

Packaging Review

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OF THE PACKAGING INDUSTRY



RECOVERY
OF PACKAGING WASTE
FROM POLYMER MATERIALS

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Packaging Review

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Two Flagships, one September

This September, Europe hosts two powerhouse events set to redefine the future of packaging and beverage technology.

Labelexpo Europe 2025 (Barcelona, 16-19 September) evolves into a broader platform by incorporating folding carton technology. This long-anticipated step reflects the growing convergence between label, flexible, and carton packaging, fueled by digital, hybrid, and inline flexo innovations. From automation to sustainability, the show promises a wealth of insight and solutions — especially for label converters looking to diversify. A special Folding Carton Masterclass will offer a roadmap into new markets, alongside live demos from Edale, Actega, Rotatek, Tec-ni-Fold, and more.

Meanwhile, drinktec 2025 (Munich, 15-19 Sept) returns as the global summit for the beverage and liquid food industries. With visitor registration now open, the show is fully on track to deliver cutting-edge trends in processing, filling, packaging, and digitalization. Packaging takes center stage through innovations in PET, can and glass lines, smart labeling, digital printing, secondary packaging, and materials designed for recyclability and reuse. Whether you're exploring ultra-efficient production lines or AI-powered quality control, drinktec remains the place where beverage packaging trends are born.

For packaging professionals, September offers a rare chance to witness two worlds converge — with innovation leading the way.

Anna Naruszko, M.Sc. Graduate of the Institute of Printing at Warsaw University of Technology (currently the Department of Printing Technologies, Faculty of Mechanical and Industrial Engineering, Warsaw University of Technology). Editor-in-chief of the monthly trade magazines "Poligrafika" and "Opakowanie", CEO of Alfa-Print Sp. z o.o, publisher of these magazines and of the scientific quarterly "Packaging Review".

Dwa kluczowe wydarzenia branżowe we wrześniu

Wrzesień br. przyniesie dwa strategiczne wydarzenia dla sektora opakowań i przetwórstwa – Labelexpo Europe i drinktec.

Labelexpo Europe 2025 (Barcelona, 16–19 września br.) rozszerza zakres tematyczny o technologie produkcji opakowań kartonowych. To odpowiedź na rosnącą konwergencję technologii druku etykiet, opakowań giętkich i kartonów, napędzaną przez rozwój maszyn inline flexo, offsetu rotacyjnego oraz systemów hybrydowych. W programie znajdą się m.in. pokazy rozwiązań do zadruku, uszlachetniania i sztancowania kartonów w jednym przebiegu oraz Masterclass Label Academy, skierowany do przetwórców planujących dywersyfikację działalności.

drinktec 2025 (Monachium, 15–19 września br.) to wiodąca międzynarodowa platforma dla branży napojowej i płynnej żywności. W centrum uwagi znajdą się systemy pakowania: linie do opakowań PET, puszek i szkła, inteligentne etykietowanie, druk cyfrowy, automatyzacja pakowania oraz zrównoważone materiały zgodne z zasadami gospodarki obiegu zamkniętego.

Wrzesień 2025 to istotny punkt odniesienia dla wszystkich śledzących kierunki rozwoju w obszarze druku, przetwórstwa i opakowań.

Mgr inż. Anna Naruszko. Absolwentka Instytutu Poligrafii Politechniki Warszawskiej (obecnie Zakład Technologii Poligraficznych, Wydział Mechaniczny Technologiczny PW). Redaktor naczelna miesięczników branżowych „Poligrafika” i „Opakowanie”, prezes zarządu Alfa-Print Sp. z o. o, wydawcy tych miesięczników oraz kwartalnika „Packaging Review”.

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RECOVERY OF PACKAGING WASTE FROM POLYMER MATERIALS

ODZYSK ODPADÓW OPAKOWANIOWYCH Z TWORZYW POLIMEROWYCH

ABSTRACT: In the EU countries, more than 16 million tons of packaging waste from polymeric materials are generated. This is a significant group, which constitutes about 20% of the mass of all packaging waste. This waste requires management through recovery processes including recycling, energy recovery or reuse after preparation for further use. For polymeric waste from classic plastics, the basic form of recycling is material recycling. In the future, due to new investments, chemical recycling will become more important. For the waste from biodegradable plastics with confirmed compostability, organic recycling is the appropriate method. Due to its high calorific value, packaging waste from polymeric materials that is not suitable for recycling is subject to energy recovery.

Key words: packaging, packaging waste from polymer materials, recovery

STRESZCZENIE: W państwach UE powstaje ponad 16 mln ton odpadów opakowaniowych z tworzyw polimerowych. Jest to znacząca grupa, która stanowi około 20% masy wszystkich odpadów opakowaniowych. Odpady te wymagają zagospodarowania poprzez procesy odzysku obejmujące recykling, odzysk energii lub ponowne wykorzystanie po przygotowaniu do kolejnego użycia. Dla odpadów polimerowych z klasycznych tworzyw podstawową formą recyklingu jest recykling materiałowy. W przyszłości, ze względu na nowe inwestycje, większe znaczenie zyska recykling chemiczny. Dla odpadów z tworzyw biodegradowalnych o potwierdzonej kompostowalności właściwą metodą jest recykling organiczny. Z uwagi na wysoką wartość opałową nieprzydatne do recyklingu odpady opakowaniowe z tworzyw polimerowych poddawane są odzyskowi energii.

Słowa kluczowe: opakowania, odpady opakowaniowe z tworzyw polimerowych, odzysk

PACKAGING WASTE

According to Eurostat data, in 2022 in the European Union, ca. 83.4million tons of packaging waste were generated; the waste from paper and cardboard constitutes 34.0 million tons, the waste from polymer materials (plastics) – 16.1 million tons and the waste from glass – 15.7 million tons (Fig.1).

In the same year, each inhabitant of the EU generated, in average, 186.5 kg of the packaging waste and the mentioned weight was different for the particular countries; it varied from 78.8 kg for Bulgaria to 233.8 kg in Ireland.

The weight of the packaging waste generated in the EU in the years 2011-2022 according to the type of material and calculated per one inhabitant is given in Fig.2.

The structure of the packaging waste in 2022 is illustrated in Fig.3. The waste from paper and cardboard constitute 40.8%, plastics – 19.4%, glass – 18.8%, wood 16.0% and metal – 4.9%.

The submitted data show that in the EU countries, more than 16 million tons of the packaging waste from polymer materials are produced. It is a meaningful group which constitutes ca. 20% of the total weight of all packaging waste [1]. According to the requirements of the environmental protection, the

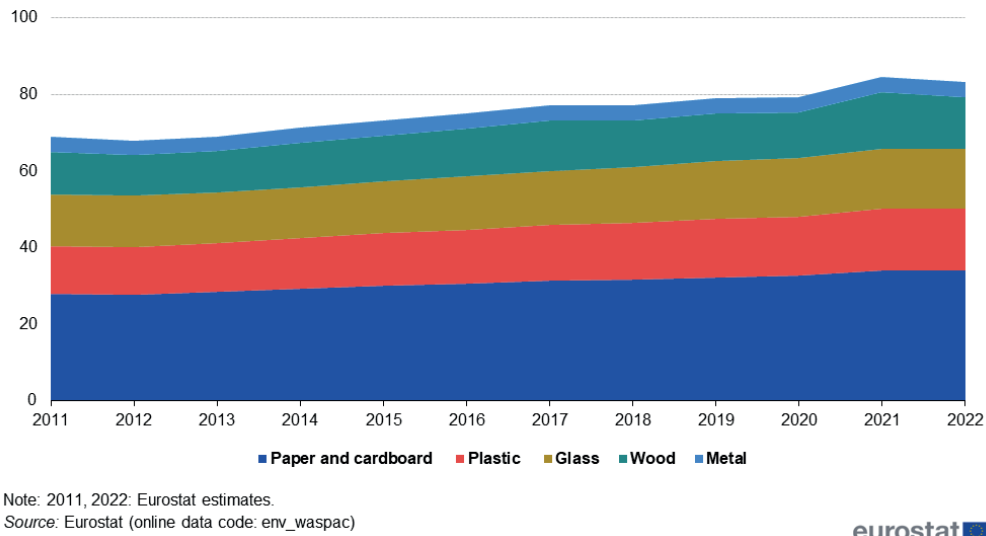


FIG.1. THE WEIGHT OF PACKAGING WASTE GENERATED IN THE EU IN THE YEARS 2011-2022 ACCORDING TO MATERIAL GROUPS (IN MILLION TONNES)

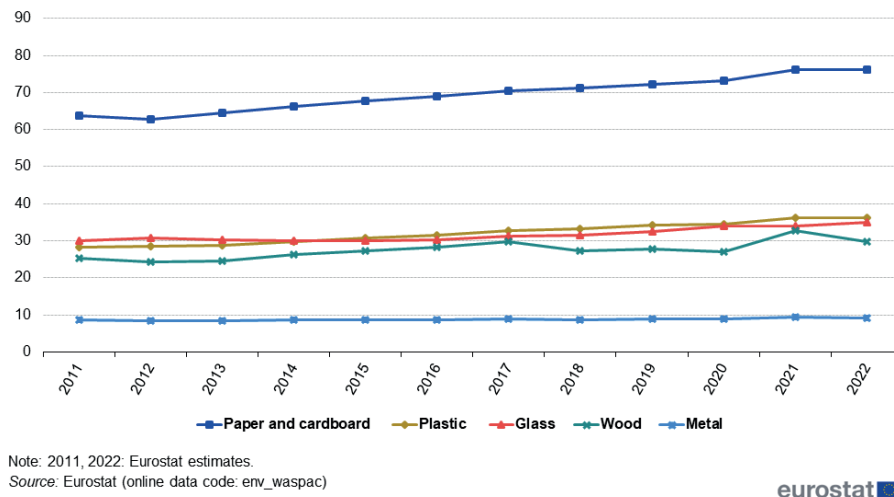


FIG.2. WEIGHT OF THE PACKAGING WASTE AS CALCULATED PER ONE INHABITANT OF THE EU, GENERATED IN THE YEARS 2011-2022 ACCORDING TO THE TYPE OF MATERIAL (KG PER CAPITA)

mentioned waste should be managed via recovery processes what would reduce the deposits at the landfill sites.

TYPES OF POLYMERS EMPLOYED IN MANUFACTURE OF THE PACKAGING

Polymer materials have found the application as the universal packaging materials. In their production, there is utilized a wide spectrum of polymers, characterized by the properties, being suitable from the viewpoint of optimization of the processes of packaging, storage and transport of various products. The appropriately chosen polymers (copolymers) together with the

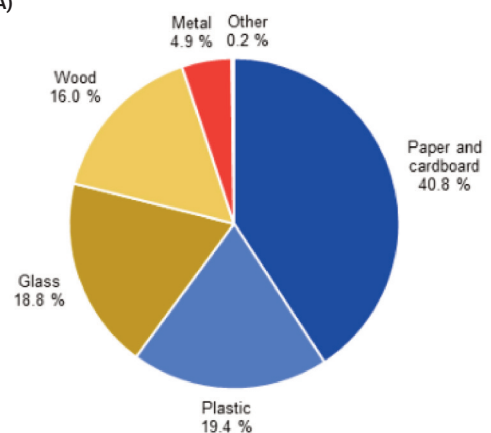


FIG.3. MATERIAL STRUCTURE OF THE PACKAGING WASTE IN THE EU IN 2022

TAB.1. POLYMERS EMPLOYED IN MANUFACTURE OF PACKAGING

| CLASSIC | BIOMATERIALS | | |
|------------------------------------|---------------------------------------|--------------------------------|--|
| Non-renewable sources (petrol) | Renewable sources | Non-renewable sources (petrol) | Renewable sources |
| PET, PE-LD, PE-HD, PP, PVC, PS, PC | bio PET, bio PE-LD, bio PE-HD, bio PP | PCL, PVAL | Starch compositions, PLA, CR, PHBV, PHBH |
| Non-degradable | | Biodegradable* | |

* subjected to degradation as affected by the enzymes, produced by microorganisms (bacteria and fungi) in aerobic conditions, into carbon dioxide, water and mineral salts (mineralization) and new biomass whereas in the anaerobic conditions – to carbon dioxide, methane, minerals salts and new biomass.

TAB.2. ABBREVIATED NAMES OF POLYMERS AND COPOLYMERS USED IN PACKAGING MANUFACTURE

| CLASSIC | BIOPLASTICS |
|--|---|
| E/AA copolymer ethylene-acrylic acid | bio PA polyamide derived partially or completely from renewable sources |
| E/EA copolymer ethylene-ethyl acrylate | bio PE polyamide derived partially or completely from renewable sources |
| E/MA copolymer ethylene-meta-acrylic acid | bio PE-HD polyethylene of high density |
| E/VAC (EVA) copolymer ethylene-vinyl acetate | bio PE-LD polyethylene of low density derived partially or completely from renewable sources |
| E/VAL (EVOH) copolymer ethylene-vinyl alcohol | bio PET poly(ethylene terephthalate) derived partially or completely from renewable sources |
| PA polyamide | bio PTT poly(trimethylene terephthalate) derived partially or completely from renewable sources |
| PC polycarbonate | CR cellulose film |
| PE polyethylene | PBAT poly[(butylene adipate)-co-(butylene terephthalate)] |
| PE-HD polyethylene of high density | PBS poly(butylene succinate) |
| PE-LD polyethylene of low density | PBSA poly[(butylene succinate)-co-(butylene adipate)] |
| PE-LLD linear polyethylene of low density | PCL poly(caprolactone) |
| PE-MD polyethylene of medium density | PEF poly(ethylene furoate) |
| PET poly(ethylene terephthalate) | PES poly(ethylene succinate) |
| APET amorphous, thermoformable poly(ethylene terephthalate) with isophthalic acid | PHA poly(hydroxyalkanoate) |
| CPET crystal form of poly(ethyleneterephthalate) | PHB poly(hydroxybutyrate) |
| PETG copolymer of terephthalic acid with ethylene glycol and di-methanol-cyclohexane | PHBH poly(hydroxybutyrate-co-hexanoate) |
| PP polypropylene | PHBV poly(hydroxybutyrate-co-hydroxyvalerate) |
| CPP non-oriented form of polypropylene film | PLA polylactide, poly(lactic acid) |
| PS polystyrene | PTT poly(trimethylene terephthalate) |
| EPS expanded polystyrene | PVAL (PVOH or PVA)) poly(vinyl alcohol) |
| PS-HI high compact polystyrene | |
| PVAC poly(vinyl acetate) | |
| PVC poly(vinyl chloride) | |
| PVDC poly(vinylidene chloride) | |

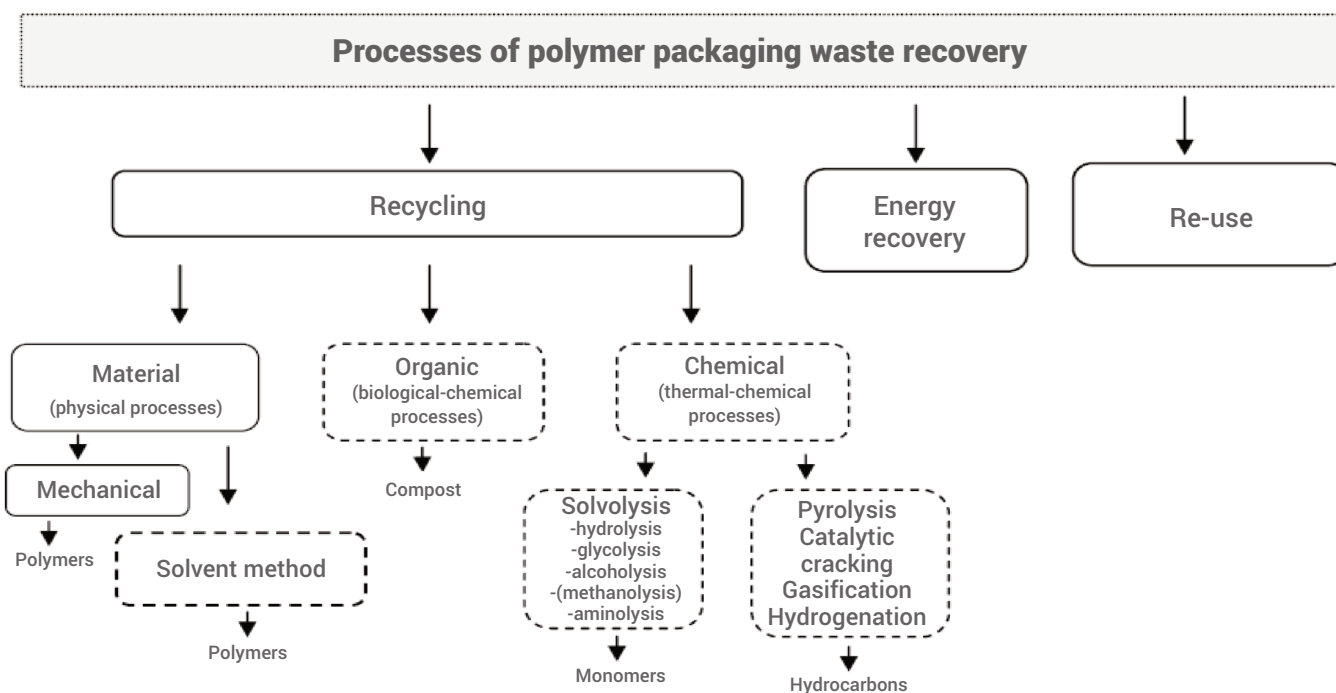


FIG.4. THE RECOVERY PROCESSES OF POLYMER WASTE

properties-modifying additives give the appropriate physical, mechanical and chemical properties which enable processing and ensure the proper protection of the packed products. Polymer plastics include two basic groups: classic and bio-materials, presented in Tab.1 which considers the sources of the materials' origin, and classification into non-degradable and degradable. We should, however, stress that the scale of production of biomaterials (polymers of new generation) as compared to the classic petrol-derived materials is small. In the case of classic products, the world capacities in 2022 amounted to ca. 363 million tons, for bio-materials ca. 1.8 million tons and for packaging purposes ca. 35 % – 45% of the mentioned capacities are utilized. The classic petrol-derived materials such as polyethylene, polypropylene etc. do not reveal the capabilities of biodegradation similarly as the equivalents from the renewable sources.

The types of polymers/copolymers used in production of packaging and their abbreviated names have been listed in Tab.2.

RECOVERY PROCESSES

According to the definition, contained in the act on the waste, the recovery is understood as usable management of the waste

[2]. In the case of packaging waste produced from polymers it refers to the processes of recycling, energy recovery and the re-use. The discussed processes have been graphically presented in Fig.4, with the consideration of different forms of recycling. It should be stressed that the hierarchy of the methods of the waste management gives the preference to the recycling and the re-use after the appropriate preparation to the successive application.

The levels of the packaging waste recovery obtained in the EU countries in 2022, with the classification into recycling and energy recovery is given in Fig.5. The levels above 95% were obtained in Belgium, Estonia, Germany, Austria, Denmark and Finland whereas in Poland it amounted to ca. 60%.

RECYCLING

Recycling is a basic form of recovery, within the frames of which the waste is reprocessed for the products, materials or substances, utilized for a primary purpose or for other goals. It includes also the re-processing of organic material (organic recycling) but not does not include the energy recovery and re-processing for the materials which may be utilized as fuels or for the ground work.

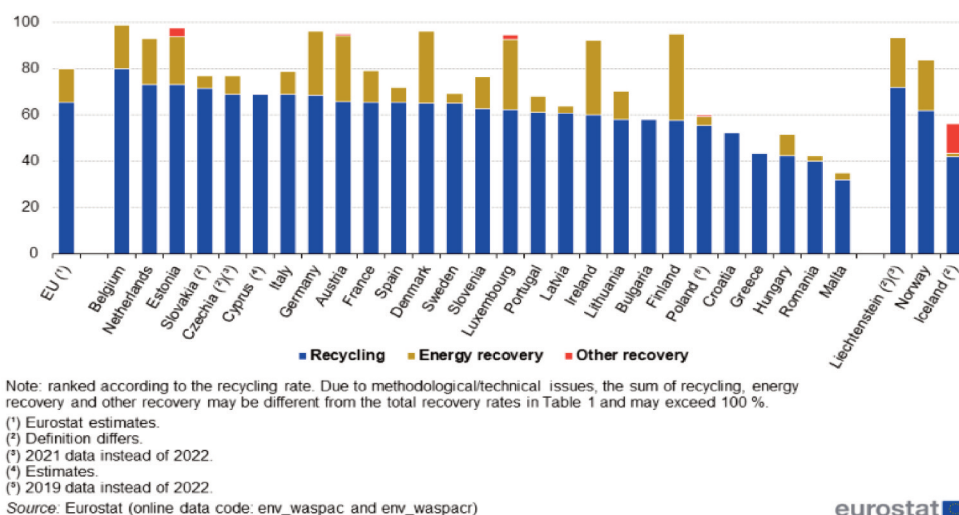


FIG.5. THE LEVELS OF THE RECOVERY OF PACKAGING WASTE IN 2022

Polymer packaging may be subjected to three forms of recycling (Fig.):

- **Material recycling** (physical processes, without the change of chemical structure)
 - **Mechanical** – commonly used in the case of classic petrol-derivate polymers, utilizing thermal-plastic properties of polymer. The mentioned type of processing concerns mainly pure (homogenous) polymers or their mixtures.
 - **Solvent application** – polymer as being present e.g. in the mixed material waste or in multilayer composites is selectively subjected to solvent effect what allows separation of the dissolved polymer and its recovery in a pure form.
- **Organic recycling** (biological-chemical processes) – intended for biodegradable materials, meeting the criteria of compostability. Organic recycling means the oxygen (composting) or anaerobic treatment (biomethanization) of biodegradable parts of the packaging waste, carried out in the controlled conditions and with the application of microorganisms, leading to generation of stable organic residues or methane (depositing of the waste at the landfill site is not treated as a form of organic recycling).
- **Chemical recycling (raw material)** – being now employed in a small scale for the packaging made from traditional polymers; it consists in a partial degradation of material to

low-molecular weight compounds or the complete depolymerization (to initial compounds or their derivatives)

Chemical recycling is not the competition to mechanical recycling. It develops the recycling potential, especially in relation to the waste which are difficult or unprofitable in the mechanical processing. Chemical recycling is found in the preliminary stage of development but when we consider the meaningful investments in this respect, it is a perspective direction and covers many technologies based upon the chemical and thermal processes or their combinations:

- **Pyrolysis** – the process of degradation of polymers, occurring under the effect of high temperature; it is conducted without oxygen access and under the reduced pressure. The main product is a pyrolytic oil – the mixture of short-chained hydrocarbons. After the appropriate treatment, the pyrolytic oil may replace petrochemical raw material in production of basic hydrocarbons such as ethylene and propylene which are crucial for production of polyolefins. At present, pyrolysis is mainly used in the case of the mixed polyolefins (PE and PP) i.e. packaging, bags, films and mixed waste made from plastics and, also, polystyrene (PS) e.g. from insulation and food packaging;
- **Pyrolysis and gasification** may convert the mixed plastic waste into pyrolytic oil and synthesis gas, respectively, in

TAB.3. ANNUAL OBLIGATORY LEVEL OF RECYCLING OF PLASTIC PACKAGING WASTE [5, 6]

| Year | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 |
|---|------|------|------|------|------|------|------|
| Level of recycling of plastic packaging waste [%] | 45 | 50 | 51 | 52 | 53 | 54 | 55 |

the thermal-chemical process. Oxygen is here the main differentiating factor;

- **Catalytic cracking** – this term determines the reactions of degradation of carbohydrates with a quite high molecular weight into hydrocarbons with a lower molecular weight, using catalysts;
- **Hydrogenation** – plastic waste are heated at hydrogen atmosphere. As a result, polymer chains are broken and the mixture of liquid hydrocarbons is generated.

Chemical processes include reactions of solvolysis (effect of different solvents):

- **Hydrolysis** of plastics is one of its main forms. It is a popular method for treatment of plastic waste and the main role is played by water, high pressure and temperature. As affected by the mentioned three factors, polymers are subjected to

degradation and the resulting products are used as semi-products in the industry;

- **Glycolysis** – the disintegrated plastics are subjected to effect of high temperature, ethyl glycol and other chemical compounds; the initial low-molecular weight compounds or their derivatives;
- **Alcoholysis (methanolysis)** – as affected by methyl alcohol, polymers are subjected to stratification and generate a new raw material;
- **Aminolysis** – it is a reaction occurring between amine (ammonia derivate) and polymers – owing to it, plastics are subjected to degradation into short-chained compounds and they may be reused in the industrial processes;
- **Acidolysis** – chemical reaction of the degradation of chemical compound as affected by acid. It is usually carried

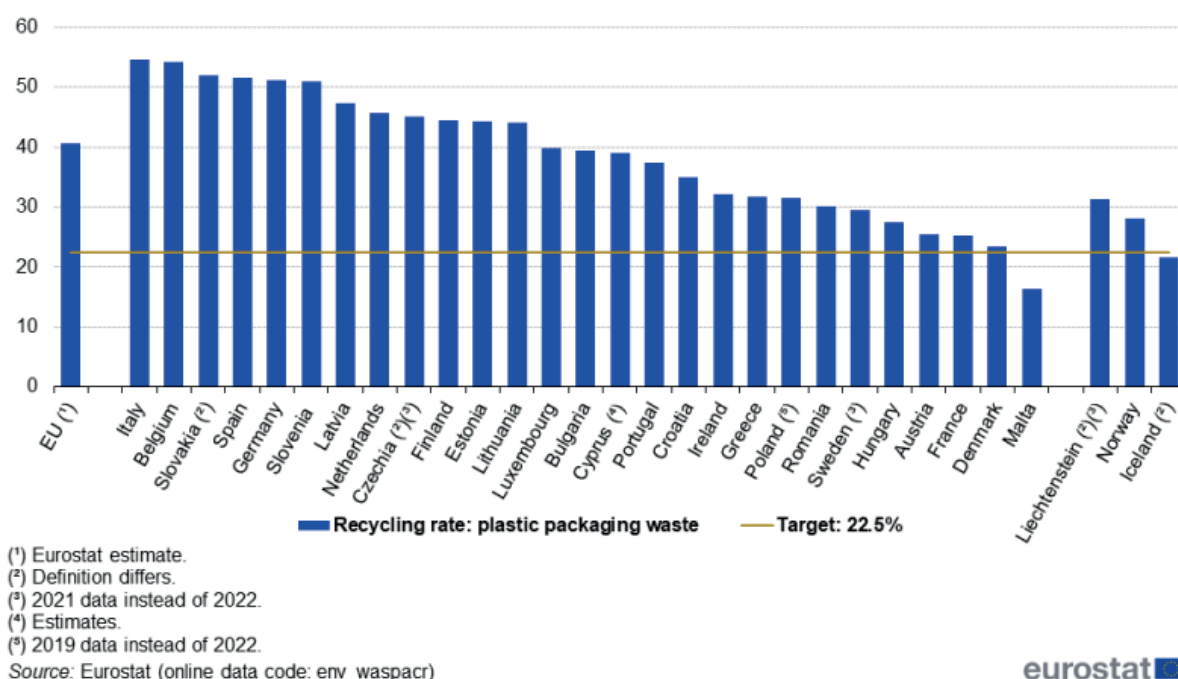


FIG.6. THE LEVELS OF RECYCLING OF PLASTIC PACKAGING WASTE IN 2022, OBTAINED IN THE EU COUNTRIES



out under the anhydrous condition in order not to allow the acid-catalyzed hydrolysis.

From the raw materials obtained in the chemical recycling processes, we may receive polymers of identical quality as those produced from classical monomers (virgin polymers), obtained from petrol or gas, also intended for having a contact with food.

In the EU countries, the obligatory annual levels of recycling of the packaging waste until 2030 have been established [4]. The obligatory levels for plastic polymers in Poland have been given in Tab.3. The level amounting to 55%, as established for 2030 seems to be difficult to be reached when we consider the diversity of plastic materials used in production of packaging, the limited recycling capabilities, high costs of segregation into homogenous groups (in respect of polymers) and, also unsuitability of a great group of unitary packaging for recycling (especially multi-material ones, with the participation of plastics).

The levels of the recycling of polymer plastic packaging waste as obtained in the EU in 2020 are illustrated in Fig.6. As early as in 2022 many countries obtained the level of recycling above 50% (Italy, Belgium, Slovakia, Spain, Germany and Slovenia). The discussed level in Poland amounted to ca. 30%.

ENERGY RECOVERY

In Poland as well as in other EU countries, the polymer packaging waste constitute ca. 14% of the total stream of the municipal waste. It is a fraction which is not suitable for recycling but it has combustion properties (burning value above 6 MJ/kg) and energy recovery from it is possible and fully justified; it also rises the calorificity of the mixed waste. It may be used in energy recovery in the municipal waste incineration plants. In Europe there already about 500 waste combustion factories which meet the rigorous requirements concerning emissions of contamination. In Poland, there are 8 waste incinerators which recover the energy and heat (Białystok, Bydgoszcz, Konin, Cracow, Poznan, Szczecin, Rzeszów and Warsaw).

The polymer packaging waste are also utilized in co-incineration processes in cement manufacturing plants and in heat power plants as a replacement fuel RDF (Refuse Derived Fuel). In Poland, such fuel is used in heat power plant in Zabrze [7].

SOURCE TEXTS:

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GREEN TRANSFORMATION IN THE PACKAGING INDUSTRY: HOW LEGAL REGULATIONS SHAPE THE MARKET IN POLAND AND THE EU

ZIELONA TRANSFORMACJA BRANŻY OPAKOWAŃ: JAK REGULACJE PRAWNE KSZTAŁTUJĄ RYNEK W POLSCE I UE

ABSTRACT: The packaging industry in Poland and across the European Union is undergoing profound changes driven by increasingly stringent environmental regulations. Key legislative acts, including Directive 94/62/EC on packaging and packaging waste, subsequent amendments promoting circular economy objectives, and the Single-Use Plastics Directive, establish ambitious targets for waste prevention, recycling, and the reduction of hazardous substances. In Poland, these EU directives are transposed into national law via the Act on Packaging and Packaging Waste, which mandates detailed reporting, fee obligations, and extended producer responsibility. While meeting these requirements entails higher operating costs—such as purchasing eco-friendly materials, modernizing production lines, and implementing new waste management systems—it also spurs innovation. Producers of packaging materials and machinery are increasingly focusing on biopolymers, compostable solutions, and smart packaging technologies that reduce both resource consumption and environmental impact. Heightened consumer awareness and global sustainability trends further reinforce the shift toward eco-design and closed-loop practices. Consequently, businesses that proactively adapt to evolving regulations can not only ensure compliance but also position themselves as sustainability leaders, thereby gaining a competitive market advantage.

Key words: packaging industry, legal regulations, circular economy, eco-design, extended producer responsibility, SUP Directive, Polish legislation, EU directives

STRESZCZENIE: Branża opakowaniowa w Polsce i całej Unii Europejskiej przechodzi intensywną transformację związaną z rosnącymi wymogami środowiskowymi. Kluczowe regulacje, takie jak Dyrektywa 94/62/WE w sprawie opakowań i odpadów opakowaniowych oraz Dyrektywa w sprawie jednorazowych tworzyw sztucznych (SUP), obligują producentów do ograniczania ilości odpadów, podnoszenia poziomu recyklingu i zastępowania tworzyw pierwotnych bardziej przyjaznymi środowisku materiałami. W Polsce przepisy unijne wdrażane są głównie za pomocą ustawy o gospodarce opakowaniami i odpadami opakowaniowymi, która nakłada na przedsiębiorców m.in. obowiązki raportowe, opłaty środowiskowe i zasady rozszerzonej odpowiedzialności producenta. Choć dostosowanie do nowych regulacji bywa kosztowne i wymaga inwestycji w linie produkcyjne, materiały biodegradowalne czy systemy zbiórki odpadów, jednocześnie stwarza szanse rozwoju innowacji i poprawy konkurencyjności. W odpowiedzi na większą świadomość ekologiczną konsumentów oraz politykę gospodarki o obiegu zamkniętym, producenci coraz częściej decydują się na ekoprojektowanie, stosowanie recyklatów oraz rozwiązania wielokrotnego użytku.

Słowa kluczowe: branża opakowaniowa, regulacje prawne, gospodarka o obiegu zamkniętym, ekoprojektowanie, rozszerzona odpowiedzialność producenta, Dyrektywa SUP, polskie przepisy, unijne dyrektywy



In recent years, the regulatory framework for the packaging industry has changed dramatically, both at the national and EU levels. “In all Member States of the European Union, measures adopted in the area of packaging and packaging waste primarily aim to prevent the generation of waste, as well as to promote reuse, recycling, and other forms of recovery so as to reduce the final disposal of waste” (Directive 94/62/EC, 1994, art. 1). Newly introduced regulations affect the entire value chain – from raw material suppliers, through packaging and packaging machine manufacturers, to end users in the food, cosmetics, and pharmaceutical sectors (European Commission, 2020). This article discusses the key EU and Polish regulations, highlights the main obligations of entrepreneurs, and examines the prospects for the further development of legislation and its consequences for the packaging market in Poland and across the European Union.

LEGAL FOUNDATIONS AND KEY ACTS REGULATING THE PACKAGING MARKET

Packaging regulations stem from both EU directives and national legislation. One of the most important EU acts is Directive 94/62/EC of the European Parliament and of the Council on packaging and packaging waste (Directive 94/62/EC, 1994). This directive is complemented by, among others,

Directives (EU) 2018/851 and (EU) 2018/852, which form part of the circular economy policy and introduce more ambitious recycling targets (European Parliament and Council, 2018a; European Parliament and Council, 2018b). Another crucial piece of legislation is the Single-Use Plastics Directive, which restricts the use of certain single-use plastic products (European Parliament and Council, 2019).

In Poland, the key legal act is the Act on Packaging and Packaging Waste of 13 June 2013 (Polish Act on Packaging and Packaging Waste, 2013). This act includes a number of regulations aimed at implementing EU provisions, particularly with respect to selective waste collection and fee obligations for introducing packaging to the market (Ministerstwo Środowiska, 2020).

KEY PROVISIONS OF THE PACKAGING AND PACKAGING WASTE DIRECTIVE

Directive 94/62/EC, in its original form and subsequent amendments, aims to ensure that the packaging industry focuses on reducing waste generation, improving recovery and recycling processes, and minimizing the presence of hazardous substances in packaging (Directive 94/62/EC, 1994). A special emphasis is placed on designing all packaging so that it can

be processed. The directive specifies that “Packaging shall be so designed as to: (a) limit its weight and volume to the minimum necessary, (b) reduce the content of noxious or hazardous substances to a minimum, (c) ensure the possibility of reuse or recovery, including recycling” (Directive 94/62/EC, 1994, art. 9).

Over the long term, the introduction of such regulations stimulates the development of ecodesign and promotes environmentally friendly solutions, including the use of lighter and more easily recyclable packaging materials (European Commission, 2021).

EXTENDED PRODUCER RESPONSIBILITY (EPR)

Extended Producer Responsibility (EPR) is one of the key instruments supporting the achievement of environmental objectives. Under this concept, the producer bears responsibility for the entire life cycle of packaging – from design and production through to the management of the resulting waste (European Parliament and Council, 2018a). In practical terms, this means that businesses are required to pay fees, establish collection systems, run environmental education programs, and maintain accurate reporting.

In Poland, EPR is implemented through relevant regulations and amendments to the Act on Packaging and Packaging Waste, with the aim of financing the entire waste management system (Polish Act on Packaging and Packaging Waste, 2013). As legal changes progress, costs will increase, especially for producers and importers of plastic-packaged products. “Instruments such as extended producer responsibility are designed to encourage shifts in business models, motivate ecological design, and enhance the quality of secondary raw materials” (European Parliament and Council, 2018a, p. 5).

SINGLE-USE PLASTICS DIRECTIVE (SUP)

The Single-Use Plastics Directive came into force in 2021, introducing restrictions on products widely recognized as the most environmentally damaging, including plastic straws, cotton swabs, and cutlery (European Parliament and Council, 2019). The directive states firmly that “Single-use plastic products account for about 50% of plastic litter found on

European beaches, necessitating urgent legislative intervention” (European Parliament and Council, 2019, preamble).

In practice, the directive bans certain single-use plastic products from the market, requires a reduction in the consumption of plastic cups and containers, and mandates separate collection of bottles to achieve a high recycling rate (Directive (EU) 2019/904, 2019). The impact of these regulations on enterprises in the food and catering sectors is particularly pronounced as they prompt a search for alternative materials and new technological solutions.

POLISH REGULATIONS – THE ACT ON PACKAGING AND PACKAGING WASTE

Polish legislation focuses on implementing EU directives, with the main act being the Act of 13 June 2013 on Packaging and Packaging Waste (Polish Act on Packaging and Packaging Waste, 2013). It establishes rules for record-keeping and reporting for businesses via the Waste Database (BDO), defines environmental fees, and imposes penalties for non-compliance (Ministerstwo Środowiska, 2020). The act states, among other things, that “any entity introducing packaging or packaged products into the territory of the Republic of Poland is obliged to ensure the recovery, including recycling, of waste generated from these packaging materials” (Polish Act on Packaging and Packaging Waste, 2013, art. 17).

IMPACT OF REGULATIONS ON MANUFACTURERS OF PACKAGING MACHINERY AND PACKAGING MATERIALS

Increasingly stringent environmental requirements and growing demand for eco-friendly solutions compel manufacturers of packaging machinery to adapt to new standards. There is a rising need for production lines capable of handling biodegradable materials, minimizing raw material consumption, and reducing carbon dioxide emissions (European Commission, 2021). Technological innovations include automation, integration with RFID systems or barcodes, and the ability to rapidly switch packaging formats while maintaining high process efficiency (Król & Nowak, 2022).

Companies producing packaging materials are investing in research on biopolymers, compostable materials, and lightweight multilayer structures that are easier to recycle. "Policies supporting the circular economy, combined with growing consumer pressure, force manufacturers to pursue increasingly novel solutions. For example, materials with enhanced barrier properties derived from paper or film made from renewable resources are gaining popularity" (European Environment Agency, 2020, p. 12).

CHALLENGES RELATED TO REPORTING AND CERTIFICATION

The implementation of EU and national regulations means that many companies must maintain detailed documentation on the packaging they place on the market. Inadequate record-keeping can result in non-compliance with reporting obligations, exposing businesses to substantial financial penalties (Ministerstwo Środowiska, 2020). Both large and small enterprises often need to implement new IT tools, train staff, and sometimes hire additional environmental specialists.

Furthermore, there is a growing emphasis on a variety of certificates attesting to the use of "green" procedures and raw materials. These include FSC (Forest Stewardship Council) certification for paper packaging, biodegradability certificates (e.g., DIN CERTCO), or environmental management systems in accordance with ISO 14001 (International Organization for Standardization, 2015). Certified solutions can be part of a marketing strategy and serve as evidence of meeting specific sustainability criteria (Nowak, 2021).

SIGNIFICANCE OF ECODESIGN AND THE CIRCULAR ECONOMY

Ecodesign and circular economy principles are two priority areas in the evolution of EU legislation. According to the European Commission, "by managing resources efficiently, reducing waste, and extending the life cycle of products, it is possible to cut greenhouse gas emissions and reduce dependence on primary raw materials" (European Commission, 2020, p. 7).



Ecodesign, which involves considering the full product life cycle in the design process, compels packaging manufacturers to seek optimal solutions for raw material use, energy consumption, and recyclability. Meanwhile, the circular economy, emphasizing the reduction of waste and the multiple reuse of resources, constitutes the framework within which EU packaging policy is expected to progress in the coming years (European Parliament and Council, 2018a).

ENVIRONMENTAL ASPECTS AND GROWING SOCIAL AWARENESS

Contemporary regulations are no longer merely a set of "command-and-control" rules for businesses. They also respond to consumer and NGO demands, for whom environmental protection has become a fundamental issue (European Environment Agency, 2020). In the past decade, numerous social campaigns have highlighted the problem of plastic pollution in seas and oceans, increasing pressure on public authorities and policymakers (Greenpeace, 2019).

Consumers—particularly in Western Europe—are increasingly willing to pay more for products in packaging made from renewable, recyclable, or compostable materials (Nowak, 2021). For large retail chains and well-known brands, this not only signals concern for the planet but also represents an opportunity to differentiate themselves from competitors and build a favourable brand image.

IMPLEMENTATION COSTS AND COMPETITIVENESS

Many producers emphasize rising costs associated with compliance with new requirements (Król & Nowak, 2022). These costs include purchasing more expensive materials (e.g., biopolymers), modernizing production lines, developing alternative packaging designs, and conducting recycling research. EU directives such as (EU) 2018/851 and (EU) 2018/852 set specific recycling percentage targets, which in practice lead to greater emphasis on selective waste collection and the development of processing infrastructure (European Parliament and Council, 2018a; 2018b).

On the other hand, some businesses view stringent regulations as an innovation catalyst. “Companies that are the first to introduce products meeting forward-looking ecological requirements may gain a competitive edge and become leaders in their sectors” (Nowak, 2021, p. 45). Such firms can benefit from EU funding programs—such as LIFE or Horizon Europe – that finance pro-environmental initiatives.

PROSPECTS FOR FURTHER LEGISLATIVE CHANGES

It can be anticipated that regulations in the packaging sector will continue to evolve toward greater stringency, particularly regarding plastic content, the proportion of recycled materials, and the expansion of deposit systems. There is also discussion of introducing more detailed guidelines requiring manufacturers to incorporate a minimum amount of recycle in packaging (European Commission, 2021).

Among the potential measures under consideration is the extension of deposit systems to additional types of packaging, including larger plastic bottles and even certain multi-material packaging in the food sector (Król & Nowak, 2022). This may necessitate investments in collection and sorting infrastructure and could drive modifications in packaging design to meet recyclers’ requirements.

EXAMPLES OF BEST PRACTICES

Although legal restrictions can be costly to implement, there are many examples of successfully adopting eco-friendly

solutions. One innovation is reusable packaging, introduced by some retail chains and foodservice establishments to minimize generated waste (European Environment Agency, 2020). Another example is the growing popularity of biopolymers such as PLA (polylactic acid), which can be industrially composted under appropriate conditions, although there are still concerns about the availability of well-organized composting facilities (Nowak, 2021).

Major food corporations are also testing innovative approaches to labeling and smart packaging, intended to help consumers monitor storage conditions and reduce losses along the supply chain. Such efforts address the EU objective of reducing food waste and align with the principles of a circular economy (European Commission, 2020).

OPPORTUNITIES

AND RISKS FOR POLISH ENTERPRISES

Legal regulations offer Polish businesses various opportunities, such as entering new markets, particularly premium segments where customers value ecologically conscious design. Access to EU funding facilitates the transition toward sustainable production, which can enhance a firm’s long-term competitiveness (Król & Nowak, 2022).

However, evolving legal frameworks also present risks, notably higher operating costs and challenges arising from the rapid pace of legislative amendments. The lack of regulatory predictability may hinder investment planning, especially for smaller enterprises with limited resources.

INTERNATIONAL COOPERATION

AND THE ROLE OF INDUSTRY ORGANIZATIONS

Given the complexity and rapid evolution of the legislative landscape, international cooperation and industry associations are increasingly important. Organizations such as the Polish Chamber of Packaging or the European Packaging Institutes Consortium host conferences, seminars, and joint R&D projects, enabling participants to share experiences, best practices, and research findings. This helps companies prepare for upcoming legal changes and also shape regulations through public

consultations with EU and national institutions (Polish Chamber of Packaging, 2021).

Industry organizations also play a vital role in representing the sector's interests. They can address the Polish government or the European Commission with proposals for amendments to directives and acts, ensuring that regulations are both effective and compatible with market realities and technological capacities (European Commission, 2021).

CONCLUSION

The packaging industry in Poland and across the European Union is undergoing a profound transformation, driven by increasingly stringent legal regulations and growing societal pressure to protect the environment (European Environment Agency, 2020). Legislation such as Directive 94/62/EC and its subsequent amendments, along with the Single-Use Plastics Directive and national regulations, emphasizes minimizing waste generation, increasing recycling rates, and reducing the use of virgin plastics (Directive 94/62/EC, 1994; European Parliament and Council, 2019).

Although many entrepreneurs face costs and administrative challenges in implementing these directives, they also provide an opportunity to adopt innovative solutions in line with ecodesign and the circular economy (European Commission, 2021). Some companies are already introducing reusable packaging, using biodegradable materials, and designing smart systems to reduce food waste (Nowak, 2021).

With upcoming legislative changes – such as stricter requirements for recycled content in plastic products or expanding deposit systems—the packaging market will continue to evolve. “EU legislation on packaging and packaging waste imposes high standards but simultaneously encourages companies to seek novel solutions and enhance competitiveness” (European Commission, 2020, p. 9). Through international cooperation, active involvement of industry organizations, and access to EU funding, Polish enterprises can rise to these challenges and become leaders in the green transformation of the packaging sector.

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CONSUMER AGE AND ATTITUDES TOWARDS ENVIRONMENTAL PROTECTION

WIEK KONSUMENTA I POSTAWY WOBEC OCHRONY ŚRODOWISKA

ABSTRACT: This study aimed to understand how different consumer generations approach environmental protection. It analyzed aspects such as attitudes toward eco-friendly products in both everyday and high-value purchases, changes in environmental awareness over the past five years, and sources of knowledge on the subject. The results indicate that while environmental awareness and the resulting purchasing decisions vary across generations, the differences are not particularly pronounced. No age group demonstrates a clear advantage in practically implementing environmental protection principles. Although different generations are driven by distinct motivations, their level of engagement is similar, and regardless of age, consumers primarily consider price as the key factor in their purchasing decisions.

Key words: buyer attitudes, environmental protection, generational differences

STRESZCZENIE: Niniejsze badanie miało na celu zrozumienie, jak poszczególne pokolenia konsumentów podchodzą do kwestii ochrony środowiska. Analizowano między innymi kwestie takie jak postawy wobec produktów zgodnych z zasadami ochrony środowiska w codziennych i droższych zakupach, zmiany w podejściu do kwestii środowiskowych na przestrzeni ostatnich pięciu lat czy źródła wiedzy na ten temat. Wyniki pozwalają stwierdzić, iż poziom świadomości środowiskowej oraz wynikające z niej decyzje zakupowe różnią się wprawdzie w zależności od generacji, rozbieżności nie są bardzo wyraźne. W ich świetle żadna grupa wiekowa nie wykazuje wyraźnej przewagi w praktycznym wprowadzaniu w życie zasad ochrony środowiska. Poszczególne generacje kierują się wprawdzie innymi pobudkami, jednak poziom ich zaangażowania jest zbliżony, a przy podejmowaniu decyzji zakupowych konsumenci bez względu na wiek kierują się przede wszystkim pragmatycznym kryterium ceny.

Słowa kluczowe: postawy nabywców, ochrona środowiska, generacyjne zróżnicowanie

INTRODUCTION

It is commonly believed that younger generations are more open to innovative ideas and more likely than older consumers to choose eco-friendly products. It also seems that attitudes toward ecological consumption are independent of age. However, an increasing number of studies suggest that it is actually seniors who are more inclined toward environmentally conscious choices. Such findings have been obtained, among others, by researchers in the field of product and packaging management from the Warsaw School of Economics. According to their research, people over the age of 55 are more likely than younger generations to expect companies to engage in pro-environmental actions. The author emphasizes that the

common image of young people as particularly active in environmental issues is based on stereotypes. Subsequent studies indicate that older individuals may, in fact, be the most engaged group when it comes to environmental matters¹.

The phenomena observed in recent years are likely a result of the fact that environmental protection is increasingly seen not as a trend or a passing fad, but as a social or moral imperative. As awareness increases, it becomes a key factor in shaping how older generations perceive the world. It can be assumed

¹ <https://panelariadna.pl/news/ile-jest-wart-csr-czyli-o-tym-jaki-jest-stosunek-polakow-do-odpowiedzialnosci-spoecznej-biznesu> (access:29.10.2024)

that concerns about the future of children and grandchildren, as well as a sense of duty, play an important role here. In the case of the reusable product model, savings may also be a significant factor.

While the literature on various cohorts is extensive, it seems that it does not fully capture the current situation. Therefore, it is crucial to identify and describe the ongoing changes, as well as to gain a deeper understanding of their nature: quantitatively verifying whether senior consumers are indeed more or most likely to be guided by environmental concerns, and exploring the motivations behind this group's purchasing decisions.

Subsequent generations are typically defined by their birth years, but also by a shared set of traits shaped during key periods of life. A collection of historical events and the phenomena associated with them form the foundation for the significant differences that emerge between generations^{2,3,4,5,6,7,8}. The five currently coexisting generations are:

- Silent Generation, Builders, Veterans – individuals born between 1922 and 1945,
- Baby Boomers, Demographic Boom Generation – individuals born between 1946 and 1964,
- Generation X – individuals born between 1965 and 1977/1980,
- pokolenie Y (Millennials) – osoby urodzone w latach 1977/80–1993/94,
- Generation Z – individuals born between 1993/1995 and 2005/2015^{9,10},
- Generation Alpha – approximately individuals born after 2010¹¹.

The Silent Generation is commonly seen as leaning towards conformist attitudes, yet it was from this generation that leaders of civil rights movements and key figures of alternative culture and 1960s rock emerged. In reality, this generation played a significant role in the social changes typically attributed to the Baby Boomer generation¹².

Boomers are the generation of the post-World War II baby boom. Their experiences vary depending on the cultural and political context, but a common thread is the generational rebellion, expressed through the hippie movement and counterculture. While this generation is often criticized for the overexploitation of natural resources, they also became pioneers of a close connection with nature, inspired by the hippie spirit. This generation is characterized by stability in behavior, respect for authority, acceptance of rules, concern for quality of life, and independence in decision-making. They are also notable for their active involvement in social life.^{13,14,15,16}

Generation Y is characterized by a lesser respect for hierarchy and a strong sense of self-worth. Its members are open to change and often assess life situations from the perspective of their own benefits. While they may quickly lose interest in new ideas, they are also willing to engage in activities that benefit the community¹⁷.

The youngest generation, Alpha, stands out for its heightened awareness of upcoming challenges. In many families, it is often this generation that takes the lead in environmental protection efforts. Studies show that for 80% of parents, it is their children

2 A. Turner, *Generation Z: Technology and Social Interest J. Individ. Psychol.* 71(2), 2015, pp. 103-113
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 12 J. M. Twenge, *Generations: The Real Differences Between Gen Z, Millennials, Gen X, Boomers, and Silents – and What They Mean for America's Future*, Atria Books, New York 2023
 13 J. M. Twenge, *ibidem*
 14 G. Rosa, *Formy komunikacji Polaków na podstawie badań pokoleń Y, X i baby boomers*, „Zeszyty Naukowe Uniwersytetu Szczecińskiego”, nr 751, 2013, s. 135-145
 15 J. M. Twenge, *ibidem*
 16 G. Rosa, *ibidem*
 17 G. Rosa, *ibidem*

who influence their eco-friendly choices and consumption decisions^{18, 19, 20}.

The attitude of different age groups towards environmental protection is also analyzed on a global scale. Research in EU markets indicates that the greatest concerns are expressed by the Baby Boomer generation, which also most frequently expects companies to take actions towards sustainable development. Generations Z and Y focus on the environmental commitments of brands: in the UK, more than two-thirds of Generation Z is willing to pay more for products that align with environmental protection principles. In the United States, spending on sustainable brands is increasing across all generations, especially Generation X, which has increased its spending by 24% in recent years^{21, 22, 23, 24}.

RESEARCH METHOD

The study was conducted using a consumer e-panel method, with a sample of 1,110 individuals, reflecting the demographic structure in terms of key characteristics (Table 1). The respondents were selected using a quota sampling method, ensuring representativeness while also allowing for analysis based on age groups: Silent, Boomers, X, Y, and Z, according to criteria commonly accepted in the literature. It is important to note that the Silent group contained only three respondents – their results were included in the charts to maintain methodological consistency, but no in-depth analysis was conducted for this group.

The respondents invited to the study were asked to answer a series of questions according to the developed questionnaire. It concerns consumer ecological awareness and their approach to products compliant with environmental protection principles. The study includes questions about whether respondents pay

attention to the environmental impact of products in both everyday and high-value purchases, such as vacations, electronic devices, or cars, and whether their approach to ecology has changed over the past five years. Additionally, it addresses the awareness of a product's life cycle, including the origin of materials, transportation impact, and waste management.

The questionnaire also examines how important environmentally friendly packaging is to consumers and where they obtain information about products compliant with environmental protection principles – whether they rely on their general knowledge, online materials, press, advertisements, or opinions from friends. Respondents are asked to express their views on ecology, indicating whether they see it as just a trendy slogan, a necessity driven by concern for the future, or an ethical issue. Another key aspect of the study is determining whether consumers prioritize compliance with environmental protection principles or price when choosing both everyday items and expensive purchases. Respondents also indicate what motivates them to care for the environment – whether they act based on ethical principles, concern for future generations, financial considerations, trends, and social perception, or whether they are skeptical about ecology, viewing it as merely a marketing or political tool.

At the end of the questionnaire, respondents are asked which age group, in their opinion, pays the most attention to the compliance of purchased products with environmental protection principles. The survey consists mainly of closed-ended questions with multiple-choice answers.

RESULTS OF RESEARCH

The first question concerned whether, when purchasing products, respondents take into account their entire life cycle and all

¹⁸ D. Lavelle, *ibidem*

¹⁹ C. Gramling, *2020 babies may suffer up to seven times as many extreme heat waves as 1960s kids*, Science News, 2021, <https://www.sciencenews.org/article/children-climate-change-generation-burden-extreme-heat> (access:19.09.2024)

²⁰ McCrindle, *Generation Alpha and environmental consciousness*, <https://mccrindle.com.au/article/blog/generation-alpha-and-environmental-consciousness/> (access:17.09.2024)

²¹ Innovia Market Insights, *European Consumer Trends: Generational Look at Sustainability Values*, <https://www.innoviamarketinsights.com/trends/european-consumer-trends/> (access:17.09.2024)

²² Innovia Market Insights, *ibidem*

²³ Statista, *Share of sustainable shopping behaviors among UK shoppers in 2022 and 2023*, <https://www.statista.com/statistics/1056522/sustainable-shopping-behavior-of-uk-shoppers/> (access:17.09.2024)

²⁴ World Economic Forum, *Gen Z cares about sustainability more than anyone else – and is starting to make others feel the same*, <https://www.weforum.org/agenda/2022/03/generation-z-sustainability-lifestyle-buying-decisions/> (access:17.09.2024)

environmental impacts. Chart 1 illustrates the differences in responses between generations: Silent, Boomers, X, Y, and Z, divided into the categories: no / rather no and yes / rather yes. Among the representatives of the Boomer generation, negative responses are predominant (almost 60%), with the largest

difference between positive and negative answers in this group. In the case of Generation Y, negative responses slightly dominate, while Generations X and Z exhibit more balance between the categories of no / rather no and yes / rather yes. Notably, while differences between the generations (especially

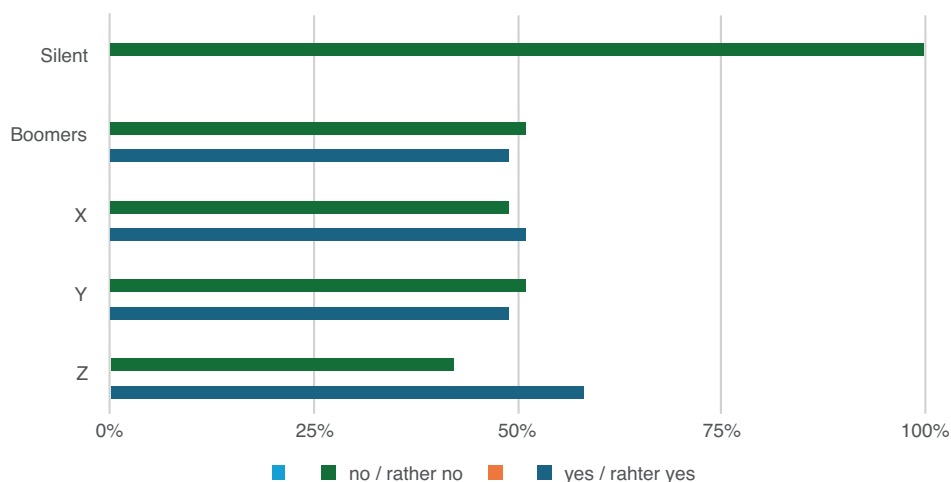


CHART 1: RESPONSE TO THE QUESTION „WHEN PURCHASING PRODUCTS, DO YOU CONSIDER THEIR ENTIRE LIFE CYCLE AND ALL ENVIRONMENTAL IMPACTS, SUCH AS WHERE THE MATERIALS COME FROM, WHAT HAPPENS TO WASTE AFTER THE PRODUCT IS USED, WHETHER LONG-DISTANCE TRANSPORT IS NECESSARY, ETC.” SOURCE: OWN RESEARCH ²⁵

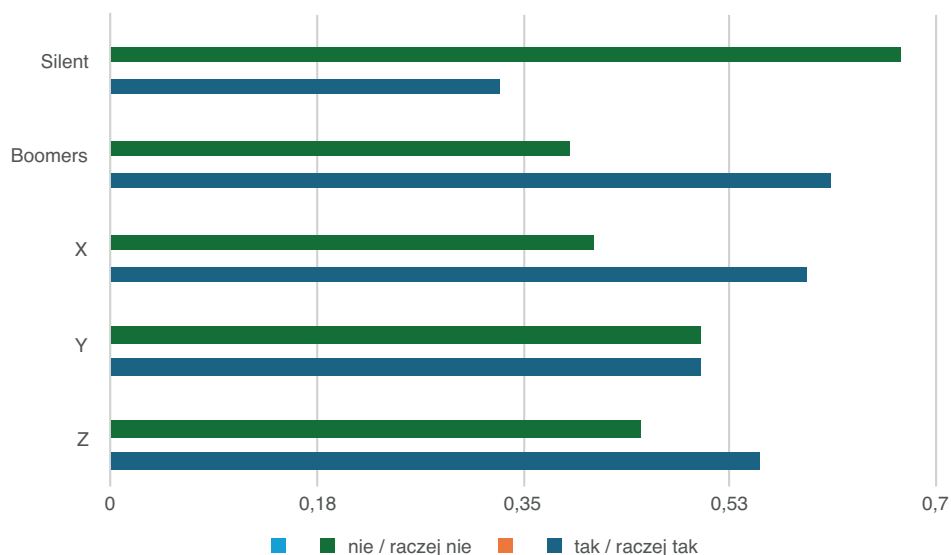


CHART 2: RESPONSE TO THE QUESTION „WHEN MAKING EVERYDAY PURCHASES, DO YOU PAY ATTENTION TO HOW A GIVEN PRODUCT IMPACTS THE NATURAL ENVIRONMENT?” SOURCE: OWN RESEARCH ²⁶

²⁵ J. Karwowska, *Generacyjne różnicowanie konsumentów a postawy wobec ochrony środowiska*, Research project – statutory work funded by a grant from the Ministry of Science, SGH Warsaw School of Economics, Warsaw 2024.

²⁶ J. Karwowska, *Generacyjne różnicowanie konsumentów a postawy wobec ochrony środowiska*, Research project – statutory work funded by a grant from the Ministry of Science, SGH Warsaw School of Economics, Warsaw 2024.

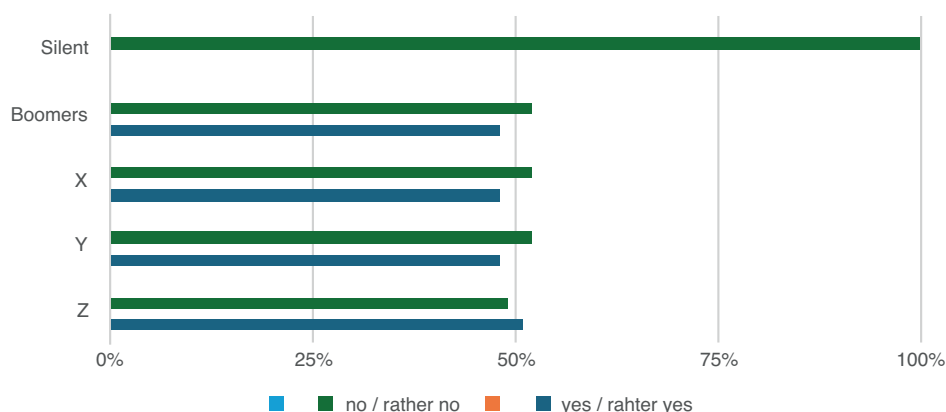


CHART 3: RESPONSE TO THE QUESTION „WHEN MAKING MORE EXPENSIVE PURCHASES (SUCH AS VACATIONS, ELECTRONIC EQUIPMENT, OR A CAR), DO YOU PAY ATTENTION TO HOW THE OFFER / PRODUCT IMPACTS THE NATURAL ENVIRONMENT?” SOURCE: OWN RESEARCH ²⁷

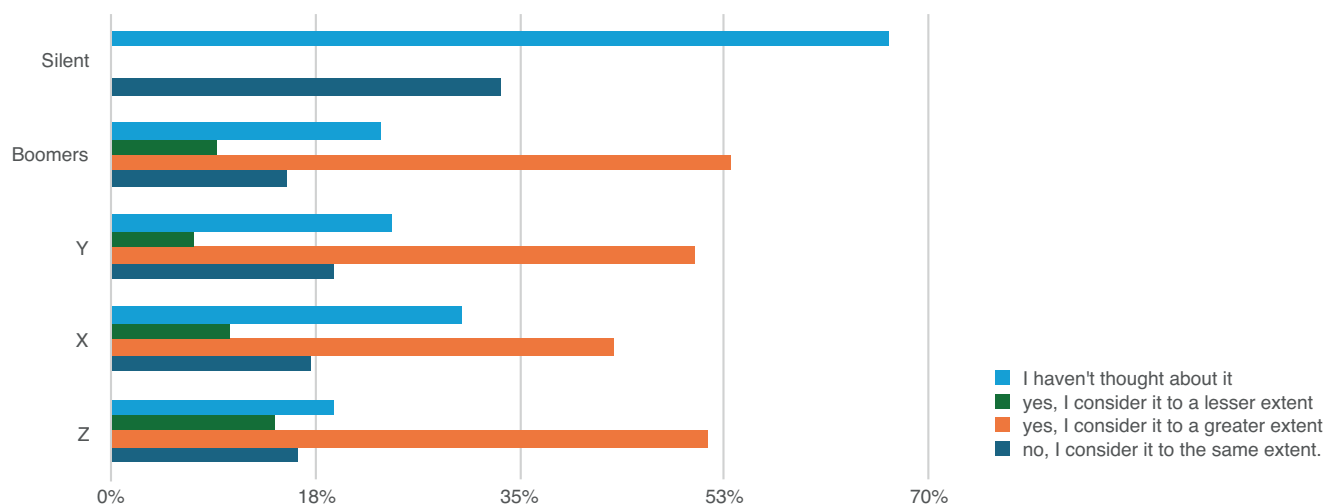


CHART 4: RESPONSE TO THE QUESTION „IN THE LAST 5 YEARS, HAS YOUR APPROACH TO THE ECO-FRIENDLINESS OF PRODUCTS IN EVERYDAY PURCHASES CHANGED?” SOURCE: OWN RESEARCH ²⁸

between similar pairs like Boomers and Y, and X and Z) are noticeable, they are not very pronounced.

Next, respondents were asked whether, in their daily shopping, they pay attention to how a given product impacts the natural environment. Chart 2 presents the percentage of responses divided by generation: Silent, Boomers, X, Y, and Z. The answers were classified into two categories: no / rather no and yes / rather yes.

The analysis shows that negative responses slightly outweigh positive ones in the Boomers and Y generations. For Generation Z, the highest percentage of positive responses was recorded (58%), and the disparity between the categories yes / rather yes and no / rather no is the largest in this group. The Boomers, X, and Y generations exhibit similar proportions of positive and negative responses, indicating similar patterns of attitudes within these age groups.

²⁷ J. Karwowska, *Generacyjne różnicowanie konsumentów a postawy wobec ochrony środowiska*, Research project – statutory work funded by a grant from the Ministry of Science, SGH Warsaw School of Economics, Warsaw 2024.

²⁸ J. Karwowska, *Generacyjne różnicowanie konsumentów a postawy wobec ochrony środowiska*, Research project – statutory work funded by a grant from the Ministry of Science, SGH Warsaw School of Economics, Warsaw 2024.

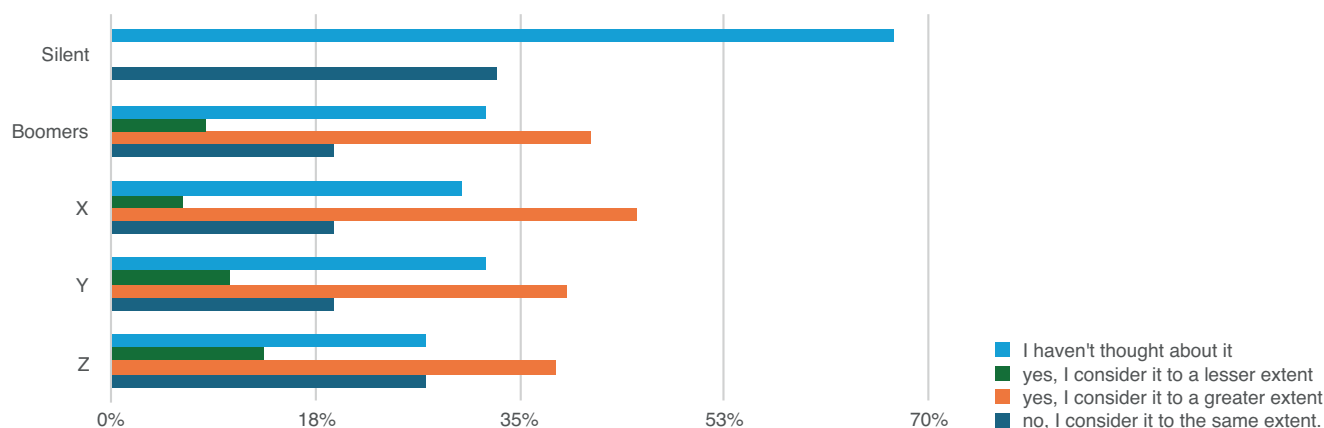


CHART 5: RESPONSE TO THE QUESTION „IN THE LAST 5 YEARS, HAS YOUR APPROACH TO THE ECO-FRIENDLINESS OF PRODUCTS

IN MORE EXPENSIVE PURCHASES (SUCH AS VACATIONS, ELECTRONIC EQUIPMENT, OR CARS) CHANGED?” SOURCE: OWN RESEARCH ²⁹

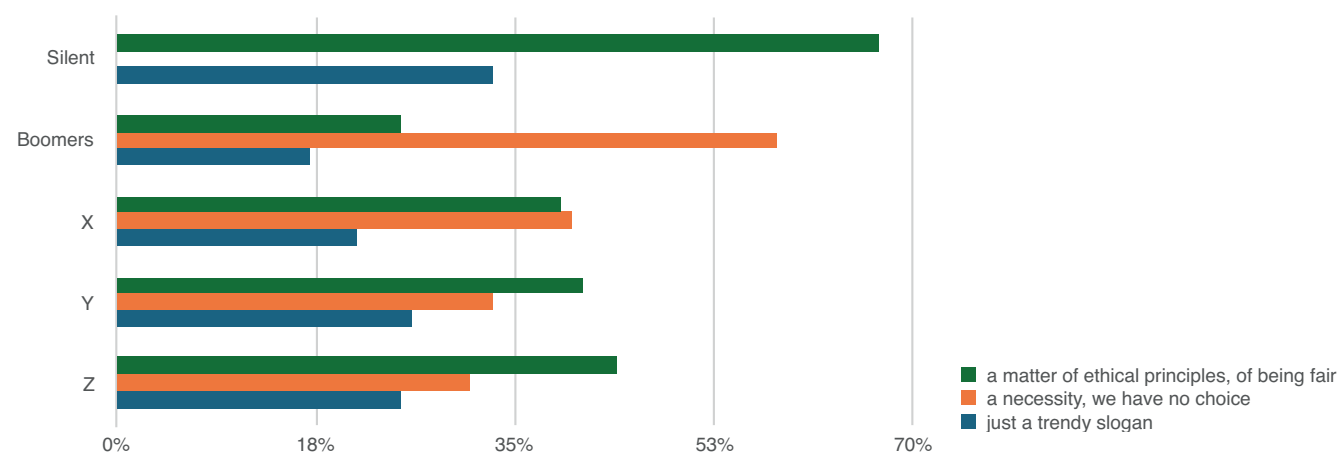


CHART 6: RESPONSE TO THE QUESTION „IN TODAY'S WORLD, PAYING ATTENTION TO ENVIRONMENTAL PROTECTION IS, IN YOUR OPINION:

JUST A TRENDY SLOGAN, A NECESSITY, A WAY OUT, AN ETHICAL ISSUE, OR ABOUT BEING RESPONSIBLE?” BROKEN DOWN BY COHORTS.

SOURCE: OWN RESEARCH ³⁰

Similar to the previous question, Chart 3 presents the percentage of responses divided by generation: Silent, Boomers, X, Y, and Z. This time, the question concerned purchasing decisions related to more expensive purchases, such as vacations, electronic equipment, or cars.

The proportions of positive and negative responses are even more balanced in this case, and the Boomers, X, Y, and Z generations show greater similarity. The results concerning

everyday products and more expensive purchases are therefore largely consistent, with the only noticeable difference being the attitude of Generation Z, where significantly fewer respondents consider environmental aspects when purchasing more expensive goods, such as vacations, electronic equipment, or cars, compared to everyday products.

The next question concerned whether, in the last 5 years, the respondent's approach to the eco-friendliness of products in

²⁹ J. Karwowska, *Generacyjne zróżnicowanie konsumentów a postawy wobec ochrony środowiska*, Research project – statutory work funded by a grant from the Ministry of Science, SGH Warsaw School of Economics, Warsaw 2024.

³⁰ J. Karwowska, *Generacyjne zróżnicowanie konsumentów a postawy wobec ochrony środowiska*, Research project – statutory work funded by a grant from the Ministry of Science, SGH Warsaw School of Economics, Warsaw 2024.

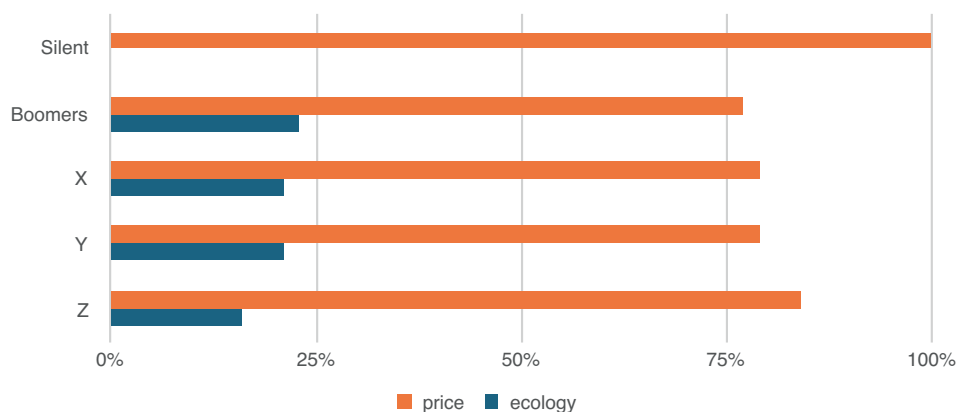


CHART 7: RESPONSE TO THE QUESTION „WHEN IT COMES TO EVERYDAY PRODUCTS, WHICH IS USUALLY A MORE IMPORTANT CRITERION FOR YOU: ECOLOGY OR PRICE?” SOURCE: OWN RESEARCH ³¹

everyday purchases has changed. Chart 4 presents the responses given by each generation to the question regarding changes in their approach to the environmental compliance of products during everyday purchases.

The results indicate that for all analyzed groups, attention to environmental protection in everyday purchases has increased to a similar extent in recent years. The highest percentage of respondents declaring that they now take this issue into account to a greater degree was recorded in the Boomer generation (53%), followed by Generation Z (51%). This result suggests that environmental awareness is increasing in both older and younger age groups, although it may stem from different motivations and factors.

Similarly, for more expensive products (Chart 5), all age groups report greater consideration of environmental protection than five years ago. However, the percentage of responses indicating „I take it into account more” is lower than for everyday purchases. The highest level of responses in this category was recorded among respondents from Generation X (45%) and Boomers (41%).

Next, the respondents were asked whether, in their opinion, paying attention to environmental protection today is: just

a trendy slogan, a necessity, an ethical issue, or about being responsible. Chart 6 presents the responses given by each generation.

The highest percentage of respondents from the Boomer generation, as well as across the entire sample, views environmental protection as a necessity due to the lack of alternatives (58%), while the smallest number in this group perceives environmental protection as just a trendy slogan (17%). In Generation X, there is a relative balance between responses related to ethical issues and necessity, with the percentage of responses linked to the trendy slogan being higher than among Boomers (21%), and it gradually increases in younger cohorts. In Generations Y and Z, responses predominantly emphasize the ethical nature of environmental protection (41% and 44%, respectively), followed by necessity. Among younger groups, there is also a greater reflection on the perception of environmental protection as a trendy slogan, with the highest value being 26% in Generation Y.

Next, an analysis was conducted on the criteria that influence buyers more when making decisions about purchasing everyday products. Respondents were asked to choose between environmental protection and price, and their opinions are presented in Chart 7.

³¹ J. Karwowska, *Generacyjne różnicowanie konsumentów a postawy wobec ochrony środowiska*, Research project – statutory work funded by a grant from the Ministry of Science, SGH Warsaw School of Economics, Warsaw 2024.

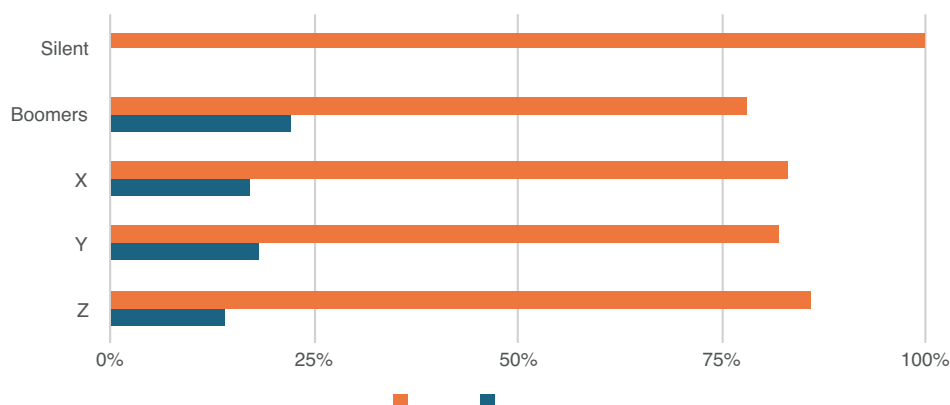


CHART 8: RESPONSE TO THE QUESTION „WHEN IT COMES TO EXPENSIVE PURCHASES (SUCH AS VACATIONS, ELECTRONIC EQUIPMENT, OR A CAR), WHICH IS USUALLY A MORE IMPORTANT CRITERION FOR YOU: ECOLOGY OR PRICE?” SOURCE: OWN RESEARCH ³²

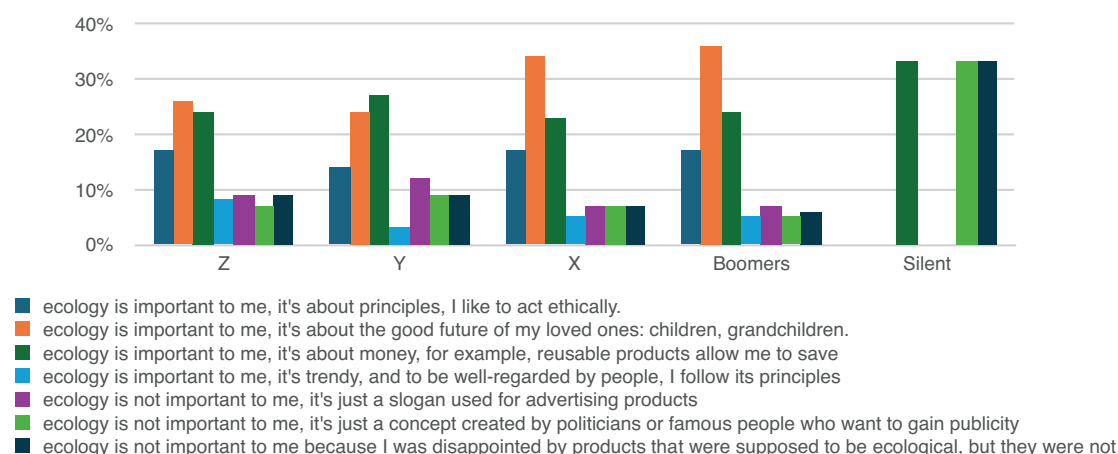


CHART 9: RESPONSE TO THE QUESTION „WHICH STATEMENT DESCRIBES YOU BEST?” SOURCE: OWN RESEARCH ³³

For everyday products, price is by far the more important criterion, with about 80% of respondents across all groups selecting it, and the differences are relatively small. Interestingly, the highest level of environmental concern in purchasing decisions is observed among Boomers (23%), while the lowest is found in Generation Z (16%).

For more expensive products (Chart 8), the differences are also relatively small, and a greater tendency to consider environmental protection is once again observed among

respondents from the Boomer generation (22%). The least attention to the environmental aspect in purchasing expensive products is paid by Generation Z (14%).

The next question aimed to encourage respondents to engage in deeper self-reflection regarding their attitudes toward environmental protection (Chart 9).

The future of loved ones and financial savings are the most important motivations for all analyzed cohorts, with only the proportions of responses differing. Children and grandchildren

³² J. Karwowska, *Generacyjne różnicowanie konsumentów a postawy wobec ochrony środowiska*, Research project – statutory work funded by a grant from the Ministry of Science, SGH Warsaw School of Economics, Warsaw 2024.

³³ J. Karwowska, *Generacyjne różnicowanie konsumentów a postawy wobec ochrony środowiska*, Research project – statutory work funded by a grant from the Ministry of Science, SGH Warsaw School of Economics, Warsaw 2024.

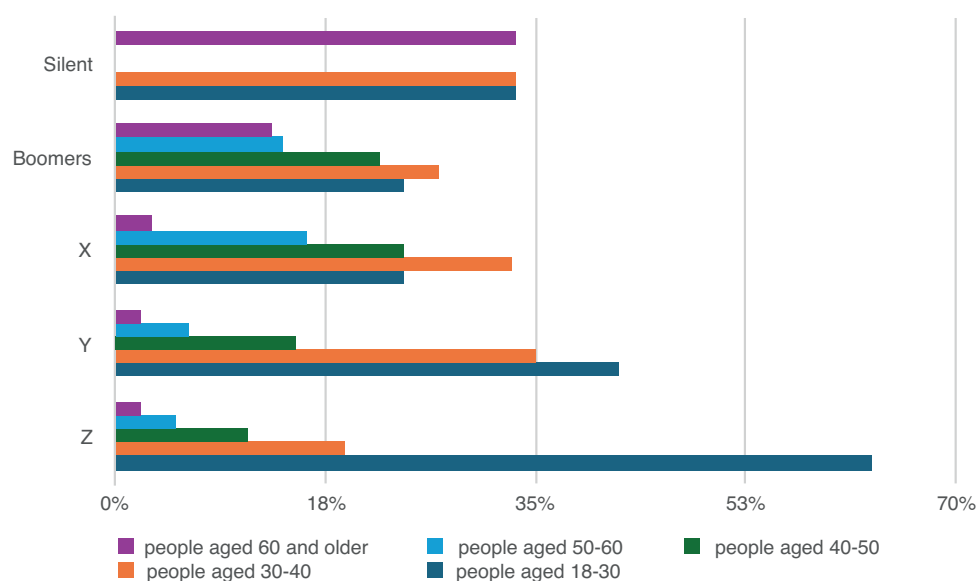


CHART 10: RESPONSE TO THE QUESTION „WHICH AGE GROUP, IN YOUR OPINION, PAYS THE MOST ATTENTION TO THE ECO-FRIENDLINESS OF THE PRODUCTS THEY PURCHASE (COLLECTIVELY)?” SOURCE: OWN RESEARCH ³⁴

are the most important motivation for the Boomer generation (36%), followed by Generation X (34%). For Generation Y, savings are crucial (27%). In Generation Z, although finances also matter (24%), greater emphasis is placed on the future of loved ones (26%).

Respondents were also asked for their opinion on which age group, in their view, pays the most attention to the environmental qualities of the products they purchase (Chart 10).

The analysis of responses reveals interesting patterns: the older the generation, the fewer indications of the youngest group, and a higher percentage of responses pointing to the Boomer generation. Generation Z, as the most environmentally conscious, identifies itself (63%). The youngest group is also indicated by Generation Y (42%). Boomers and Generation X tend to consider the 30-40 age group as the most environmentally conscious (27% and 33%, respectively). Interestingly, individuals aged 60 and over were identified as the least environmentally conscious by all analyzed cohorts, regardless of the respondents' ages.

The last question concerned the sources of knowledge about the environmental compliance of products. All groups indicated their own knowledge of the world (the highest percentage for Generation Z at 52%, the lowest for Y at 43%) and materials and texts available on the Internet, excluding online forums (the highest percentage among Boomers at 52%, the lowest among Y at 45%). Online forums play the biggest role for Generation Z (27%). Among the few respondents who indicated other sources, options such as packaging, labels, leaflets, or points of sale were mentioned (Chart 11).

SUMMARY

Environmental awareness and the purchasing decisions based on it differ across generations, although these differences are not very pronounced. The Baby Boomer and Generation Y cohorts more frequently show negative attitudes towards environmental protection when making everyday purchases, while Generation Z tends to have more positive responses. For more expensive purchases, the generational differences are

³⁴ J. Karwowska, *Generacyjne zróżnicowanie konsumentów a postawy wobec ochrony środowiska*, Research project – statutory work funded by a grant from the Ministry of Science, SGH Warsaw School of Economics, Warsaw 2024.

less noticeable, and Generation Z places less emphasis on environmental issues compared to daily purchases. Over the last five years, attitudes towards environmental protection in purchasing decisions have improved in most groups, particularly in the Baby Boomer and Generation Z cohorts. When it comes to everyday purchases, price remains the dominant factor for all generations, but for more expensive products, environmental concerns are given more consideration. For Baby Boomers, environmental care is more often viewed as a necessity, while younger generations approach it more from an ethical standpoint. Motivations differ across cohorts: Baby Boomers are primarily driven by concern for their loved ones, whereas younger generations focus more on financial aspects. Important sources of knowledge about the environmental qualities of products include personal experience and materials available online, and for younger generations, online forums—often containing subjective content – also play a significant role. Interestingly, Generation Z sees



itself as the most environmentally conscious, while older generations tend to point to individuals aged 30-40 as the most engaged in environmental issues.

Purchasing decisions in each age group are largely influenced by price, especially for everyday products. Environmental

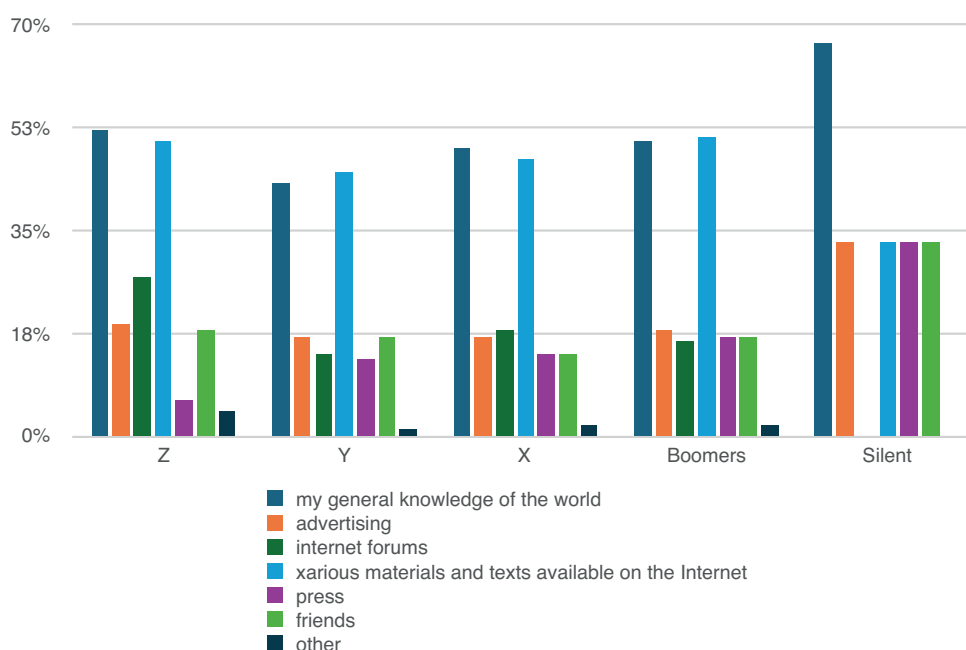


CHART 11: RESPONSE TO THE QUESTION „WHERE DO YOU PRIMARILY GAIN KNOWLEDGE THAT PRODUCTS ARE ENVIRONMENTALLY FRIENDLY (MULTIPLE CHOICE QUESTION)?” SOURCE: OWN RESEARCH ³⁵

³⁵ J. Karwowska, *Generacyjne różnicowanie konsumentów a postawy wobec ochrony środowiska*, Research project – statutory work funded by a grant from the Ministry of Science, SGH Warsaw School of Economics, Warsaw 2024.

considerations are more apparent in the purchasing decisions of older cohorts for daily products, although the differences between generations are small. Interest in environmental protection is more dependent on the type of product rather than the age of the consumer. No age group shows a clear dominance in implementing environmental protection principles in practice, which in some ways challenges stereotypes about different generations (for example, the Greta Thunberg syndrome, which suggests that younger generations are more active in environmental protection) and complements previous research that points to higher engagement from older generations. Baby Boomers tend to view environmental choices as a necessity and a sign of concern for their loved ones' future, while younger generations, particularly Generation Z, are more focused on ethical considerations.

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DRINKTEC 2025: A COMPREHENSIVE SHOWCASE OF BEVERAGE AND LIQUID FOOD INDUSTRY

World's leading trade fair for the beverage and liquid food industry, drinktec 2025, is coming close – with only four months remaining until its opening. All leading companies around the globe have already secured their space for the industry's global economic summit, which will take place from 15th to 19th September 2025 in Munich, and are actively preparing their exhibits.

Preparations for the trade fair are in full swing and we are already able to assure our visitors from all corners of the world that they will once again receive a comprehensive view of all raw materials, ingredients, packaging options as well as solutions and technologies for their product concepts and production needs – explains Markus Kosak, Executive Director drinktec Cluster at trade fair organizer YONTEX. Internationality remains a significant strength of the fair in 2025. With exhibitors from approximately 60 countries, drinktec will again serve as the definitive platform for showcasing the global range of solutions available to the beverage and liquid food industry.

NEW FORMATS IN THE SUPPORTING PROGRAMME

The trade fair organizers are placing special emphasis on the Liquidrome supporting programme. This new format represents a continued evolution of drinktec, enhancing its value proposition: *We see drinktec as a platform created by experts for experts. This naturally includes the exhibitors' presentations at the trade fair and the introduction of new ideas on the future of the industry. With a dedicated space for knowledge exchange in Hall C4, we will place even greater focus on communication between*

researchers, visitors, and exhibitors – explains Markus Kosak. In various interactive zones, the future of the beverage and liquid food industry will be discussed with demonstrations, presentations and executive discussions. This format will be rounded off with a networking area for exchange among visitors with exhibitors also invited to participate.

Visitors from all over the world will be able to experience exciting innovations – many of them in action – from exhibitors at the 2025 edition of drinktec. *drinktec offers a unique opportunity to draw the attention of a global audience to cutting-edge technology and its benefits. Its a clear unique selling point of drinktec that the entire value chain is often available here in live operation. Nowhere else in the world can visitors observe the technical details of complete filling and packaging systems, for example, across all performance ranges, from low-tech to high-tech –* explains Markus Kosak. drinktec, therefore, serves as a one-stop shop for tackling both current challenges and future prospects in the beverage and liquid food industries.

HIGHLY DYNAMIC FRAMEWORK CONDITIONS DEMAND ACTION

Future-oriented approaches are essential across the entire value chain. In the coming years, the diverse range of consumer preferences will continue to influence product offerings in the beverage and liquid food industry. This trend will also be driven by the increasing demand for bespoke product formulations tailored to consumer needs, supported by new ingredients and innovative production processes, such as those for protein production. In order to provide orientation here, the drinktec



team is consolidating these emerging trends within the supporting programme, under the main theme “Lifestyle & Health”. Visitors will gain a comprehensive overview of plant-based beverages, with their flavor profiles and associated processing technologies. The use of plant-based side streams will also be explored as a future avenue.

Progress in the digitalisation of business processes remains a broad field of work in the industry. The key topic „Data2Value” is dedicated to these activities in the industry, highlighting how the use of AI tools is expanding the potential applications of data across the value chain. Many tasks in beverage and liquid food production can benefit from the deeper integration of data, including the use of external data and machine learning-based forecasting tools that reveal overarching relationships in product formulation, process technology, and plant operations.

The triad of focal points is completed by the topic area of „Circularity & Resource Management”. Sustainable products and production processes continue to be of paramount importance in consumer surveys. For many beverage producers, these criteria are now integral to investment decisions. Despite some shifts or adjustments to sustainability targets by some global players, the recovery of materials, the efficient use of energy and innovative recycling solutions – often in collaboration with other sectors – remain priority objectives. A prime example of this is wastewater treatment concepts that help optimise water use in production cycles.

The contributions of start-ups, which will feature prominently within the Liquidrome, also play a crucial role in stimulating idea generation among trade visitors.

We fully support the realignment of the supporting program – states Richard Clemens, Managing Director of the Food Processing and Packaging Machinery Association within VDMA e.V. In the current economic environment, the exchange of ideas within the industry and the expansion of the range of future-oriented topics is more important than ever.

ONLINE REGISTRATION

Anyone interested in visiting the trade fair can do it online at the ticketshop, which allow industry professionals to plan their trip to Munich from 15th to 19th September 2025 and secure their tickets.

All important visitor services are available on the website, providing an overview of which exhibitors are located in which halls and effectively plan the visit to drinktec. With the new exhibitor and product database on the website, visitors have extensive options to plan their route at drinktec with the help of filter options based on halls, industry, product categories, export market and entries in the solutions or innovation directory.

As in previous editions, the event team has strategically positioned exhibitors according to key product groups, ensuring that related exhibitors are clustered together based on their specific exhibition focus. *Our goal is to simplify the thematic overview – explains Markus Kosak – and therefore place our exhibitors in the appropriate halls according to the main themes wherever possible.* This provides a coherent route and facilitates comparisons of the various solutions on display.

ANDY THOMAS

FOLDING CARTONS

COME TO LABELEXPO EUROPE

From this year Labelexpo Europe will be expanded to include folding carton technology. Andy Thomas-Emans, Strategic Director at Informa Markets Labels & Packaging Group, explains how Labelexpo is evolving. Labelexpo Europe 2025, held in Barcelona from 16-19 September, will now include folding carton technology alongside labels and flexible packaging. This looks like a big change for the show, but in fact is more of a natural evolution based on inline and digital technologies which look set to disrupt the traditional folding carton industry in much the same way they did with flexible packaging.

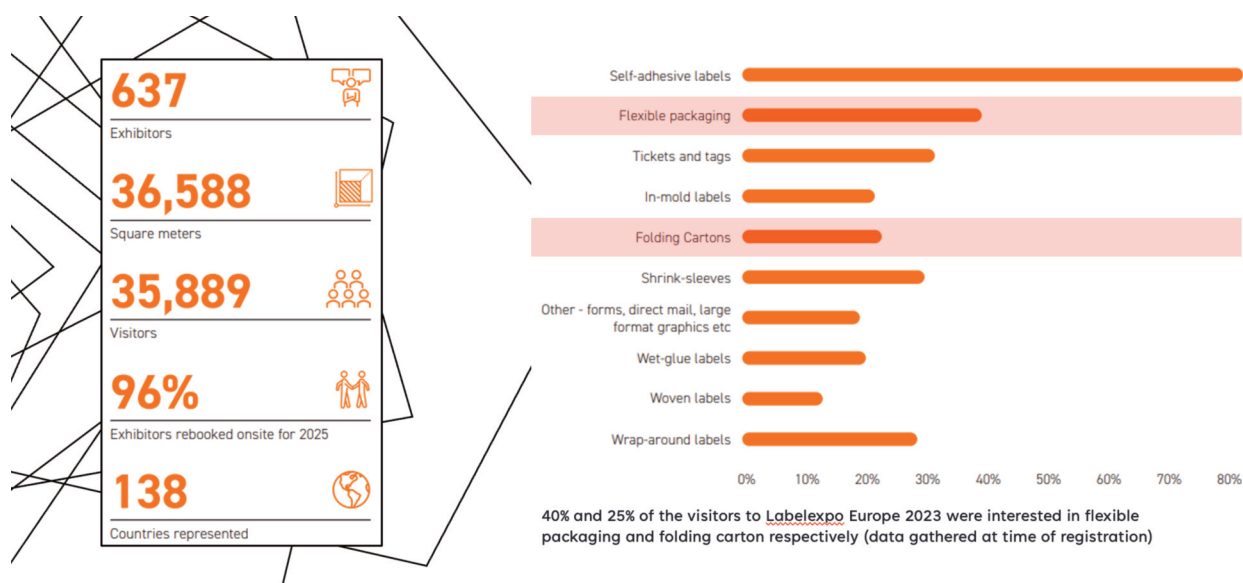
FROM LABELS TO PACKAGING

Labelexpo has constantly adapted to new package printing technologies. The early Labelexpo shows, starting in 1980 in Brussels, focused on what was then the new technology of

self-adhesive labels converted inline on narrow web presses. As labels expanded into new formats, such as shrink sleeves, wraparound and in-mold labels, Labelexpo adapted to showcase these technologies.

The next big evolution for Labelexpo was the addition of flexible packaging, which happened around a decade ago with the launch of the 30-in wide HP Indigo 20000 Digital Press. Flexo press manufacturers then developed wider 'mid-web' presses in the 26-30in/670-800mm range better adapted to handling these larger packaging formats. Label converters who diversified into flexible packaging – typically stand-up pouches – found this opened up new market opportunities which strengthened their label businesses.

There's happening a similar convergence of print technologies between labels and folding cartons nowadays, with the potential



OVER 25 PERCENT OF VISITORS TO LABELEXPO EUROPE 2023 REGISTERED AN INTEREST IN FOLDING CARTONS

Andy Thomas: Labelexpo could speed the adoption of digital printing for folding cartons, just as it did for labels and flexible packaging. The addition of folding cartons to Labelexpo is also likely to galvanise developments in short-run converting systems and digital embellishment

to open up new markets for label converters and other market disruptors.

CONVERGING TECHNOLOGIES

Folding cartons are today overwhelmingly printed on sheetfed presses followed by further off-line operations such as creasing and die cutting, hot stamping and embossing. These multiple process steps add to lead time and create a lot of work-in-progress (WIP) as pallets are moved between workstations. The technologies which could revolutionise this traditional workflow are core Labelexpo technologies: inline flexo and rotary offset, digital and hybrid.

Inline flexo, rotary offset and hybrid presses allow the processing of folding cartons in a single pass from printing and coating to cut-crease and sheeting. As with any label press, additional processes can be added in-line, such as screen printing, foiling and embossing and VDP/numbering. The finished cartons are immediately ready for shipping or further processing on folder-gluer machinery.

Digital printing has huge potential for short run and personalized folding cartons. In 2013 HP Indigo demonstrated a folding carton line built around a Tresu coater, 30000 digital press and with partner Kama demonstrating half-size cut/creasing.

Since then there have been interesting developments in water-based inkjet for folding cartons, and Mark Andy's executive vice president Tom Cavalco says the company is actively looking at how to apply its hybrid UV inkjet platform to the folding carton market.

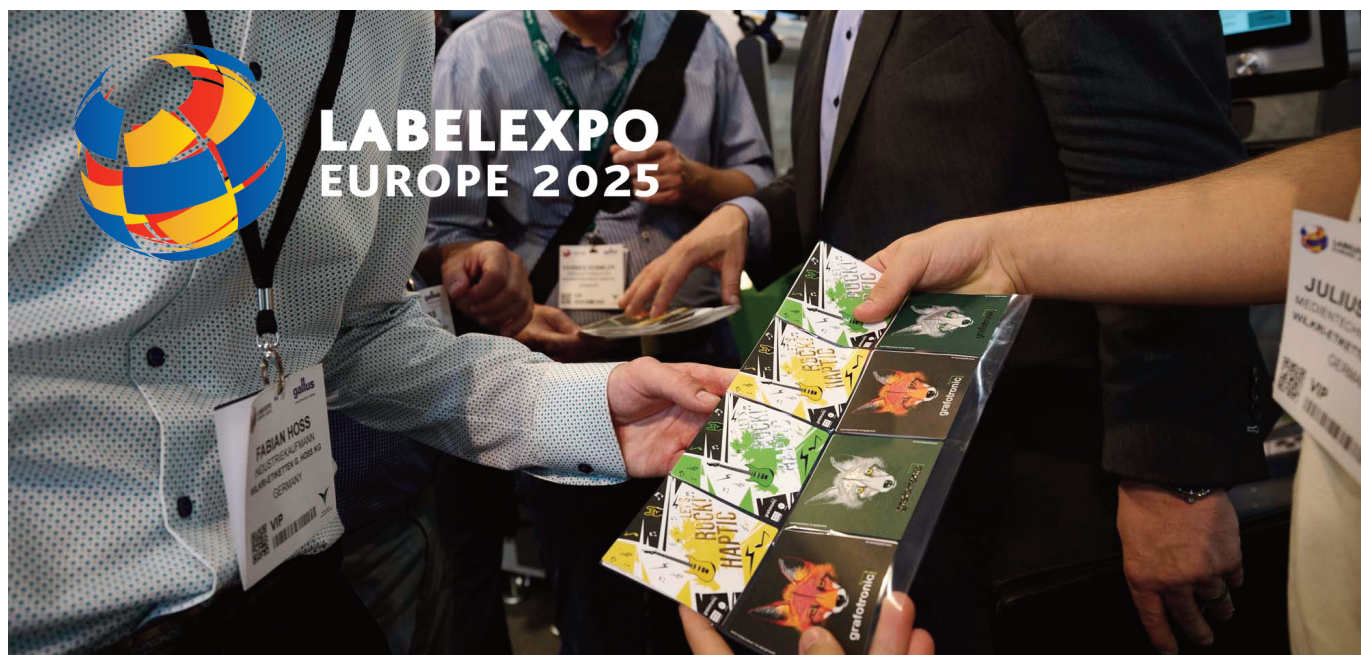
Labelexpo could speed the adoption of digital printing for folding cartons, just as it did for labels and flexible packaging. The



addition of folding cartons to Labelexpo is also likely to galvanise developments in short-run converting systems and digital embellishment.

It should not be forgotten that by far the biggest volumes of wet glue labels and in-mold labels are printed on sheetfed offset presses. One result of bringing folding cartons into Labelexpo will be an increased focus on the high levels of automation on these presses as well as new in-line coating and foiling systems.





COMMON THEMES

As well as overlapping print technologies, there are wider themes which unite labels, flexible packaging and folding carton converters at Labelexpo. Sustainability is a key one, driven by the EU's looming PPWR initiative. Labelexpo Europe 2025 will examine these trends at a feature area on the show floor, with daily presentations and interactive exhibits.

One consequence of PPWR is that many brands are looking to move from plastics to technical paper and fibreboard-based packaging formats. Topics covered in the Labelexpo PPWR feature will include the potential replacement of laminated cartons and flexible packaging with technical coatings to make recyclable mono-material packaging.

Automation is another common theme. Labelexpo exhibitors are already demonstrating process automation software and robotics systems, particularly focused on end-of-line material handling. The addition of folding cartons will no doubt expand this area of the show.

THE FUTURE

What might persuade a folding carton converter to visit Labelexpo? Probably the same reasons that now prompt flexible packaging converters visit the show: a general interest

in visiting co-suppliers; and a general interest in new print and decorative technologies.

Also, with the entry of Private Equity finance into the packaging sector we are seeing more big groups which include labels, flexible packaging and folding carton operations.

This is reflected in a growing visitor interest in both flexible packaging and folding cartons. At Labelexpo Europe 2023 over 25 percent of visitors registered an interest in folding carton technology and 40 percent in flexible packaging. This demonstrates that Labelexpo has transformed into a package printing show, albeit with labels at its core.

Labelexpo Europe 2025 is already shaping up to be an exciting show for folding cartons. Edale, now owned by Canon, has confirmed it will bring its FL5 Carton Production Line to the show. Actega will demonstrate its barrier coating technology, Tec-ni-Fold launches an inline creasing module and Rotatek shows a print station from its Universal 850 rotary offset press specified for folding cartons. There are also a wide range of existing exhibitors like Omet who also supply to the folding carton market.

Labelexpo Europe 2025 will be a 'soft launch' for folding cartons. By 2027 we expect folding cartons to be fully integrated into the show.

Packaging Review

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