth curriculums that target circular economy principles. If organizations want to ensure the longevity of their businesses, they will need to catalyse their employees' growth through capacity building. For the general public, education entails shaping and abating demand via awareness campaigns.

Parallel to this, *human resources* at organizations should focus on finding candidates with qualities that can support their organizations' sustainability initiatives, both technically and strategically. It is important to note that circularity principles are all-encompassing, and all departments should be educated on these topics. For instance, in textiles industry, design teams will need to understand which styles, patterns, blends and textiles have higher recovery potentials while the procurement department will need to know which KPIs to assess while purchasing new materials and goods. Concomitantly, R&D with a focus on circular practices should be another strategic objective.

Innovations in digitalization provide solutions in countless functions and industries. World Economic Forum's analysis shows that 84% of Internet of Things (IoT) applications either are already applicable, or are potentially applicable, for supporting SDGs. Increasing real-time connectivity between previously separate entities can increase efficiency in resource consumption alongside accurately quantifying the enablement effect[(110)][373]. For instance, consolidating information from on-site humidity sensors and weather forecasts can assist cotton farmers with optimizing water consumption during irrigation. Another example of innovative information technology are QR codes and blockchain technology. These can act as digital passports for materials and products by storing information pertaining to their supply chain journey, circularity, optimal disposal method and potentially much more. They not only increase traceability and accountability but also provide valuable information to optimize circularity in the value chain.[374]

Optimizing circularity also relies on a strong *infrastructure* and *network*. For instance, disseminating local recycling facilities and improving collecting schemes will require the coalition of municipalities, financial institutions, manufacturers and end-users. This type of network should also enable transferring products, materials and waste within and between consumers and producers to increase the application of circularity strategies other than recycling.

[110] Mechanisms that facilitate the avoidance of carbon emissions

Aligning *laws* and *regulations* with circularity principles will increase industry participation and preserve Turkey's environment. Banning the incineration of recoverable materials, implementing fiscal policies that incentivize sustainable investments while limiting environmentally detrimental activities, and enforcing stricter policies regarding circular practices are some ways to advance nation-wide circular economy practices. Zero Waste Regulation is a great example of the potency of such regulations; since its implementation in 2018, it has raised awareness, improved data collection and increased collection of recyclable wastes throughout the nation. Regulations regarding patents need to be re-evaluated as well; the positive and negative impact of IP laws should be considered to accelerate sustainable innovations.

Finally, *reporting* and *reliable data sets* are the backbone of governance. Without an established and sweeping dataset, interpretations of companies, industries and countries' performances will be challenged. Tracking, understanding and utilizing these KPIs will help consumers, businesses, investors, financial institutions and regulators make more sustainable decisions.

Seizing Opportunities in a Circular Economy

For Companies:

- Increasing the circularity of inputs, by using more materials recovered via remanufacturing, repurposing, recycling and upcycling, provides multitude of benefits:
  - An organizations' Scope 1,2 and 3 emissions will decrease.
  - Profits can increase in the short and long run.
    - Substituting linear inputs with circular ones, such as waste streams, can reduce procurement related costs.
    - There may be monetary and fiscal incentives that support the switch to a circular business case.
  - Supply chain related risks are curtailed since sustainable inputs are more reliable, especially in the long run.
  - Implementing processes and technologies that utilize a company's own waste and by-products shortens supply chains.
- Innovation is key to realizing and increasing recovery potential.
  - Water management technologies like reverse osmosis, rainwater harvesting, and brine treatment reduce a company's demand for water. In regions where water crises is already looming, such innovations will reduce the demand on scarce resources and support local biodiversity.
  - Innovations, such as green cement and bioplastics, can increase the circularity of inputs.
  - 3D printing is an auspicious technology for reducing inputs, waste, emissions and costs in addition to shortening supply chains. Firms can be more flexible with their inputs when they use 3D printing and supply chains can become more efficient.
    - In the construction sector, bamboo and plastic waste can be used as building materials. 3D printing structures is not labour-intensive, and some projects can be completed within days; lowering labour and energy related costs makes such projects more feasible which will be critical in ameliorating the housing crises.
    - Products' repairability potential can be increased. In industries where spare parts are in demand such as home appliance sector, components can be printed on demand in stores or even consumers' houses. This way, parts or equipment would not be manufactured in excess, products' lifetimes would be prolonged, supply chains would be shortened and demand for storage space reduced.

- Shifting the focus of research and development to circular economy principles will:
  - Make companies more resilient to changes in the market
  - Make companies leaders in sustainability initiatives, which are still at a relatively early stage in Turkey
  - Increase efficiency and decrease products' environmental footprint

- Private and public organizations can work together via associations, events and councils. Communication will be integral in advancing good practices, sharing resources and optimizing the flow of materials.
- By engaging with their supply chains and customers to gather data on the circularity of their inputs and outputs, companies will collect better information on making their products more efficient and sustainable.
- Sustainability is becoming more salient for publicly traded companies as stock market indexes consider ESG KPIs and non-financial assets more. Growing number of stock exchanges are mandating non-financial reporting and other sustainability related criteria.

For the Authorities:

- Harmonizing regulations, directives and roadmaps with markets that have stricter ESG standards will ensure that Turkish companies stay competitive in those markets.
  - Carbon Border Adjustment Mechanism (CBAM), Green Deal and Circular Economy Action Plan (CEAP), are some of the developments in the European market that will have major implications on trade. Turkey is currently working on its Circular Economy Transition Project[111] which aims to strengthen Turkey's institutional and technical capacity of Turkey in line with the EU Circular Economy Package.
  - Developing and publishing a circular economy action plan will accelerate the Turkey's transition to circular economy.
- Issuing new regulations and policies, updating existing ones and increasing audits can endorse a circular economy.
  - Minimum standards for circular practices will be elevated throughout the nation.
  - Organizations' Scope 1,2 and 3 emissions will be reduced, which will help Turkey achieve its climate goals.
  - While many regulations exist that promote recycling, they can be expanded to promote other circular economy strategies that target the final stages of a product's lifecycle, such as remanufacture, refurbish and repurpose.
- Tracking and reporting system that includes KPIs related with circularity can be established.
  - Accurate and sweeping datasets will result in more reliable assessments and realistic goals which will attract more investment.
  - Traceability system for products' LCAs in all sectors will make it possible to estimate Turkey's circularity rate.
- Increasing monetary incentives such as tax abatements, tax exemptions, subsidies and loans at lower interest rates for circular initiatives will pave the way for new investments, circular business models and R&D.

[111] An Overall Assessment of the Potential of Turkey in the Context of Transition to Circular Economy Project

- Expanding infrastructure that supports circular economy strategies will increase efficiency.
  - Increasing the number of strategically located collection facilities and sorting/recycling centres will exploit economies of scale and increase products' end-of-life recovery potentials.
  - Providing an ecosystem for industrial symbiosis will optimize the flow of materials and information within and among sectors.
- Circular initiatives will generate green jobs and support the national economy.
- Implementing nation-wide circular solutions will support SDGs, lower emissions, limit biodiversity loss and reduce resource consumption. This will lower the impact of historical linear consumption on communities, the economy and natural assets, which will facilitate a more sustainable ecosystem for businesses and people's livelihood.

For Financial Institutions (some major categories include central banks, retail and commercial banks, investment banks, investment companies, credit unions, savings and loans associations, brokerage firms and insurance companies):

- No circular economy transition can be realized without sustainable finance; generating funds for circular strategy investments is one of the pillars of a sustainable economy.
  - For example, from transition to low-carbon transportation to creating "superblocks", finance sector's contribution holds a pivotal position.
  - Sustainable finance market is growing in the Turkish market and all related regulatory bodies such as BBDK and Ministry of Treasury and Finance have published Sustainable Finance related frameworks, guidelines or action plans. Upcoming taxonomy and legal framework studies will boost sustainable investment in Turkish market.
  - In 2021, green bonds accounted for USD 836 million of the USD 3.1 billion bond market in Turkey.
  - New business models, such as sharing models, is pushing insurance companies to device new insurance solutions.
- EU Taxonomy has an important role in scaling up sustainable investments; it serves as a guidance on six environmental objectives which includes the transition to circular economy.
- Financial institutions need to reconcile ESG topics, including circularity, with finance to make more sound deals and transactions in addition to more accurate portfolio and risk assessments.
  - Circular actions taken by businesses and individuals should be factored into assessments since circularity principles cushion the direct and indirect impact of linear consumption and reduce the likelihood of defaults.
- Circularity concept provides a methodology of quantifying environmental performance.
  - New tools and methodologies need to be employed to quantify portfolios and clients' environmental risks and performances. For example, BBVA has developed its own carbon footprint calculator for its clients.
  - Making these data more commonplace will help stakeholders understand and compare results within and across sectors.
  - For instance, the methodology used in this report is designed to measure a business's circularity and it can be used to determine whether an investment is paying off in terms of circularity principles.
  - The Paris Agreement Capital Transition Assessment (PACTA) is another tool that can assess a financial institution's portfolio's alignment with climate scenarios.

- Financial institutions can implement circular solutions in their direct operations.
    - Partnerships or diversifying business operations can generate new revenue streams. Some banks are already expanding their services by facilitating office equipment rentals and shared office space schemes.
    - With hybrid and remote work becoming more standardized, financial intuitions that once used to occupy vast real estate can apply circular principles to spaces that are becoming obsolete.
    - Some banks like Akbank are now switching to circular inputs such as recycled materials to make their credit cards. Banks can engage with their own value chains to facilitate such projects.
- Supporting and investing in their portfolio's transition to a circular economy will improve financial institutions' ESG and financial performance. while mitigating climate, policy, reputation and trade related risks.
    - Financial institutions can lower their Scope 3 emissions.
    - For organizations that have committed to initiatives such as CDP (Carbon Disclosure Project) and SBTi (Science Based Targets Initiative), circularity related ameliorations in the value chain will be integral for materializing their commitments. Financial institutions can partner with other companies in their portfolios to finance the company's supply chain transformation which would boost both organizations' CDP and SBT performances.
- With their vast network and expertise in quantifying risks and opportunities, financial institutions can catalyse change and realize Paris Agreement's mission "to leave no one behind".
    - They can support or lead sectoral studies, events and competitions to improve circularity within industries. For instance, ING Bank has partnered with ABN AMRO and NIBC to develop Responsible Ship Recycling Standards (RSRS).[377]

9. Acknowledgements

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10. Appendix

10.1 Appendix 1: Definitions as defined in the Circularity Calculation Methodology

% circular input

This ratio assesses the circularity rate of input materials. Input materials are the sum of non-renewable, renewable and secondary materials used in production, as classified based on the following definitions:

Non-renewable materials (tonnes): This is the weight of input that has neither been previously used or consumed (virgin) nor is it renewable. Therefore, for these materials, circularity is 0%.

Renewable materials (tonnes): Renewable input is the weight of sustainably managed resource that is replenished/regrown after extraction. Input can consist of either fully or partially of renewable content. Thus, in this case, % circularity input is the % renewable material content.

Secondary materials (tonnes): Secondary material is the weight of previously recovered non-virgin or secondary (reused, refurbished, remanufactured or recycled) materials. Input can consist of either fully or partially of renewable content. Hence, in this case, % circularity input is the % recovered content.

In the event input is both renewable and secondary, it is counted only once in the input in order to prevent double counting.

% circular output

This ratio assesses the circularity rate of output materials. Output materials are the sum of products, by-products and waste generated during and after production and are as classified based on following definitions:

Product (tonnes): These are the weight of the target output of the manufacturing activities.

By-product (tonnes): In some sectors and companies, weight of by-products were included in calculations if data was available.

Waste (tonnes): These are the weight of outputs of the manufacturing activities that, based on a linear model, no longer have economic utility.

% Potential ratio of recovery: This is the potential recoverability rate of outputs based on how they were designed and treated in a way that they can be recovered on a technical, material level at end of life. Recovery design solutions can include disassembly, repairability and recyclability. Recovery potential refers to material recovery but does not include energy recovery.

% Actual recovery: This is the realized recovery rate of outputs that leave the organization and actually find their way back into the value chain (either the same or a different value chain) and covers products, by-products, and waste). Recovery is different from collection. After collection, materials can still end up in landfill or incinerated. For this reason, this indicator is not based on estimates but requires actual data and in case no data is available the actual recovery is deemed to be 0%

Recovery strategies include reuse, repair, refurbish, repurpose, remanufacture, recycle and biodegrade. At present, the methodology for calculating circularity does not distinguish between these recovery strategies used and they all contribute at the same weight to the circularity performance. Nevertheless, tighter loops (such as reuse) are more efficient forms of recovery and allow materials to maintain their inherent value better than larger loops (such as recycling). Recovery strategies include the following:

Reuse: To extend a product's lifetime beyond its intentional designed life span, without changes made to the product or its functionality.

Repair: To extend a product's lifetime by restoring it after breakage or tearing, without changes made to the product or its functionality.

Refurbish: To extend a product's lifetime by large repair, potentially with replacement of parts, without changes made to the product's functionality.

Remanufacture: To disassemble a product to the component level and reassemble (replacing components where necessary) to as-new condition with possible changes made to the functionality of the product.

Recycle: To reduce a product back to its material level, thereby allowing the use of those materials in new products.

Biodegrade: Microbial (bacteria and fungi) breakdown of organic matter in the presence of oxygen to produce soil with high organic (humus) content.

Renewable: - Refers to bio-based sustainably managed resources (most often demonstrated by internationally recognized certification schemes like FSC, PEFC or RSPO) that, after extraction, return to their previous stock levels by natural growth or replenishment processes at a rate in line with use cycles. Therefore, they are replenished or regrown at a faster rate than they are harvested/extracted.

Renewable Energy: - Energy is considered Renewable Energy if it is solar, wind, water, geothermal, tidal or if it comes from sustainably managed bio-based resources (demonstrated by certification), which are harvested at a lower rate than at which natural growth/replenishment occurs and from residues and/or by-products.

Circularity Calculation Formula:

Weight of circular input (tons) = weight of renewable input + weight of secondary (non-virgin) input

% Circularity rate of input = (weight of renewable input + weight of secondary (non-virgin) input) / total weight of all input x100

Weight of circular output (tons) = Total weight of output x % recovery potential x % actual recovery

% Circularity rate of output = Weight of circular output/ Total weight of output x 100

% Actual Recovery of output = Weight of actual recovered output/ Weight of output x 100

% Recovery Potential = Weight of potentially recoverable output / total weight of output x 100 (ranging from 0% if not recoverable, to 100% if fully recoverable

Key Circular Strategies

For each of the sectors covered by this study, key strategies that can be applied within Turkey's context were selected. Strategies were aligned with the material flows at three key intervention points as defined by the circularity calculation methodology and as outlined below. Material flows can include nutrients, compounds, materials, parts, components or even products. By analysing these flows, an organization can determine its ability and ambition to minimize resource extraction and waste material.

Circular Input: Circular resources, materials, products and parts sourced

Output – Recovery Potential: Biodegradable materials and designs that allow technical recovery of components and materials (e.g., by designing for disassembly, repairability, recyclability, etc.)

Output – Actual Recovery: Products, by-products and waste-streams that are recovered for closed-loop applications or open loop recovery schemes

10.2 Appendix 2: Case Studies

The case studies in this report, from Turkey and France, have been categorized based on classifications determined by the European Commission in the report "Categorization System for the Circular Economy" and as outlined below.

Types of Circular Strategies:

0. Refuse: Make product redundant by abandoning its function or by offering the same function by a radically different (e.g. digital) product or service.

1. Rethink: Make product use more intensive (e.g. through product-as-a-service, reuse and sharing models or by putting multi-functional products on the market).

2. Reduce: Increase efficiency in product manufacture or use by consuming fewer natural resources and materials.

3. Re-use: Re-use of a product which is still in good condition and fulfils its original function (and is not waste) for the same purpose for which it was conceived.

4. Repair: Repair and maintenance of defective product so it can be used with its original function.

5. Refurbish: Restore an old product and bring it up to date (to specified quality level).

6. Remanufacture: Use parts of a discarded product in a new product with the same function (and as-new-condition).

7. Repurpose: Use a redundant product or its parts in a new product with different function.

8. Recycle: Recover materials from waste to be reprocessed into new products, materials or substances whether for the original or other purposes. It includes the reprocessing of organic material but does not include energy recovery and the reprocessing into materials that are to be used as fuels or for backfilling operations.

9. Recover: Incinerate materials and waste for energy production

Types of Circular Projects:

1. Circular Design and Production Model: These activities increase resource efficiency through design innovation, process innovation, process re-engineering and/or material innovation and substitution. These changes are implemented at the earlier stages of production, but their benefits are reaped usually towards the end of the lifecycle.

2. Circular Use Model: Efficiency is increased via product and asset lifecycle extension based on reuse, repair, repurposing, refurbishment or remanufacturing strategies and/or product and asset use-optimizing leasing and sharing models. These activities take place during or at the end of the use phase.

3. Circular Value Recovery Model: Waste is recovered for reuse, recycling or other circular economy strategies to increase efficiency. This process takes place at the after-use phase of the products or assets.

4. Circular Support: These enable other circular activities and project to indirectly contribute to increasing resource efficiency.

10.3 Appendix 3: Key Sources for data used in the circular performance calculations for sectors covered by this study

Table 31: Plastic Packaging Sector (1/6)

Material	Data Type	Sources	Explanation
PET	Weight	Weight: 2020 Domestic Usage-Raw Material: page 27, Table 23 https://pagev.org/upload/files/T%C3%BCrkiye%20Plastik%20Sekt%C3%B6r%20%C4%B0zleme%20Raporu%202020%20revize%20%283%29.pdf Ratio of PET: page 19, graph 12. https://pagev.org/upload/files/T%C3%BCrkiye%20Plastik%20Sekt%C3%B6r%20%C4%B0zleme%20Raporu%202020%20revize%20%283%29.pdf	Ratios from PAGEV Sector Report 2020/. plastic raw material usage used for each type of category calculation. Ratios are used with the 2020 Total Domestic Consumption amount
PET	Non-renewable Materials	Non-Virgin Content: Transparent 2020 report by WWF page 12 Figure 4, https://c402277.ssl.cf1.rackcdn.com/publications/1346/files/original/Transparent_2020.pdf?1591728490	Case study from 5 major plastic packaging producer and consumer (P&G, The Coca-Cola Company, Mc Donalds, Keuring Dr.Pepper, Starbucks) Similar ratios for plastic packaging found from the report, https://www.procarton.com/wp-content/uploads/2018/06/PC-Carton-Plastic-Sustainability.pdf p. 12
PET	Renewable Materials	Non-Virgin Content: Transparent 2020 report by WWF page 12 Figure 4, https://c402277.ssl.cf1.rackcdn.com/publications/1346/files/original/Transparent_2020.pdf?1591728490	Case study from 5 major plastic packaging producer and consumer (P&G, The Cola -Cola Company, Mc Donalds, Keuring Dr. Pepper, Starbucks) Similar ratios for plastic packaging found from the report, https://www.procarton.com/wp-content/uploads/2018/06/PC-Carton-Plastic-Sustainability.pdf p. 12
PET	Secondary Materials	Non-Virgin Content: Transparent 2020 report by WWF page 12 Figure 4, https://c402277.ssl.cf1.rackcdn.com/publications/1346/files/original/Transparent_2020.pdf?1591728490	Case study from 5 major plastic packaging producer and consumer (P&G, The Coca-Cola, Mc Donald's, Keuring Dr. Pepper, Starbucks) Similar ratios for plastic packaging found from the report, https://www.procarton.com/wp-content/uploads/2018/06/PC-Carton-Plastic-Sustainability.pdf p. 12

Table 31: Plastic Packaging Sector (2/6)

Material	Data Type	Sources	Explanation
HDPE	Weight	Weight: 2020 Domestic Usage-Raw Material: page 27, Table 23 https://pagev.org/upload/files/T%C3%BCrkiye%20Plastik%20Sekt%C3%B6r%20%C4%B0zleme%20Raporu%202020%20revize%20%283%29.pdf Ratio of HDPE: page 19, graph 12. https://pagev.org/upload/files/T%C3%BCrkiye%20Plastik%20Sekt%C3%B6r%20%C4%B0zleme%20Raporu%202020%20revize%20%283%29.pdf	Ratios from PAGEV Sector Report 2020. plastic raw material usage used for each type of category calculation. Ratios are used with the 2020 Total Domestic Consumption amount
HDPE	Non-renewable Materials	Non-Virgin Content: Transparent 2020 report by WWF page 12 Figure 4, https://c402277.ssl.cf1.rackcdn.com/publications/1346/files/original/Transparent_2020.pdf?1591728490	Case study from 5 major plastic packaging producer and consumer (P&G, The Coca-Cola Company, Mc Donalds, Keuring Dr. Pepper, Starbucks) Similar ratios for plastic packaging found from the report, https://www.procarton.com/wp-content/uploads/2018/06/PC-Carton-Plastic-Sustainability.pdf p. 12
HDPE	Renewable Materials	Non-Virgin Content: Transparent 2020 report by WWF page 12 Figure 4, https://c402277.ssl.cf1.rackcdn.com/publications/1346/files/original/Transparent_2020.pdf?1591728490	Case study from 5 major plastic packaging producer and consumer (P&G, The Coca-Cola Company, Mc Donalds, Keuring Dr. Pepper, Starbucks) Similar ratios for plastic packaging found from the report, https://www.procarton.com/wp-content/uploads/2018/06/PC-Carton-Plastic-Sustainability.pdf p.2
HDPE	Secondary Materials	Non-Virgin Content: Transparent 2020 report by WWF page 12 Figure 4, https://c402277.ssl.cf1.rackcdn.com/publications/1346/files/original/Transparent_2020.pdf?1591728490	Case study from 5 major plastic packaging producer and consumer (P&G, The Coca-Cola Company, Mc Donalds, Keuring Dr.Pepper, Starbucks) Similar ratios for plastic packaging found from the report, https://www.procarton.com/wp-content/uploads/2018/06/PC-Carton-Plastic-Sustainability.pdf p. 12

Table 31: Plastic Packaging Sector (3/6)

Material	Data Type	Sources	Explanation
PVC - Polyvinyl Chloride	Weight	Weight: 2020 Domestic Usage-Raw Material: page 27, Table 23 https://pagev.org/upload/files/T%C3%BCrkiye%20Plastik%20Sekt%C3%B6r%20%C4%B0zleme%20Raporu%202020%20revize%20%283%29.pdf Ratio of PVC: page 19, graph 12. https://pagev.org/upload/files/T%C3%BCrkiye%20Plastik%20Sekt%C3%B6r%20%C4%B0zleme%20Raporu%202020%20revize%20%283%29.pdf	Ratios from PAGEV Sector Report 2020. plastic raw material usage used for each type of category calculation. Ratios are used with the 2020 Total Domestic Consumption amount
PVC - Polyvinyl Chloride	Non-renewable Materials	Calculated as remaining %	
PVC - Polyvinyl Chloride	Renewable Materials	0	Due to our online research we were not able to find any proof for a renewable content in PVC production. Therefore, we assumed this content as 0%.
PVC - Polyvinyl Chloride	Secondary Materials	https://learn.eartheasy.com/articles/plastics-by-the-numbers/	Products made using PVC plastic are not recyclable.
LDPE - Low Density Polyethylene	Weight	Weight: 2020 Domestic Usage-Raw Material: page 27, Table 23 https://pagev.org/upload/files/T%C3%BCrkiye%20Plastik%20Sekt%C3%B6r%20%C4%B0zleme%20Raporu%202020%20revize%20%283%29.pdf Ratio of LDPE: page 19, graph 12. https://pagev.org/upload/files/T%C3%BCrkiye%20Plastik%20Sekt%C3%B6r%20%C4%B0zleme%20Raporu%202020%20revize%20%283%29.pdf	Ratios from PAGEV Sector Report 2020. plastic raw material usage used for each type of category calculation. Ratios are used with the 2020 Total Domestic Consumption amount
LDPE - Low Density Polyethylene	Non-renewable Materials	Non-Virgin Content: Transparent 2020 report by WWF page 12 Figure 4, https://c402277.ssl.cf1.rackcdn.com/publications/1346/files/original/Transparent_2020.pdf?1591728490	Case study from 5 major plastic packaging producer and consumer (P&G, The Coca-Cola Company, Mc Donalds, Keuring Dr. Pepper, Starbucks) Similar ratios for plastic packaging found from the report, https://www.procarton.com/wp-content/uploads/2018/06/PC-Carton-Plastic-Sustainability.pdf p.2

Table 31: Plastic Packaging Sector (4/6)

Material	Data Type	Sources	Explanation
LDPE - Low Density Polyethylene	Renewable Materials	Non-Virgin Content: Transparent 2020 report by WWF page 12 Figure 4, https://c402277.ssl.cf1.rackcdn.com/publications/1346/files/original/Transparent_2020.pdf?1591728490	Case study from 5 major plastic packaging producer and consumer (P&G, The Coca-Cola Company, Mc Donalds, Keuring Dr.Pepper, Starbucks) Similar ratios for plastic packaging found from the report, https://www.procarton.com/wp-content/uploads/2018/06/PC-Carton-Plastic-Sustainability.pdf p. 12
LDPE - Low Density Poly Ethylene	Secondary Materials	Non-Virgin Content: Transparent 2020 report by WWF page 12 Figure 4, https://c402277.ssl.cf1.rackcdn.com/publications/1346/files/original/Transparent_2020.pdf?1591728490	Case study from 5 major plastic packaging producer and consumer (P&G, CocaCola, Mc Donalds, Keuring Dr.Pepper, Starbucks) Similar ratios for plastic packaging found from the report, https://www.procarton.com/wp-content/uploads/2018/06/PC-Carton-Plastic-Sustainability.pdf p. 12
PP - Polypropylene	Weight	Weight: 2020 Domestic Usage-Raw Material: page 27, Table 23 https://pagev.org/upload/files/T%C3%BCrkiye%20Plastik%20Sekt%C3%B6r%20%C4%B0zleme%20Raporu%202020%20revize%20%283%29.pdf Ratio of PP: page 19, graph 12. https://pagev.org/upload/files/T%C3%BCrkiye%20Plastik%20Sekt%C3%B6r%20%C4%B0zleme%20Raporu%202020%20revize%20%283%29.pdf	Ratios from PAGEV Sector Report 2020. plastic raw material usage used for each type of category calculation. Ratios are used with the 2020 Total Domestic Consumption amount
PP - Polypropylene	Non-renewable Materials	Non-Virgin Content: Transparent 2020 report by WWF page 12 Figure 4, https://c402277.ssl.cf1.rackcdn.com/publications/1346/files/original/Transparent_2020.pdf?1591728490	Case study from 5 major plastic packaging producer and consumer (P&G, CocaCola, Mc Donalds, Keuring Dr.Pepper, Starbucks) Similar ratios for plastic packaging found from the report, https://www.procarton.com/wp-content/uploads/2018/06/PC-Carton-Plastic-Sustainability.pdf p. 12
PP - Polypropylene	Renewable Materials	Non-Virgin Content: Transparent 2020 report by WWF page 12 Figure 4, https://c402277.ssl.cf1.rackcdn.com/publications/1346/files/original/Transparent_2020.pdf?1591728490	Case study from 5 major plastic packaging producer and consumer (P&G, CocaCola, Mc Donalds, Keuring Dr.Pepper, Starbucks) Similar ratios for plastic packaging found from the report, https://www.procarton.com/wp-content/uploads/2018/06/PC-Carton-Plastic-Sustainability.pdf p. 12

Table 31: Plastic Packaging Sector (5/6)

Material	Data Type	Sources	Explanation
PP - Polypropylene	Secondary Materials	Non-Virgin Content: Transparent 2020 report by WWF page 12 Figure 4, https://c402277.ssl.cf1.rackcdn.com/publications/1346/files/original/Transparent_2020.pdf?1591728490	Case study from 5 major plastic packaging producer and consumer (P&G, CocaCola, Mc Donalds, Keuring Dr.Pepper, Starbucks) Similar ratios for plastic packaging found from the report, https://www.procarton.com/wp-content/uploads/2018/06/PC-Carton-Plastic-Sustainability.pdf p. 12
PS - Polystyrene	Weight	Weight: 2020 Domestic Usage-Raw Material: page 27, Table 23 https://pagev.org/upload/files/T%C3%BCrkiye%20Plastik%20Sekt%C3%B6r%20%C4%B0zleme%20Raporu%202020%20revize%20%283%29.pdf Ratio of PS: page 19, graph 12. https://pagev.org/upload/files/T%C3%BCrkiye%20Plastik%20Sekt%C3%B6r%20%C4%B0zleme%20Raporu%202020%20revize%20%283%29.pdf	Ratios from PAGEV Sector Report 2020. plastic raw material usage used for each type of category calculation. Ratios are used with the 2020 Total Domestic Consumption amount
PS - Polystyrene	Non-renewable Materials	Calculated as remaining %	non-renewable virgin content: remaining amount as 100% used.
PS - Polystyrene	Renewable Materials	0	Renewable content, with the lack of supporting information on PS production renewable content use, we took 0% as an assumption.
PS - Polystyrene	Secondary Materials	https://learn.eartheasy.com/articles/plastics-by-the-numbers/	Non virgin content - Recycling is not widely available for polystyrene products.
Plastics Packaging Materials	Weight	2020 Plastic Good total production page 27, Table 23 https://pagev.org/upload/files/T%C3%BCrkiye%20Plastik%20Sekt%C3%B6r%20%C4%B0zleme%20Raporu%202020%20revize%20%283%29.pdf page 10, graph 3 plastic packaging goods / 2020 Plastic Good total production page 18, Table 12 https://pagev.org/upload/files/T%C3%BCrkiye%20Plastik%20Sekt%C3%B6r%20%C4%B0zleme%20Raporu%202020%20revize%20%283%29.pdf	In the report, total plastic goods production number is given with the packaging breakdown. this ratio is taken into account for downsizing total amounts for packaging purposes. The total weight of 2020 plastic packaging is calculated according to this assumption. Pls see the calculation in the appendix sheet.

Table 31: Plastic Packaging Sector (6/6)

Material	Data Type	Sources	Explanation
Plastics Packaging Materials	Potential Ratio of Recovery	Recovery Potential for PS,PP,PET, HDPE,LDPE assumed as 100% taken from a survey For PVC Recovery Potential https://www.recyclingtoday.com/article/recovinyl-axion-vinyl-pvc-recycling-uk-ireland/, this case study rate taken as potential due to the lack of information about PVC recovery potential and PVC recovery potential in Turkey.	85%= Recovery Potential for PS,PP,PET, HDPE,LDPE assumed as 100% taken from a survey 15%= For PVC Recovery Potential 18%: https://www.recyclingtoday.com/article/recovinyl-axion-vinyl-pvc-recycling-uk-ireland/, this case study rate taken as potential due to the lack of information about PVC recovery potential and PVC recovery potential in Turkey. Rates are weighted with their weights in the total production number.
Plastics Packaging Materials	Actual Recovery	Actual Recovery: https://webdosya.csb.gov.tr/db/cygm/icerikler/2018ambalajbulten_20200303-20200303123731.pdf	(Recovered + Returnable) / (Production)

Table 32: Textile Sector (1/4)

Material	Data Type	Sources	Explanation
Cotton	Weight	Annual Industrial Products Production Statistics 2019 numbers for "Cotton sewing thread, Cotton, carded or combed, cotton yarn (other than sewing thread)" from TUIK Mega Data	
Cotton	Non-renewable Materials	Calculated as remaining %	Circularity calculation methodology approach for each material circularity content is that each material's composition was assumed to be Non-renewable Virgin content + Non-virgin Content + Renewable Content = 100%. For data where no circularity content could be found, it is assumed that the non-renewable virgin content is 100%.
Cotton	Renewable Materials	Renewable Cotton: page 62 "2.34% of Turkey's cotton is organicé from Textile Exchange Report https://textileexchange.org/wp-content/uploads/2020/08/Textile-Exchange_Organic-Cotton-Market-Report_2020-20200810.pdf	
Cotton	Secondary Materials	Non-virgin cotton %, page 98 https://www.ellenmacarthurfoundation.org/assets/downloads/publications/A-New-Textiles-Economy_Full-Report.pdf	In the report it is mentioned as "currently only use around 20% recycled cotton from used clothing"
Wool	Weight	Annual Industrial Products Production Statistics 2019 numbers for "Wool, degreased or carbonized, not carded or combed, Yarn of wool put up or not put up for retail store" from TUIK Mega Data	
Wool	Non-renewable Materials	Non-renewable virgin content, Renewable content, non-virgin wool from Textile Exchange Materials Impact Dashboard 2019, Link: https://mci.textileexchange.org/dashboard/	Volume of wool reported: 62,525 tons Share conventional: 57,988 tons Conventional (93%)
Wool	Renewable Materials	% Renewable content, % of non-virgin wool from Textile Exchange Materials Impact Dashboard 2019, Link: https://mci.textileexchange.org/dashboard/	Volume of wool reported: 62,525 tons Share preferred, renewable: 2,088 tons Preferred, renewable (3%)
Wool	Secondary Materials	% Renewable content, % of non-virgin wool from Textile Exchange Materials Impact Dashboard 2019, Link: https://mci.textileexchange.org/dashboard/	Volume of wool reported: 62,525 tons Share preferred, recycled: 2,449 tons Preferred, recycled (4%)

Table 32: Textile Sector (2/4)

Material	Data Type	Sources	Explanation
Viscose	Weight	Annual Industrial Products Production Statistics 2019 numbers for "Viscose high tenacity filament yarn" from TUIK Mega Data	
Viscose	Non-renewable Materials	% Renewable content, % of non-virgin from "Manmade Cellulosics" in Textile Exchange Materials Impact Dashboard 2019, Link: https://mci.textileexchange.org/dashboard/	Volume of manmade cellulosics reported: Conventional (68%) Preferred, recycled (<1%) Preferred, renewable (32%)
Viscose	Renewable Materials	% Renewable content, % of non-virgin from "Manmade Cellulosics" in Textile Exchange Materials Impact Dashboard 2019, Link: https://mci.textileexchange.org/dashboard/	Volume of manmade cellulosics reported: Conventional (68%) Preferred, recycled (<1%) Preferred, renewable (32%)
Viscose	Secondary Materials	% Renewable content, % of non-virgin from "Manmade Cellulosics" in Textile Exchange Materials Impact Dashboard 2019, Link: https://mci.textileexchange.org/dashboard/	Volume of manmade cellulosics reported: Conventional (68%) Preferred, recycled (<1%) Preferred, renewable (32%)
"Synthetic Fibers (polypropylen, polyamid, nylon, acrylic)"	Weight	Annual Industrial Products Production Statistics 2019 numbers for "Yarn of artfifical and synthetic fibers, Yarn of man made filaments" from TUIK Mega Data	
Synthetic Fibers (polypropylen, polyamid, nylon, acrylic)	Non-renewable Materials	Calculated as remaining %	Circularity calculation methodology approach for each material circularity content is that each material's composition was assumed to be Non-renewable Virgin content + Non-virgin Content + Renewable Content = 100%. For data where no circularity content could be found, it is assumed that the non-renewable virgin content is 100%.
Synthetic Fibers (polypropylen, polyamid, nylon, acrylic)	Renewable Materials	Assumption as "Synthetic Fibers can not be renewable"	

Table 32: Textile Sector (3/4)

Material	Data Type	Sources	Explanation
Synthetic Fibers (polypropylen, polyamid, nylon, acrylic)	Secondary Materials		Circularity calculation methodology approach for each material circularity content is that each material's composition was assumed to be Non-renewable Virgin content + Non-virgin Content + Renewable Content = 100%. For data where no circularity content could be found, it is assumed that the non-renewable virgin content is 100%.
Organic Fibers (Other vegetable textile fibres)	Weight	Annual Industrial Products Production Statistics 2019 numbers for "Other vegetable textile fibres, processed but not spun" from TUIK Mega Data	
Organic Fibers (Other vegetable textile fibres)	Non-renewable Materials	Calculated as remaining %	Circularity calculation methodology approach for each material circularity content is that each material's composition was assumed to be Non-renewable Virgin content + Non-virgin Content + Renewable Content = 100%. For data where no circularity content could be found, it is assumed that the non-renewable virgin content is 100%.
Organic Fibers (Other vegetable textile fibres)	Renewable Materials	Assumption as "Organic Fibers are renewable"	
Organic Fibers (Other vegetable textile fibres)	Secondary Materials	Calculated as remaining %	Circularity calculation methodology approach for each material circularity content is that each material's composition was assumed to be Non-renewable Virgin content + Non-virgin Content + Renewable Content = 100%. For data where no circularity content could be found, it is assumed that the non-renewable virgin content is 100%.
Textile Products	Weight	Weight textile products data calculated from the TÜİK data according to NACE codes (13 and 20) (https://data.tuik.gov.tr/Bulten/Index?p=Yillik-Sanayi-Urun-(PRODCOM)-Istatistikleri-2019-33600)	
Textile Products	Recovery Potential	% recovery potential from Survey	This has been validated by sectoral associations and experts
Textile Products	Actual Recovery	https://apparelinsider.com/turkey-sets-ambitious-textile-recycling-targets/#:~:text=ISTANBUL%20%E2%80%93%20Turkey%20aims%20to%20increase,ambitious%20new%20waste%20management%20initiative.	The Zero Waste Campaign Turkey aims to increase its textile recycling rate to 35 per cent over the next five years as part of an ambitious new waste management initiative.

Table 32: Textile Sector (4/4)

Material	Data Type	Sources	Explanation
Residual Fabric and Fibres	Weight	Weight residual fabric (döküntü) data calculated from the TÜİK data according to NACE codes (https://data.tuik.gov.tr/Bulten/Index?p=Yillik-Sanayi-Urun-(PRODCOM)-Istatistikleri-2019-33600)	
Residual Fabric and Fibres	Recovery Potential	% recoovery potential from Survey	This has been validated by sectoral associations and experts
Residual Fabric and Fibres	Actual Recovery	https://apparelinsider.com/turkey-sets-ambitious-textile-recycling-targets/#:~:text=ISTANBUL%20%E2%80%93%20Turkey%20aims%20to%20increase,ambitious%20new%20waste%20management%20initiative.	The Zero Waste Campaign
Residual Fabric and Fibres			Turkey aims to increase its textile recycling rate to 35 per cent over the next five years as part of an ambitious new waste management initiative.
Industrial Waste	Weight	page 10 Table 1 https://usaktso.org/dosya/Kurumsal/Trk_Teks_Ger_Don.pdf	Average waste ratio per year is calculated from the report and this ratio is used with the Textile Products amount
Industrial Waste	Recovery Potential	% recoovery potential from Survey	This has been validated by sectoral associations and experts
Industrial Waste	Actual Recovery	https://apparelinsider.com/turkey-sets-ambitious-textile-recycling-targets/#:~:text=ISTANBUL%20%E2%80%93%20Turkey%20aims%20to%20increase,ambitious%20new%20waste%20management%20initiative.	The Zero Waste Campaign Turkey aims to increase its textile recycling rate to 35 per cent over the next five years as part of an ambitious new waste management initiative.

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