DELIVERABLE D.T1.2.4 "FINAL VERSION OF STRATEGY DOCUMENT"

ABOUT THIS DOCUMENT

This document presents a summary on how the BIOCOMPACK-CE project team views the options for the development of sustainable paper-plastic, combined packaging in Central Europe. It defines strategic steps needed to move to a desired outcome in which packaging will better adhere to principles of sustainability and circular resource management.

The document starts with an analysis of the situation. It first outlines the **background context** explaining why we believe that changes in multimaterial products and packaging are needed. Then the specific **situation in Central Europe** is discussed, looking at the different sectors involved. **Basic challenges** of development are defined and **critical issues** throughout the value chain are analysed.

The analysis is followed by **Our view** and a discussion of **Desired outcome** defining long-term and short-to-medium term goals. The document is concluded with two specific **Implementation scenarios** that would lead to the desired change.

The document represents a possible view on how positive change in mutimaterial packaging could be achieved within the given conditions found in Central Europe. It is intended to help stakeholders and policy-makers to define their specific strategies

BACKGROUD CONTEXT

Development of sustainable packaging solutions is one of the most important challenges for the European society. Packaging has an important although often invisible role and is a significant factor in a number of issues that have become leading principles of modern development such as:

Resource efficiency – both in terms of the substantial use of materials used for the production of packaging (approx. one third of plastics production) but even more so in the protection (and waste prevention) of packaged goods which represent an immense investment of resources at all stages of use. Resource efficiency can be maximized only if all product life stages: production, use and end-of-life are properly managed.

Safety – packaging is a prerequisite for safe products, most significantly in areas such as medicine and in particular food, but also in endless industrial applications.

Economic development – packaging as a sector by itself is a significant economic contributor since it resides at the crossroads of the resource intensive, material-industrial production and modern "soft(er)" elements such as R&D, design, marketing, information technologies etc. At the same time, packaging is a necessary accompaniment of a vast majority of other products and allows for their efficient handling during all stages of their life. Packaging is also an extremely vibrant sector with constant innovation that strongly supports all aspects of economic activity.

Environmental burdens – due to its large quantities, extremely broad use and its great variety, packaging has emerged as an important environmental concern. Directly and acutely in terms of pollution, with plastics leading in the public discourse, but also in broader terms such as climate change due to its extremely fast turnover rates, inevitability and very high resource demands.

At the same time packaging is strongly connected to society at large. It touches the existence of every individual in meeting consumers' demands with respect to functionalities, new life styles and trends and is also constantly exposed to public scrutiny.

The central position of packaging as well as the associated challenges are recognized in the increasing amount of **legislative and strategic attention** it is receiving. Safety has largely been dealt with in a systematic way and economic aspects are left to be developed freely by active market players. Most of the recent attention is now focused on environmental sustainability. Plastic and plastics-containing packaging has emerged as the most critical packaging segment. In the EU this is evidenced in the recent revision of EU directive 94/62/CE (29 April 2015: Directive (EU) 2015/720 of the European Parliament and of the Council amending Directive 94/62/EC as regards the consumption of lightweight plastic carrier bags) that is specifically targeting the reduction of plastic carrier bags use. The legally binding legislation introduced requirements to follow and report on plastic carrier bag use as well as specific limits and targets on their use with deadlines by which targets must be reached. A much broader document is the document: "A European Strategy for Plastics in a Circular Economy Plastic strategy" (Jan. 16, 2018) that seeks an overall improvement in the management of plastics, including packaging. It is significant that plastics are the only material group that has to-date received such specific attention, showing that plastics are indeed recognized as an important challenge that is unlikely to be resolved through market action etc. alone and requires legislative intervention. The strategy is a comprehensive set of documents that outline the broad challenges as well as specific measures. Interestingly, it is geared at existing materials and the improvement of their management, with particular attention given to reducing obstacles for recycling. Even more recently (June 12, 2019) a new EU Directive (EU) 2019/904 "on the reduction of the impact of certain plastic products on the environment" commonly reffered to as the "Single-Use Plastics Directive" — introduced measures to prevent and reduce the impact of certain plastic products, and promote transition to a circular economy. Specifically the Directive concerns itself with single use products and possible

methods for lowering their use. This document covers packaging items and is in principle looking into products with extremely short life times – a characteristic of a large portion of packaging.

With the intensified focus on recycling and plastics, products made from a combination of materials, especially if one is plastic, are also undergoing more scrutiny. Among these, especially **combinations of paper and plastic**, due to their wide use, are an attractive target since the impact of their improvement can be significant. It is fair, to broadly consider such combined-material products, even if they are not packaging, to be an obstacle toward recycling and therefore represent a problem in terms of resource efficiency, and an out-of-proportion environmental burden and contributor to most general challenges such as climate change.

The recycling targets that are being regularly raised for most packaging materials give even more relevance to proper end-of -life options. Furthermore, environmental, social and economic challenges focus on the need for a sustainability transition towards a circular bio-based economy. In this context, **paper and bioplastic packaging** products may play a strategic role.

Plastics and paper are an excellent match for combinations since they have useful complementary properties. An often used basis for combinations is the different resistance to water/moisture: plastics are waterproof and paper (by itself) is not. In addition they bring different physical properties important for shape retention, different tear properties, different processing requirements and finally, possibly most importantly they have different costs. Paper and bioplastics raw materials also share some important features:

- They are produced from renewable bio-based resources (although not in all cases as bioplastics can also be produced from fossil resources or a combination of renewable and non-renewable)
- They allow for efficient waste management methods; they are recyclable (material recycling or organic recycling)
- They can be biodegradable and compostable (again with limitations, both on the paper and plastic side).

Recently, biodegradable compostable packaging has quickly become an essential part of the global packaging market although it is still a very limited niche sector compared to the large-scale packaging market. The demand is increasing and will continue to increase as the companies utilize packaging like a mean to protect and promote the safety of the environment along with their products. In the context of current waste management applicable solutions, compostable packaging products with a short life cycle, such as food contaminated packaging (e.g. wrapped foils and bags) and articles intended for a single use (plastic cutlery, trays, cups, jars, food thermo-boxes, etc.) may be organic recycled in composting plants, particularly, in the framework of “a closed loop”, in communities (e.g. schools), or in organizations, where it is easily manageable handling paper/bioplastics products avoiding contamination with conventional plastic.

Presently, conventional plastic represents a large majority of the total materials used in food packaging applications with a low recycling rate. Consequently, a gradual replacement of this material with paper and bioplastic will help (i) to decrease the amount of not-renewable fossil-based products in the market (ii) enhance recycling options (iii) reduce the release of not biodegradable microplastics into the environment.

SITUATION

Biocomposites

Biocomposites that combine paper and plastics are not recognized as a separate material or product group. As a consequence they are not represented in available statistical data. This is a result of the relatively small quantities produced and used. These combined materials are also not commonlytreated separately in the frame of packaging or packaging waste. Therefore it is difficult to obtain reliable data on the extent of their use, especially in markets that are still at an early stage of development.

Central European countries involved in BIOCOMPACK-CE project

Central Europe is a very specific region in terms of paper/plastic biocomposites as it covers the traditionally innovative broader alpine area as well as stradling the historic and wealth divide between western and eastern Europe. The countries represented in BIOCOMPACK-CE include Italy – a founding member state representing western Europe on one side of the spectrum and Croatia the most recent member state from southeeastern Europe on the other. Italy is home to one of the largest bioplastics producers (Novamont), has a large and extended composting industry, a very innovative industry and is a European frontrunner in terms of legislative measures supporting sustainable packaging. On the other hand Croatia due to its relatively recent entry into the EU is lagging in waste management organization and infrastructure as well as innovation in packaging sustainability. For example, Croatia is still experimenting with only several municipalities collecting organic waste and a very modest extent of composting facilities. Other countries in the project: Poland, Slovenia, Slovakia and Hungary can be placed into the “space” between these two extremes, each with specific strengths and weaknesses.

Paper industry

The potential of the paper/bioplastic biocomposite sector depends primarily on the paper and bioplastic sectors. The paper sector is larger and more widely spread in the region. Due to the nature of the paper industry, its large-scale technology and historic development it is dominated by relatively few large companies, in many cases parts of multinational companies. The paper industry in Central Europe builds on a long paper production tradition and a relatively abundant regional resource base. Wood as the main resource for cellulose fiber and pulp is the most abundant renewable resource in the region. In principle paper is a commodity, although the sector is divided into many smaller niches with production of specialty paper types. Due to specialization these can reach higher prices and market availability constrains can also exist. Recent reports (2018) from the packaging sector show that paper and especially special types is in growing demand so that availability of quantities for growth is limited. All project countries have a strong domestic paper production industry in large scale commodity paper types. The proximity, established trade links and common market conditions (within the EU) mean that the region has a relative self sufficiency in terms of paper.

Plastics sector

The situation in the plastics sector is significantly different. Commodity plastics are sourced globally and very limited production is available in the region. The situation is further complicated by the number of different plastic types that are used in combination with paper. Leading are polyolefins (polyethylenes of different densities and polypropylene) followed by polyesters (PET) although other types are also used in smaller quantities. Bioplastics, be it biobased or biodegradable, are niche materials that represent and estimated 2% of the overall plastics market. As a consequence

bioplastic production, especially in biodegradable plastics is fragmented among smaller producers mainly focused on compounding of specialty grades and not basic polymer production. The region has one of the most important bioplastics producers in Italy (Novamont). This is an important factor in the broad use of bioplastics in Italy which is felt in plastic products such as carrier bags as well as in paper/plastic composites.

Converting and packaging sector

Both the converting and packaging production sectors are strongly developed in the Central European region. They need to cater to very demanding and technologically advanced markets both domestic and foreign (European) so they cover a very broad range of products and technologies. Of special interest is the capacity for combined paper/plastics packaging products which is present in all countries of the region. The packaging sector involves both large as well as a number of small companies.

In general, Central European economies are characterized by a focus on exports and a strong involvement in the broader European market. In part this is due to specialization in niche products by a number of companies and the fact that several domestic markets are relatively small so that large scale production quickly exceeds them.

Flexible packaging

Multicomponent packaging composed of paper and plastics is strongly linked to flexible packaging and beverage cartons. Flexible packaging recycling in general is a problem in current recycling schemes due to the dispersion of the packaging (small sizes) and a great variety of materials and material combinations. Examples are metalized plastics and multilayer barrier composites. The issue is addressed by the CEFLEX (Circular economy for flexible packaging) association: www.ceflex.eu The association aims to improve the sustainability of flexible packaging. One key envisioned measure are improvements in design and material selection. For this purpose, the association plans to prepare guidelines. The association is also addressing beverage cartons that represent a relatively homogeneous group of products produced in large quantities (0,8 M tons annually in EU).

The technical issues of flexible packaging recycling were studied within the REFLEX project. (https://ceflex.eu/public_downloads/REFLEX-Summary-report-Final-report-November2016.pdf) Provisional guidelines for design developed within the project covering polymer type, coatings, adhesives, inks and lacquers, but were focused on the opportunities for improvement that are offered through the use of polyolefins, which already represent 80 % of flexible packaging.

BASIC CHALLENGES

Faster development of innovative paper, bioplastics and paper/bioplastic multi-materials to replace plastic packaging:

- Eco-design of paper/bioplastics multi-materials products shall aim to keep industrial recyclability
- Paper is inherently biodegradable in compost and in the marine environment. Biocomposites made of paper/bioplastics shall aim to maintain these properties.

Acceleration of all bio-based plastics development is necessary to reduce costs of sustainable products:

- Non-biodegradable (presently BioPP, BioPE already exist while BioPET is partially bio-based)
- Biodegradable (presently mainly PLA, TPS and PHA)

Especially biodegradable biobased plastics still require an improvement in the variation of grades targeting different uses, availability of additives, inks, adhesives that are functionally efficient and maintain the biobased and biodegradable property of the basic plastic (polymer)

Conventional plastics have to be separated from bio-based biodegradable plastic waste with high efficiency to lower the impact during organic recycling

- Labelling systems have to be improved but should strive toward harmonization
- Legislation and policies have to be modified (created)
- Composting of biodegradable bioplastics must be readily available

Bio-based paper/bioplastic multi-materials shall be recycled in paper mills as much as possible to recover fibres

- Promote development of suitable infrastructures (collection and recycling mills)
- Promote recyclability standardization for multi-materials to limit recycling constrains

CURRENT CRITICAL ISSUES IN THE VALUE CHAIN

PERFORMANCES/PROPERTIES/FUNCTIONALITIES MATERIALS
Properties of biodegradable bioplastic and biopolymers are not yet fully comparable to oil-based material, mechanical and/or functional properties of the bio-based packaging products shall be further developed against the current state-of-the-art in the field.

AVAILABILITY OF RAW MATERIAL AND TECHNOLOGY OF CONVERSION PROCESSES
Bio-based non-biodegradable bioplastics are available at higher costs than equivalent fossil-based plastics. Few biodegradable biopolymers are available at a commercial scale (TPS, PLA, PHA), their processability is relatively good for their conversion into bioplastics, on the contrary there are still not many companies with a know how and practice of processing paper and bioplastics in composites.

COSTS/MARKET
The cost of biopolymers and bioplastics is generally still much higher than conventional plastics. Furthermore, the use of bioplastics in combination with paper to achieve greater functionalities (barrier, transparency) leads to increased costs in comparison to mono-materials. Often, the present small niche market does not allow sufficient returns.

WASTE COLLECTION SYSTEMS AND PRODUCTS END OF LIFE
Currently, waste collection systems are not optimised for multi-material packaging. The presence of specialised paper recycling mills capable of treating these materials is scattered or not present at all in some CE countries. Composting infrastructures are not yet widely spread in several countries. Organic waste is still highly contaminated with conventional plastics even in countries adopting strict legislations (e.g. Italy). Compostable packaging is not easily distinguishable from conventional plastics leading to high contamination and a potential for microplastics pollution. The fast development of integrated anaerobic and aerobic digestion industrial plants in some countries poses additional constrains to the acceptance of biodegradable compostable packaging in composting plants due to the fact that bioplastics are often too resistant to anaerobic digestion.

INNOVATION SYSTEM
• Improve production processes of raw materials and additives decreasing costs and enhancing availability and through that the amount of bio-based content in final products.
• Innovation in transformation-converting technologies (i.e. plastic extrusion, lamination, thermoforming, biobased coatings) to guarantee proper performances according to consumers' need.
• Supporting innovation in SMEs intended to create new services and products across Central Europe.
• Set-up of co-innovation partnerships alongside existing and new value chains

VALUE CHAIN AND COMMUNICATION

• Spread awareness about sustainable production of bio-based products among associations, industries, public bodies, entrepreneurs and other stakeholders.
• Enhance the clarity, accessibility and harmonization of sustainability certifications and standards through further development of fit-for-purpose sustainability scheme, including standards, labels and certifications for bio-based products.
• Expanding the adoption of life-cycle methodologies (LCA, LCC, S-LCA) among decision makers in public bodies and private companies.
• Improve mechanisms to identify and promote case studies and best practice exchange at production, product, application, system level which can illustrate sustainability benefits of bioplastics and paper/bioplastic bio-composites.
• Encourage market pull for biocomposite products through the assessment of consumers' preferences and acceptance.

POLICY, REGULATION, MARKET

• Integrating (natural) sciences and engineering approaches with social sciences and humanities-based approaches in order to formulate guidelines for a common framework promoting the development of regulations and standards (national or international) to support the adoption of business innovation models in the bio-based products sector.
• Perform scenario analysis at regional level in order to support the development of a common framework to achieve harmonized policy regulation.
• Public procurement regulation used to foster innovation, developing tools for purchasers thus facilitating the creation of buyers' groups. The increased awareness and incentives may lower the barriers to purchasing thus leading to the opening of new markets of bio-based products in Central Europe.
• Create a new cross-sectorial interconnection in bio-based economy clusters linking to the complete value chain, from bio-based raw material to end-users with the aim to create new services and products.
• Promote current applications of paper/bioplastics products in closed communities (hotels, hospitals, schools, administrative buildings etc.) – according to smart cities concept - taking into account and developing local recycling/waste treatment infrastructures. These cases are limited in scope so that they can serve as a proof of concept testing ground. Cases can be stimulated by a sectoral action or public-private initiative.
• Open new markets for new applications for biobased/biodegradable packaging calculating costs of new materials on a life cycle basis compared to current materials.
• Support creation of knowledge centres gathering data from stakeholders and research community thus providing access to relevant information for markets and products innovations in the bio-based packaging supply chain.
• Support new companies accompanying converters to develop and integrate bioplastics/biomaterials into packaging products.

WASTE COLLECTION SYSTEMS
• Promote material recycling of paper/bioplastic products not contaminated with food in the paper industry based on standard recyclability assessment of multi-material products.
• Develop suitable locally based collection systems according to local infrastructures
• Develop low cost composting infrastructures in all countries to accept biodegradable/compostable food contaminated packaging products
• Avoid dragging effect of conventional plastic into composting plants through clear labelling and consumers' education.

OUR VISION

- **Packaging contributes to food safety** providing a barrier to external physical agents and microbial contamination. Very importantly, it increases the shelf life of packaged foods thus reducing food waste. Nonetheless, due to its large use and often very short life cycle it brings a significant environmental burden.
- **Material combinations (like paper and plastics**) in packaging add value, functionality and improve critical properties (e.g. barrier properties). On the other hand, it may provide a substantial barrier to optimal recovery options like reuse and recycling.
- **Acceptable material combinations** must be
    - easy to separate
    - recyclable by existing and available technology intended for a common material stream.
- **Sustainability of combined materials** use strongly depends on real, not potential, waste management practices and available infrastructure. However, recycling infrastractures shall develop in order to meet the complexity of new packaging multi-materials.
- **The best ecological solution** in paper/plastics composites is offered by materials produced from renewable raw materials (bio-based). Following this principle that should reduce the carbon footprint in the production stage. Since bio-based plastics can be either biodegradable or non-biodegradable the end-of-life impact is addressable through two options:
    - *paper/biodegradable plastics combinations that are fully biodegradable and compostable*
    - *paper/not-biodegradable bioplastic may be recycled separately or in specialised paper recycling mills.*
- **Multi-material recycling is the preferred waste treatment option**, before organic recycling (aerobic treatment - industrial composting or aneorobic treatment - biogasification) due to material preservation. In principle, the following general approach may be suggested to ensure a limited impact on recycling operations
    - *Non-food packaging and dry food packaging shall be recycled, prefferentially in the paper stream if not separate streams*
    - *Wet food packaging in contact with wet or greasy food shall be organically recycled – composted in aerobic or anaerobic conditions*
- **Combined materials and products** thereof have a real potential to be an integral part of both circular resource use and the bioeconomy providing that
    - **Systemic policy measures will** greatly support a widespread application of sustainable combined materials
    - **Ecodesign and considerations of real end-of-life options** are taken as a prerequisite for efficient combined materials products
    - **Effective technical standard** for ecodesign and multi-material recycling as well as the **development of advanced recycling infrastructures** in CE will be encouraged and implemented

DESIRED FUTURE OUTCOMES

GENERAL GOALS

The desired future situation that BIOCOMPACK-CE will contribute to can be best described by production and use of next-generation, sustainable packaging, combining paper and plastics, in the region. Regional expertise in design and production of innovative and sustainable packaging will lead to a number of positive results:

- Economic activity
- Jobs creation
- Strengthening regional innovation
- Exports
- Higher added value products
- Regional value chains
- Recognition of region
- Improved utilization of local renewable resources
- Contribution to circular and bio economy
- Contribution to global sustainable development goals

SPECIFIC LONG-TERM GOALS

- Industrial leadership in biocomposite products encompassing entire value chain
- New generation of biocomposite packaging materials that allow for complete and environmentally optimal resource use – close to 100% reuse of waste material in a manner that minimizes the overall environmental burden of material reuse according to LCA and reaches goals of a circular, bio-based economy
- Innovative production technologies, value chain organization and increased market share will reduce overall cost of biocomposite products and the gap in comparison to conventional plastics.
- Paper and bioplastic producers will develop a full range of materials compatible with different end-of life options (material recycling, industrial composting, home composting, anaerobic treatment)
- The entire bio-based industry supply chain, from resource sources, material producers, converters, to users and waste management will engage in greater alliance to develop sustainable packaging solutions to fulfilling new consumer needs.
- Separated waste collection as well as low cost waste conversion infrastructure such as aerobic composting plants established in all CE countries.
- Anaerobic digestion plants will develop technological solutions to efficiency process biodegradable bioplastics and paper based biodegradable multi-materials.
- Material sorting taking advantage of automation both in advanced collection platforms and at recycling mills.
- The capacity and technologies of specialized paper recycling mills treating multi-materials will increase leading to better environmental performances (reuse and refining of side streams).
- Development of bio-additives and bio-coatings will further enhance the sustainability of bio-based materials by increasing the performance of mono-materials thus reducing recycling constrains.
- Policy development and implementation resulting in specific measures, regulation, and standards supporting biocomposite use
- Greater environmental awareness of consumers will improve acceptance of the higher costs and drive stricter regulation on packaging waste management.
- Calculation of social costs and Corporate Social Responsibility will be an important driver.
- Green public procurement based on achieving circular economy and bioeconomy goals a broadly accepted standard playing a central role in the promotion of market for biocomposite packaging.
- Incorporation of information technologies in collection sorting and waste management

SPECIFIC MID-TERM GOALS ACTIONS AND SUPPORTING MEASURES

In the mid-term the main priorities for biocomposite advances are seen in the following areas:

- Further development of the Innovation system (R&D funds at local level for SMEs)
- Greater integration and cooperation between paper and bioplastic actors in the context of the EU bioeconomy and circular economy strategies
- Improved technical communication among stakeholders of paper-bioplastics value chain
- Increased the level of education and communication with final consumers for greater awareness and support
- Create new market opportunities based on social responsibility (e.g. replacement of single-use plastic products in closed communities such as schools, public buildings etc.)
- Ambitious regulative measures promoting resource efficiency, reduced environmental footprint, green public procurement etc. promoting creation of markets thus increasing opportunities at local level
- Develop local infrastructure for collection, recycling and composting thus creating job opportunities

IMPLEMENTATION SCENARIOS

The listed goals can be achieved through a number of measures. In principle, two main scenarios can be distinguished:

- Scenario 1 in which development is supported through strong official innovation and sustainability policy.
- Scenario 2 that relies on “soft” non policy measures.

Scenario 1 relies on policymakers at local, national, regional and European levels to continue and deepen in very specific ways the current support for innovation, circular economy, bioeconomy and sustainable development goals. The example of Italy in its decision to mandate the use of biodegradable carrier bags shows that regulatory intervention has the ability to influence the market and consumer habits efficiently and in a short time. Still, such regulation represents a strong intervention in the market and must be well argumented and with a sufficient public and political support.

There are several regulatory approaches that could be taken:

1. *Prohibiting combined packaging* (vs. monomaterial packaging) on the basis that it limits recycling taking into account available recycling technology. This option is more hypothetical since it is unlikely to pass legislative scrutiny. There is no precedence for such a measure that could limit common market regulation. It would likely also concern beverage cartons that represent an important packaging option.
2. *Mandating that paper/plastic composites are designed to standards* that support a) easy paper (and plastic) recycling or b) composting (alternatively aerobic biogasification). Such regulation would need to set exact requirements for the packaging. Wet food contact could be a factor for requiring composting (biogasification) whereas dry and non-food packaging could be subject to recycling friendly design.

In order to reach regulatory change it is important to have several conditions met:

- Public pressure and support for change
- Awareness of the issue
- Sufficient information that supports the need for change

- Existing solutions that can realistically be applied

These conditions are most reliable on:

media (informing and raising awareness),

NGOs (informing, raising awareness and creating political pressure)

science/research (providing data showing need for change)

industry (offering workable solutions)

Early voluntary actions can serve as important support in that they show that practical and workable solutions are available.

Scenario 2 relies on a voluntary change in packaging design. In the absence of regulatory stimulation positive change can be achieved by presenting clear arguments for improved designs, however the change can be initiated or at least affected by different stakeholders in the value chain. The most likely are:

1. *packaging waste management companies:* packaging fees could play a crucial role in the promotion of multimaterial packaging better suited for recycling or composting. Fees are set by packaging waste management companies and do not require legislation. In principle the fees should reflect the cost of managing different packaging waste types so setting a lower fee for "better" designs would be admissible. A significant difference in fees for packaging that is difficult to recycle and better designs would motivate producers/users to change to more sustainable designs. Changing fees would need to be accepted voluntarily by packaging waste management companies. This option is not truly a legislative intervention although it is a systemic change. Due to the systemic, general effect stakeholder discussions indicated that in absence of regulatory intervention packaging fees are one of the best methods to initiate change.
- *Retailers*, especially large retailers with significant market shares or important positions. Retailers can choose to change packaging especially for own-brand products based on internal goals for higher sustainability. In surveys and stakeholder analysis retailers were most often identified as key movers to make a change.
- *Local government* that regulates public systems such as municipal markets or publicly owned businesses. An example can be given by the city of Ljubljana in Slovenia where the municipal government mandated the use of biodegradable carrier bags at the city food market and in (municipality owned) pharmacies. Decisions of municipalities likely take into account the waste management aspects of mandated solutions in that municipal waste management companies are commonly fully owned and supervised by the municipality. This option involves local government, (publicly owned) businesses and waste management and can thus serve as an example to other non-public businesses. The same principle can also be used by *national government* and applied to publicly owned companies.
- Companies, especially those selling to the public as well as NGOs and similar. An example are food vendors. Using biocomposite packaging can offer a chance for distinguishing the enterprise and to reach internal sustainability goals if they exist. Producers of packaged goods (for example confectionary) are also well positioned to use improved packaging to reach business and sustainability objectives.
- Producers of packaging can offer improved multicomponent packaging as part of their business development in effort to gain customers or position themselves in the market. Development from the side of producers (in absence) of direct demand represents a "push" approach that is intended to create demand.

Voluntary introduction of multicomponent packaging with improved design will in large measure depend on public pressure and acceptance, both of which are strongly influenced by media and NGOs.

SPECIFIC MEASURES TO REACH PACKAGING CHANGE

- Preparation of information providing accurate and objective arguments for stakeholders
- Setting proper alliances to make change possible (e.g. material supplier – packaging producer – user – waste management)
- Solving technical issues (production, material selection, technology)
- Certification (standards, testing, certificates, authorized organizations)
- Communication with stakeholders including policy-makers