



DELIVERABLE D.T2.2.2 REPORT BASED ON THE OUTCOMES OF THE BUSINESS SUPPORT SERVICE (PANARA)

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TABLE OF CONTENT

1. Trends in Europe
 - 1.1. Bioplastics
 - 1.2. Packaging market
 - 1.3. Regulatory environment
2. Country specific data – Slovakia
 - 2.1. Market in Slovakia
 - 2.2. Multimaterial products
 - 2.3. Bioplastics and biocomposites market in Slovakia
3. Economic feasibility study
 - 3.1. Calculation of the total cost of new packaging material
 - 3.2. Benefits

1. TRENDS IN EUROPE

1.1. BIOPLASTICS

Plastic waste has increasingly been interfering with ecosystems and waste management in recent years, which is related to the growing production and consumption of plastics. These include products with a short life-cycle period, which are mainly packaging materials (films, pockets, bags) and articles intended for single use (plastic cutlery, trays, cups, jars, thermo-boxes for food, etc.). Due to the nature of use, these plastic products have a recycling problem, with their vast majority being made of synthetic plastics with very good durability practically against all types of degradation (thermal, light, oxidative, hydrolytic, biological). If these materials come into the natural environment, they remain in it for several decades to centuries. Gradually they get in the form of microparticles in the food chain and today there is nothing exceptional to detect these materials in fish bodies or in drinking water.

The proposal for a directive of the European Parliament and the European Commission of the 28.5.2018, under the heading "A European Strategy for Plastics in A Circular Economy" clearly declares the need to tackle plastic waste problems, in particular by reaching 100% recycling of all packaging plastic materials by 2030. This directive mentions to reduce the impact of several plastics products on the environment which represent about half of all disposable plastic items in marine litter found on European beaches. Europe has a responsibility for addressing the problem of marine litter originating from Europe and pledged to act on a global level, particularly through the G7 and G20 groups, but also through the implementation of the objectives of the United Nations in the field of sustainable development. The problem with the waste is naturally cross-border and waste originating from one country can have an impact on other countries by moving in the marine environment.

Addressing the ever-deteriorating situation in the field of the accumulation of plastic waste in the environment is looking for a long time in two basic ways: a) recycling of plastic materials in terms of material or energy recycling; b) manufacture and use of biodegradable plastic materials. From the point of view of the target of solving problems with plastics and plastic waste in connection with the protection of the environment, the production and the use of biodegradable plastic produced from renewable sources of raw materials is prospective and real sustainable alternative. Biodegradable plastics are able bio-degrade under conditions of controlled composting, as well as in the wild (land, water, sea water). The use of compostable biopolymer produced exclusively from renewable resources is in its essence an innovative concept.

1.2. PACKAGING MARKET

The comprehensive research employed in the future of Global Packaging to 2022, shows that packaging demand will grow steadily at 2.9% to reach \$980 billion in 2022. Technological improvements in the food processing sector, changing lifestyles, growth of the organized retail industry, and increasing popularity of food delivery services are the major driving factors behind the growth of flexible packaging market globally. The global flexible packaging market is expected to grow from USD 252.34 Billion in 2017 to USD 370.23 Billion by 2025 at a CAGR of 4.91% during the forecast period from 2018-2025, according to the new report published by Fior Markets.

Biodegradable packaging has quickly become an essential part of the global packaging market aiding to the ever-increasing consumer awareness and importance of eco-friendly substitutes. Major manufacturers of packaging are now looking to differentiate their products from those of their competitors by providing best possible biodegradable packaging products as per consumer demands. The demand for biodegradable packaging is increasing and will continue to increase as the companies utilize packaging like a medium to protect and promote the safety of the environment along with their products. Due to increasing degree of consumer awareness, and generic and contract manufacturing activities in Europe and North America, the developed geographies are expected to register maximum growth.

In line with existing but also forthcoming EU legislation, it is clear that the most viewed from the ecology perspective are plastic products with a short period of life, particularly disposable plastic items, mainly covering packaging materials. In many applications, especially in food, plastic packaging is not possible to substitute e.g. by paper. Paper that has significantly worse barrier properties than plastic barrier film materials. At the same time, existing plastic film materials, most often available as shopping bags, or pockets do not meet the requirements for packaging food, in particular in the following parameters: - have weak mechanical properties; - have a very low barrier capability, in particular high permeability of oxygen and water vapor; - from an ecological point of view, it is either problematic to biodegradation, or contains a high proportion of plastics produced from fossil sources of raw materials.

Customers are becoming more aware of the environmental impact of their lifestyles. As fears over climate changes and Western consumption patterns continue to put a strain on the world's resources, environmentally conscious citizens are attracted to companies that share their concerns about environmental degradation. Customers want details of who manufactured a product and what they believe in. Sustainable production is therefore gaining in importance as customers choose brands that reflect their own values, lifestyles and worldview.

1.3. REGULATORY ENVIRONMENT

Environmental regulations play a role in motivating more biopolymer consumption in the longer term, especially with regards to recycling and composting. The European Union has introduced specific legislation requirements that support the environment friendly production, via legislation such as the Packaging Waste Directive and the new law banning single-use plastic items such as plates, cutlery, straws and cotton buds stick by 2021.

Biobased plastics, in which the fossil carbon is replaced by bio/renewable-based carbon, offer the intrinsic value proposition of a reduced carbon footprint and are in complete harmony with the rates and time scale of the biological carbon cycle. The process carbon footprint arising from the conversion of feedstock to final product is computed using life-cycle assessment (LCA) methodology.

2. COUNTRY SPECIFIC DATA – SLOVAKIA

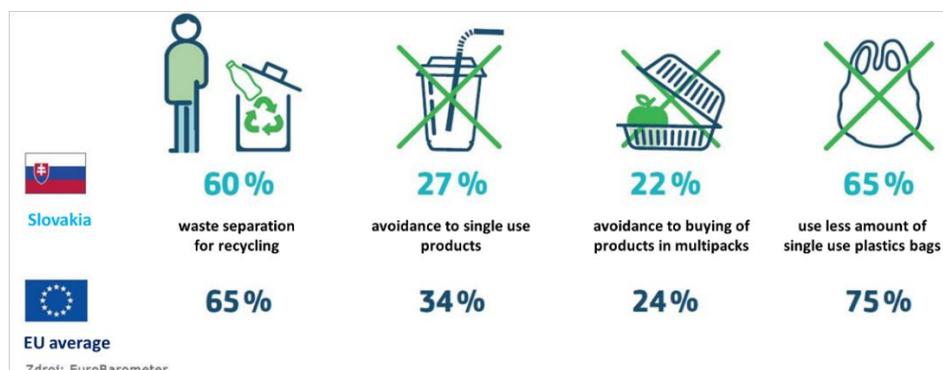
2.1. MARKET IN SLOVAKIA

Slovakia has a problem with the increase of packaging and packaging waste. Between 2010 and 2016, the number of packages placed on the market increased from 436 thousand to 518 thousand tones. The volume of packaging waste increased from 278 to 360 thousand tones. In the latter case, this is an increase of almost 30 percent. Both trends called the Slovak Republic's waste prevention program for the years 2019 – 2025 as "unfavourable".

When the photo of the river full of the plastic bottles was discovered, it showed a warning finger in Slovakia. There was no remote country whose problems could be overlooked. It was a river Bodva and it was clear that with plastic waste we have a problem too. The Slovak market will come a year of billions of plastic bottles and roughly 345 million cans. Despite the sorted collection it manages to collect about something more than 60 percent of bottles and an unknown percentage of cans. The rest ends in landfills.

Or in nature. Freely determined beverage packaging distorts the ecosystem, sail on the rivers, seams and remove something. For example, the water dam Ružín must be cleaned regularly. Each year it catches hundreds of cubic meters of waste, which means the cost of tens of thousands of euros. The European Union calls for up to 90 percent of plastic bottles to be collected within ten years. The System of backup PET bottles and cans will begin to work since 2022. The lowest deposit per bottle will be 12 cents, per tin 10 cents.

Compared to the EU in 2015, Slovakia produced 106 417 ton of the plastics waste. In Slovakia, 19.6 kg of waste from plastic packaging per person was produced and 54% of plastics from plastic waste was recycled. In the EU it was 31 kg of plastic waste per person and 40% was recycled.



2.2. MULTIMATERIAL PRODUCTS

Advances in technology have improved product quality and versatility made from biodegradable plastics, while lowering production costs. This leads to better performance and provide economic incentives to motivate biopolymer market acceptance. The technology development will provide many new types of bioplastics for packaging and better ways of producing bioplastics. These developing bioplastics will offer varying degrees of bio-renewability and biodegradability.

2.3. BIOPLASTICS AND BIOCOSCOMPOSITES MARKET IN SLOVAKIA

In Slovakia, it is difficult to talk about a market for products made of biodegradable plastics or packaging made from the bioplastics market and biocomposites. There are several marketing activities aimed at showing the advantages of this type of products, mainly in the ecological aspect, but their sale rate is negligible. It can be said there is no market developed for the paper-bioplastic packaging products yet. On the other hand, it has a good potential to develop as demand for such products is rising as it is seen from activities of PANARA company. All the players involved in the value chain of the paper-bioplastic packaging are already well represented, the only question is, how and when they will get started with new products business and trading.

3. ECONOMIC FEASIBILITY STUDY ON SOLUTION

PANARA possesses know how in the field of research, development and production of biodegradable plastics from renewable sources, while owning a sole license for the production of bioplastics on the basis of international patent WO2012141660A1 and at the same time is the applicant's own patent (PCT/SK2017/050009) concerning the production of second-generation bioplastics. In addition, the registered mark for the labelling of these bioplastics is the name NONOILEN® (NON-OIL, therefore, oil-free). Currently, the company possesses a technology capable of producing bioplastics of sufficient quantity for testing in semi-operational conditions and pilot projects.

Bioplastics like NONOILEN present the basis for an environmentally preferable, sustainable alternative to current materials based exclusively on petroleum feed stocks and thus help to avoid climate change. Biobased materials

offer value in the sustainability/life-cycle equation by being a part of the biological carbon cycle, especially as it relates to carbon-based polymeric materials. NONOILEN is 100% based on renewable resources (biomass) and is blend with components made by biotechnological processes (PLA and PHB). The environmental contribution of newly developed NONOILEN material is very promising as bioplastics can reduce CO2 emissions by 30-70% compared to conventional plastics.

The following table shows the position of the patented material input, which will be modified in the project according to the application area and the processing technology used, compared to similar-existing products on the European market.

	PANARA Pat.	Novamont (I)	Bio-Fed (D)	FKuR (D)	Biopolynov (F)	Nature Works	Corbion (F/NL)	BASF (D)
PRODUKT	Nonoilen	Mater-Bi®	M-Vera®	Bio-Flex®	NaturePlas t	Ingeo PLA	Corbion PURAC	Ecovio
Functionality								
100% renew. resources	✓	no	no	no	✓	✓	✓	no
Composition PLA/PHB	✓	no	no	✓	PLA	PLA	PLA	PLA
Biodegradable	✓	✓	✓	✓	✓	✓	✓	✓
Transparent	✓	no	✓	✓	✓	✓	✓	✓
Industrial composting	✓	✓	✓	✓	✓	✓	✓	✓
Contact with food	✓	✓	no	✓	✓	-	✓	-

Biodegradable plastics are not readily distinguishable from non-degradable plastics therefore other means of marking them are necessary so that they can be properly used and disposed of. The method that is most reliable and is already in common use in many European countries is certification combined with the use of a special logo marking products made from biodegradable plastics. Certification is a well-defined process in which a certification organization confirms the property of a plastic material, intermediate or product.

Mitigation: To eliminate such a barrier, proper certification and communication of such certification with appropriate symbols must be covered. Additionally, awareness raising and education - of both end consumers (i.e. how to deal with such waste) and waste management (i.e. building of confidence that those materials can be safely composted industrially) must be addressed by general communication activities. The marketing potential of composting is very high, as such composite materials/packaging can be promoted as innovative, sustainable and environmentally friendly at the same time.

3.1. CALCULATION OF THE TOTAL COST OF NEW PACKAGING MATERIAL

Some biodegradable materials are two to three times more expensive to produce than comparable non-biodegradable materials. However, non-biodegradable materials have their own hidden costs. For example, conventional plastic/paper packaging material is cheaper than biodegradable ones, but when you factor in the eventual cost of remediating the toxic chemicals they release in landfills, paper/biodegradable plastics materials are a more attractive choice.

The main components of new bioplastic NONOILEN is polylactide (PLA) and polyhydroxybutyrate (PHB). Therefore, the price and availability of these materials is crucial for success of this new material. While PLA is already widespread bioplastic material with relatively stable market conditions, PHB market is still turbulent. Demand for PHB is still in its infancy and one of the main PHB market barriers is unstable price. In years 2013 - 2014 the price per 1 kg of PHB was about 5€. However, the monopolization of the European market for production of PHB combined with unstable demand resulted in the price increase, while currently the PHB prices are between 2-10€ per kg.

Mitigation: As demand for biodegradable materials increases, the prices will fall until they could become comparable to their environmentally unfriendly competitors. The price of packaging materials with biodegradable plastics could be competitive to other bioplastic material.

3.2. BENEFITS

Biobased plastics, in which the fossil carbon is replaced by bio/renewable-based carbon, offer the intrinsic value proposition of a reduced carbon footprint and are in complete harmony with the rates and time scale of the biological carbon cycle. The process carbon footprint arising from the conversion of feedstock to final product is computed using life-cycle assessment (LCA) methodology.

Currently, the penetration of biodegradable plastics is increasing (mainly in packaging and injection molding). The key drivers for increasing demand of biodegradable plastics are favorable government outlook toward green procurement policies, shift of consumer toward green packaging, and compostability of biodegradable plastics. The technological developments and innovations are identified as key strategies to expand the biodegradable plastics market.

Green image of companies and end-users - customers are becoming more aware of the environmental impact of their lifestyles. As fears over climate change mount and Western consumption patterns continue to put a strain on the world's resources, environmentally conscious citizens are attracted to companies that share their concerns about environmental degradation. Customers want details of who manufactured a product and what they believe in. Sustainable production is therefore gaining in importance as customers choose brands that reflect their own values, lifestyles and worldview.