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Technical Sector Report on Data Models for Bio-based Plastics

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Executive Summary

This deliverable report summarizes the main findings made in the framework of bio-based plastics sector of LCA to go project in WP2. The outcome of this deliverable is a methodological concept for further implementation within WP3 aimed at the development of the specific sectoral tool. It should be pointed out that the targeted group of this methodological concept are the bio-based plastics converters, since these are usually SME's. On the contrary bio-based plastics resin producers are in most cases multinational companies or even whether SME's owned by large chemical groups or joint ventures with large-scale enterprises.

Furthermore, due to the bio-based nature of bio-based plastics dozens of families can be found. If it is taken into account that the bio-based plastic sector have not reached is maturity yet, it is clear the need for a proper categorization of those bio-based plastics that are whether implemented in the current market or will have a promising future due to technical properties and market projections. A deep analysis on the bio-based plastics families revealed that the most of the bio-based plastics have a technical substitution potential for most of the oil-based plastics commodities (PP, PE, PVC, PS and PUR) whereas this potential is low for high-end plastics with specific properties (oxygen barrier, moisture barrier, engineered plastics, etc.). However, market projections and production capacities must be taken into account in order to estimate sound values for substitution potential. This task was done by calculating the substitution potential only to those materials which have demonstrated that can fully compete in technical terms, taking into account worldwide oil-based plastic consumption projections for 2015 and the estimated worldwide production capacity for bio-based plastics in 2015. Results from this analysis have shown that the real substitution capacity can reach a maximum of 2.14% for the bio-based PA. For the remaining bio-based plastics, results are even lower for biodegradable bio-based plastics like PHA, PLA and starch-based plastics that can compete mainly to PP, PE and PUR (from 0.18% to 0.83%) and slightly higher for those non-biodegradable bio-based plastics like bio-based PE and bio-based PET, since the properties of these materials are exactly the same as the oil-based ones. Such work delivered a selection of the most promising bio-based plastics families: (1) starch-based plastics, (2) PLA, (3) PHAs and (4) bio-based PE. However several different materials can be found in these families. Therefore, it was analysed by looking at the materials, producers, current production and synthesis routes. This refined list of materials to be implemented within the LCA to go sectoral tool for bio-bases plastics was: (1) Mater-Bi® and Solanyl® for starch-based plastics, (2) Ingeo® for PLA, (3) Mirel™ for PHAs and (4) Green PE® for bio-based PE. The manufacturing processes for the converting of the selected bio-based plastics materials do not require specific equipment. These are able to be processed with conventional equipment just with minor adjustment. Although the only one exception is PLA which require a drying process before processing.

When materials selected, the next step was to select those environmental impact categories which are scientifically relevant for an LCA of bio-based plastics, while are aligned with the sectoral demands of the targeted group. An ABC analysis was performed in order to estimate the dominance of each impact category vs the relevance for the SME's. The impact categories selected were: GWP, Water Footprint, Land use, Acidification, Eutrophication, POCP, CED and Respiratory Inorganics. Such results were confirmed by checking with bio-based plastics eco-profiles of the selected materials for which LCA results are public and available. The analysis of the eco-profiles confirmed the need of consider a wider set of environmental impacts, even though the main current need for SME's is the Carbon Footprint (GWP).

The next step consisted of an analysis of the software landscape through an analysis of the current tools which can be used as the LCA to go bio-based plastics sectoral tool. Only two tools dedicated to bio-based materials were found: CCalC® BIOCHEM Carbon Footprinting Tool and Polymers Environmental Comparator (Iowa State University). However, the main drawbacks of these tools for an SME-aimed LCA were analysed, concluding that whether are complex for non-trained users or are extremely simple being not able to take alternative decisions at company level. Therefore any of them can be used for the intended sectoral objective in LCA to go. Generic LCA tools like Sima Pro or GaBi do not match with the targets of LCA to go project due to its complexity, cost as well as the lack of bio-based specific data.

Considering preceding data, the methodological concept was built by addressing the main bottlenecks to the four stages in a LCA: (1) Goal & Scope, (2) LCI, (3) LCIA and (4) Interpretation of results.

The main proposals for the sectoral concept for the (1) Goal & Scope definition in the sectoral tool were that use and enfd-of life stages should be removed from the system boundaries, due to the fact that bio-based plastics are not usually energy consuming products as well as the lack of reliable data for the end-of-life, respectively. The uncertainty of the data is also an important issue for the bio-based plastic sector and therefore several actions were proposed in order to mimize such risk: allow to enter customizable KEPI values for bio-based plastics, fully customizable converting and transport steps as well as enable/disable gate-to-gate LCC with own company data. Furthermore cut-off rules specified in PCRs for plastics in EPD system represent a good framework in order to simplify data collection at company level.

Proposals for (2) LCI data can be summarized in the use of templates for data collection and generic data for background processes (plastics, electricity, transport) whereas processes under the control of the SME can be fully customizable. Moreover criteria from PCR's of plastics within EPD system can be a base framework for data update in a three year basis (to be done by experts) and for data quality measurement.

In case of (3) LCIA, a full set of impact categories will be considered in accordance with the results from the ABC analysis: Global warming, Water Footprint, land use, CED (renewable & non-renewable), eutrophication, acidification, POCP, and respiratory inorganics.

Finally, for the (4) interpretation of the impact assessment results, the proposal is to use a predefined set of assessments in order to avoid misunderstanding whenever the results are interpreted. The use of templates and explanatory graphics will be the main proposals.

The LCA to go methodological proposal for the bio-based plastic sector was tested with the development of a streamlined LCA test of a biodegradable and compostable PLA shopping bag from Valsay. Results from the streamlined LCA confirmed the suitability and coherence of the proposals of the LCA to go bio-based plastics methodological concept.