GREEN-LOOP

Funded by the European Union

Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or HADEA. Neither the European Union nor the granting authority can be held responsible for them

GREEN-LOOP

Sustainable manufacture systems towards novel bio-based materials

WP7 – Business Model, Replication, and Exploitation

D7.1 GREEN-LOOP Market Analysis [M6]

Version 1.0

Document information

Contractual Due date: 28.02.2023	**Delivery Date**: 28.02.2023
Author(s): AXIA Innovation	
Lead Beneficiary of Deliverable: AXIA Innovation	
Dissemination level: Public	
Nature of the Deliverable: Report	
Internal Reviewers: All Partners	

GREEN LOOP Key Facts

Project title	Sustainable manufacturing systems towards novel bio-based materials
Starting date	09/01/2022
Duration in months	36
Call (part) identifier	TWIN GREEN AND DIGITAL TRANSITION 2021 (HORIZON-CL4-2021-TWIN-TRANSITION-01)
Topic	HORIZON-CL4-2021-TWIN-TRANSITION-01-05 Manufacturing technologies for bio-based materials (Made in Europe Partnership) (RIA)
Consortium	17 organizations. 15 EU Member States + 2 non-EU state

GREEN LOOP Consortium Partners

	Partner	Acronym	Country
1	IDENER RESEARCH & DEVELOPMENT	IDE	ES
2	NATIONAL INSTITUTE OF CHEMISTRY	NIC	SI
3	SLOVENIAN NATIONAL BUILDING AND CIVIL E. I.	ZAG	SI
4	FRAUNHOFER GESELLSCHAFT ZUR FOERDERUNG DER ANGEWANDTEN FORSCHUNG E.V	FHF	DE
5	LABRENTA SRL	LBRT	IT
6	MIXCYCLING SRL	MYX	IT
7	NERO SU BIANCO	NSB	IT
8	GERACE MARIA CRISTINA - TERRE DI ZOE'	TDZ	IT
9	IRIS TECHNOLOGY SOLUTIONS, SOCIEDAD LIMITADA	IRIS	ES
10	GLOWNY INSTYTUT GORNICTWA	GIG	PL
11	AACHEN UNIVERSITY: PROCESS CONTROL ENGINEERING / AACHEN UNIVERSITY: INSTITUTE OF SOCIOLOGY	AAU	DE
12	AUSTRIAN STANDARDS INTERNATIONAL	ASI	AT
13	INSTITUTO DE SOLDADURA E QUALIDADE	ISQ	PT
14	AXIA INNOVATION UG	AXIA	DE
15	ASOCIACIÓN DE INVESTIGACIÓN METALÚRGICA DEL NOROESTE	AIMEN	ES
16	NATIONAL COMPOSITE CENTER	NCC	UK
17	UNIVERSITY OF BRISTOL	UBRIS	UK

GREEN LOOP is a project funded by the European Commission under the Horizon Europe - HORIZON-CL4-2021-TWIN-TRANSITION-01-05- Manufacturing technologies for bio-based materials (Made in Europe Partnership) (RIA) under Grand Agreement Number 101057765.

Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or HADEA. Neither the European Union nor the granting authority can be held responsible for them.

Executive Summary

This report provides an overview of the markets addressed by the GREEN-LOOP project. The content of this analysis is part of the work that will be conducted in WP7 Business Model, Replication, and Exploitation under the actions of Task 7.1 Market Analysis, and Circular Business Planning.

The GREEN-LOOP project innovates with three bio-based value chains that direct their final products to the industrial sectors of construction, packaging, appliances and tools and a preliminary overview of the market is essential to develop a strategy for the exploitation of the project results.

The initial market analysis is performed following a dual approach. The first step consists of providing insights into relevant markets, the market size, tendencies, and market segmentation. A second level of analysis goes further, with the identification of the methodological approach to exploit the current market potential and requirements. This covers an overview of the state-of-the-art business landscape and more specifically the description of the methodology and market tools that will be used to support the market study during the project implementation. The goal of these actions is to provide a comprehensive analysis of the external environment which can affect positively or negatively the development of the new products, using suitable market analysis approaches (i.e., Patent search and Porter´s five analysis) and tools (i.e. SWOT analysis and PESTLE analysis).

The deliverable will be updated during the project, and the final version will be provided in month M36 with a detailed analysis of the strategies towards the optimal plan for market uptake.

Table of Contents

List of Figures

Abbreviations

Abbreviation	Explanation
EU	European Union
GA	Grand Agreement
CAGR	Compound Annual Growth Rate
IP	Intellectual Property
IPR	Intellectual Property Rights
KPI	Key Performance Indicators
TRL	Technology Readiness Level
KERs	Key Exploitable Results
M	Month
PTFE	Polytetrafluoroethylene
EV	Electrical Vehicles
EPA	Environmental Protection Agency
HAP	Hazardous air pollutants
ME	Middle East
GCC	Gulf Cooperation Council
HSE	Health, Safety and Environmental
IPC	International Patent Classification
CPC	Cooperative Patent Classification
UPC	United Stated Patent Classification
SoA	State-of-the-art
ME	Middle East
MEA	Middle East and Africa
WC	Wood composite Material
PEDR	Plan for Exploitation and Dissemination of Results
PESTLE	Political, Economic, Social, Technological, Legal, Environmental
SWOT	Strengths, Weaknesses, Opportunities, Threats
TBD	To be defined
WP	Work Package

1. Introduction

GREEN-LOOP project aims to provide novel bio-based materials solutions through innovative manufacturing techniques and efficiency improvements, through three value chains:

- **Multifunctional rubber panels** with fire resistance and anti-vibrational properties for civil application
- **Bioplastic bottle closures** for the packaging, food and beverage sectors
- **Wood composite bearing**s for plastic injection machines for the appliance and tools sector

The three value chains will be optimized from raw materials to final products using smart manufacturing features, such as artificial intelligence, microwave and ultrasound technology to ensure the optimization of the lines in agreement with the circular economy approach.

To understand the positioning of bio-based manufactured products on the market, AXIA Innovation developed a market analysis strategy (Figure 1), to understand consumer needs along with expectations and further analyse potential entry barriers to the market, thus ensuring the market deployment of innovation.

Figure 1 Market Research Process

The **primary market analysis** of the GREEN-LOOP focuses on the industrial sectors and products considered in the three value chains developed within the project, which are i) multifunctional rubber panels for the construction market, ii) bottle closures for the beverage sector and iii) wood composites bearings for the appliance and tools market.

The information and data collected in the different industrial sectors will provide a framework into which GREEN-LOOP products are targeted to enter. The identification of the markets and their characteristics define a clear picture of the industry, the characteristics, customers, alternative technologies and final

products that potentially cover the needs of the relevant stakeholders. Therefore, a strategic business plan can be designed for each value chain product that allows the definition of the commercial potential. The analysis is included in Chapter 2 of this deliverable.

The **intensive market analysis** includes a more detailed approach where specific characteristics of the market are analyzed. This analysis includes the identification of dominant market players, the analysis of the external and internal environment, and the patent search analysis methodology. All these aspects will provide an overview of the European landscape and will allow the identification of key technologies, geographic areas, and licence opportunities that will support the business planning. This part of the analysis is included in Chapter 3.

2. Primary Market Analysis

This section aims to evaluate the potential market sectors addressed by GREEN-LOOP value chains. The first phase of the market analysis is to understand the nature of the market, its segments and its tendencies. An understanding of the business landscape will lead to identifying the best strategy to exploit the project's results and strategically identify a plan for market uptake.

Once the most relevant key markets are identified it is critical to go a step further to understand whether other similar products are addressing the same market and acting as substitutes. This structured approach led to the segmentation of the market analysis based on the three value chains that are investigated in three different work packages:

1. WP3: Value Chain 1- Multifunctional rubber panels for the construction sector
2. WP4: Value Chain 2- Bottle closure for the food and beverage sector
3. WP5: Value Chain 3 - Wood composites bearings for the tool and appliance sector

The layout of the market analysis for all the sectors reviewed is shown in *Figure 2*.

The three value chain market analysis structure includes the product market and the industry sectors where the products will be targeted.

The updated version of this deliverable will be developed at the final stage of the project in M36 and will include further promising markets where the project results could find a further application (e.g., agriculture, healthcare, and cosmetics).

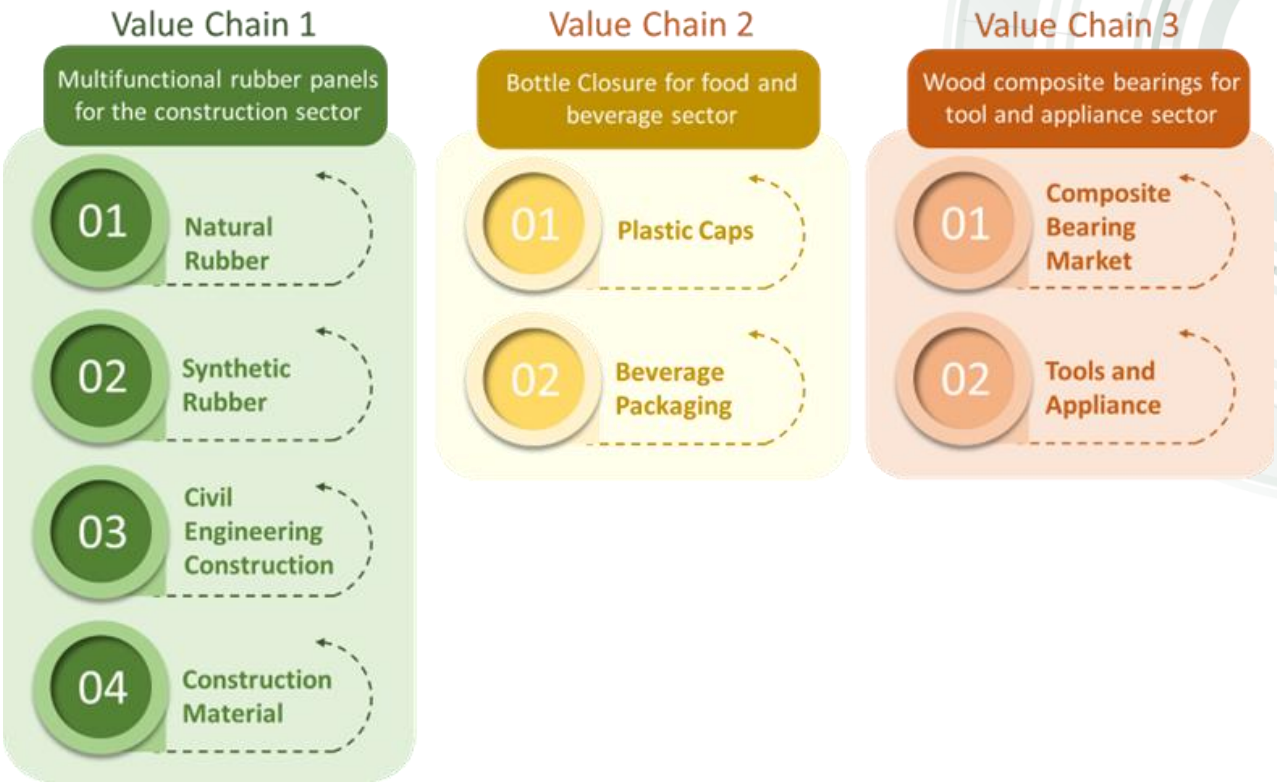

Figure 2. Primary Market Analysis Structure

2.1 GREEN-LOOP Value Chain 1 - Multifunctional rubber panels for the construction sector

WP3 of the GREEN-LOOP project covers the whole value of Bio-rubber production, aiming at using rubber in construction panels. The feedstock will mainly come from recycled tyres, primarily made from natural rubbers and synthetic rubber (e.g., styrene-butadiene rubber, butadiene rubber, etc.) and waste product lignin. GREEN-LOOP will optimise this bio-rubber material up to Technology readiness level (TRL) 5 and further improve it to produce bio-rubber panels with multifunctional fire-retardant and anti-vibrational properties by using lignin from Kraft process residues.

One of the major features of Kraftlignin in the GREEN-LOOP product formulation is the enhancement of the fire retardant properties in the final product, which has high thermal stability. In addition, innovative ultrasound technology will be used to improve the manufacturing process.

These products target the construction industry in a wide variety of uses, such as indoor and outdoor walls or floors. In particular, flame-retardant lignin-rubber composites are directed at the production of

construction panels. This product has a high potential in the market as a renewable material that is gradually attracting more and more attention in this industrial area.

2.1.1 Natural Rubber Market

This section covers the landscape of the market for natural rubber, as it will participate in the first value chain towards the production of bio-based rubbers (as a mix with lignin). The bio-based rubber will act as an enhanced natural rubber, and it is directed to request a market share from the natural one. Its rising route reveals the turn of the market towards more sustainable and natural solutions in the industrial area to support the end-user application.

Market Overview

Between 2023 and 2028, it is projected that the global size of the natural rubber market will grow with a CAGR of 3.5%, and will reach a value of 36 EUR billion in 2028.[1]

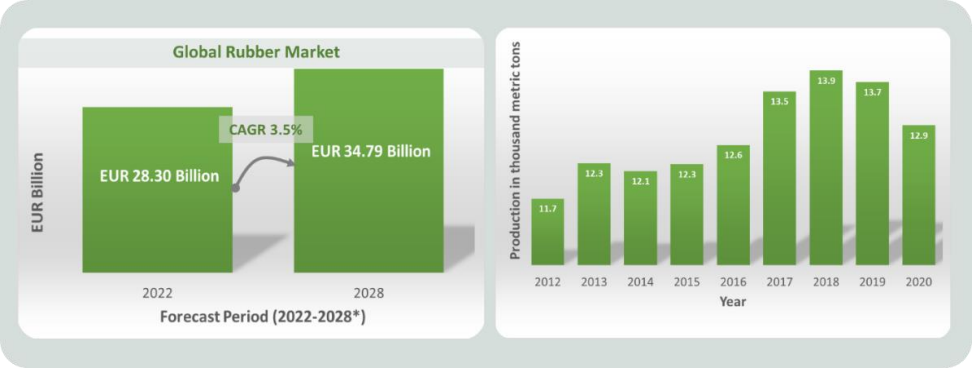

Figure 3. Global Natural rubber forecast projections 2023-2028 (left)[1]/ production from 2012 to 2020 (right)[2]

The worldwide production of natural rubber accounted for 12,945 metric tons in 2020[2]. Figure 4, shows the global natural rubber projections (2023-2028) and the natural rubber production accounted for from previous years (2012-2020).

Drivers

The significant preference for natural rubber over synthetic rubber is based on the growing global environmental concern for sustainable products. Together with the low environmental impact, the characteristics that it provides (high tensile strength, vibration properties, and tear resistance) make natural rubber a better option for the construction and automotive sectors. The growth in the automotive sector

[1] Natural Rubber Market Size, Industry Share, 2023-2028, Trends, Forecast (expertmarketresearch.com)
[2] Natural rubber global production 2020 | Statista

(application in pipes, gaskets, car tyres, hoses, and other parts) together with the additional increase in latex products (catheters, gloves, belts, etc.) had likely contributed to the rise of the natural rubber demand. It should be noted that the decrease over the years 2019 (the market drives the fall, being China the world's largest importer and consumer of natural rubber, consuming around 40.0% of total global production annually) and 2020 (Figure 4) is due to the global pandemic Covid-19 and the restrictions of lockdown that negatively affected the supply of raw materials.

Market Segmentation

The largest end-user of natural rubbers is the automotive industry (automobile tyres accounted for 46% of the global market in 2019). Natural rubber is also used in the footwear industry (17% of the global market in 2019) for the production of casual and formal footwear that exploits properties such as durability, slip resistance, tensile resistance, etc. Other uses of natural rubber are directed at the infrastructure and construction industry (e.g., tubes that occupy 15% of the global market in 2019) and alternative latex products. Figure 4 describes the different market segmentation per type of product, application area and geographic area that will be analysed in the next paragraph[3].

Figure 4. Natural Rubber Market segmentation[4]

Regional Analysis

The natural rubber market is established in North America, Latin America, Europe, the Middle East, Africa, and Asia Pacific. Asia-Pacific dominates the market (Figure 5) once Thailand, Malaysia and Indonesia are some

[3] https://www.mordorintelligence.com/industry-reports/natural-rubber-market
[4] https://www.marketsandmarkets.com/Market-Reports/natural-rubber-market-6581337.html

of the dominant natural rubber producers. Among key consumers, China is one of the main players as one of the three basic automobile manufacturers in the world.

In Europe in 2017, natural rubber was listed as a critical raw material[6] that gives priority status in EU policies on trade and research (e.g., projects based on dandelion and guayule). Natural Rubbers in the EU are 100% imported with 20% sourced from Africa. The countries that play a key role in the EU natural rubber market are Germany, Italy, France, and Turkey, which are mainly representing the automotive leaders in this region consuming the material to produce automotive parts.[7]

Figure 5 Market share by regions in % Global (2021)[5]

2.1.2 Synthetic Rubber Market

The analysis below covers the business landscape of synthetic rubber as a competitive alternative to the bio-based rubber that GREEN-LOOP proposes.

Market Overview

Synthetic rubber is an artificial polymer (elastomers) produced in conventional petroleum synthesis as a by-product and characterised by resistance to oil and water (abrasion), elasticity and high durability. The market for synthetic rubber is growing with a significant CACR of 6.34% by 2030 (Figure 6). The main parameter that plays a role in the increment is the price, which is lower than the natural rubber one.

[5] https://www.mordorintelligence.com/industry-reports/natural-rubber-market
[6] https://single-market-economy.ec.europa.eu/sectors/raw-materials/areas-specific-interest/critical-raw-materials_en
[7] https://www.etrma.org/key-topics/materials/natural-rubber/

Drivers

The application of industrial rubber in the automotive industry (including both tyre and non-tyre applications) is a leading force for market growth. However, at the same time, disruptive factors have been impacting the supply chain in this market. The COVID-19 pandemic and the trends of a circular economy that lead to car rentals have decreased sales in 2020. In addition to these, the different rigorous environmental regulations are putting elimination factors to the production of synthetic rubber (tyre manufacturing and rubber processing are two primary sources of hazardous air pollutants (HAP), according to the Environmental Protection Agency (EPA)). Despite the different obstacles, the shift of the automotive sector toward electric vehicles (EVs) is an opportunity to use synthetic rubber (due to its high-performance characteristics) instead of traditional metals and other materials. Based on the recovery trend of the automotive industry after the pandemic and the penetration of EVs worldwide, the forecast of the demand for synthetic rubber is highly encouraging, and another[10] important aspect determining how the demand and the supply are balanced is the market prices. As synthetic rubber is a crude oil-based product, differentiation in the oil process might lead to higher production, eliminating the profit margins. Many of the different segments of the markets that synthetic rubber is addressed are price sensitive. This causes an increase in the prices for consumers and therefore a reduction of the industrial rubber demand.

Figure 6. Global Synthetic rubber forecast projections 2023-2028 [8,9]

Market Segmentation

Industrial rubber can be divided according to the phase of the raw material in a solid and liquid state. However, market segmentation follows the basic parameter of the chemical type and the application field

[8] https://www.maximizemarketresearch.com/market-report/synthetic-rubber-market/513/
[9] https://www.precedenceresearch.com/synthetic-rubber-market
[10] https://www.marketsandmarkets.com/Market-Reports/synthetic-rubber-market-761.html

(Figure 7). The basic application that leads the market is the automotive sector. Specifically, the automotive tyre segment contributed to the largest revenue share in 2020. Furthermore, industrial goods constitute a robust revenue share due to the high resistive power and durability properties that industrial rubber conveys to the final products.[11]

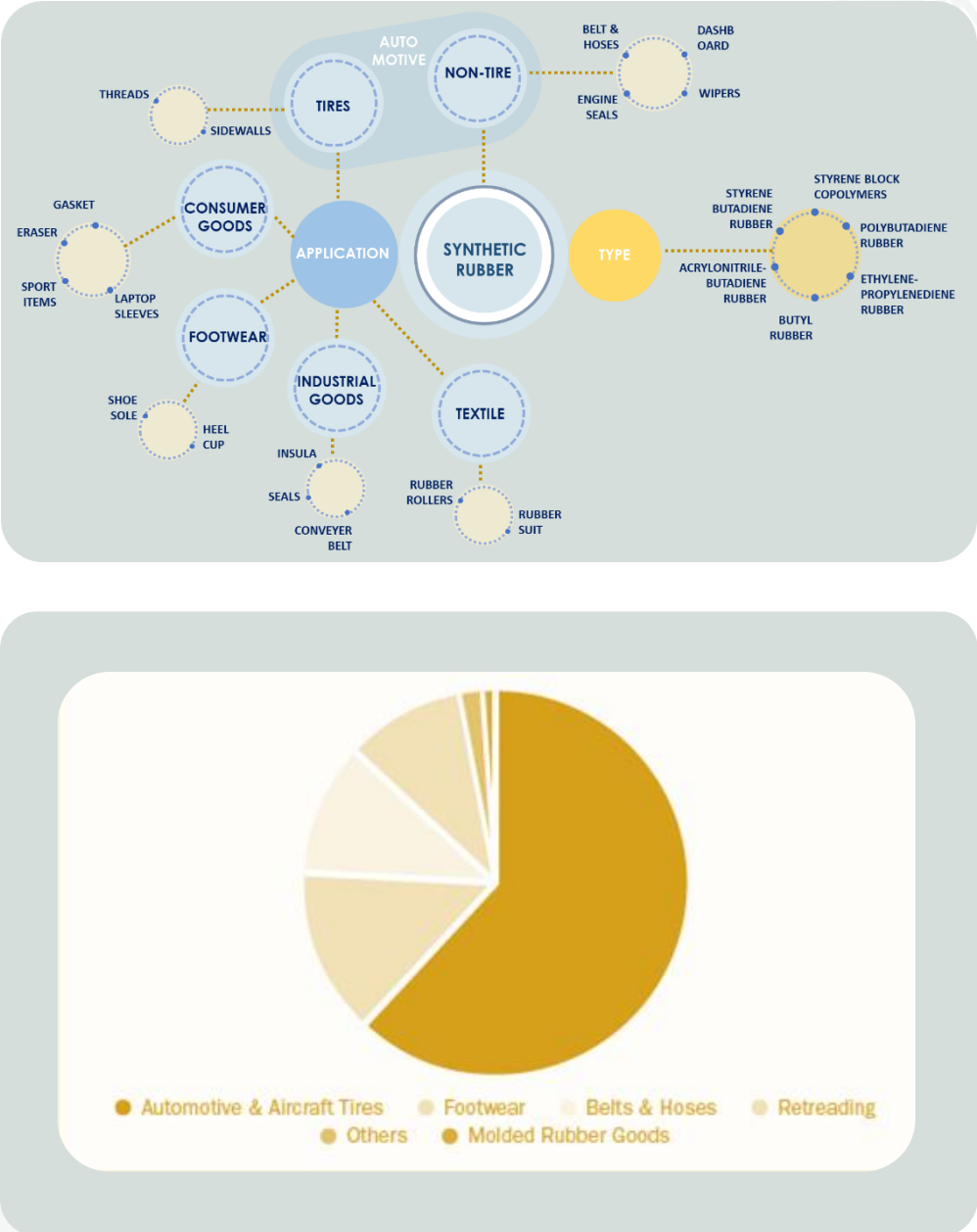

Figure 7. Global Synthetic rubber forecast projections 2023-2028[10] and Global Reclaim Rubber Market[12]

[11] https://www.emergenresearch.com/industry-report/synthetic-rubber-market
[12] https://www.grandviewresearch.com/industry-analysis/reclaimed-rubber-market

Regional Analysis

The dominant player in the synthetic rubber market in 2021 was ASIA Pacific, followed by Europe and North America (Figure 8). The main driving industrial forces are based in China and Southeast Asia nations, including automobile tyre and non-tyre applications.[10] Further, particular types of industrial rubber (nitrile rubber and styrene butadiene rubber) are increasingly becoming a promising area for long-established and newcomer companies in China, Australia, and India.

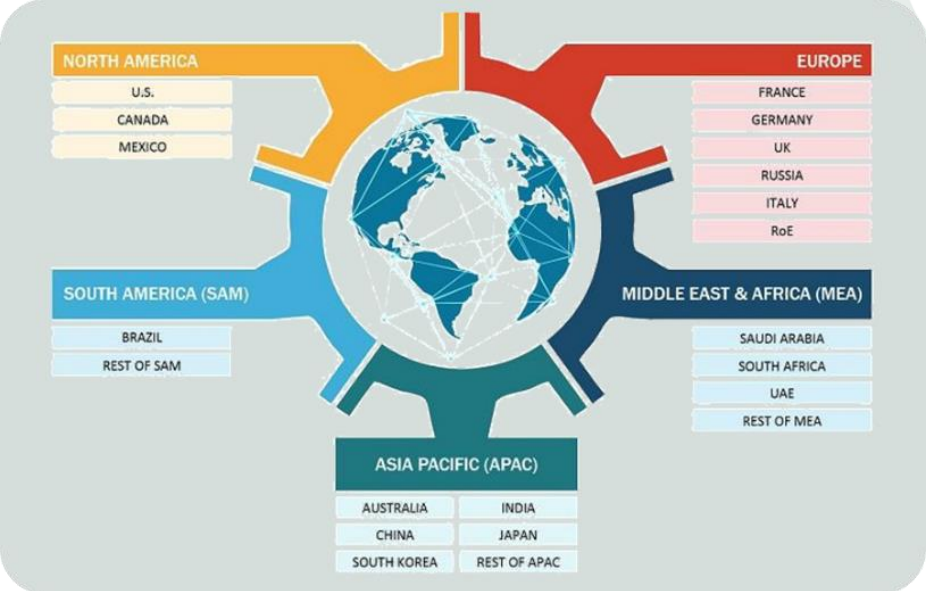

Figure 8. Global Synthetic Rubber Forecast Projections 2023-2028 [13]

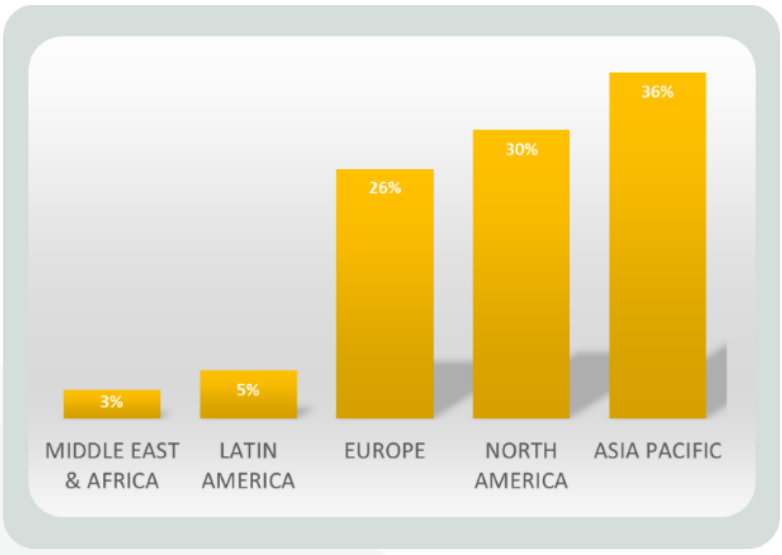

Figure 9. Synthetic Rubber Market Share, by Region, 2021 (%)[13]

On the other hand, the market in Europe is forecast to be positive (expanding nitrile rubber demand) for industrial products, footwear tyres, hoses, and belts. The main players in the EU are Germany, France, Italy, and the UK. As also described above, the penetration of EVs constitutes an attractive industrial field which can flourish in Canada and the US leading to regional growth (*Figure 9*).[13]

[13] https://www.grandviewresearch.com/industry-analysis/green-building-materials-market

2.1.3 Civil Engineering Construction Sector

The Global Construction & Building materials market size was valued at EUR 6.7 trillion in 2022 and is projected to grow at a CAGR of 5.53%, estimated to reach EUR 13.38 trillion by 2030. The overall construction market can be split by type of construction into:

- Building Construction
- Heavy and civil engineering construction
- Speciality trade constructors
- Land planning development

From the segments mentioned above, the heavy and civil engineering construction sectors (which are those addressed by GREEN-LOOP products) represented 44.8% of the total market in 2021.[14]

Market Overview

Heavy and Civil Engineering Construction

Figure 10 shows the size of the market and its expansion during the next 10 years with a CAGR growth of 6.4%. The largest representatives in this market are small and medium enterprises (SMEs) accounting for 51.8% of the total market in 2021. At the same time, large enterprises are expected to grow faster with a CAGR of 7.3%.[14] The growth of the market size is related to the increase in infrastructure

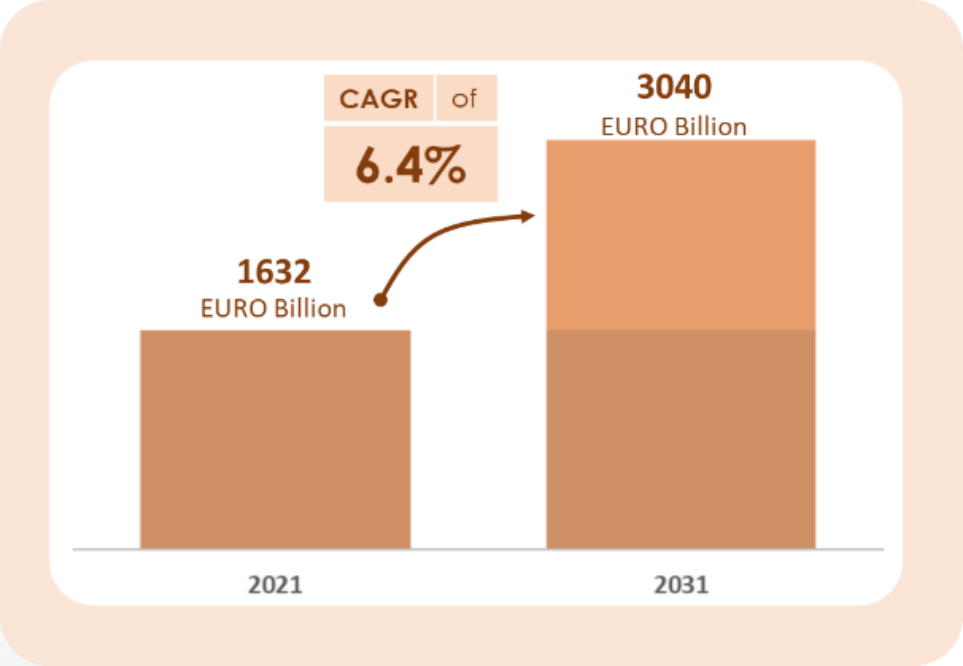

Figure 10. Heavy and Civil Engineering Construction Market[14]

[14] https://www.researchandmarkets.com/reports/5639093/heavy-and-civil-engineering-construction-global

activities. These include the design and maintenance of the infrastructure and publicly owned works such as bridges, pipelines, railways, buildings, airports, etc.

Construction Materials

The building material industry is a rising market driven by commercial activities toward a modern infrastructure. New technologies and innovative building materials are some of the contributing factors in construction. The analysis requires a glimpse of the new tendencies of material construction, which contribute to the environmental benefit and energy-efficient building standards. The development of the so-called green building material is also rising with a CAGR of 9% for 2020-2024.[16] The growth is supported by the local increasing governmental initiatives of the building standard.

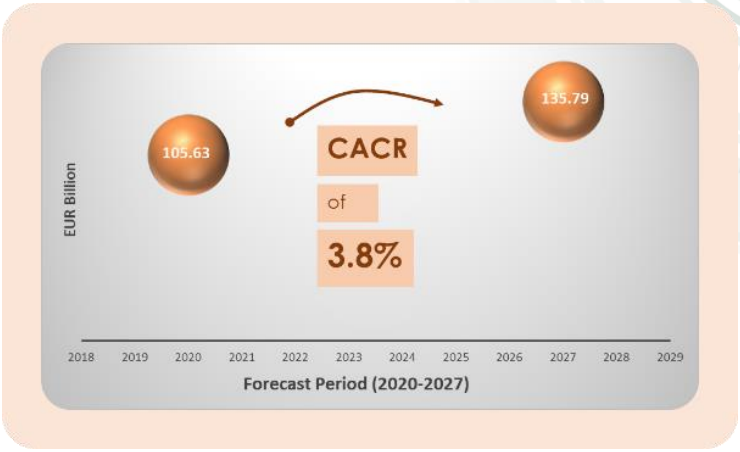

Figure 11. European Market forecast for the construction materials[15].

Drivers

Heavy and Civil Engineering Construction

The market witnesses enormous growth that is derived from the rise of disposable income together with new technological advances in civil engineering. Further, a critical parameter for this rapid growth is the **urbanisation of the global population** (e.g., according to data from the United Nations (U.N) more than 54% of the global population is living in urban areas) to generate employment opportunities, thus enhancing the income level of the individuals. Additionally, an increase in innovative solutions in alternative construction materials is a leading force in the construction industry. Thus, new civil designs are expected within the forecasted periods such as green building materials for the minimization of energy use together with the innovative concept of smart cities which are built around the public infrastructure, industrial plants etc.[17]

[15]https://www.gminsights.com/industry-analysis/europe-building-materials-market

[16]https://www.prnewswire.com/news-releases/green-building-materials-market-to-grow-by-usd-132-13-billionkey-drivers-and-market-forecasts17000-technavio-research-reports-301314302.html

[17] https://www.alliedmarketresearch.com/civil-engineering-market-A10707

Finally, the growth in the real estate sector in developing countries such as Asia-Pacific, India and China is also contributing to the rise of the civil engineering market.[18]

Construction Materials

Different parameters contribute to the increase of market growth in construction materials. Different innovative initiatives such as smart cities and alternative material components such as green buildings are supported by various governments in Europe, thus propelling the market growth. The demand for different urban services (public transportation, road networks) leads to the need for novel sustainable smart designs with the regulation of green buildings shifting the focus toward high-performance materials. The incorporation of new technological advances will lead to the growing production of these innovative materials.

Market Segmentation

Heavy and Civil Engineering Construction

The civil engineering market can be segmented as shown in Figure 12 according to service, application area, customer group, and activity region.

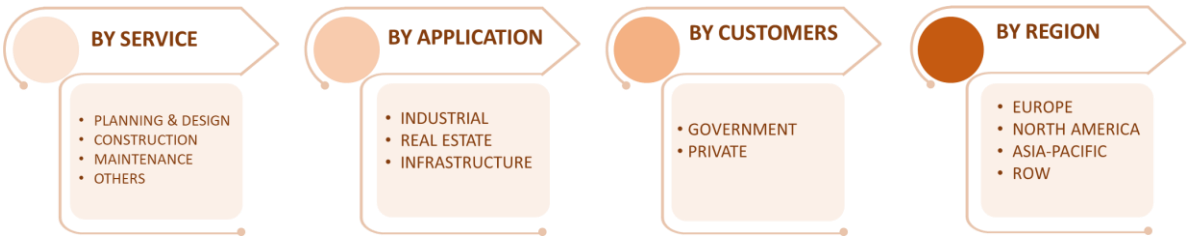

Figure 12 Civil Engineering Construction Market segmentation[17]

Construction Materials

The construction material market can be categorised on the basis of the different applications. In 2022, the insulation material is estimated to be the largest application segment, accounting for 80.44 billion EURO . The basic critical factor contributing to this fact is the achievement of energy conservation due to this material. The second large application is roofing followed by farming. All these products include rubber, slag sludge, stone granules, and corrugated mixed paper. The market is represented by the growing popularity of

[18] https://menafn.com/1098208065/India-Civil-Engineering-Market-2019-Global-Industry-Size-Share-Top-Leaders-Gross-Margin-Analysis-Emerging-Trends-Opportunity-Assessment-and-Regional-Forecast-By-2023

non-toxic recycled rubber for roofing purposes, handling properties of durability, and weather resistance. This aspect is of critical importance for the GREEN-LOOP initiative since this is exactly the target of the first value chain of the project towards the production of bio-based rubber with enhanced properties.[19] Figure 13 includes the drivers of the European market per country and interest.

Figure 13 Countries in the European Area and active in the construction material market

.

- UK: Growth of the construction sector and expansion of infrastructure renovation projects
- Germany: rising demand for green building material
- France: increasing demand for prefabricated residential buildings
- Belgium: rising demand for repair and maintenance activities
- The Netherlands incentives schemes supporting the construction industry
- Luxemburg: increasing urbanization
- Italy: progression in the wood industry
- Russia: growing awareness towards green building practices
- Rest of Europe: preference for wood-based building products

2.2 GREEN-LOOP Value Chain 2- Bottle closure for the food and beverage sector

WP4 is dedicated to the characterization of the overall value chain of bio-plastic production for bottle closure manufacturing. The value chain begins with natural fibres derived from the agro-industrial sector that are combined with polymeric carriers for the development of innovative composite materials. GREEN-LOOP will optimize the bio-composite material to TRL5 and further upscale the bio-based closure optimising specific properties such as tensile strength, flexural modulus, notched and unnotched impact etc. to achieve the most suitable blend. It is highlighted that the product will also be tested to all the related restrictions coming from the food contact application regulation.

[19] https://www.grandviewresearch.com/industry-analysis/green-building-materials-market

GREEN-LOOP targets the production of bottle closures for spirits and olive oil. These products seem to have significant market potential, making room for a new emerging bio-plastic industrial market. Bio-composites are contributing to the formation of a circular shift in the existing plastic-based industry.

2.2.1 Plastic Caps and Closures

Caps and closures usually represent the smallest part of the packaging of a product. They are the final components, but they have high value since the whole product integrity is relayed on their integrity and effectiveness. Based on the industrial sector for which they are used, they change their shape and functionality to enhance alternative aesthetics and workable purpose.

Market Overview

The global plastic caps and closure market size is currently expected to grow at a CAGR of 6.4% from 2022 to 2028 since they offer significant competitive advantages compared to other materials such as metal, and rubber. Plastic caps are durable, resistant to corrosion, and have versatile properties; these are all desirable characteristics in the packaging sector. The biggest end-use sector closely related to plastic caps is that of the beverage market, which is growing at a CAGR of 3% over the next five years, developing a great foundation that will impact the development of the caps and closure market.[20] In addition to the beverage market, other emerging segments that will propel the demand for plastic bottle closures and caps are estimated to be i) healthcare, ii) cosmetics and toiletries, iii) the automotive industry and iv) cleaning products. [20]

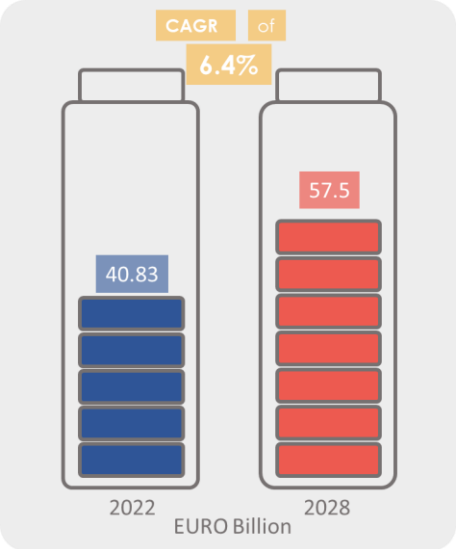

Figure 14. Bottle closures market project market[20]

It should also be noted that in 2022 nearly 97% of the total plastic caps and closures market was coming from thermoplastics, with the[21] properties of high strength, lightweight, and low processing cost contributing to rapid growth in recent years. In GREEN-LOOP thermoplastics, the polymer will be used to produce the bio-composites, and therefore particular attention should also be given to this market sector.

[20] https://www.imarcgroup.com/plastics-caps-closure-market#:~:text=The%20global%20plastic%20caps%20and%20closure%20market%20size,a%20growth%20rate%20%28CAGR%29%20of%205.13%25%20during%202023-2028.
[21] https://www.futuremarketinsights.com/reports/plastic-caps-and-closures-market

Drivers

The basic drivers for the market raise are as follows:

- Technological advances in packaging solution
- Growth in healthy beverage alternatives, sports drinks, ready-to-drink tea, and coffee.
- Steady market growth based on milk and fruit juice

A challenge however is posed by the legislative framework regarding plastic use in contrast with the expected market rise, as the search in this market area has been shifted towards the substitution of plastic caps and closures with more sustainable raw material.[22]

Market Segmentation

The beverage caps market can be segmented by product, raw material, container type, technology, and geography, as shown in Figure 15. The main raw material used for bottle closures and caps is plastic with over 54% in 2020 in terms of revenue, followed by metal, which shows an increasing market position being more sustainable and durable than plastic. Other caps materials are wood and glass[23]. Plastic closures made of Polypropylene (PP) accounted for the largest market share of 45% in 2018, linked to their extensive use in end industries such as the food & beverage sector.

Regarding the product segment, dispensing caps have obtained in 2020 the highest revenue share of 34%.[24] Further to the beverage market, this category of caps can be further used in cosmetics, pharmaceuticals and automotive sectors. Screw caps are also used for bottles in the medicine sector (syrup bottles). The product market segment also includes other types of products, such as cans for the food sector. Further segmentation can be done on the basis of the technology of can manufacturing.

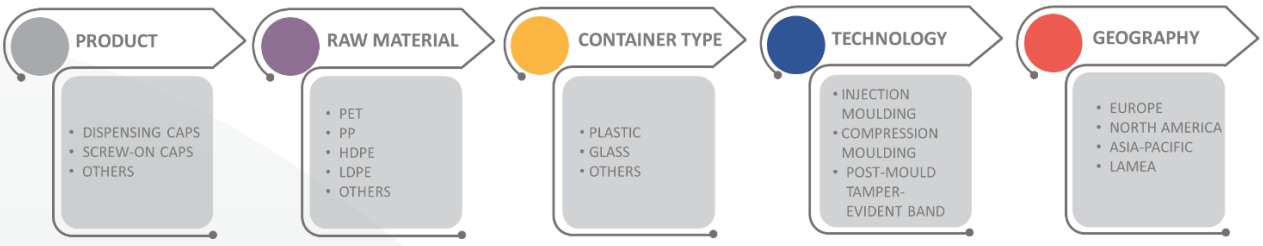

Figure 15. Plastic and Closure Market segmentation[23]

[22] https://www.mordorintelligence.com/industry-reports/beverage-caps-and-closures-market
[23] Caps And Closures Market Size | Industry Report, 2021-2030 (grandviewresearch.com)
[24] https://www.grandviewresearch.com/industry-analysis/caps-and-closures-market

Regional Analysis

Asia Pacific is the leading key industry in the cap and closure market (Figure 16). The change in consumer preferences for energy and nutritional drinks, as well as the increasing amount of alcohol consumed, are some of the main drivers for the flourishing of this market in countries such as India and Taiwan. However, the market is also growing in other parts of the world such as North America (US, Canada) and Europe (Germany, UK, France).

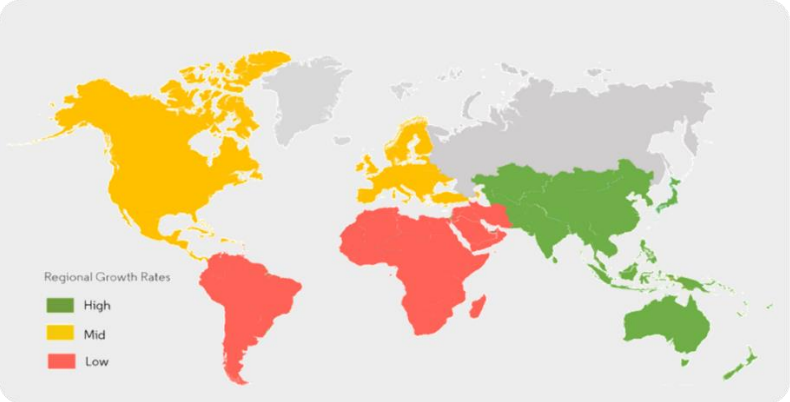

Figure 16. Beverage Caps and Closure Market Growth by regions (2019- 2024)[22]

2.2.2 Beverage Packaging Market

The beverage packaging market is driven by different trends and design innovations that attract customers and by the demand for sustainable packaging solutions. The different types of beverages are using alternative types of materials and different sizes.

Market Overview

Beverage packaging plays a vital role in the general growth of the beverage industry. The global market size is expected to grow at a CAGR of 6.4% between 2021 and 2030. The growth of the market depends on alternative factors including beverage and single-serve packaging.[25]

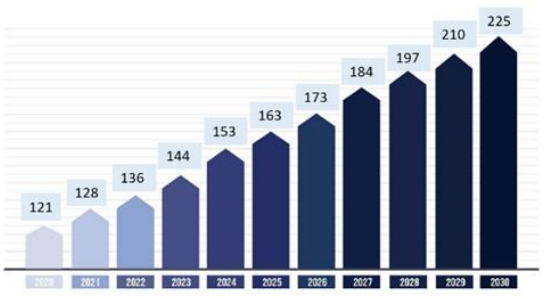

Figure 17. The beverage packaging market in EUR Billion (2020-2030)[25]

[25] https://www.precedenceresearch.com/beverage-packaging-market

Drivers

Beverage packaging witnesses several rising factors such as:

- Demand for smaller pack sizes and cans easily carried by the customers
- Increased demand for bottled water as more consumers continue to make the transition from carbonated drinks to low-sugar drinks
- Energy drinks, functional drinks and in general ready-to-drink are also other key factors that contribute to the market growth

Growing beverage packaging is also facing the great challenge of satisfying the demand for more sustainable packaging solutions, which are compostable, recyclable, and biodegradable. The growing legal restrictions along with government initiatives government also contribute to the potential of a new sustainable packaging market in the global beverage industry.

Market Segmentation

Manufacturers in the beverage industry are committed to offering products that keep the product fresh in user-friendly and sustainable packaging. Based on the different technologies, the beverage industry can be adaptable according to the demands and trends towards healthier, fresher, and less processed foods. The beverage packaging material can be segmented according to material, product, application, and geography (Figure 18).

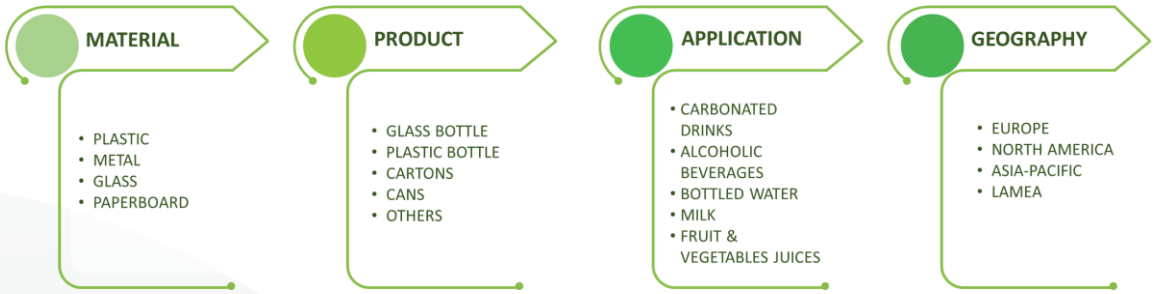

Figure 18. Beverage packaging market Segmentation26

[26] https://www.mordorintelligence.com/industry-reports/beverage-packaging-market#:~:text=The%20Beverage%20Packaging%20Market%20is%20segmented%20by%20Material,Energy%20Drinks%2C%20Plant-based%20Drinks%20%28Emerging%20Market%29%29%2C%20and%20Geography.

Regional Analysis

Half of the beverage market is covered by the Asia Pacific area, with significant growth potential in India, in the next years. The increasing use of disposable products combined with high temperatures increases the need for bottled and canned water in this emerging area. Furthermore, the consumption of non-alcoholic beverages is also contributing to the high incremental growth. In the European area, the United Kingdom, Germany, France, Italy, Spain, Austria, Poland, and Russia are highly engaged in this industrial field.[25]

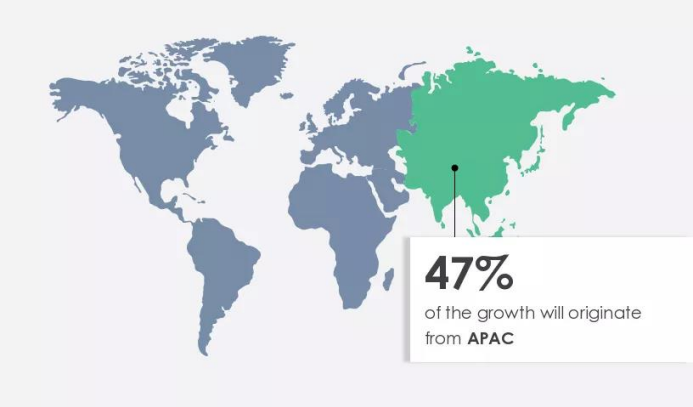

Figure 19. The dominant market regions of the beverage packaging market

2.3 GREEN-LOOP Value Chain 3- Wood composites bearings for the tool and appliance sector

GREEN-LOOP will develop and demonstrate in WP5 the manufacturing of wood composite material (WC) for the production of sliding bears. The matrix will be reinforced using natural wood fibres (or particles) together with the currying of a bio-polymer. Friction properties along with ear and long product lifetime will also be tested in a real-life environment at TRL6.

2.3.1 Composite Bearing Market

Composite bearings are characterised by various properties such as reduction of friction, high-temperature resistance and corrosion resistance. Composite bearings are made up of various materials including fibre-reinforced resin or plastics that are often mixed up with other materials to provide the tailored parameters each time (e.g., Friction reducing polymers such as Polytetrafluoroethylene (PTFE)).

Market Overview

The composite bearing market will be in a growth phase for the next 6 years at a CAGR of 7.29%. These products need to be characterised by high mechanical properties to last longer and require low maintenance. Composite bearings are implemented in a variety of demanding sectors such as construction and mining, agriculture, automotive and others.[28]

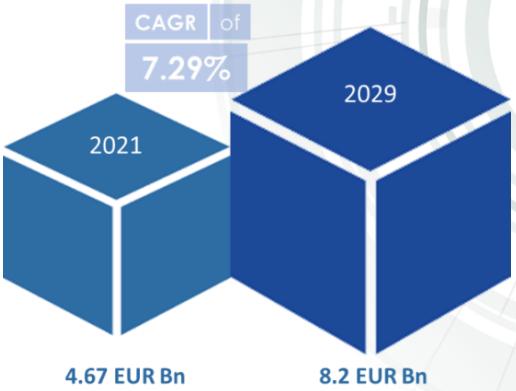

Figure 19. Composite Bearing market[27]

Drivers

The basic driving factor of the market is the need for long-lasting products with low maintenance costs. This aspect formulates the trend in the sector. The demanding and growing sectors of the automotive and aerospace industries are leading the market of composite bearings to continuous growth. Further, the aircraft sector is also demanding lightweight materials and this plays also a vital role in the development of new materials to achieve the optimal design of composite bearings.[29]

Market Segments

The composite bearing market can be characterized by five notable segments based on product type, material, form, application and geography. Below are some relevant features for the mentioned segments:

- The metal matrix segment dominates the global market with a market share of 64.73% as these types of matrices can be easily shaped to serve different types of industries.
- 75.04% of the market share is dominated by the PTFE compound which is used mainly by the automotive sector for interior design products.
- The reduction of vibrations and noise created by engines characterises the global cylindrical bushes market at 39.45%
- The automotive sector dominates the global composite market with a share of 23.34%

[27] https://www.maximizemarketresearch.com/market-report/global-composite-bearings-market/22805/
[28]https://www.marketsandmarkets.com/Market-Reports/composite-bearing-market-241142853.html?gclid=Cj0KCQiA6LyfBhC3ARIsAG4gkF8HfCCRAyF-tcbK5pjT8emcUdYQ8EqEFj4O9FH8b40vz3GyEArUlLcaAs0QEALw_wcB
[29] https://www.persistencemarketresearch.com/market-research/composite-bearings-market.asp

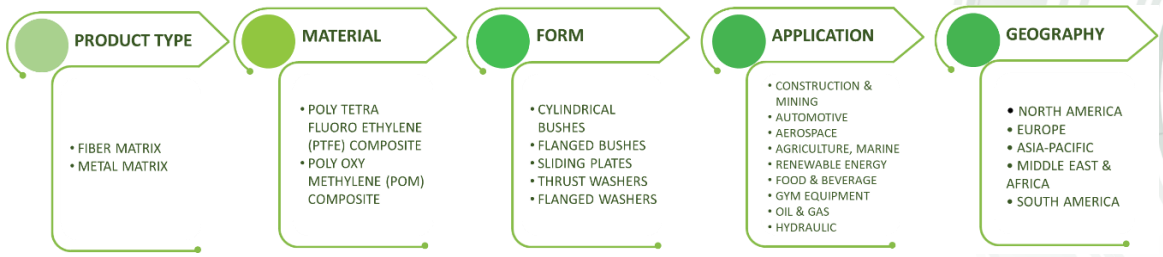

Figure 20. Composite Bearing Market Segmentation[30]

Regional Analysis

The market for composite bearings is increasing globally. North America is the dominant player due to the end user application in the aerospace industry, where the advanced properties of the composite bearing are enhancing the market. The Western European area and Asia Pacific also have a significant share of the global market. This factor is due to the strong presence of automotive, aerospace, construction, and agricultural companies in the area.

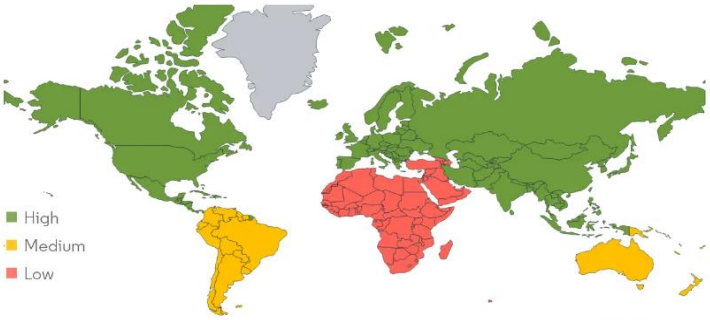

Figure 21. Composite Bearing Market Growth by regions (2019-2024)[22]

2.3.2 Sliding Bearing Market

Sliding friction is generated on the surface of the contact between the moving element and the fixed element. Sliding bearings are bearings in which only sliding friction is generated. In this type of bearing, also known as a plain bearing, the bearing is supported by a sliding surface with oil and air in between to produce the sliding movement.

Market Overview

The global Sliding Bearing market is projected to grow at a CAGR of 7% reaching 1.4 EUR Billion by 2027. The split of the sliding bearing market in the metallic and non-metallic segments is expected to grow at a CAGR of 8% and 6.6% accordingly. The significant market development is related to the wide spectrum of end users in industries such as machinery & equipment, automotive, aerospace & defence, and others.[31]

[30] https://www.databridgemarketresearch.com/press-release/global-composite-bearings-market
[31] https://dataintelo.com/report/sliding-bearing-market/

Drivers

The leading forces in the market developments are based on:

- Increased benefits by the use of bearings
- Increased demand from the automotive sector
- Continuous research of innovative products in the automotive industry in the field of robotics and safety systems, and other attractive features that pose a great challenge in the area of sliding bearings
- A new area of activities such as medical technology, aerospace, and energy[31]

Market Segments

The global sliding bearing market can be segmented as shown in Figure 24 by type, material, bearing type and application. Most of the related features were already discussed in the previous paragraphs and will be eventually further developed in the next period considering the GREEN-LOOP results.

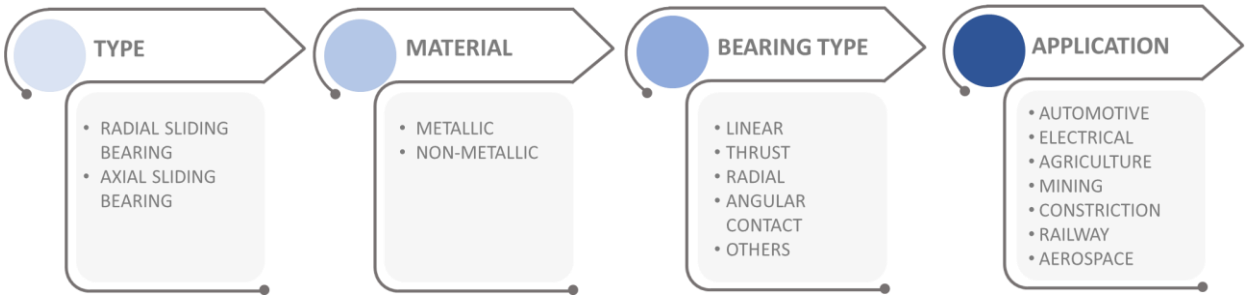

Figure 22. Sliding Bearing Market Segments[32]

Regional Bearing Analysis

Regionally the basic players in the Sliding Bearing market are namely North America (US and Canada), Europe region (U.K., France, Germany, Italy, Spain, Russia, and the Rest of Europe), Asia-Pacific (China, Japan, South Korea, India, Australia, South East Asia, and Rest of Asia Pacific), Latin America (Brazil, Mexico, and Rest of Latin America) and Middle East and Africa (MEA) (into GCC, Turkey, South Africa, and Rest of ME). In detail the market projections by the year 2027[33] for some of the main segments are:

[32] https://www.theinsightpartners.com/reports/sliding-bearing-market
[33] https://www.globenewswire.com/news-release/2022/12/07/2569531/0/en/global-sliding-bearing-market-to-reach-1-5-billion-by-2027.html

- China's CAGR of 11.6%
- Japan's CAGR of 4.6%
- Canada's CAGR of 6.2%
- Germany's CAGR of 5.6%

3. Intensive Market Analysis

The second part of the market analysis includes the analysis of the different aspects that formulate a holistic procedure addressing the exploitation potential of GREEN-LOOP technologies. According to Figure 23 to be able to effectively handle the market uptake and the strategic approach of the inventions proposed in the GREEN-LOOP project, it is mandatory to map out the competition and sketch a business plan for each key exploitable (KER) result of the project.

The general outcome of the primary market analysis is that all the markets considered are going to increase steadily by 2028 in the three areas considered. The GREEN-LOOP project is a 3-year research project that aims to achieve TRL 6 by 2025. The markets that GREEN-LOOP is addressing will be flourishing and the potential to lead some of the results to a marketable TRL can be enhanced in a post-project period (the impact of GREEN-LOOP will be maximised within 4 years from the end of the project when a marketable product can be produced).

To support a successful exploitation plan, it is of great importance to gain an accurate and thorough knowledge of the market structure. For this reason, the external environment will be analysed following precise steps: i) state-of-the-art analysis, ii) Market analysis iii) Competitive analysis iv) PESTLE and SWOT analysis and v) Patent mapping. The market analysis consists of the analysis of the volume and size of the market, the customer segments and the competition. The development of a dedicated market strategy requires deep knowledge of the state of the art of the technologies investigated. The analysis of the dominant trends in the application areas allows us to identify key players and proceed with a benchmark competitor analysis (similar products, commercial practices, existing customers, and marketing channels). The determination of competitive market forces will guide the partners towards the most suitable market strategy. Further, an external environment analysis together with the identification of strengths and weaknesses will provide the advantage of mitigating potential risks in the procedure toward market uptake. Competitors and benchmarking analysis will be supported by the patent search that will allow for the identification of IPRs of competitors in force. This step will allow us to complement the list of competitors, identify similar technologies and/or products, and address opportunities that might be available in the industrial field.

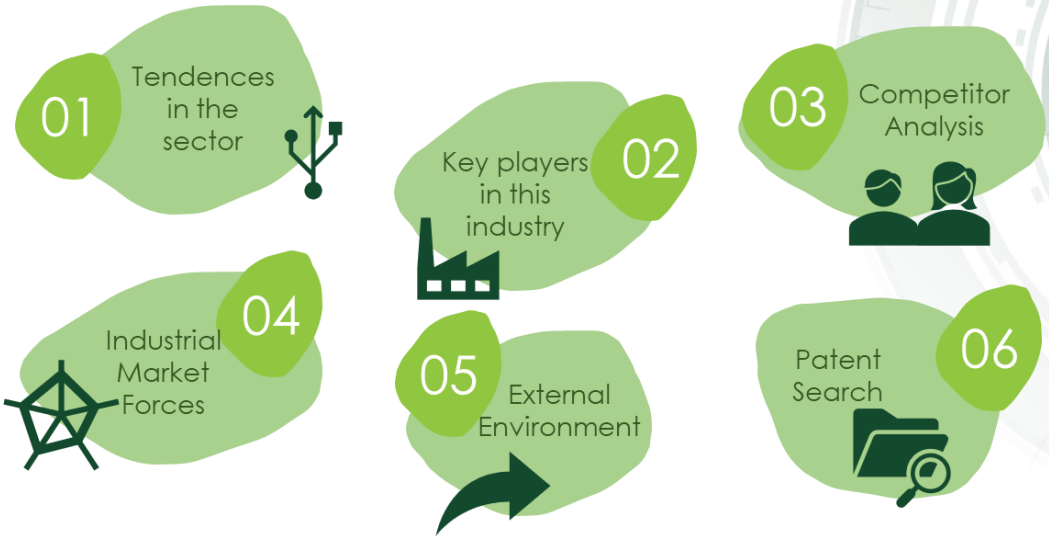

Figure 23.Intensive Market Analysis of the GREEN-LOOP project

3.1 State-of-the-art of the GREEN-LOOP technologies

A State-of-the-Art (SoA) analysis consists of the acquisition of information related to the current technological state and market trends. The analysis is performed through an intensive review of the scientific literature and market research of the related companies (e.g., through websites, blogs, white papers, and articles). GREEN-LOOP focuses on the development of innovative and reusable materials in the field of antivibration pads, bottle closures, and siding bearings. Therefore, these three macro areas will be considered in the SoA analysis.

3.1.1 Multifunctional rubber panels made of lignin and natural rubber

The first value chain analysed in GREEN-LOOP consists of the production of a bio-composite made of natural rubber and lignin with a percentage of these compounds that will vary based on the resulting performance.

The material produced will have antivibration and flame-retardant properties conferred by the natural rubber and lignin, respectively. Therefore, bio-composite is suitable for a wide range of applications in the construction and transport sectors.

Due to its properties, natural rubber has already been widely used to produce vibrational products such as pads[34]. Rubber is considered the best vibration-reducing material[35] as it can be manufactured with high damping coefficient properties and can be highly resilient with low levels of creep [36]. It features excellent resilience, as well as high surface friction and abrasion properties. Natural rubber made from latex from the Have tree is a substance originating from plants. At present, southeast Asia countries are major plantations and producers.

Lignin is the second most abundant biopolymer in present in nature after cellulose[37], produced mainly in the paper and pulp industries, with a high potential of substituting fossil-based products. Lignin presents some properties that allow its use as a sustainable flame retardant additive for polymeric materials [38]. Kraft lignin (the one used in GREEN-LOOP) is an industrial lignin obtained from Kraft pulp, produced in large amounts accounting for about 85% of the total lignin production in the world[39,40]. The interest in the use of lignin as a flame retardant agent is growing in recent years due to the high environmental footprint of commonly used products (mainly aluminium hydroxide and chlorinated and brominated products).

Some studies already investigated the influence of lignin as a filler on the thermal stability ad properties of natural rubber composite[41,42]. Lignocellulosic fillers are attracting indeed the attention as an alternative reinforcement to carbon black in rubber composites due to their renewability, biodegradability, availability, and high mechanical properties[43]. The bio-composite produced within GREEN-LOOP will therefore observe the Circular Economy principles of reuse, recycling, and reduction, following the EU directives.

3.1.2 Bioplastics for Bottle Closures

The global plastic industry is currently facing an enormous transformation to meet the challenges of the circular economy strategy action plan. EU policymakers drafted the new initiatives to establish a strong and

[34] https://www.verifiedmarketresearch.com/product/anti-vibration-polymer-market/
[35] https://www.researchgate.net/profile/Nabel-Abd-Ali/publication/320798436_Industrial_Applications_of_Anti-Vibration_Rubber/links/59faa8d4a6fdcc9a1626e9e4/Industrial-Applications-of-Anti-Vibration-Rubber.pdf
[36] https://www.gmtrubber.com/using-rubber-effective-anti-vibration/
[37] file:///C:/Users/con_/Downloads/4336-Article%20Text-20231-2-10-20210502.pdf
[38] L. Costes, M. Aguedo, L. Brison, S. Brohez, A.Richel, F. Laoutid, "Lignin fractionation as an efficient route for enhancing Polylactide thermal stability and flame retardancy", Flame Retardancy and Thermal Stability of Materials, 1, 14, 2018
[39] Hongzhang Chen, in Lignocellulose Biorefinery Engineering, 2015- Kraft Lignin - an overview | ScienceDirect Topics -
[40] https://www.hindawi.com/journals/amse/2022/1363481/
[41] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8036919/
[42] https://pubs.acs.org/doi/10.1021/acssuschemeng.2c02113
[43] https://engj.org/index.php/ej/article/view/4336

coherent product policy framework that will make sustainable products, services and business models towards greener solutions[44].

Biodegradable and bio-based plastics are considered nowadays the alternative to synthetic fibres. At first, bioplastics were used only for garbage and shopping bags, but now biopolymer products are used in many different industries sectors (automotive, electronics, flexible packaging and construction). The main goal is to obtain bio-based sustainable packaging materials that are ideally derived from renewable resources or side streams from the processing of agricultural or food products. These two sectors are receiving considerable attention in industry and academia because they are not competing with primary food production[45].

The main material used for bottle closures is plastic, followed by metal. Several studies are going on about the production of bio-based caps where one of the main challenges is finding a biopolymer able of maintaining its properties during the thermoforming or injection moulding processes which are the processes used to produce rigid plastic containers [45].

In GREEN-LOOP the value chain related to the production of bio-based caps using agricultural waste will be analysed aiming to produce a 100% biopolymer.

3.1.3 Wood-based composite bearings using biopolymer as a binder

The third value chain considered in GREEN-LOOP consists of the production of wood-based composites using lignin as a binder.

Wood polymer composites (WPCs) consist of both non-renewable plastics and renewable materials (wood fibers)[46]. Some research already exists on the use of lignin as a bio-based additive in the production of these bio-composites where lignin acts as a coupling agent in the composite[46,47,48], but the feasibility of the production of functional products is still under study.

The target product of the third value chain is the sliding bearing. Bearings are used in several sectors such as the building and material logistics sectors and are usually made of metallic material even though the non-metallic bearing sector has been forecast to grow in the next years. Non-metallic bearings are generally

[44] https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:52020DC0098&from=EN
[45] https://www.mdpi.com/2073-4360/12/7/1558
[46] https://www.sciencedirect.com/science/article/abs/pii/S0926669019307149
[47] https://www.mdpi.com/2073-4360/14/24/5519
[48] https://www.hindawi.com/journals/amse/2022/1363481/

plastics or composites made by combining various types of resins with reinforcement fibers as base material[49].

These materials have been used mainly for interior and exterior applications such as doors, foldings, and brake callipers because they offer the advantages of being lightweight and compact. This segment is expected to grow in Europe, therefore GREEN-LOOP has great potential in the market uptake.

in GREEN-LOOP wood bio-composite will be defined and optimised to fulfil the bearing configurations. The specific recipe for the formulation will be developed within the project.

3.2 Key player´s overview

This section outlines the dominant players in markets where the GREEN-LOOP project is active at a global level. Furthermore, a short reference will be provided for the innovative bio-based product developments which are relevant to the GREEN-LOOP project.

Figure 24 presents the 3 different main competitors at a Global level for (a) natural rubber, (b) synthetic rubber, (c) plastic caps and (d) composite bearing. International global players are actively involved in all strategic markets around the world. North America, the European region, Asia-Pacific, and the Middle East are involved in all sectors (details on the market shares are included in the related market search section 2).

Figure 24. Key market players segmented by area of action [50,51,22,52]

[49] https://www.asdreports.com/market-research-report-487564/sliding-bearing-market-global-forecast
[50] https://www.expertmarketresearch.com/reports/natural-rubber-market
[51] https://www.openpr.com/news/1808217/synthetic-rubber-market-growth-leading-segments-analysis
[52] https://www.mordorintelligence.com/industry-reports/composite-bearings-market

Highlights in the market towards a more sustainable solution

January 2020, Goodyear Tyre & Rubber Company and Rubber-Cal, a supplier of rubber flooring and mats, entered into a partnership to develop a new line of rubber flooring and mats. ReUz rubber flooring rolls and ReUz rubber tiles are made from discarded Goodyear tyres, which consume less energy for production and can be easily coloured, allowing for an attractive textured floor for use in fitness facilities. This action reveals the interest of major players in supporting the circular economy perspective and investing in greener solutions such as alternative bio-based products covering the same market need.[53]

May 2021- BMW India equipped their cars with tyres made from certified sustainable natural rubber. This step boosts the adoption of more eco-friendly solutions in the area of tire production[54]

April 2022, The Goodyear Tyre and Rubber Company

announced a new project with the support of the USA Department of Defence, the Air Force Research Lab, and BioMADE to work with Ohio-based Farmed Materials to develop a specific specie of dandelion to produce natural rubber. [54]

Bio-based Rubber

The bio-based rubber is an emerging market that gains year by year many great players from the pool of conventional producers. Bio-based rubber such as EPDM (ethylene propylene diene monomer rubber), and bio-butadiene-based rubbers are some of the bio-based fields that Versalis (joint venture with Genomatica), and Lanxess are stepping into.[55]

Figure 25 Key market players of bio-based Rubber [58]

[53] https://www.rubbercal.com/resource-center/pr-news/press-release-rc-01292020.html

[54] https://www.futuremarketinsights.com/reports/natural-rubber-market#:~:text=Natural%20Rubber%20Market%20Outlook%20(2023%20to%202033)&text=By%20the%20end%20of%20the,US%24%2018%2C270.6%20million

[55] https://www.marketwatch.com/press-release/bio-based-rubber-market-share-new-product-innovation-global-competitors-strategy-new-report-segments-important-statistics-and-growth-to-2028-analysis-2023-01-04

Bio-based Caps

Recent developments in the bio-based industry led to commercial products based on agricultural, forestry products or residues providing the raw material towards a spectrum of products. The bio-based caps industry is an active area with recent developments towards sustainable bio-based plastic use.

Two major players are active in packaging material for beverages, Tetra Pac and United Caps, which launched bio-based caps made from renewable resources that are also recyclable.

Tetra Pak has launched the 'world's first' bio-based opening for gable-top packages: The bio-based version of TwistCap OSO 34 (Figure 26 ,left), is made from high-density polyethene (HDPE) derived from 'sustainably sourced' sugar cane. The bio-based HDPE has been supplied by the thermoplastic resin producer Braskem.[56]

United Caps has launched the bioplastic caps where bioethanol, feedstock for I'm green Polyethylene, the basis for United Caps bio-based caps, is derived from sugarcane. The company initiated two types of closures based on resins from Braskem; Victoria (30/25) screw closure for still drinks and Proflatseal for dairy and still drinks both pressurized and non-pressurised (Figure 26)[57]

Figure 26 Bio-based caps from Tetra Pak (left) and United Caps (right)

3.3 Competitor Analysis

Since the project is still in the implementation phase, a preliminary identification of the main characteristics of the competitor is provided in this section. Based on this initial approach a deeper analysis is foreseen

[56] https://resource.co/materials/article/tetra-pak-launches-%E2%80%98worlds-first%E2%80%99-bio-based-gable-top-cap

[57] https://www.dairyreporter.com/Article/2018/08/28/United-Caps-and-Braskem-launch-I-m-green-bio-sourced-plastic-caps-and-closures

within the next period of the project addressing the core-direct competitors of the GREEN-LOOP technologies. AXIA's strategy consists of developing several steps to acquire the appropriate information in close collaboration with the project partners. The first step consists of acquiring information about the main competitors in the area, and if the data available allow further insights, a benchmark analysis is suggested. The benchmark analysis focuses on the technical characteristic of the product/service and its functionalities and highlights the strength and weaknesses compared to the GREEN-LOOP products. Further, strategic partnerships, commercial practices, existing customers and marketing channels, and intellectual property (IP) protection means will give a holistic overview of the direct competition. All these steps are scored together with the type of competition shown in Figure 27. The overall approach will provide a view of the position of the partners with respect to their competitors, suggesting the most suitable strategy for market penetration. [58]

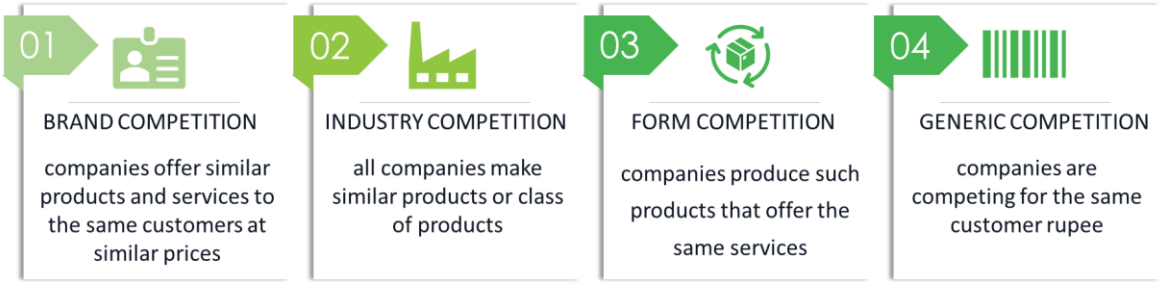

Figure 27 Level of competition[58]

3.4 Industrial Market Forces

In parallel with the competitor analysis, **Porter's Five Forces Model** is used to quantify the power of the market forces that can affect market uptake. Porter's five forces identify:

- The strength of competition in the industry (competitive rivalry)
- The pressure on suppliers to determine the prices (drive up) of the input raw materials (suppliers' power)
- The strength of customers to determine the prices of the product/service (drive down)
- The different products and services that can replace your product (threat of substitution)

[58]Methodology for Industrial Exploitation & take-up. Deliverable 2.2 of the FOCUS project funded under the Union's Horizon 2020 research and innovation programme GA No: 637090. Available at: www.focusonfof.eu/results.asp

- Room for new competitors in the market that will potentially affect your prices (potential drive down) (threat of new entry)

This type of analysis is applied to understand the positioning of a company's product within the industry and how an effective differentiation strategy can be designed. A simple scoring system (from low to high) to refine the dominant forces for the product and their implication to the strategy of the partners. In addition to the competition, this approach can also be used to define the drivers of profitability.

3.5 External Environment

The analysis of the external environment is of high importance when an innovative product is to enter the market. In the case of the GREEN-LOOP project, the external macro-environment is defined as a set of factors, not controlled by the partners that have an impact on its market positioning. The different factors mainly include scientific, technological, industrial, political, economic, financial, environmental, regulatory, social, and legal aspects (status) at the time of the exploitation process of the Key Exploitable Results. To address these elements, PESTLE and SWOT analysis will be used and updated during the project's lifetime.

3.5.1 PESTLE Analysis

One of the commonly used tools to map out the macro environment in which a product or service is directed is the PESTLE (Political, Economic, Social, Technological, Legal and Environmental) analysis. This tool categorises the potential impact factors and provides a global vision of the external landscape by discovering possible opportunities and obstacles outside the control of an organisation. Figure 28 presents an initial identification of these factors considering the three value chains and the technological innovations within GREEN-LOOP. During the project implementation and as the macro-marketing environment is unstable, an update is planned for the project developments.

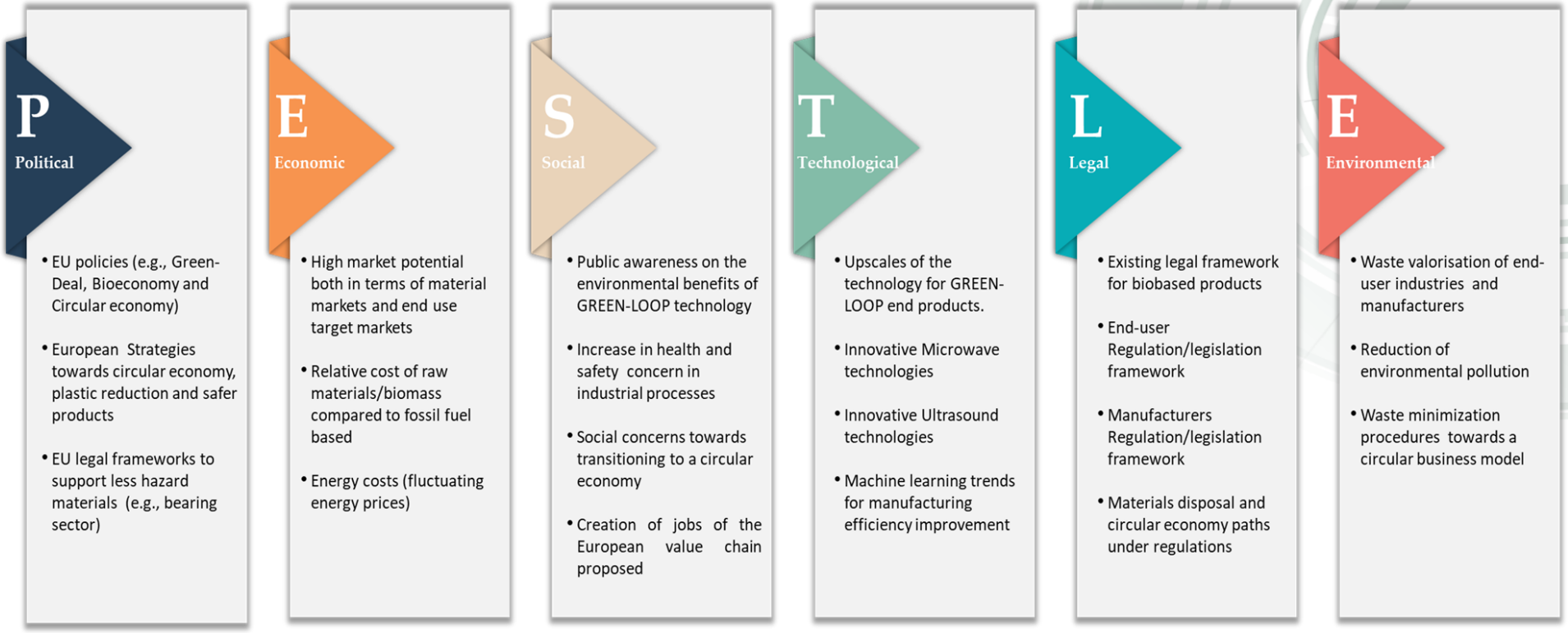

Figure 28. Preliminary PESTLE Analysis for the GREEN-LOOP project

3.5.2 SWOT analysis

A complementary analysis is suggested to assess the situation in parallel with an organisation in terms of internal and external affecting factors. SWOT analysis is used to identify those parameters that could affect the exploitation plan. The categorisation of internal and external factors provides the advantage of strategically organising actions to enhance strengths, exploiting new opportunities, and minimising weaknesses while mitigating threats. Figure 29 provides a preliminary SWOT analysis that is projected to be updated during the next period of project implementation.

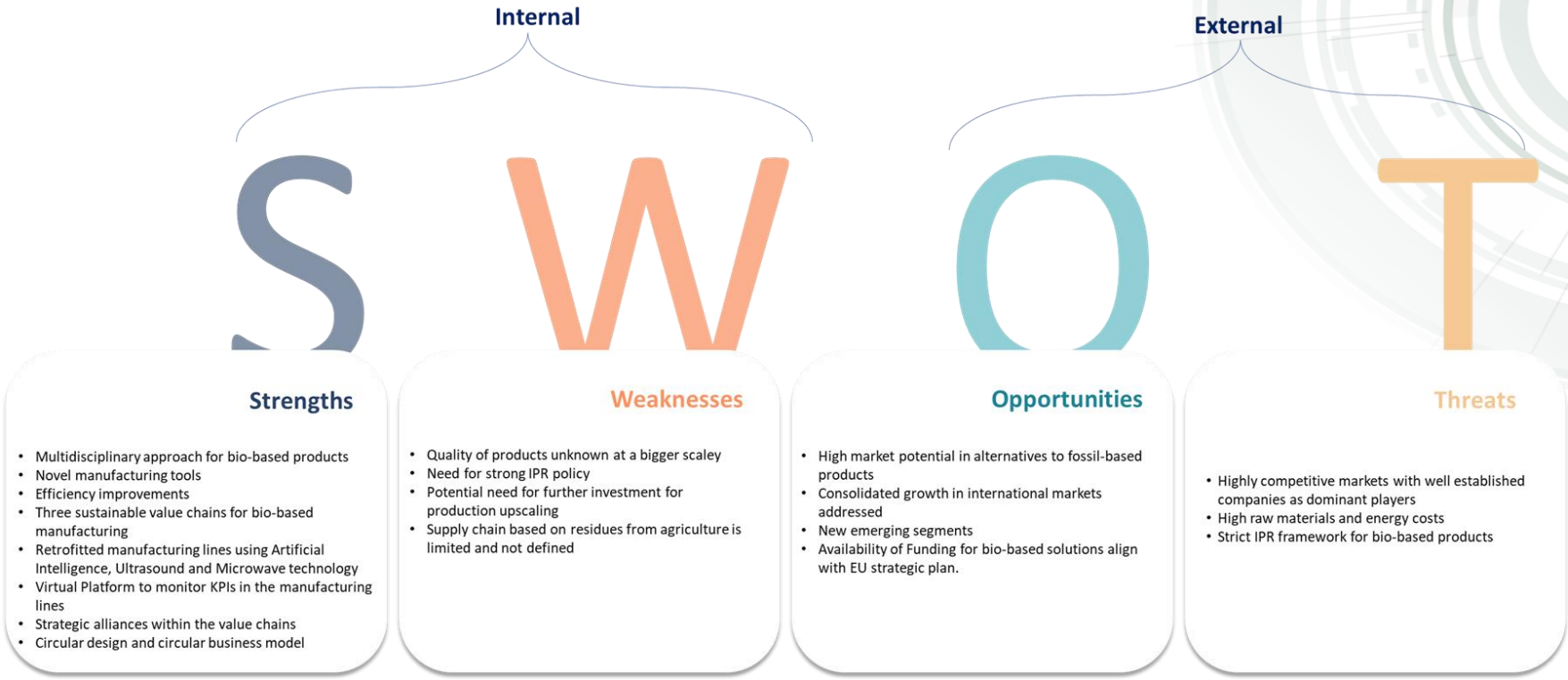

Figure 29 GREEN-LOOP SWOT Analysis

3.6 Patent Search

Complementary to the competitive analysis is the patent search analysis. Novelties in an industrial/ scientific area can be identified giving hints on how to approach the particular market, how 'crowded' the market is and who are the dominant competitors actively involved. The patent search is used to gain more information about other innovations in the field of interest, the patents in force, the years of applications, the top authorities where the patents were granted and the potential competitors that might have not been detected in the competitor analysis phase. The patent search methodology consists of:

- Identify highly relevant patents based on technological developments
- Identify Patent owners
- Identify Location/geographical territories
- Understand IP for products and technologies
- Identify key technology players and relative strengths
- Understand the competitors and their IP holdings
- Conduct benchmarking analysis
- Track the evolution of the patent landscape
- Locate in which regions the highly relevant patent has been applied

3.6.1 Patent search analysis

AXIA Innovation proposed a stepwise approach to support the patent search analysis. The first part includes the **identification of keywords**. Based on the most relevant keywords (words related to technologies, product/ processes, material, end-user applications etc.,) which are collected with the support of the interested parties a ''bottom-up'' or ''top-down'' approach is designed. The search includes several other considerations such as the status of the patent (Granted, Examined, Published etc.), the year of interest and the targeted geographical area. After the search that will be performed via commercial software a list of estimated patents is produced together with the information below:

- Top Assignees & Authorities
- Top Classification Patent Codes
- Application Trends
- Technological Landscape

Figure 30 Patent search methodology

3.6.2 Patent Search Outcomes

3.6.2.1 Patent Status

The current status of a patent plays a vital role throughout the procedure of patent screening as it might reveal hidden opportunities and gaps. Figure 31 describes the different categories of patent statutes.

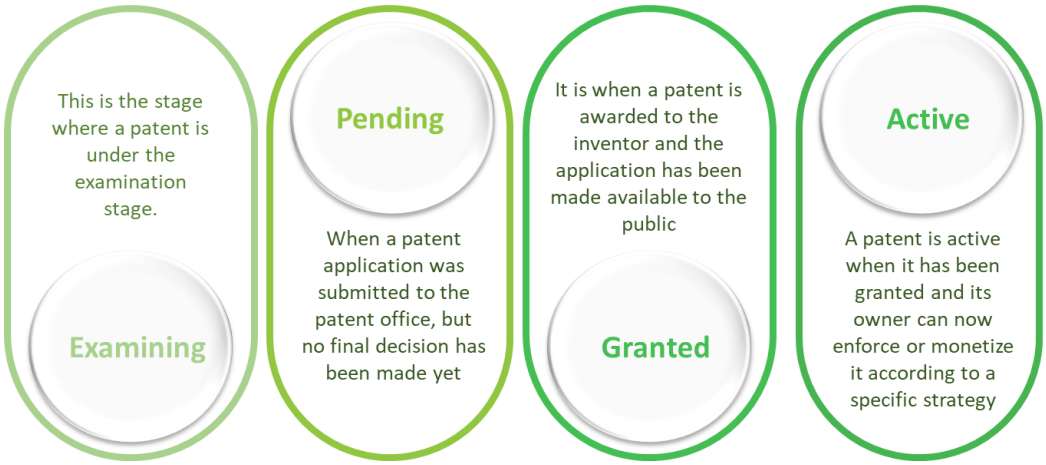

Figure 31 Structure of Patent Search

One other category of patent status is that of inactive. This status refers to a patent that cannot be enforced or monetized anymore particularly (a) abandoned, when the application is abandoned by the applicant (b) withdrawn, when the patent was dropped by the assignee, (c) expired when the patent reaches its end of life and (d) lapsed when the patent maintenances fees haven't been paid. Obviously, in the analysis of patent searches, these types are no longer considered. However, useful outcomes can be reached through the observation of these results as well (gaps and opportunities of market entry etc.)

3.6.2.2 Classification codes

Another important aspect of patent screening is the classification code. Patent classification is a way to define the technical field of an invention. Nowadays, the most popular patent classification systems are the International Patent Classification (IPC) and the Cooperative Patent Classification (CPC) and the United States patent classification (UPC).

- **International Patent Classification (IPC):** The International patent classification, abbreviated as IPC, was established by the Strasbourg Agreement of 1971[59]. Create a hierarchical system of language-independent symbols for the classification of patents and utility models according to the different technical fields to which they belong.
- **Cooperative Patent Classification (CPC):** The CPC is an extension of the IPC and is jointly managed by the EPO and the US Patent and Trademark Office[60]. It is divided into nine sections, A-H and Y, which in turn are subdivided into classes, sub-classes, groups and sub-groups[61].
- **United States patent classification** (UPC)**:** UPC is an additional categorization system for US patents. Like IPC, CPC and other classification systems, UPC is used to group and classify patents in an orderly manner.

[59] https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Glossary:International_patent_classification_(IPC)
[60] https://www.epo.org/searching-for-patents/helpful-resources/first-time-here/classification/cpc.html
[61] https://www.sciencedirect.com/science/article/pii/S0172219016300588

4. Conclusions

Deliverable 7.1 "Market analysis" includes the first results of the market analysis performed in the initial phase of the GREEN-LOOP project and the work plan that will be presented at the end of the project.

The report was subdivided into two sections. The first part focused on general market analysis based on the three value chains that will be developed within the project. The second part provided more information on external market forces and the main competitors that can affect the commercialisation of the products.

The market analysis focused on the three main products that will be developed within the project: i) Multifunctional rubber panels for the construction sector; ii) Bottle closure for the food and beverage sector; and iii) wood composite bearings for the tool and appliance sector.

Each market analysis included the market of the product and the industry sector where the product will be targeted. The main outcomes can be summarised as follows:

- Multifunctional rubber panels for the construction sector (WP3). The market study focused mainly on the natural and synthetic rubber markets and the civil engineering construction sector and the construction material sector. The analysis revealed that the markets are growing due to the demand for new performing and sustainable materials for different applications and in different regions.
- Bottle closure for the value chain (WP4). The market study showed great potential for bio-plastic developments in the food and beverage sector since this material is an interesting alternative to synthetic plastic. The market is driven mainly by the increased interest in the consumption of healthy beverage alternatives and by the need for sustainable and natural materials that have the same mechanical and resistance properties as synthetic ones.
- Wood composites bearing value chain (WP5). A market analysis showed a very high growth rate of more than 9% for bearing products, driven by the increased demand for bearings in the automotive and other industry sectors. New sustainable materials are also required in this sector and therefore the GREEN-LOOP product has also in this case, a great opportunity for market uptake.

Key competitors were also identified in this preliminary analysis. Companies such as Versalis and Lanxess approached the bio-based rubber market with the production of bio-based composite and Tetrapak and United caps already launched the first samples of bio-based caps. To understand the external and internal forces affecting the development of GREEN-LOOP products, preliminary PESTLE and SWOT analyses were conducted. GREEN-LOOP technologies have an outstanding advantage due to the multidisciplinary approach and the use of innovative solutions such as artificial intelligence to confer smart features on products in the manufacturing process.

This preliminary overview provides an idea about the challenges and opportunities that GREEN-LOOP will face during the commercialization phase and even if the project is still in the initial phase, it was of high importance to have a look at the market to be able to build an effective exploitation strategy.