Methodological analysis of the Impact Assessment Report accompanying the Proposal for a Regulation of the European Parliament and Council on packaging and packaging waste, amending Regulation (EU) 2019/1020 and repealing Directive 94/62/EC (COM (2022) 677 final)

List of Contents

Pro Food
Fresh Food Packaging Producers Group
c/o Federation of Plastic and Rubber - Unionplast.
Via San Vittore 36, Milan

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1. Introduction

This document sets out a methodological analysis of the Impact Assessment Report (European Commission, 2022b) accompanying the Proposal for a Regulation of the European Parliament and of the Council on packaging and packaging waste (European Commission, 2022a). The Impact Assessment Report deals with the assessment of the economic, environmental and social impacts of a series of measures proposed by the European Commission with the aim to reduce the economic, environmental and social impacts of packaging and packaging waste and to enhance their sustainability. The measures have been grouped into three basic options:

- Option 1 includes necessary measures for the establishment of precise and uniform standards and more clearly defined essential packaging requirements;
- Option 2 sets mandatory targets for packaging waste reduction, reuse, and recycled content in packaging in order to ensure that recyclability targets are met by 2030;
- Option 3 sets more ambitious mandatory targets and product requirements.

The assessment of the combined measures in the different options shows that option 2 is the preferred one. The main measures of option 2, analysed in detail in the environmental impacts assessment report, are:

1. 19% per capita reduction of packaging waste by 2030 compared to the baseline scenario (5% reduction compared to 2018 levels);
2. Definition of mandatory reuse or refill targets for packaging at EU level;
3. Phasing out unnecessary or avoidable packaging.

According to the aforementioned report, option 2 would make it possible to meet by 2030 a number of targets with respect to the baseline scenario, such as a reduction of 18 million tonnes of waste generated, a reduction of 23 million tonnes of CO2-equivalent emissions (corresponding to 42% of Hungary's total annual emissions), a reduction in monetised environmental externalities by EUR 6.4 billion and a net increase in “green jobs”. The measures set out in the policy package are expected to result in overall savings of EUR 47.2 billion from reduced waste management costs and reduced sales and consumption of packaging, a decrease in fossil fuel demand estimated at 12-15 million tonnes, an increase in overall packaging recycling rate to 73% by 2030, and a decrease in the rate of disposal in landfills to 9.6% by 2030.

This document aims to highlight a number of methodological limitations that have emerged from an analysis of the report and the documents attached to it. Such methodological limitations are analysed in the following sections:

2. Analysis of the impact assessment model

2.1 Analysis of environmental impact assessment models

2. Analysis of the impact assessment model

This section and its subsections set out an analysis of the impact assessment model put forward by the European Commission to assess the sustainability of the policy measures proposed.

In general, it is thought that the assessment of environmental, economic and social impacts is not based on detailed enough scientific data to make a study verifiable and repeatable. As a result, the analysis does not appear to be fully suitable to indicate proper transition paths towards circular models of production and management of packaging and packaging waste.

The methods used to assess environmental, economic and social impacts are described in the report in summary form and are discussed in greater detail in Annex D to the draft Regulation (European Commission, 2021a). References to Annex D can be found on pp. 114 and 118 of the impact assessment report. First of all, the annex refers to the mass flow model, whose results are used to determine the financial, environmental and social impacts of individual policy measures or combination of policy measures. To calculate the impacts, the change in mass flow brought about by the measures – obtained by comparing the mass flow of the measures with the base mass flow (e.g., change in tonnes of waste recycled) – is multiplied by unit impact data (e.g., greenhouse gases (GHG) emitted per tonne of packaging or costs per unit of packaging). A different analysis model is used for each type of assessment:

a) multiple methods and sources for the quantification of the environmental impacts of the life cycle phases of packaging and for the estimation of the relative external environmental costs;
b) cost-benefit analysis model for quantifying financial costs and benefits;
c) mass flow model for estimating impacts on employment along the entire life cycle of the packaging.

In general, the aforementioned methods have several shortcomings that make it difficult to arrive at an adequate assessment of the impacts of the various proposed measures, which, instead, could be achieved with other established and standardised methodologies.

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2.1 Analysis of environmental impact assessment models

In the methodological section of the impact assessment report and in Annex D to the draft regulation, no explicit reference is made to a specific methodology for assessing environmental impacts, such as the LCA, and the methods, assumptions and data sources used to quantify emissions at the various stages of the life cycle of packaging are described instead. A study of the report reveals a lack of transparency and detail that makes it difficult to understand how the results were arrived at. The main limitations of the environmental impact assessment model used by the European Commission are described below:

1. **The assessment of environmental impacts is not carried out according to the Life Cycle Assessment (LCA) methodology (ISO, 2021a; ISO, 2021b):** the approach used does not appear to follow a standardised methodology recognised by the international scientific community for the assessment of alternative environmental options and policies, but rather seems to be a combination of multiple methods and approaches with none of the stages and sub-stages typical of robust scientific methodologies.

   It should be noted that the LCA methodology is recognised as an appropriate tool for assessing the potential environmental impacts of one or more product/service systems. It is believed that it can be used to assess the environmental sustainability of packaging systems in an integrated manner by taking into account the entire life cycle and the full complexity of environmental impacts. At the same time, the LCA methodology may be used to assess the potential environmental impacts of multiple policies – e.g., packaging policies – in a comparative manner. Definitions of Life-Cycle-Assessment are given in standard ISO 14040:2021 and in Sala et al. (2016). In standard ISO 14040:2021, LCA is defined as "an environmental management technique that makes it possible to identify and assess, with reference to a product (a service, a process or an activity) system and all its life cycle stages:

   1) The environmental aspects associated with it, by compiling an inventory that identifies and quantifies input flows (energy and material consumption) and output flows (releases to the environment);

   2) The potential impacts associated with those uses of materials and energy and with waste released into the various environmental compartments (atmosphere, water, soil);

   3) The opportunities for environmental improvements attainable at the different life cycle stages."

   In the work by Sala et al. (2016) it is stated that "life cycle assessment (LCA) has been included among the tools aimed at supporting the assessment of the impacts and benefits associated with different policy options. The many features of LCA are particularly relevant for addressing sustainability issues, such as: (i) the life-cycle perspective (from raw material extraction to end-of-life, when the supply chains are assessed); (ii) identification of the most important burdens and the most relevant life-cycle stages contributing to environmental and social impacts; (iii) identification of environmental (and social) "hot spots" of goods/services/systems/technologies/innovations/infrastructures; (iv) identification of unintended burdens shifting between environmental (and/or socio-economic) impacts and over life cycle stages." This methodology is in line with the latest policies adopted by the European Commission to define a common European method for assessing and communicating the environmental footprint of products referred to as Product Environmental Footprint – PEF (European Commission, 2021b).

2. **Little clarity and detail in the determination of the environmental impacts of climate change and water use:** the determination of the greenhouse effect potential of different packaging options is carried out using energy consumption data taken from recognised databases, e.g., Ecoinvent, and emission intensity data and characterisation factors taken from the IPCC. However, the procedure lacks the transparency necessary to make the calculation processes reproducible and verifiable.

3. **Use of different approaches to assess the impact of greenhouse gases and water consumption and the impacts of other pollutants released into the atmosphere (ammonia, nitrogen oxides, particulates, sulphur dioxide and volatile organic compounds - VOCs):** while the assessment of the impact of greenhouse gases is carried out using methods defined by the IPCC and others, the assessment of other pollutants is carried out using external cost assessments. It would be preferable to use a single methodology, such as LCA pursuant to the European Footprint 3.0 method (EC-JRC, 2018), which takes into consideration sixteen environmental impact categories for a proper assessment of environmental impacts:

   - Climate Change (CC)
   - Ozone Depletion (OD)
   - Ionizing radiation HH (IOR)
   - Photochemical Ozone Formation (POF)
   - Particulate Matter (PM)
   - Human Toxicity non Cancer Effects (HTNC)
   - Human Toxicity Cancer Effects (HTC)
   - Acidification potential (A)

- Freshwater Eutrophication (FEU)
- Marine Eutrophication (MEU)
- Terrestrial Eutrophication (TEU)
- Freshwater Ecotoxicity (FEC)
- Land use (LU)
- Water Use (WU)
- Resource use, fossils (RUF)
- Resource use, minerals and metals (RUMM).

Hence, it would be appropriate for the assessment of the environmental impacts of different packaging options to take into account all sixteen environmental impact categories provided for in the aforementioned European Environmental Impact Assessment Method.

4. **Little clarity and detail in the determination of the environmental impacts of other pollutants released into the atmosphere (ammonia, nitrogen oxides, particulates, sulphur dioxide and volatile organic compounds - VOCs):** the determination of the environmental impacts of the pollutants released into the atmosphere is carried out using the externalities of such pollutants as calculated according to the model developed by the European Institute of Environmental Policy (IEEP, 2021). The reference to this model can be found on page 111, line 3, of the impact assessment report). However, the procedure lacks the transparency necessary to make the calculation processes reproducible and verifiable.

5. **Different end-of-life impact assessment approach**: the end-of-life of packaging is modelled according to the model developed by Eunomia Research & Consulting (Eunomia) (European Commission, 2014), which envisages a higher number of air pollutants (CO_2, CH_4, N_2O, NH_3, NOx, PM2,5/PM10, SO_2, COV, arsenic, cadmium, chromium, nickel, 1,3 butadiene, benzene, PAH, formaldehyde and dioxin) for the different technologies considered (material recovery and recycling, source-sorted organic waste treatment, mechanical biological treatment, incineration and disposal in landfill). Reference to this model can be found on pp. 120, 122, 123 and 124 of the impact assessment report. It is not clear why such pollutants are not considered in other phases of the life cycle.

6. **Lack of definition of a reference unit (a functional unit) of the study that can be used to compare different scenarios:** since a reference quantitative unit (functional unit) is not defined, different product systems cannot be compared and the results of the study cannot be reproduced or verified.

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7. **Lack of methodological assumptions for assessing the environmental impacts of different packaging options:** to compare different packaging systems, relevant assumptions, such as number of uses, weight of reusable packaging, washing methods and transport logistics, should be taken into account.

8. **Lack of a clear definition of system boundaries:** the boundaries of the system under study are not well defined and this does not permit a clear definition of the life cycle phases and processes taken into consideration, thereby limiting system comparability.

9. **Lack of clarity regarding the inclusion of anaerobic digestion systems and mechanical-biological treatments:** the assessment of the environmental impacts of different waste treatment scenarios considers incineration and landfilling and leaves out other waste treatment systems, such as anaerobic digestion and mechanical-biological treatments.

10. **Failure to break down VOCs in the impact assessment:** the report does not specify whether or not methane is included in this class of pollutants (p. 111, line 3, of the European Commission's impact assessment report). This omission makes it difficult to properly associate inventory data with the relative environmental impact categories.

11. **Failure to address emissions into water and soil:** emissions into water and soil are not addressed in the report because, it is stated, there is no agreed methodology for assessing such impacts. It is recommended to follow approaches that consider all environmental matrices in order to avoid the shifting of environmental impacts from one life cycle stage to another and/or from one environmental matrix to another.

12. **Lack of sensitivity analysis and/or scenario analysis:** in this type of study, no sensitivity analyses and/or scenario analyses were carried out to determine the environmental break-even point of the various measures and options proposed. Such analyses would be useful to have a systemic and comprehensive view of the systems analysed. In LCA studies, sensitivity analysis makes it possible to enhance the reliability of the results. Studies without an explicit interpretation of the degree of sensitivity do not always prove suitable as supports for decision-making processes or comparative assessments.

13. **Failure to take into account environmental credits of recycling and re-use phases:** taking into account the environmental credits of recycling and reuse processes could lead to different results from those reached in the report, in that it would reduce the overall environmental impacts of the proposed measures. The only environmental credits considered are those from

avoided CO_2-equivalent emissions (p. 110, line 4, of the European Commission's impact assessment report)

2.1.1 Limitations of the Eunomia model for assessing the environmental impacts of different waste management methods

The European Commission's impact assessment report refers to the Eunomia model for the assessment of the environmental impacts of different waste management methods. Reference to this model is made on pp. 120, 122, 123 and 124 of the impact assessment report. This environmental impact assessment model was developed by Eunomia, that was entrusted by the Environment Directorate General of the European Commission with the task of developing a European reference model for municipal waste management and undertaking further analysis and reporting tasks. An analysis of the model shows a number of limitations, and namely:

1. **Use of different approaches to the assessment of climate change impacts and other emissions into the air**: The assessment of the environmental impacts of climate change is conducted using the LCA methodology, while the combined assessment of the externalities of greenhouse gas emissions and atmospheric pollutants uses a cost-benefit approach. As several scientific LCA studies have shown, it is important that all potential environmental impacts, not just the global warming potential, be assessed for each waste management system (Adeleke et al., 2022; Mulya et al., 2022).

2. **Failure to take into account atmospheric emissions other than those typical from waste treatment plants (CO_2, CH_4, N_2O, NH_3, NO_x, PM2.5/PM10, SO_2, VOCs, arsenic, cadmium, chromium, nickel, 1,3 butadiene, benzene, PAH, formaldehyde and dioxin):** the model only takes into account emissions for which reliable measurement data is available. LCA studies, instead, consider all atmospheric emissions from waste management systems by making use of secondary data when field data are not available.

3. **Failure to consider emissions into the soil:** the model does not consider emissions into the soil other than fly ash from incinerators. This results in a non-homogeneous analysis of different waste management methods in that the requirement of comparability is not met.

4. **Failure to consider emissions into the water**: the model does not consider emissions into the water and hence the costs of the ensuing environmental damage are overlooked. The only emissions into water taken into account are nitrate emissions from composting, while other important water pollution emissions, such as those from landfills, are disregarded. The incomplete analysis of emissions into water prevents the comparability of different waste management systems.

5. **Failure to take into account the water consumption of waste treatment plants:** the model does not take into account water consumption by the different waste treatment operations. Disregarding the water consumption of waste treatment processes makes it impossible to compare the overall impacts of the other phases in the life cycle of packaging.

2.1.2 Limitations of the methodology for the estimate of external environmental costs

The methodology used to estimate external environmental costs is given in the document prepared by the European Institute of Environmental Policy. A reference to this model can be found on page 111, line 3, of the impact assessment report. The study relies on an analysis of the literature to work out estimates of external environmental costs per unit of pollutant, and makes use of methodological approaches suitable for each thematic area and type of pollutant. For the estimates of the external costs of air and water pollution, the literature on Impact Pathways Analysis (IPA) studies was used, with specific values for each Member State. The estimates of the costs of air pollution from waste management systems were supplemented with estimates of landfill disposal costs using the hedonic pricing method. Estimates of greenhouse gas emission costs are based on literature data on abatement costs. Total cost estimates at Member State and EU levels are obtained by multiplying unit cost estimates by the air and water emission data provided by Eurostat and other databases. Some of the limitations of the model for estimating external environmental costs are described below:

1. **Assessment of external costs restricted to certain pollutants:** Only the externalities of certain substances are estimated in the model (p. 109, first three lines of section 4.1.2, and p. 111, line 3, of the European Commission's impact assessment report). In particular, for air pollution, the environmental costs considered were those arising from atmospheric emissions of GHG, ammonia, nitrogen oxides, particulate matter, sulphur dioxide and volatile organic compounds – VOCs. Consequently, the costs of air pollution do not include the costs arising from emissions of other toxic substances such as, for example, heavy metals and persistent organic pollutants. As for water pollution, only the environmental costs of nitrogen and phosphorus emissions are assessed. Finally, the environmental costs of waste management systems do not take into account emissions into water and soil.

2. **High uncertainty in the estimates of external costs:** impact assessment studies based on external costs can be characterised by a high degree of uncertainty. For this reason, many authors advise against the use of this approach in support of environmental policies (Gulli, 2006). The overall external costs of one system, in fact, could be higher or lower than another depending, for instance, on the value assigned to the marginal cost of greenhouse gas emissions. These external costs should be considered with caution, in that alternative methods for the estimate of environmental costs could lead to substantially different results.

2.2 Analysis of economic impact assessment models

The economic assessment of the scenarios analysed is carried out using the cost-benefit analysis (CBA) model to quantify the financial costs and benefits of the policy measures proposed. Some of the limitations of the financial cost analysis model used are described below:

1. **Failure to use a "parallel" methodology to LCA for the assessment of packaging life-cycle costs:** the assessment of the economic impacts of the policy measures proposed by the European Commission should be carried out with a methodology parallel to LCA, such as the Life Cycle Costing - LCC method (ISO, 2017; ISO, 2021c; Rebitzer & Seuring, 2003), which makes it possible to quantify and monitor the environmental and economic costs and benefits arising at all stages in the life of a product or a service (investment costs, operating costs, maintenance costs and end-of-life costs). As per the definitions found in the literature, "the life cycle cost of a product is the sum of all the costs incurred from its conception and manufacture to the end of its useful life" (White and Ostwald, 1976). This method has the advantage of considering both the direct benefits of a given activity (e.g., the economic value of the material recovered from the recycling process) and the relative indirect benefits (e.g., economic value of the CO2 avoided through the recycling process), as well as the advantage of making the costs of alternative systems comparable. The LCC method can also include the costs of environmental externalities without the need to resort to additional external cost assessment methods. Furthermore, the use of this method has the advantage of analysing the final results of the LCC study together with the results of the parallel LCA study for the identification of economic-environmental trade-offs.

2. **Little clarity in the data and methods for the determination of financial costs and benefits:** the European Commission's impact assessment report does not specify the sources of the data and the procedures used to determine the relative financial costs and benefits (p. 108, paragraph 4.1.1, of the European Commission's impact assessment report). As a result, understanding the different cost items is non-transparent and difficult.

3. **The determination the costs of packaging materials is restricted to paper, cardboard and plastic:** changes in the costs of packaging materials – a useful tool for estimating the financial savings for manufacturers that may arise from changes in mass flows – are considered only for paper, cardboard and plastic, and several other materials used in packaging (e.g., wood, glass, aluminium) are left out.

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4. **Omission of some monetary costs and lack of clarity in the estimation of some cost items:** in the model, only the monetary costs for which the necessary data were available are quantified. Estimates, assumptions and modelling parameters that are not very clear are used for some missing data. Non-quantified costs are discussed in the report only in qualitative terms.

2.3 Analysis of the assessment model for social impacts

As for the assessment of social impacts, as mentioned above, the European Commission report refers to the mass flow model and only considers impacts on employment. The modelling of social impacts refers to changes in the number of jobs for each stage of the packaging life cycle. Jobs in the manufacturing sector are calculated by comparing value added per worker for each type of material and turnover manufacturer's turnover. Employment data for the various treatment and disposal options were taken from the Eunomia model. Reuse employment data were calculated using the same approach as for the calculation of reuse costs. Some of the limitations of the social impact assessment model used are described below :

1. **Approach limited to the employment aspect:** the social impacts of the measures proposed by the European Commission only take into account the employment aspect, focusing on a single category of stakeholder, i.e., the workers (p. 111, paragraph 4.1.3, of the European Commission's impact assessment report). The analysis does not take into account other important stakeholder categories (society, local communities, consumers and other actors in the value chain), leaving out a whole series of other social impact categories (human rights, health and safety, cultural heritage, governance, socio-economic repercussions).

2. **Failure to use a scientifically recognised methodology such as Social Life Cycle Assessment – S-LCA (UNEP, 2020):** according to the definition given by the United Nations Environment Programme "S-LCA is a methodology for assessing the social impacts of products and services during their entire life cycle (e.g., from raw material extraction to the end-of-life phase, e.g., disposal). S-LCA provides information on social and socio-economic aspects useful in decision-making, with a view to improving the social performance of an organisation and, ultimately, the well-being of the parties concerned". This method has the potential advantage of considering a multiplicity of stakeholders and different categories of social impact. This methodology is also "parallel" to LCA, but addresses the social dimension of sustainability.

3. **Lack of clarity as to the sources and methodology for the determination of employment changes at the different stages of the packaging life cycle:** It is not clear in the report how jobs in the manufacturing sector, the waste management sector and the packaging reuse sector were calculated. Also not very clear are the sources of the data used in the calculations.

3. Conclusions

In this report, a methodological analysis is put forward of the impact assessment report accompanying the Proposal for a Regulation of the European Parliament and Council on packaging and packaging waste (COM (2022) 677 final). In particular, this paper explores the methodological limitations of the methods used for the assessment of environmental, economic and social impacts.

This analysis has shown that the environmental, economic and social assessment of the measures proposed by the European Commission to reduce packaging and packaging waste in the European market is not very transparent as to the sources of the data and the calculation methods used.

The main limitation of the impact assessment model in question is that it uses a multiplicity of methods for the assessment of impacts, which leads to results whose uniformity, verifiability and reproducibility cannot always be counted on.

This report provides some suggestions on how to choose a valid procedure for assessing environmental, economic and social impacts, underscoring the need to use analytical tools based on a life-cycle approach, such as LCA, LCC and S-LCA, which are characterised by robust methodologies that ensure greater transparency in the calculations and comparability of results. Such tools would permit a comprehensive and integrated analysis of the environmental, economic and social impacts of packaging systems throughout their entire lifecycles. The three tools mentioned above are methodologically aligned and lead to “parallel” analyses focusing on the three pillars of environmental, economic and social sustainability.

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c/o Federation of Plastic and Rubber - Unionplast.
Via San Vittore 36, Milan

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