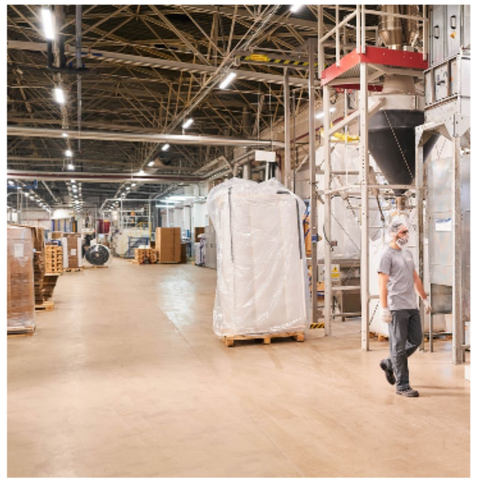
# HOW **WE CREATE** VALUE

# PLASTIC PACKAGING IS PART OF THE SUSTAINABLE SOCIETY

**Profit & loss 3-dimensional (3D P&L) assessment on PACCOR packaging solutions with Digimarc digital recycling passport**

**Background document**





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# INTRODUCTION

**FINANCIAL CAPITAL** **NATURAL CAPITAL** **SOCIAL CAPITAL**

Driven to find solutions to the modern challenges, stakeholders demand more and more insight and transparency regarding the societal impact of companies and their products. While previously the shared value estimate was mainly driven by the financial performance, it now has become clear that the larger societal issues are transforming the competitive landscape. As a result, leading businesses change the way they think and communicate about their products, processes, and business models. At PACCOR, we strive to incorporate economic, environmental, and social impact assessment in our decision making.

To get better insights into the benefits of implementing the Digimarc system[1] on PACCOR's packaging solutions as enabler to create closed plastic loops and reduce marine littering[2], we launched a study, in which we focused on valuating relevant societal aspects of the Digimarc digital watermarking implementation across the whole value chain, based on the three pillars of sustainability: environmental, economic, and social.

The societal aspects can also be expressed in monetary values and translated into societal costs (externalities) or benefits, according to a 3-dimensional benefit framework (3D). Each of the pillars of the 3D framework is assessed with a separate methodology and is based on robust, and widely accepted methodologies, developed by universities[3], the WBCSD Natural & Social Capital Protocols[4,5] and other experts in the field.

The study focuses on the comparison between 1,000 black polypropylene (PP) food trays with implemented Digimarc technology (resulting in improved food grade mechanical recycling end of life management) and without Digimarc technology (considering existing end of life management in Germany) introduced to the German market by PACCOR.

The same methodology can be applied to other kinds of plastic packaging, volumes, or countries.

1 https://www.digimarc.com/
2 https://www.paccor.com/news-detail/paccor-gives-plastic-packaging-a-digital-identity
3 Environmental Priority Strategy (EPS) system (Chalmers University of Technology, Bengt Steen, 2015) Available at: www.lifecyclecenter.se/projects/environmental-priority-strategies-in-product-design-eps/
4 World Business Council for Sustainable Development (WBCSD), Human and Social Capital Protocol, 2019 Available at: www.wbcsd.org/Programs/Redefining-Value/Business-Decision-Making/Assess-and-Manage-Performance/Social-Human-Capital-Protocol/Resources/The-2019-Social-Human-Capital-Protocol
5 World Business Council for Sustainable Development (WBCSD), Natural Capital Protocol, 2018 Available at: www.capitalscoalition.org/capitals-approach/natural-capital-protocol/




# DIGIMARC DIGITAL WATERMARKING


**DETECTION IN SORTING RECYCLING CENTERS: ADD-ON MODULE**

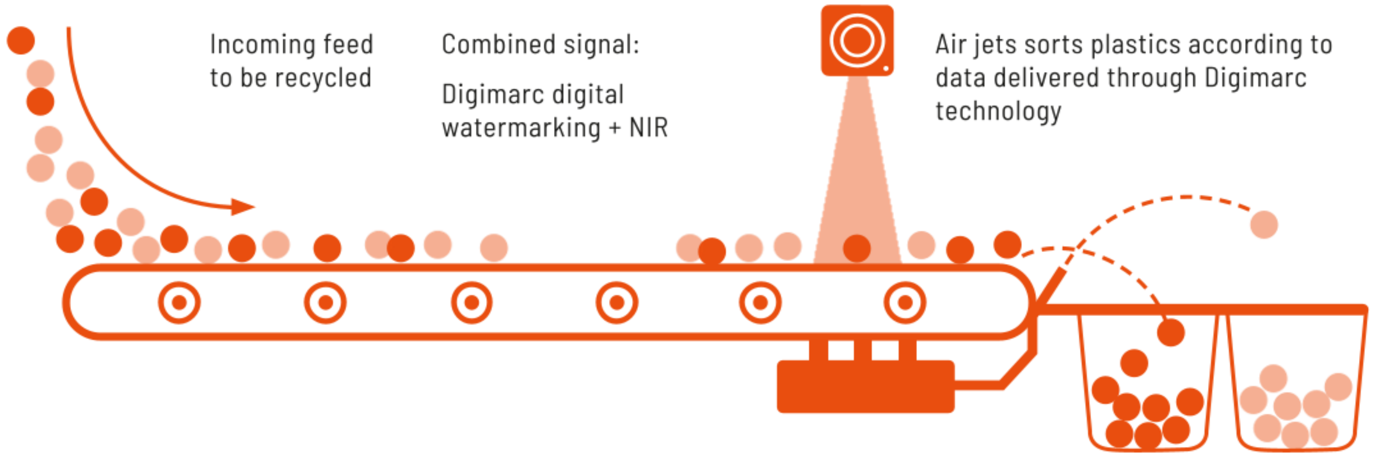



Figure 1: Schematic representation of a sorting facility with implemented Digimarc digital watermarking.

The plastic packaging is given what Digimarc has termed a 'Digital Recycling Passport', which can be used in supply chains to track and trace goods, to speed retail checkout and engage and inform consumers through smartphones. The digital identifier is repeatedly replicated throughout the package by subtly modulating the existing pixels in the graphic design (for print) or through subtle texture variations in the plastic substrate via the molding process. The process is ideal for the circular economy as there are no 'additives' utilized in the enhancement process which applies the digital watermarking. When packaging waste is collected, it can be scanned and absolutely identified. This will create new value streams for recycled plastics and keep used packaging from ending up being incinerated, in landfills or in our oceans. The visually imperceptible barcode also allows for the possibility to detect opaque, carbon-black, and other difficult-to-recycle objects, increasing both the quantity and quality of recyclates needed to meet regulatory requirements and corporate pledges.

# PRODUCT INFORMATION


## PRODUCT DESCRIPTION

This study focuses on black PP trays for ready meals, produced at PACCOR site in Skierniewice, Poland. The product content declaration is reported in table 1.

| MATERIAL/CHEMICAL SUBSTANCE | WEIGHT (GR./TRAY) | HAZARD CLASSIFICATION |
|---|---|---|
| Virgin polypropylene (granulates) | 11.75 | Not classified under (EC) no 1272/2008 (CLP) |
| Post industrial polypropylene (regrind) | 11.75 | Not classified under (EC) no 1272/2008 (CLP) |
| Talc (mineral) | 2.70 | Not classified under (EC) no 1272/2008 (CLP) |
| Carbon black | 0.81 | Not classified under (EC) no 1272/2008 (CLP) |
| **Total** | **27.00** | |

Table 1. Product content declaration of PACCOR black polypropylene trays.

# 3D PROFIT & LOSS IMPACT ASSESSMENT

***In this study, we focus on assessing and comparing the positive and negative impacts of plastic value chains based on three capitals: environmental, financial, and social. A capitals approach broadens the quantity and quality of business-relevant information available to decision-makers.***



**FINANCIAL CAPITAL** **NATURAL CAPITAL** **SOCIAL CAPITAL**

Each of the three capital is assessed with a separate methodology, based on robust, open sourced, and reproducible approaches[4,5].

The positive and negative impact of the compared value chains were expressed in monetary terms for the environmental and Financial Capital, while for the Social Capital a semiquantitative risk-based approach was used.

In this report, we will explain the 3D P&L framework, the methodologies used as well as the results of our case study on the comparison between black PP food trays with applied Digimarc technology (resulting in improved food grade mechanical recycling end of life management, 'Digimarc scenario') and without the Digimarc technology (considering existing end of life management in Germany, 'base scenario'). Results are presented per 1,000 trays introduced to the German market by PACCOR. This product life cycle was chosen since it is especially black plastic which poses difficult challenges in the present sorting and recycling processes, while the occurrence on the market is growing, due to its advantageous properties as well as societal lifestyle changes.

More information on how PACCOR creates value to society and on our partnership with Digimarc can be found in our Sustainability Annual Report 2020[6].

4 World Business Council for Sustainable Development (WBCSD), Human and Social Capital Protocol, 2019 Available at: www.wbcsd.org/Programs/Redefining-Value/Business-Decision-Making/Assess-and-Manage-Performance/Social-Human-Capital-Protocol/Resources/The-2019-Social-Human-Capital-Protocol

5 World Business Council for Sustainable Development (WBCSD), Natural Capital Protocol, 2018 Available at: www.capitalscoalition.org/capitals-approach/natural-capital-protocol/

6 https://www.paccor.com/holistic-sustainability/leading-transition





# NATURAL CAPITAL

Business activities have an impact on environment and nature: they use several natural resources, lead to, among others, fossil fuel consumption, greenhouse gases emission (collectively expressed as carbon dioxide equivalents, $CO_2$ eq.) and waste production.

Natural Capital is defined as the stock of renewable and non-renewable natural resources (e.g. plants, animals, air, water, soils, minerals) that combine to yield a flow of benefits to people (adapted from Atkinson and Pearce 1995[7]; Jansson et al. 1994[8]).

Traditionally the value of Natural Capital has, for the most part, been excluded from decision-making. Even when included, methods have been inconsistent, open to interpretation, limited to moral arguments or based on an incomplete understanding of organizational relationships to Natural Capital.

The Natural Capital Protocol Framework[9] responds to this gap by offering an internationally standardized framework for the identification, measurement and valuation of impacts and dependencies on Natural Capital in order to inform organizational decisions.

In this study, we have followed the Natural Capital Protocol Framework and quantified the environmental burden and natural costs (negative externalities) associated with the investigated value chains. The method is based on Life Cycle Impact Assessment (LCA), in alignment with the ISO 14040/14044 standards[10-12]. The monetary value, which is attached to the quantified environmental impacts, is in accordance with the price for impact as established in the Environmental Priority Strategy (EPS)[3], a methodology developed by Chalmers University of Technology, Sweden.

The monetary values in the EPS are based on either real or hypothetical market values and reflect the cost of either environmental remediation or resource replacement.

Schematically, the way in which the Natural Capital loss is calculated can be summarized as follows:

**COST TO NATURE = QUANTIFIED IMPACT ON NATURE (FROM LCA ASSESSMENT) X MONETARY VALUE OF THE IMPACT**

| LCA RESULTS | | EPS characterization factors | | Environmental capital |
|---|---|---|---|---|
| **$CO_2$ emissions** e.g. 5 kg/1000pcs | X | **Cost / ton $CO_2$ emitted** e.g. €-130/ton | = | **Capital loss related to $CO_2$** = € -0,65 |
| **Resource use** e.g. crude oil | X | **Cost / ton natural resource consumed** | = | **Capital loss related to natural resource use** |
| ••• | | ••• | | ••• |
| Etc. | X | Etc. | = | Etc. |
| | | | ∑ | |
| | | | | Total Natural Capital loss |

The results of the EPS impact assessment method are damage costs for emissions and use of natural resources expressed as ELU (Environmental Load Units). One ELU represents an externality corresponding to one Euro (€) environmental damage cost.
Totally, the 42 individual environmental impact categories considered in this methodology were further clustered into 5 main sustainability topics:

- Resource use
- Climate change
- Air pollution
- Land use
- Water pollution

The full list of impact categories and the corresponding EPS calculated values are reported in Appendix I.

3 Environmental Priority Strategy (EPS) system (Chalmers University of Technology, Bengt Steen, 2015) Available at: www.lifecyclecenter.se/projects/environmental-priority-strategies-in-product-design-eps/

7 Atkinson, G. and D. Pearce. 1995. 'Measuring sustainable development.' In: Bromley, D. W., (ed.) Handbook of Environmental Economics. Blackwell, Oxford, UK, pp. 166-182

8 Jansson, A., M. Hammer, C. Folke, and R. Costanza (eds.) 1994. Investing in Natural Capital: The Ecological Economics Approach to Sustainability. Island Press: Washington, DC.

9 Natural Capital Protocol Framework. Available at: Available at: www.capitalscoalition.org/wp-content/uploads/2021/01/NCC_Protocol.pdf

10 ISO 14040:2006 Environmental management – Life cycle assessment – Principles and framework

11 ISO 14040/14044 on Life Cycle Assessments Environmental management – Life cycle assessment – Requirements and guidelines

12 ISO 14021 on Environmental labels and declarations – Self-declared environmental claims

# LIFE CYCLE ASSESSMENT INFORMATION

## FUNCTIONAL/DECLARED UNIT

All impacts are calculated using the declared unit of 1,000 black PP trays.

## LIFE CYCLE STAGES DESCRIPTION

A schematic representation of the entire black PP tray value chains considered in the study is reported in figure 2.

## SCOPE AND SYSTEM BOUNDARIES

The type of analysis considered in this study is cradle-to-grave.

All major steps from the extraction of natural resources to disposal, energy, and material recovery are included. Transport to intermediate customers is also included; however, the filling process itself, transport to consumers and product use are excluded (see figure 2).

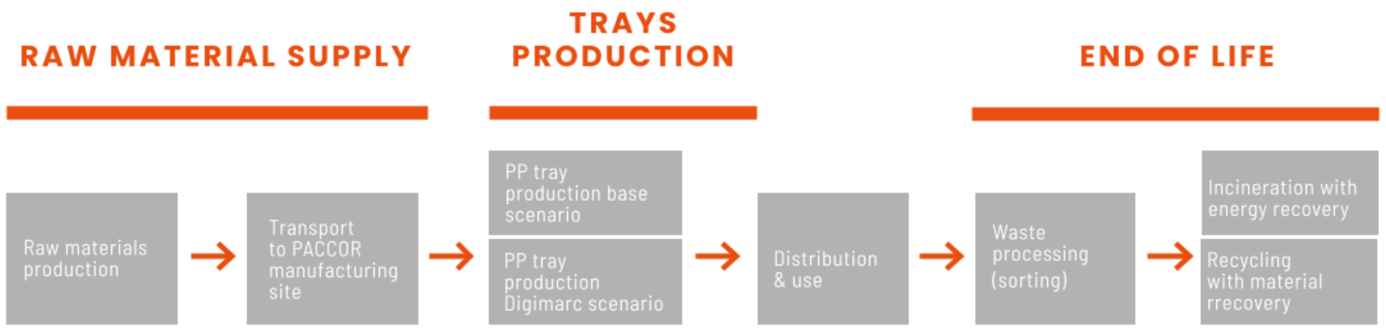



Figure 2: Schematic representation of the life cycle stages considered in the study.

## RAW MATERIALS SUPPLY

This stage begins with the extraction and processing of all raw materials and energy which occur upstream to the polypropylene tray value chains. There are no differences in the chemical composition between the conventional black tray and the Digimarc watermarked product. The raw materials used for the packaging solution are in full compliance with the requirements stipulated in the Commission Regulation (EU) No 10/2011 of 14 January 2011 on plastic materials and articles intended to come into contact with food. The bill of materials was supplied by PACCOR.

Transport of raw materials to the PACCOR production site is by road (truck). Data for transportation of all raw materials to PACCOR production site was obtained from PACCOR suppliers.



## TRAY PRODUCTION

This stage covers the production of both the conventional and Digimarc watermarked black PP trays and includes all processes linked to production by PACCOR in Poland. Electricity as well as other utilities such as compressed air and cooling energy are considered in this stage. The Digimarc watermarked trays are produced in the same way as the conventional black PP trays. Only a very limited additional amount of energy is involved in the engraving step. The electricity used for the manufacturing process is 100% renewable energy from hydropower plants, as part of PACCOR commitment to 100% renewable electricity use by 2023 and become carbon neutral by 2050[13].

During this life cycle stage, limited amount (<0,1%) of non-hazardous waste is generated in the manufacturing process, mainly polypropylene.

The products leave the PACCOR production site in their final shape. No further processing, such as forming, is applied.

## END OF LIFE

End of life describes the stage in which the black trays are considered not to have a useful lifetime anymore and are considered waste. No specific disassembling or sorting activities are applied to them, as the end users just discard the trays once their food content (i.e. ready meals in this case) is consumed.

The transport distance to disposal/recovery centers in Germany are provided by PACCOR and modelled to be by truck, representing the most common practice.

In this study two end of life (EoL) scenarios are considered:

1 Current plastic end of life management scenario[14], where the black trays are not effectively sorted and, as result, they are incinerated. During waste incineration, energy is recovered as heat and electricity. Credits are given for the recovered energy placed on the EU market. Ecoinvent 3.6 dataset documentation was used to calculate the heat and electricity recovery per unit.

2 Alternative Digimarc scenario, where the Digimarc watermarked trays can be sorted out from the waste streams with an efficiency of > 90%. As a conservative estimate it is assumed that 90% of the trays are successfully sorted for material recovery and the remaining 10% is sent to incineration with energy recovery. After sorting, the Digimarc watermarked trays are further processed (washed, etc.) and re-introduced on the market. Credits are given for the re-introduction of secondary mechanically recovered polypropylene.

13 https://www.paccor.com/fileadmin/user_upload/News/Position_Statements/03_Climate_Change.pdf

14 https://www.plasticseurope.org/application/files/8016/1125/2189/AF_Plastics_the_facts-WEB-2020-ING_FINAL.pdf

# CALCULATIONS RULES

## DATA INFORMATION

Specific data for the year 2020 was collected from PACCOR through a questionnaire, including information about the packaging technical characteristics and logistics data (e.g. transport).

## SOFTWARE AND BACKGROUND DATA

The software GaBi 9.2 Professional[15] was used in the LCA calculations. In the model, Ecoinvent 3.6 datasets were used[16].

## CUT-OFF CRITERIA FOR INITIAL INCLUSION OF INPUTS AND OUTPUTS

Auxiliary materials for production (packaging of raw material and finished products, all combined contributing less than 1%) have been excluded from the model. As the raw materials as well as the black trays do not require specific storage conditions, e.g. specific climate conditioning, this is not considered in the relevant life cycle stage. As maintenance of production equipment does not cause relevant additional energy nor intensive material use, this was also not considered in the calculations.

15 Thinkstep GaBi Software-System and Database for Life Cycle Engineering. Copyright 1992-2017 ThinkStep AG

16 Wernet, G., Bauer, C., Steubing, B., Reinhard, J., Moreno-Ruiz, E., and Weidema, B., 2016. The ecoinvent database version 3 (part I): overview and methodology. The International Journal of Life Cycle Assessment, [online] 21(9), pp.1218-1230. Available at: http://link.springer.com/10.1007/s11367-016-1087-8 Ecoinvent database version 3.6 (2020)



# FINANCIAL CAPITAL

Companies create financial value in many ways: They generate wages for their employees, tax revenue for the government, interest for their investors and profit that is shared with their shareholders. The sum of these financial gains is understood as 'Financial Capital'.

Financial Capital involves the flow of financial value along the full value chain of the plastic packaging. In this study, it comprises of all cost involved in the production and recycling of the plastic trays, which contribute to economic activity and thus profit for the companies, but also wages for the people working in the sector, taxes revenue to the government, etc. This means that both costs as well as benefits are considered positive. The methodology applied in this study is based on the Financial Capital assessment methodology developed by Ecomatters[17].

All market prices used in the study are representative for 2021 and can be found in table 2. They are generic industry prices, collected from public sources. They do not reflect PACCOR's specific suppliers or customers. PACCOR is not a resin producer; we produce plastic packaging solutions for diverse food and non-food applications.

| | PRICE (€) | SOURCE |
|---|---|---|
| **Materials** | **Per ton** | |
| Market price for VPET | 1,250 € | ICIS PET low domestic March 2021 |
| Market price for PP | 1,479 € | ICIS PP low domestic March 2021 |
| Market price for RPET | 1,008 € | Platts rPET flake EU spot March 2021 |
| Market price for Masterbatch | 2,063 € | Average price black MB March 2021 |
| **End of life** | **Per ton** | |
| Waste to landfill | 129 € | Average German price |
| Waste to incineration with heat recovery | 215 € | Average German price |
| Recycled plastic waste | 265 € | Average German price (post consumers) |
| **Electricity** | **kWh** | |
| Electricity country mix | 0.085 € | German price[18] |
| **Fuel** | **GJ** | |
| Gas | 16.58 € | German price[19] |
| **Final product** | **Per 1,000 trays** | |
| Conversion cost | 35 € | Average industry |
| Market price | 55 € | Average industry |

Table 2: 2021 average market prices for resins, other materials, energy, and waste.

Specifically, with regard of the recovered materials, the following criteria are assumed to be met:

- A market or demand exists for the material;
- The material fulfils the technical requirements for the specific purposes and meets the existing legislation and standards applicable to products.

In this study Financial Capital involves the flow of financial value along the value chain. The life cycle stages included are the same as in the Natural Capital assessment.

17 Sonnen M.J., van Maurik J.H., Damen L. Financial Capital assessment. Available at: www.ecomatters.nl/wp-content/uploads/2018/09/Ecomatters-Financial-Capital-assessment.pdf

18 Eurostat, Electricity prices by type of user. Available at: www.ec.europa.eu/eurostat/databrowser/view/ten00117/default/table?lang=en

19 Eurostat, Gas prices by type of user. Available at: www.ec.europa.eu/eurostat/databrowser/view/ten00118/default/table?lang=en



## RAW MATERIALS SUPPLY AND TRAYS PRODUCTION

The extraction and production of raw materials and the subsequent production of the black trays by PACCOR generate a Financial Capital which is reflected in the market price of the trays. The financial revenue generated by the sell is partly used by the raw materials and tray producers to pay employee wages, rent, heating, taxes, etc.

## END OF LIFE

After consumer use (outside the scope of this study), the trays are sent to a waste management facility. The Financial Capital generated by the waste facilities is reflected by the price a waste management facility (an incineration plant or recycling facility) asks for receiving and processing waste (€/ton).

## RECOVERY OF ENERGY AND MATERIALS

The recovered energy and materials are sold back onto the market. The Financial Capital created during this step is reflected by the market prices of heat, electricity, and polymer (drop-in) materials. The conventional black PP trays are assumed to be mainly incinerated according to the present plastic waste management in Germany, for this kind of packaging. The Digimarc watermarked trays are sorted and then recovered with an efficiency of 90%. The remaining 10% is considered to be incinerated with energy recovery. During incineration, energy in the form of heat and electricity is recovered and fed into the electricity grid. The energy amount recovered per kg of material incinerated was obtained from the Ecoinvent data and LCA results.

The value of mechanically recovered PP was extrapolated from known market prices for recycled PET.

Another part of the revenue is reallocated by the tray producer (PACCOR) to the PP granulates producer by means of the market prices of the PP resin. The PP granulates producer, in turn, reallocates a part of the revenue to the producer of the raw materials, and so on. Ideally, this reallocation leads to a net profit at every link of the value chain (see figure 3).

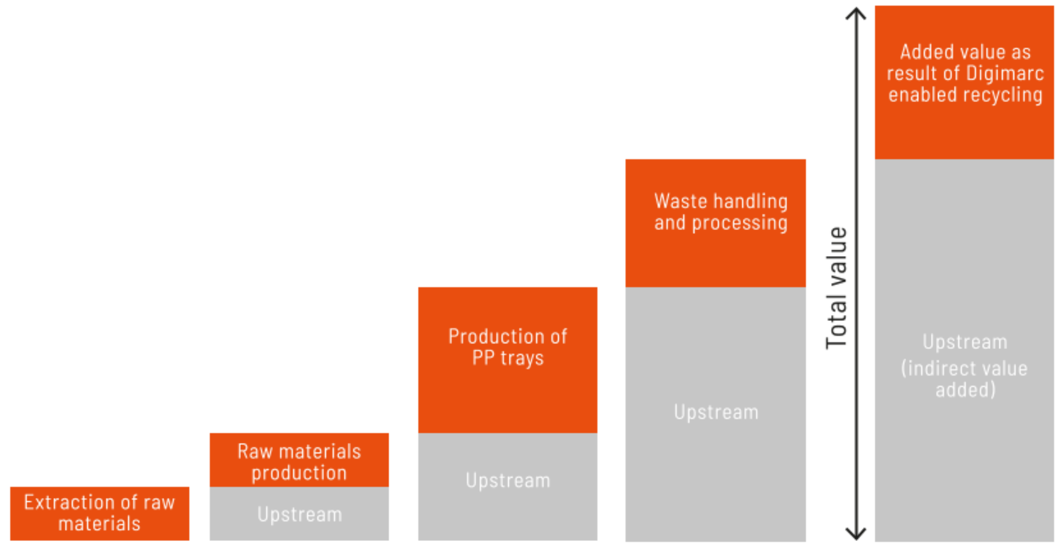



Figure 3: Schematic representation of the Financial Capital accounting considered in the study. The Financial Capital created throughout the product value chain equals the sum of Financial Capital allocated to the separate links of the product value chain. The value of the Financial Capital allocated to each value chain link is redistributed as income to various economic actors (both within the link and upstream).

The financial impact assessment of the conventional scenario compared to the Digimarc scenario mainly differentiates in the recovery and selling value of food grade mechanically recycled PP resin and the heat recovery value of conventional plastic waste management in Germany.

# SOCIAL CAPITAL

*A variety of social issues may occur in a company or industry, which can be related to either employees, consumers and/or local communities. Examples include widely discussed topics, such as health and safety, child labor, discrimination, and freedom of association, but also other sometimes overlooked matters, such as recycling targets, food safety and availability, and food waste. We address these issues collectively in what we call 'Social Capital'.*

In contrast to the other two capital metrics, we have chosen not to monetize the Social Capital. We care strongly about social matters, and therefore consider it inappropriate to associate them to a financial cost. Instead, we use a risk-based screening tool applied to a broad compilation of 32 commonly used social impact parameters (among other, from GRI standards[20]) to select, first, the most relevant and then assess them for their impact. For example, fossil resource (in)dependency was judged to be more relevant than rights of indigenous people within the context of the current evaluation. All topics were given a score between 1 to 5 (1 being not relevant and 5 being highly relevant). The average score of all experts was used to identify the five most relevant topics.

Selection of parameters as well as the impact assessment were individually performed by 3 external and 3 PACCOR internal experts in the field of sustainability, circular economy, polymers, and chemical safety and compliance.

We used the questions from this method to review our production facilities and identified risks in the operations of our upstream and downstream value chain partners. Since information on the risks associated with activities outside the boundaries of our own production sites is not always readily available, we additionally consulted generic public databases in which social risks are tracked per industry and country. Since this data partially has been collected from generic risk databases, it does not necessarily reflect the situation of PACCOR or its suppliers.

The entire list of the 32 social impact parameters and their risk-based evaluation are reported in Appendix II.

20 Global Reporting Initiative, Sustainability Topics for Sectors. Available at: www.vnci.nl/Content/Files/file/Downloads/GRI_indicators_for_chemicals_sector.pdf



# RESULTS

## NATURAL CAPITAL

The Natural Capital impact related to both black polypropylene tray value chains are reported in figure 4 and table 3. For both value chains, the main drivers for the Natural Capital loss are resource depletion and GHG emissions, due to the extraction and use of fossil based raw materials and sorting during waste management, while the Natural Capital loss due to production of trays is very limited. The overall results show a significantly lower (52.3%) net Natural Capital loss for the Digimarc scenario (- 37.45 €) compared to the conventional scenario (- 78.85 €), mainly due to the recovery and re-introduction to the market of mechanically recycled high-quality polymers for food applications, replacing virgin material extraction.

| NATURAL CAPITAL | | | | |
|---|---|---|---|---|
| | CONVENTIONAL SCENARIO | | DIGIMARC WATERMARKED SCENARIO | |
| Value chain stage | Value created (€) | % of total | Value created (€) | % of total |
| Raw materials supply (including transport) | - 60.60 | 69.78 | - 60.60 | 76.76 |
| Trays production | - 4.11 | 4.73 | - 4.12 | 5.22 |
| End of life: waste handling & processing | - 22.14 | 25.49 | - 14.23 | 18.02 |
| Total Capital lost | - 86.85 € | 100% | - 78.95 € | 100% |
| Recovery of energy & material | 8.29 | | 41.49 | |
| **Total** | **- 78.57 €** | | **- 37.45 €** | |

Table 3: Natural Capital of black polypropylene tray value chains per value chain stage. Negative numbers indicate value destruction, positive numbers value creation.

Specifically, two value chain stages (raw materials supply and trays production) present a net Natural Capital loss, while the last stage in both value chains is creating Natural Capital. A closer look at the results will demonstrated the following:

### RAW MATERIALS SUPPLY

As most of the materials required to produce the trays are manufactured in the first part of the value chain, it is not surprising that the activities here are the most resource consuming. Indeed, our calculations show that about 78% (- 50,18 €) of the Natural Capital loss is allocated to the production of virgin polypropylene and black masterbatch. A smaller loss of Natural Capital (- 10.41 €) is also allocated to the burden of raw materials transport by truck to PACCOR's production site in Poland. As the amount and kind of raw materials are the same, also the Natural Capital loss related to this life cycle stage is exactly the same for both the conventional and Digimarc watermarked black PP trays value chains.



### TRAYS PRODUCTION

The Natural Capital in the trays production stage is significantly lower than the above life cycle stage and mainly related to the energy and resources use during thermoforming, contributing to a limited negative net Natural Capital impact of about - 4.11 € in the conventional scenario and of about - 4.12 € when the Digimarc technology is applied. However, as the additional impact related to the energy use when embossing the Digimarc digital watermarking is negligible and at PACCOR only renewable electricity is used throughout the whole process, the Natural Capital impact of the tray production stage is nearly identical for both value chains.

### END OF LIFE: WASTE HANDLING AND PROCESSING AND RECOVERY OF ENERGY AND MATERIALS

In the end-of-life stage, the Natural Capital loss is about 25% (- 22.14 €) for the conventional trays and 18% (-14.23 €) for the Digimarc watermarked trays. This relates to the transport to waste management facilities, and mainly to the sorting and the recycling or incineration, where more emissions occur as result of incineration compared to recycling process.

Both recycling and, to a lower extent, also incineration processes prevent Natural Capital loss. In this case, extracting new virgin resources and their resulting emissions are avoided when recovering energy out of conventional end of life management (incineration) of trays, and reintroducing to the market high-quality food grade PP, deriving from the Digimarc watermarked trays' end of life management.

The recovery of plastic resins and the consequent replacing of virgin raw materials, as enabled by Digimarc watermarks, compensate for the smaller negative impact relating to energy use during the recycle process.

The recovery of food grade PP after recycling results in a prevented capital loss of 41.49 €. When the trays are incinerated in the conventional waste management facilities, a positive Natural Capital is also created, even if significantly smaller due to the limited heat or electricity recovery rate or lower recovery efficiency in average facilities. The prevented Capital loss obtained from the energy recovery during waste incineration of conventional trays is limited to 8.29 €.

### NATURAL CAPITAL LOSS OF 1,000 PP TRAYS

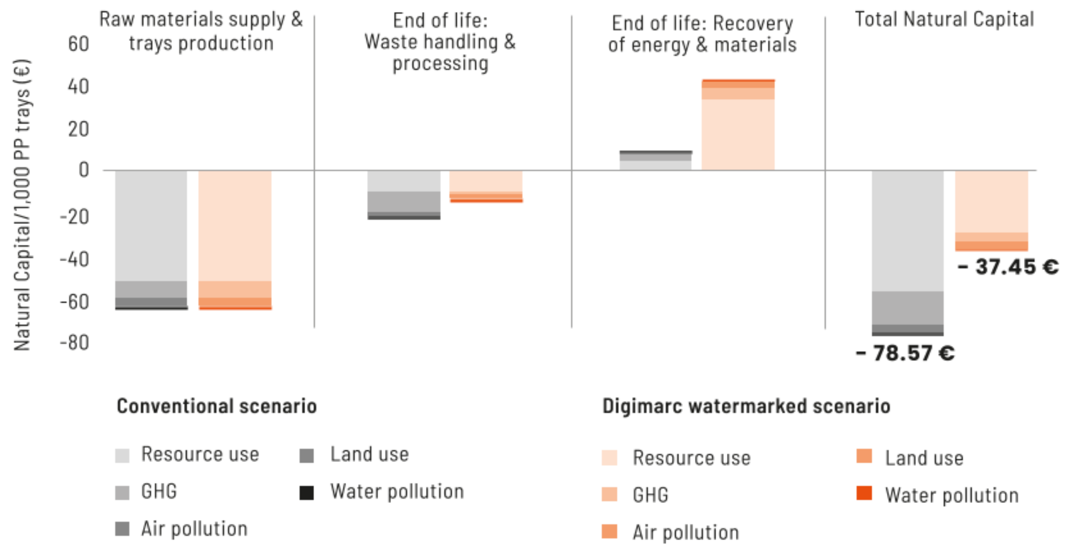



Figure 4: Natural Capital loss total and per life cycle stage of 1,000 black PP tray value chains (conventional scenario and Digimarc watermarked scenario).

# FINANCIAL CAPITAL

Financial Capital involves the flow of financial value along the value chain. We have calculated the Financial Capital throughout the conventional and Digimarc watermarked polypropylene tray value chains, based on average and publicly available materials' and products' prices. The results are reported in table 4 and figure 5.

| FINANCIAL CAPITAL | | | | |
|---|---|---|---|---|
| | CONVENTIONAL SCENARIO | | DIGIMARC WATERMARKED SCENARIO | |
| Value chain stage | Value created (€) | % of total | Value created (€) | % of total |
| Raw materials supply & trays production | 55.00 | 85.17 | 55.00 | 60.42 |
| End of life: Waste handling & processing | 5.81 | 8.99 | 7.35 | 8.07 |
| End of life: Recovery of energy & material | 3.77 | 5.84 | 28.68 | 31.51 |
| **Total** | **64.58 €** | **100%** | **91.03 €** | **100%** |

Table 4: Financial Capital of black PP tray value chains per value chain stage. Positive numbers indicate value creation.

For both value chains, the main drivers for the Financial Capital creation are the resource intensive stages, such as the raw materials extraction and production. The overall results show a 41% lower net Financial Capital creation for the conventional scenario (64.58 €) compared to the Digimarc watermarked scenario (91.03 €), mainly due to the higher financial value of mechanically recovered high-quality polypropylene for food applications and their reintroduction to the market, compared to the financial value of recovered heat after incineration.



## FINANCIAL CAPITAL CREATION OF 1,000 PP TRAYS

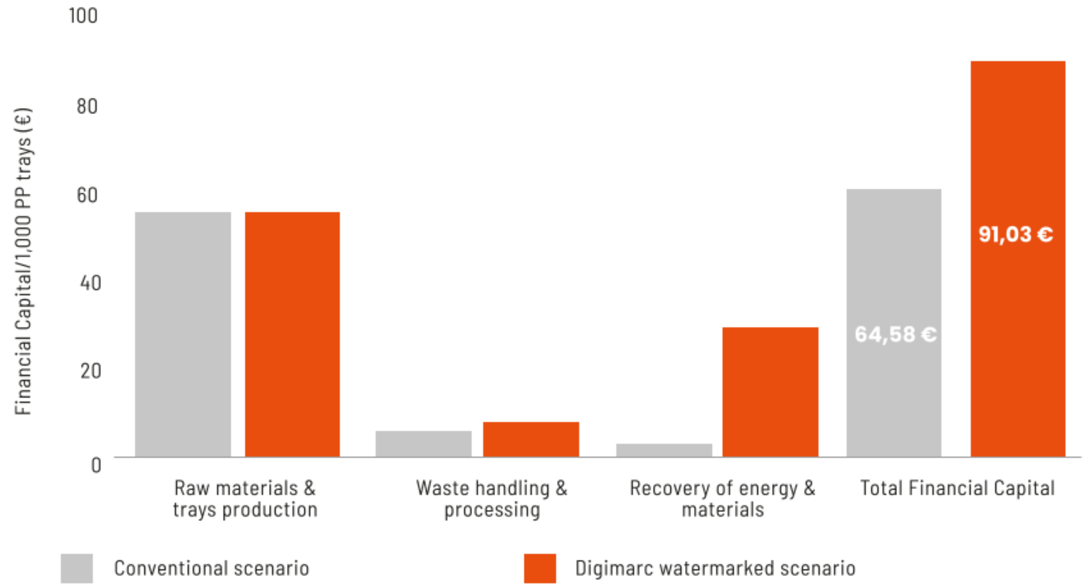



Figure 5: Financial Capital creation total and per life cycle stage of the black polypropylene tray value chains (conventional scenario and Digimarc watermarked scenario).

Specifically, each value chain stage presents a net Financial Capital creation. A closer look at the results will demonstrated following:

## RAW MATERIALS SUPPLY

Polymers are produced in large quantities and have a relatively high market value. As a result, 45.45 € of the Financial Capital is allocated to the raw materials. As the amount and kind of raw materials are the same, also the Financial Capital creation related to this life cycle stage is the same for both the conventional and Digimarc watermarked PP trays value chains. Most financial value is allocated to the polymer suppliers, who reallocate it by means of payment for their inputs of resources and energy, but also employees' wages, taxes, rent or other indirect expenses. A small creation of Financial Capital is also allocated to the transport by truck of raw materials to PACCOR's production site in Poland.

## TRAYS PRODUCTION

The Financial Capital creation related to the trays production stage (9.55 €) conveys to the PP tray market price corrected by the conversion costs. As the formulation, production technology and production facilities for the conventional and Digimarc watermarked trays are identical and the additional energy expenditure in the embossing step is negligible, the overall Financial Capital creation in the first two stages of the value chains are identical and equivalent to 55 €.

## END OF LIFE: WASTE HANDLING AND PROCESSING AND RECOVERY OF ENERGY AND MATERIALS

A limited 8.1% to 9.0% (or 7.35 € and 5.81 €) of the Financial Capital created by the tray value chains is allocated to one of the last stages, the collection and sorting activities, for both, the Digimarc watermarked scenario and the conventional scenario, respectively. As the average price for plastic recycling is slightly higher than the average price for waste incineration, the Financial Capital creation for the Digimarc watermarked scenario is slightly superior.

During the trays' incineration, some energy is recovered in the form of heat and electricity. However, the low amount of heat that is recovered on average from current incineration plants and its relatively low market price result in an overall limited creation of Financial Capital of about 3.77 € from the conventional trays value chain end of life. On the other hand, the high-quality recovered polymers, enabled by the Digimarc technology, have a high market value of about 28.68 € when substituting virgin polymers, making the Financial Capital created about 24.91 € higher than the conventional trays' waste management.

## SOCIAL CAPITAL

The five parameters with highest relevance and impact which were identified by the experts out of the 32 parameters from the GRI list and their impact are reported in a semiquantitative way in table 5.

Authorities are increasing regulatory pressure with regards to waste and circularity[21]. Efficient recycling methods leading to a reliable supply of high quality and safe drop-in[22] recycled polymers are thought to be essential in meeting those targets. The recovery and reuse of fossil-based polymers are seen as a clear path in order to effectively limit fossil resource dependency. It has been also recognised that the implementation of new digital sorting techniques can accelerate further sustainable change by making high-quality drop-in polymers available and more affordable. Finally, both virgin plastics, as well as selectively recovered polymers, offer high level of food safety, including barrier functionality and inertness. It is expected that especially for wet and fatty foodstuff there will not be suitable mechanical recycled feedstock alternatives in the near future. When recycled polymers are used for food contact purposes, it is important to exclude the risk of contaminations migrating from mixed waste into food. Digimarc tracking allows for better screening and segregation of different polymer types and use. Finally, as the product is used ambiguously world-wide, experts noted the potential for a strong reduction in plastic landfilling and marine littering, contributing to solving the biggest current challenge of plastics.

| IMPACT PARAMETER | CONVENTIONAL SCENARIO | DIGIMARC WATERMARKED SCENARIO |
|---|---|---|
| Circularity potential and meeting (regulatory) sustainability & recycling targets | - | ++ |
| Supply of drop-in[22] recycled polymers | 0 | ++ |
| Becoming less depended on fossil resource input | - | ++ |
| Driver/motivator for further sustainable change | - | + |
| Customer health and safety in relation to food packaging | ++ | ++ |

Table 5. Comparison between the top 5 most relevant social impact drivers in the conventional and Digimarc watermarked tray value chains. The first topic is a cluster of 'recycling & circularity & regulatory sustainability & recycling targets' GRI impact categories. The scores of the individual experts were averaged to obtain the total impact score (expressed as --, -, o, +, ++). The overall assessment can be found in Appendix II.

21 European Commission, A. (2018). A European strategy for plastics in a circular economy, available at: Available at: www.op.europa.eu/en/publication-detail/-/publication/33251cf9-3b0b-11e9-8d04-01aa75ed71a1/language-en/format-PDF/source-87705298

22 Drop-ins - Drop-in plastics are polymers, obtained from recycled materials that present identical technical properties to their virgin counterparts. A drop-in recyclate can be added to existing production schemes with minimal alteration of the manufacturing processes.



# HOW PACCOR CREATES VALUE

*A comprehensive overview of the Natural and Financial Capitals' profit and loss created by the PP trays value chains introduced to the German market by PACCOR over a period of one year is reported in figure 6. The results are obtained using the same Capital account methodologies as described in the '3D profit & loss impact assessment' chapter of this report.*

## FINANCIAL AND NATURAL CAPITALS

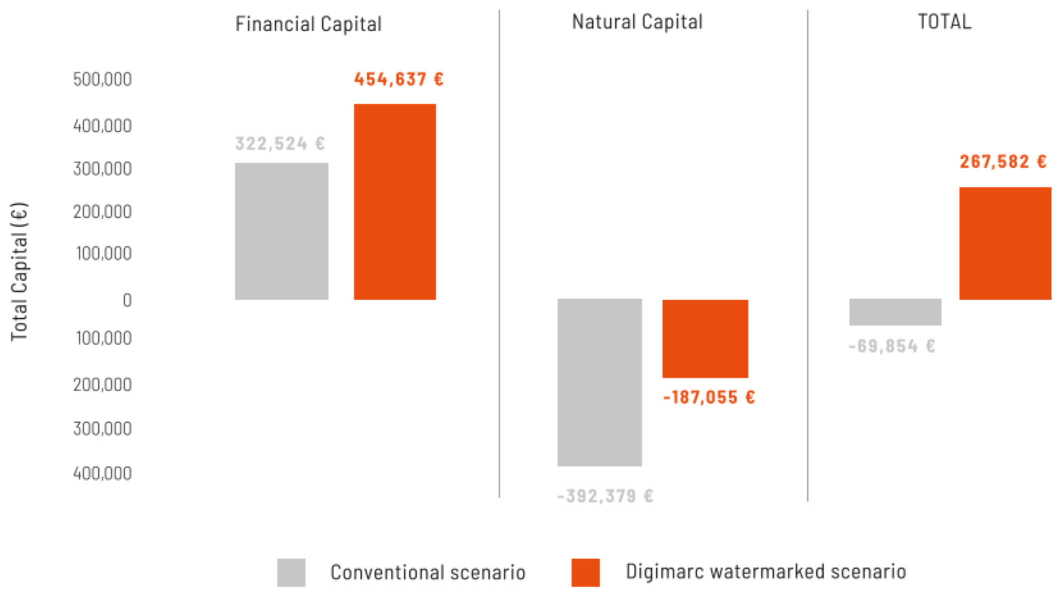



Figure 7: Total Capital creation resulting from the black polypropylene tray value chains (conventional scenario and Digimarc watermarked scenario) introduced to the German market by PACCOR over the period of one year.

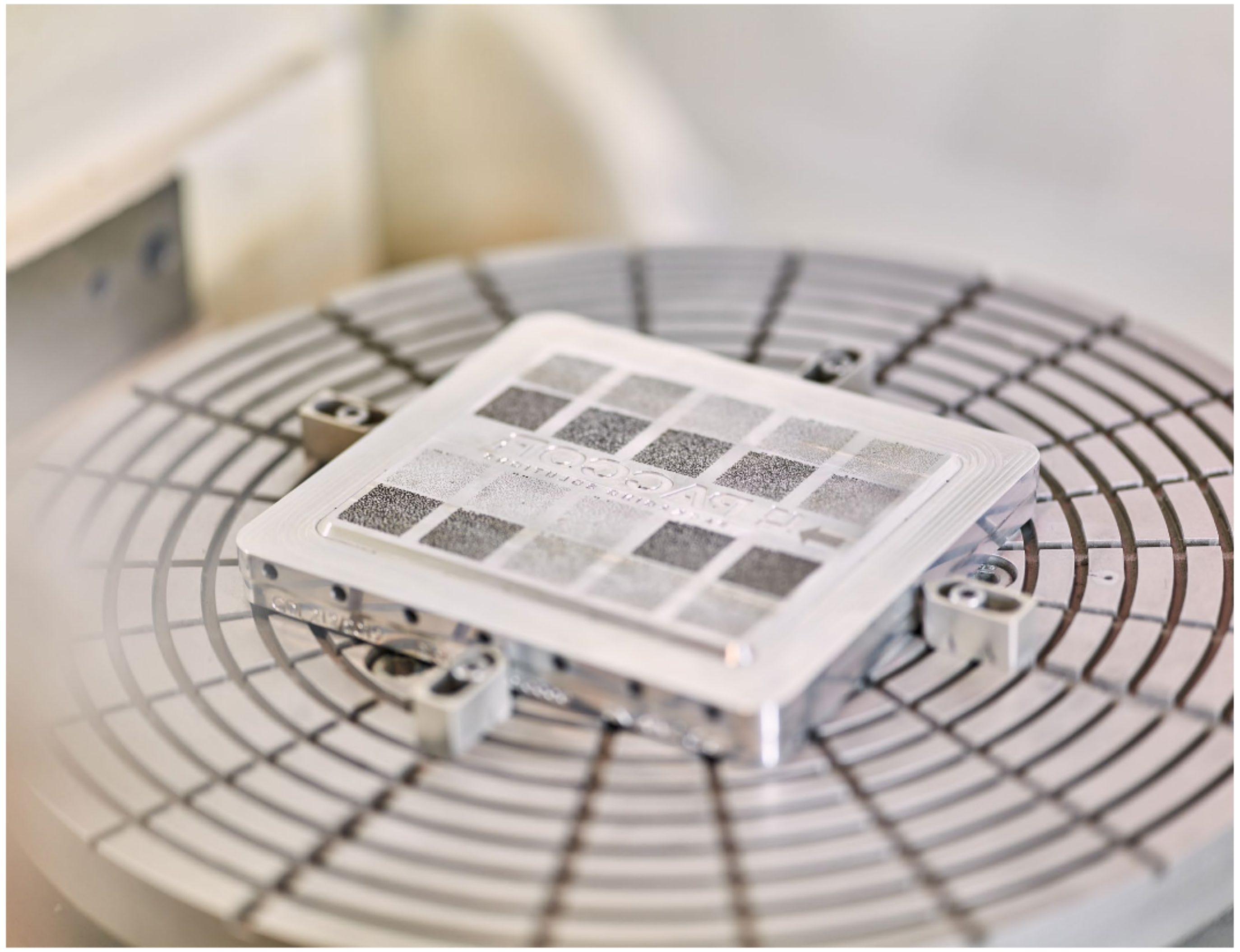
The total numbers show that the Financial Capital creation does not outweigh the Natural Capital loss of the trays in the conventional German end of life management. This is different in the Digimarc enabled sorting scenario which shows not only a substantial decrease in Natural Capital loss, but also additional Financial Capital creation. Specifically, compared to the conventional scenario, when applying Digimarc watermarks on PACCOR PP trays, this creates 41% more Financial Capital combined with a 52% reduction in Natural Capital loss. The better environmental and financial performance for the recycling scenario enabled by Digimarc is mainly resulting from the recovery of polymer feedstock preventing additional extraction and use of virgin material and creating economical value of high quality recyclates.



| IMPACT PARAMETER | CONVENTIONAL SCENARIO | DIGIMARC WATERMARKED SCENARIO |
|---|---|---|
| Circularity potential and meeting (regulatory) sustainability & recycling targets | - | ++ |
| Supply of drop-in[22] recycled polymers | 0 | ++ |
| Becoming less depended on fossil resource input | - | ++ |
| Driver/motivator for further sustainable change. | - | + |
| Customer health and safety in relation to food packaging | ++ | ++ |

Table 6: Comparison between the top 5 most relevant social impact drivers in the conventional and Digimarc watermarked tray value chains. The first topic is a cluster of 'recycling & circularity & regulatory sustainability & recycling targets' GRI impact categories. The scores of the individual experts were averaged to obtain the total impact score (expressed as --, -, o, +, ++). The overall assessment can be found in Appendix II.

From a social perspective, the recovery of virgin polymer materials, enabled by the Digimarc digital watermarking, shows a clear path into effectively limit resource dependency, accelerates further sustainable change towards circularity, while offering high level of food safety.



21 Drop-ins - Drop-in plastics are polymers, obtained from recycled materials that present identical technical properties to their virgin counterparts. A drop-in recyclate can be added to existing production schemes with minimal alteration of the manufacturing processes.

# APPENDIX I

## LCA IMPACT CATEGORIES ASSESSED ACCORDING TO THE EPS METHODOLOGY

Tables 1 and 2 report the raw data output from the Gabi model, per 1,000 trays. The Unit of the chosen EPS method is ELU (Environmental Load Units). One ELU represents an externality corresponding to one Euro (€) environmental damage cost.

Negative values reflect loss of environmental capital, while positive values indicate prevention of capital loss, due to, for example, polymers recovery and replacement of extraction of virgin materials.

**Table 1: LCA capital loss results in the current plastic end of life management scenario in Germany**

| | RAW MATERIALS AND PRODUCTION | WASTE HANDLING & PROCESSING | RECOVERY OF ENERGY & MATERIAL | TOTAL |
|---|---|---|---|---|
| EPS 2015dx_1.1 Non-renewable energy resources: Crude oil [ELU] | -1.28E+01 | -6.78E-01 | 5.91E-02 | -1.34E+01 |
| EPS 2015dx_1.2 Non-renewable energy resources: Hard coal [ELU] | -6.95E-01 | -2.15E-01 | 7.20E-01 | -1.89E-01 |
| EPS 2015dx_1.3 Non-renewable energy resources: Lignite [ELU] | -2.32E-01 | -2.22E-02 | 1.14E+00 | 8.86E-01 |
| EPS 2015dx_1.4 Non-renewable energy resources: Natural gas [ELU] | -3.72E+00 | -1.49E-01 | 1.93E-01 | -3.68E+00 |
| EPS 2015dx_1.5 Non-renewable energy resources: Peat [ELU] | -4.53E-03 | -1.27E-04 | 1.24E-04 | -4.53E-03 |
| EPS 2015dx_1.6 Non-renewable energy resources: Uranium [ELU] | -5.64E-02 | -2.51E-03 | 3.58E-02 | -2.31E-02 |
| EPS 2015dx_2. Renewable energy resources [ELU] | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| EPS 2015dx_3. Land use [ELU] | -8.05E-01 | -7.81E-01 | 1.61E-01 | -1.42E+00 |
| EPS 2015dx_4.1 Material resources: Non-renewable elements [ELU] | -3.50E+01 | -8.31E+00 | 3.31E+00 | -4.00E+01 |
| EPS 2015dx_4.2 Non-renewable resources [ELU] | -2.48E-02 | -1.39E-02 | 2.17E-03 | -3.65E-02 |
| EPS 2015dx_4.3 Renewable resources [ELU] | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| EPS 2015dx_4.3.1 Renewable resources: Water [ELU] | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| EPS 2015dx_5.1 Heavy metals to air [ELU] | -8.59E-03 | -5.36E-03 | 7.83E-04 | -1.32E-02 |
| EPS 2015dx_5.2 Inorganic emissions to air [ELU] | -6.74E+00 | -1.02E+01 | 2.19E+00 | -1.48E+01 |
| EPS 2015dx_5.3 Organic emissions to air (group VOC) [ELU] | -1.21E+00 | -1.46E-01 | 1.08E-01 | -1.24E+00 |
| EPS 2015dx_5.3.1 Organic emissions to air (group VOC): Group NMVOC [ELU] | -1.27E+00 | -1.33E-01 | 3.53E-02 | -1.37E+00 |
| EPS 2015dx_5.3.3 Organic emissions to air (group VOC) - Group NMVOC: Halogenated organics to air [ELU] | -2.39E-03 | -3.58E-04 | 8.02E-04 | -1.95E-03 |
| EPS 2015dx_5.4 Other emissions to air [ELU] | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| EPS 2015dx_5.5 Particles to air [ELU] | -2.19E+00 | -1.02E+00 | 3.18E-01 | -2.89E+00 |
| EPS 2015dx_5.6 Pesticides to air [ELU] | -4.80E-09 | -3.23E-09 | 7.48E-10 | -7.29E-09 |
| EPS 2015dx_5.7 Radioactive emissions to air [ELU] | -1.05E-03 | -1.52E-04 | 4.23E-04 | -7.80E-04 |
| EPS 2015dx_5.8 Long-term emissions to air [ELU] | -1.30E-02 | -4.71E-01 | 1.29E-02 | -4.72E-01 |



| | RAW MATERIALS AND PRODUCTION | WASTE HANDLING & PROCESSING | RECOVERY OF ENERGY & MATERIAL | TOTAL |
|---|---|---|---|---|
| EPS 2015dx_6.1 Analytic measures to fresh water [ELU] | -1.24E-05 | -9.53E-06 | 4.50E-07 | -2.15E-05 |
| EPS 2015dx_6.2 Heavy metals to fresh water [ELU] | -2.06E-05 | -2.57E-05 | 1.50E-05 | -3.13E-05 |
| EPS 2015dx_6.3 Inorganic emissions to fresh water [ELU] | -4.22E-05 | -2.12E-05 | 9.73E-05 | 3.38E-05 |
| EPS 2015dx_6.4 Organic emissions to fresh water [ELU] | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| EPS 2015dx_6.4.1 Halogenated organic emissions to fresh water [ELU] | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| EPS 2015dx_6.4.2 Organic emissions to fresh water: Hydrocarbons [ELU] | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| EPS 2015dx_6.5 Other emissions to fresh water [ELU] | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| EPS 2015dx_6.5.1 Other emissions to fresh water: Pesticides to fresh water [ELU] | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| EPS 2015dx_6.6 Particles to fresh water [ELU] | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| EPS 2015dx_6.7 Radioactive emissions to fresh water [ELU] | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| EPS 2015dx_6.8 Long-term to fresh water [ELU] | -3.87E-04 | -5.91E-04 | 9.87E-04 | 8.47E-06 |
| EPS 2015dx_7.1 Analytic measures to sea water [ELU] | -2.98E-07 | -7.11E-08 | 1.01E-08 | -3.59E-07 |
| EPS 2015dx_7.2 Heavy metals to sea water [ELU] | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| EPS 2015dx_7.3 Inorganic emissions to sea water [ELU] | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| EPS 2015dx_7.4 Organic emissions to sea water [ELU] | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| EPS 2015dx_7.4.2 Organic emission to sea water: Hydrocarbons [ELU] | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| EPS 2015dx_7.5 Other emissions to sea water [ELU] | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| EPS 2015dx_7.5.1 Other emissions to sea water: Pesticides [ELU] | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| EPS 2015dx_7.6 Particles to sea water [ELU] | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| EPS 2015dx_7.7 Radioactive emissions to sea water [ELU] | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| **Total** | **-6.47E+01** | **-2.21E+01** | **8.29E+00** | **-7.86E+01** |

**Table 2: LCA capital loss results in the alternative Digimarc watermarked plastic end of life management scenario**

| IMPACT CATEGORY EPS METHOD | RAW MATERIALS AND PRODUCTION | WASTE HANDLING & PROCESSING | SECOND-LIFE CYCLE | TOTAL |
|---|---|---|---|---|
| EPS 2015dx_1.1 Non-renewable energy resources: Crude oil [ELU] | -1.28E+01 | -6.72E-01 | 9.37E+00 | -4.06E+00 |
| EPS 2015dx_1.2 Non-renewable energy resources: Hard coal [ELU] | -6.95E-01 | -2.97E-01 | 5.72E-01 | -4.20E-01 |
| EPS 2015dx_1.3 Non-renewable energy resources: Lignite [ELU] | -2.32E-01 | -1.67E-01 | 2.91E-01 | -1.08E-01 |
| EPS 2015dx_1.4 Non-renewable energy resources: Natural gas [ELU] | -3.72E+00 | -1.50E-01 | 3.00E+00 | -8.73E-01 |
| EPS 2015dx_1.5 Non-renewable energy resources: Peat [ELU] | -4.53E-03 | -1.39E-04 | 3.58E-03 | -1.09E-03 |
| EPS 2015dx_1.6 Non-renewable energy resources: Uranium [ELU] | -5.64E-02 | -7.01E-03 | 4.80E-02 | -1.55E-02 |
| EPS 2015dx_2. Renewable energy resources [ELU] | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| EPS 2015dx_3. Land use [ELU] | -8.05E-01 | -7.84E-01 | 2.65E-01 | -1.32E+00 |
| EPS 2015dx_4.1 Material resources: Non-renewable elements [ELU] | -3.50E+01 | -8.23E+00 | 2.00E+01 | -2.32E+01 |
| EPS 2015dx_4.2 Non-renewable resources [ELU] | -2.49E-02 | -1.24E-02 | 7.21E-03 | -3.01E-02 |
| EPS 2015dx_4.3 Renewable resources [ELU] | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| EPS 2015dx_4.3.1 Renewable resources: Water [ELU] | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| EPS 2015dx_5.1 Heavy metals to air [ELU] | -8.60E-03 | -5.20E-03 | 6.29E-03 | -7.51E-03 |
| EPS 2015dx_5.2 Inorganic emissions to air [ELU] | -6.74E+00 | -2.11E+00 | 4.74E+00 | -4.12E+00 |
| EPS 2015dx_5.3 Organic emissions to air (group VOC) [ELU] | -1.21E+00 | -1.56E-01 | 9.70E-01 | -3.92E-01 |
| EPS 2015dx_5.3.1 Organic emissions to air (group VOC): Group NMVOC [ELU] | -1.27E+00 | -1.33E-01 | 9.08E-01 | -4.95E-01 |
| EPS 2015dx_5.3.3 Organic emissions to air (group VOC) - Group NMVOC: Halogenated organics to air [ELU] | -2.39E-03 | -4.39E-04 | 1.69E-03 | -1.14E-03 |
| EPS 2015dx_5.4 Other emissions to air [ELU] | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| EPS 2015dx_5.5 Particles to air [ELU] | -2.19E+00 | -1.03E+00 | 1.28E+00 | -1.94E+00 |
| EPS 2015dx_5.6 Pesticides to air [ELU] | -4.80E-09 | -2.95E-09 | 2.51E-09 | -5.25E-09 |
| EPS 2015dx_5.7 Radioactive emissions to air [ELU] | -1.05E-03 | -2.00E-04 | 6.37E-04 | -6.15E-04 |
| EPS 2015dx_5.8 Long-term emissions to air [ELU] | -1.30E-02 | -4.73E-01 | 1.05E-02 | -4.76E-01 |
| EPS 2015dx_6.1 Analytic measures to fresh water [ELU] | -1.24E-05 | -3.50E-06 | 4.49E-06 | -1.14E-05 |
| EPS 2015dx_6.2 Heavy metals to fresh water [ELU] | -2.06E-05 | -1.17E-05 | 1.53E-05 | -1.70E-05 |
| EPS 2015dx_6.3 Inorganic emissions to fresh water [ELU] | -4.22E-05 | -3.25E-05 | 4.12E-05 | -3.35E-05 |
| EPS 2015dx_6.4 Organic emissions to fresh water [ELU] | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| EPS 2015dx_6.4.1 Halogenated organic emissions to fresh water [ELU] | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| EPS 2015dx_6.4.2 Organic emissions to fresh water: Hydrocarbons [ELU] | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| EPS 2015dx_6.5 Other emissions to fresh water [ELU] | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| EPS 2015dx_6.5.1 Other emissions to fresh water: Pesticides to fresh water [ELU] | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| EPS 2015dx_6.6 Particles to fresh water [ELU] | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| EPS 2015dx_6.7 Radioactive emissions to fresh water [ELU] | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| EPS 2015dx_6.8 Long-term to fresh water [ELU] | -3.87E-04 | -6.92E-04 | 3.86E-04 | -6.93E-04 |
| EPS 2015dx_7.1 Analytic measures to sea water [ELU] | -2.98E-07 | -7.00E-08 | 1.08E-07 | -2.60E-07 |
| EPS 2015dx_7.2 Heavy metals to sea water [ELU] | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| EPS 2015dx_7.3 Inorganic emissions to sea water [ELU] | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| EPS 2015dx_7.4 Organic emissions to sea water [ELU] | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| EPS 2015dx_7.4.2 Organic emission to sea water: Hydrocarbons [ELU] | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| EPS 2015dx_7.5 Other emissions to sea water [ELU] | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| EPS 2015dx_7.5.1 Other emissions to sea water: Pesticides [ELU] | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| EPS 2015dx_7.6 Particles to sea water [ELU] | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| EPS 2015dx_7.7 Radioactive emissions to sea water [ELU] | 0.00E+00 | 0.00E+00 | 0.00E+00 | 0.00E+00 |
| **Total** | **-6.47E+01** | **-1.42E+01** | **4.15E+01** | **-3.75E+01** |

# APPENDIX II

## INDIVIDUAL SOCIAL CAPITAL IMPACT PARAMETERS AND THEIR RISK-BASED EVALUATION

| | REVIEWER 1 | | REVIEWER 2 | | REVIEWER 3 | | REVIEWER 4 | | AVERAGE | | RESULTS | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Topic | Conventi-onal | Digimarc | Conventi-onal | Digimarc | Conventi-onal | Digimarc | Conventi-onal | Digimarc | Conventi-onal | Digimarc | Conventi-onal | Digimarc |
| Health and Safety | 4 | 3 | 3 | 3 | 5 | 5 | 3 | 3 | 4 | 4 | + | + |
| Reduction of food waste | 3 | 3 | 3 | 3 | 5 | 5 | 3 | 3 | 4 | 4 | + | + |
| Versatility | 4 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | ++ | ++ |
| Cost effectiveness | 5 | 4 | 4 | 5 | 5 | 5 | 4 | 5 | 5 | 5 | ++ | ++ |
| Suitability in extreme environments | 3 | 3 | 3 | 3 | 5 | 5 | 3 | 3 | 4 | 4 | + | + |
| Recyclability and circularity | 2 | 5 | 4 | 5 | 2 | 5 | 4 | 5 | 3 | 5 | o | ++ |
| Enabling single person household lifestyles | 4 | 4 | 3 | 3 | 4 | 4 | 3 | 3 | 4 | 4 | + | + |
| supply of drop-in recycled polymers | 2 | 5 | 4 | 5 | 2 | 5 | 4 | 5 | 3 | 5 | o | ++ |
| Job security | 3 | 4 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | o | o |
| Labor/management Relations | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | o | o |
| Fair wages | 3 | 4 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | o | o |
| Freedom of Association and Collective Bargaining | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | o | o |
| Workforce diversity and Equal Opportunity | 2 | 5 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 4 | o | + |
| Ocupational Health and Safety | 3 | 3 | 4 | 4 | 3 | 4 | 4 | 4 | 3 | 4 | o | + |
| Training and Education | 3 | 3 | 3 | 3 | 3 | 4 | 3 | 3 | 3 | 3 | o | o |
| Contributing to knowledge based economy | 1 | 3 | 4 | 5 | 2 | 5 | 4 | 5 | 2 | 4 | - | + |
| landfill and landfill leaching | 2 | 5 | 3 | 5 | 3 | 5 | 3 | 5 | 3 | 5 | o | ++ |
| Meeting (regulatory) sustainability & recy-cling targets | 3 | 5 | 2 | 5 | 2 | 5 | 2 | 5 | 2 | 5 | - | ++ |
| Employee satisfaction | 3 | 3 | 3 | 3 | 3 | 4 | 3 | 3 | 3 | 3 | o | o |
| Becoming less depended on fossil recourse input | 2 | 4 | 2 | 5 | 1 | 5 | 2 | 5 | 2 | 5 | - | ++ |
| driver/motivator for further sustainable change. | 2 | 4 | 3 | 4 | 1 | 5 | 3 | 4 | 2 | 4 | - | + |
| Getting future proof | 3 | 4 | 3 | 4 | 1 | 5 | 3 | 4 | 2 | 4 | - | + |
| Forced or compulsory labor | 3 | 3 | 3 | 3 | 3 | 4 | 3 | 3 | 3 | 3 | o | o |
| Rights of Indigenous People | 2 | 3 | 3 | 3 | 3 | 4 | 3 | 3 | 3 | 3 | o | o |
| Human Rights Assessment | 3 | 4 | 3 | 3 | 3 | 4 | 3 | 3 | 3 | 4 | o | + |
| Customer health and Safety | 4 | 3 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 4 | ++ | + |
| Customer privacy | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | o | o |
| Socio-Economic compliance | 3 | 4 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | o | o |
| Type of materials in contact with food | 4 | 4 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | ++ | ++ |
| Recyclability, reusability, energy recovery or composting of the products | 2 | 5 | 4 | 5 | 2 | 5 | 4 | 5 | 3 | 5 | o | ++ |
| Knowledge based economy | 3 | 3 | 4 | 5 | 2 | 4 | 4 | 5 | 3 | 4 | o | + |
| Marketing and labeling | 3 | 4 | 3 | 4 | 3 | 4 | 3 | 4 | 3 | 4 | o | + |

Topics were given a score between 1 to 5 (1 being not relevant and 5 being highly relevant). The average score of all experts was used to identify the five most relevant topics. Selection of parameters as well as the impact assessment were individually performed by 3 external and 3 PACCOR internal experts in the field of sustainability, circular economy, polymers and chemical, safety and compliance.

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