PRIMUS

WP6.
Sustainability assessments

Task 6.2

Sustainability data and tooling

Deliverable 6.1

Open-source tool for developing LCSA for plastic recyclates

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DISCLAIMER

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V.1.1	Amendment to blockchain-based traceability system wording	GreenDelta	22/11/2024

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DEFINITIONS/GLOSSARY

Primary plastics – previously referred to as "virgin plastics"

Secondary plastics – those plastics that have undergone recycling, or that enter the use phase for a second time.

ABBREVIATIONS

CIR: Circularise

GD: GreenDelta

LCA: Life Cycle Assessment

LCSA: Life Cycle Sustainability Assessment

SLCA: Social Life Cycle Assessment

LCC: Life Cycle Costing

OEM: Original Equipment Manufacturer

EXECUTIVE SUMMARY

As part of the PRIMUS project, and in collaboration with the whole consortium for data collection, context and blockchain-based traceability system communication, GreenDelta GmbH developed an expert and non-expert sustainability tool for plastics and recycled plastics supply chains (flake, pellet and plastic part).

The **expert tool** is based in openLCA, the open source and freely available LCA software developed since 2007, and contains a database and LCA model for LCA, SLCA, LCC, Circularity and Plastic Littering assessments, following the sustainability methodology developed in the project. Furthermore, the tool connects to the Circularise blockchain-based traceability system-based traceability system (not open source) through an API to obtain supply chain information and give back LCA results. This tool is directed to LCA practitioners performing sustainability studies for recycled plastic products and related.

The **non-expert tool** is directed to actors in the recycled plastic life cycle, from recyclers producing flakes, to compounders producing pellets, to plastic part producers that would like to incorporate recycled plastics in their production. These users are interested in their environmental impact but don't have the resources or personnel for performing full LCAs. The tool is based in excel with a user-friendly interface where the user is guided along data collection, input and results.

The tools will be available to the public through the GreenDelta website[1], managed by GreenDelta.

On behalf of Authors

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[1] https://www.greendelta.com/project/primus/

PRIMUS PROJECT

PRIMUS project is dedicated to significantly contribute to the goals of the European Strategy for Plastics and enhance the amount of quality and safe recycled plastics that enter the European markets. PRIMUS is a project funded by the Horizon Europe in the following call: *HORIZON-CL4-2021-RESILIENCE-01-10: Paving the way to an increased share of recycled plastics in added value products (RIA)*. PRIMUS is a 3-year project with a total budget of 7 M€. PRIMUS has 10 partners[1], and 2 affiliated entities[2].

PRIMUS will actively engage with the plastics value chain stakeholders and innovatively develop novel methods and technologies to significantly increase the circularity, and production and use of sustainable, safe and quality recyclates in added value products. The main technological focuses are on advanced mechanical recycling coupled with broad analytics and novel pre-treatment methods for removal of hazardous substances and counteracting degradation. PRIMUS will produce 4 demonstrators where new added value products will be made from recycled and upgraded non- or underutilized plastic waste streams from waste electronics and electrical equipment (WEEE) and end-of-life vehicles (ELV). The four demo products will be automotive interior parts, automotive cooling circuits and its elements, a food contact application refrigerator, and a closed-loop demonstration of washing machine seals.

The project aims at establishing EU widely accepted and transparent procedures to control quality and safety of recyclates, especially for the waste streams containing hazardous substances like brominated flame retardants. The framework related work will include broad engagement of the European plastics sector and recyclers, but also the society, citizens and communities as well as consumers. Safety and trackability back to origin, traceability, are consistent and overlapping themes in PRIMUS. PRIMUS will not only technically and industrially support the usage of recyclates in products but will also address and support the concerns of the society and enhance the acceptance of products that have recycled content.

1 INTRODUCTION

Assessing sustainability is a relative new practice in product development. Practices such as Life Cycle Assessment (LCA) are used to quantify environmental impacts for the whole supply chain, not only the processes under the control of the study commissioner. This usually identifies environmental hotspots in a certain supply chain. Even though LCA has been in place for around 50 years, it was not until the ISO 14040/44 standards were published in the late 1990s that LCA was more widely adopted.

Back then, software like *SimaPro* or *GaBi* allowed early LCA practitioners to perform LCA models and studies with the available LCA databases at the time. Other players like *openLCA* software entered the market in 2007, introducing a fully-fledged LCA software with a new concept: open source and available for free. Since then, several other software have been launched including some that focus on specific sectors, like *OneClickLCA* (construction sector) or specific impacts, usually carbon footprint, like *Ecochain*. Not only software, but data is also high on demand, with databases such as *Carbon Minds* making a strong enter in the LCA market in the later years.

The big growth that the LCA field is encountering is surely pushed by legislation and political initiatives such as the Green Deal in 2020 and further by Original Equipment Manufacturers (OEMs) requesting environmental (usually carbon) accounting from their suppliers as well as recycled content in purchased parts. The demand and requirement for such assessments is growing fast, but not so the professionals dedicated to performing LCA assessments.

It is so that even if enough professionals would get trained in LCA, such studies are time consuming and usually take months. New solutions such as LCA automation, a model that fits several product sub-categories or non-expert LCA tools are more and more common, e.g. onlineLCA[2] developed by GreenDelta.

The work presented in this report focuses on the sustainability tools developed by GreenDelta GmbH in the PRIMUS project, catering sustainability assessments for recycled and primary plastics. From flake, to pellet, to plastic part production. Two tools were developed:

- **Expert PRIMUS Sustainability Tool**, based on the open source and professional LCA software *openLCA*,
- **Non-expert PRIMUS Sustainability Tool**, as an excel-based tool for non-LCA partitioners.

Both tools are available open source.

[2] https://www.openlca.org/onlinelca/

1.1 Scope

This task puts together data and tools to perform Life Cycle Sustainability Assessments for plastic recycled content, and its use in plastic part production in a European context.

1.2 Audience

The tools are directed to plastic recyclers and plastic part producers who want to calculate their environmental footprint. The expert tool is made thinking of LCA practitioners and the non-expert tool can be used, in principle, by anyone with life cycle inventory information.

1.3 Contributions of partners

GreenDelta GmbH has been the developer of the tools and LCA models and is responsible for writing the entirety of the deliverable report. Work was done with Circularise in order to integrate blockchain-based traceability system-based traceability system communication through an API.

1.4 Relation to other activities in the project

The following Table 1 depicts the main relationship of this deliverable to other activities (or deliverables) developed within the PRIMUS project and that should be considered along with this document for further understanding of its contents.

Deliverable Number	Contributions
T5.2	This task develops an interface, API, between CIR and GD
M8	This milestone confirms the development of an API communication between CIR and GD
T6.1	This task developed the LCA and sustainability methodology used in the tools
M5	Submission of the LCSA methodology
T6.2	This task focused on tool development and testing

Table 1. relation to other activities in the project

2 TOOLS FOR THE SUSTAINABILITY ASSESSMENT OF RECYCLED PLASTICS, FROM FLAKES TO PARTS

The following section will guide the reader through the PRIMUS Expert and Non-expert Sustainability Tools followed by information on publishing and availability of the tools.

2.1 Expert PRIMUS Sustainability Tool

2.1.1 Summary

The expert tool is directed to LCA practitioners that want to make a Life Cycle Sustainability Assessment, LCSA, for recycled plastic flakes, pellets and/or plastic parts.

The tool is based on the open source LCA software openLCA[3], developed by GreenDelta since 2007.

The tool allows to make:

- **LCA calculations** and visualise LCA results, with transparency of supply chains,
- Visualise **Social LCA** results,
- Calculate **plastic litter** across supply chain,
- Calculations for **circularity indicators** also across the supply chain.

The tool is made to be used with **an LCA database which is specifically prepared for the PRIMUS** project with the use case of modelling plastics and recycled plastics and products. The *ecoinvent 3.10*[4] cut-off database is used as a basis for the environmental LCA datasets. The database is reinforced by the *PLEX*[5] database for plastic littering estimations and the *Circularity Package*[6] for circularity indicator calculations. Furthermore, Life Cycle Costing (LCC) is possible due to the cost columns per flow available in the software and Social Life Cycle Assessment is also possible thanks to the integration of the *PSILCA*[7] database.

The tool further **connects to the Circularise[8] blockchain-based traceability system system** through an API specifically developed in the PRIMUS project. Datasets can be fetched from the blockchain-based traceability system system, mapped to the database in the sustainability tool, and results can be communicated back to the blockchain-based traceability system. The version of the tool with the Circularise blockchain-based traceability system protection is not made public due to restrictions by Circularise.

[3] https://www.openlca.org/
[4] https://ecoinvent.org/
[5] https://nexus.openlca.org/database/PLEX
[6] https://nexus.openlca.org/database/Circularity%20Package
[7] https://nexus.openlca.org/database/PSILCA
[8] https://www.circularise.com/

2.1.2 Walking through the Expert PRIMUS Sustainability Tool

After **opening the tool**, the user's first view to the software is shown in Figure 1. The PRIMUS database has to be obtained from openLCA Nexus and imported to the software by *right clicking the navigation panel > restore database*, as shown in Figure 2. **Double click on the database name to open it**, where the user will be able to see the basic model and datasets prepared for recycled plastic flakes, pellets, parts and related processes.

The tool can be **connected to information on the supply chain through the blockchain-based traceability system system** provided by Circularise (not open source), see Figure 3.

This allows to obtain specific data from material providers that is not only from a specific supplier but also from a specific product batch of a specific supplier. The connection with the blockchain-based traceability system system is allowed through a login provided by Circularise, as shown in Figure 4.

Figure 1. Screenshot of the PRIMUS Expert Sustainability Tool

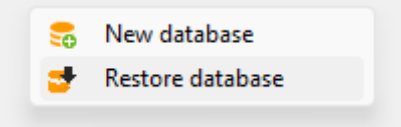


Figure 2. To import a database in the tool, *right click* in the navigation panel and click *restore database*.

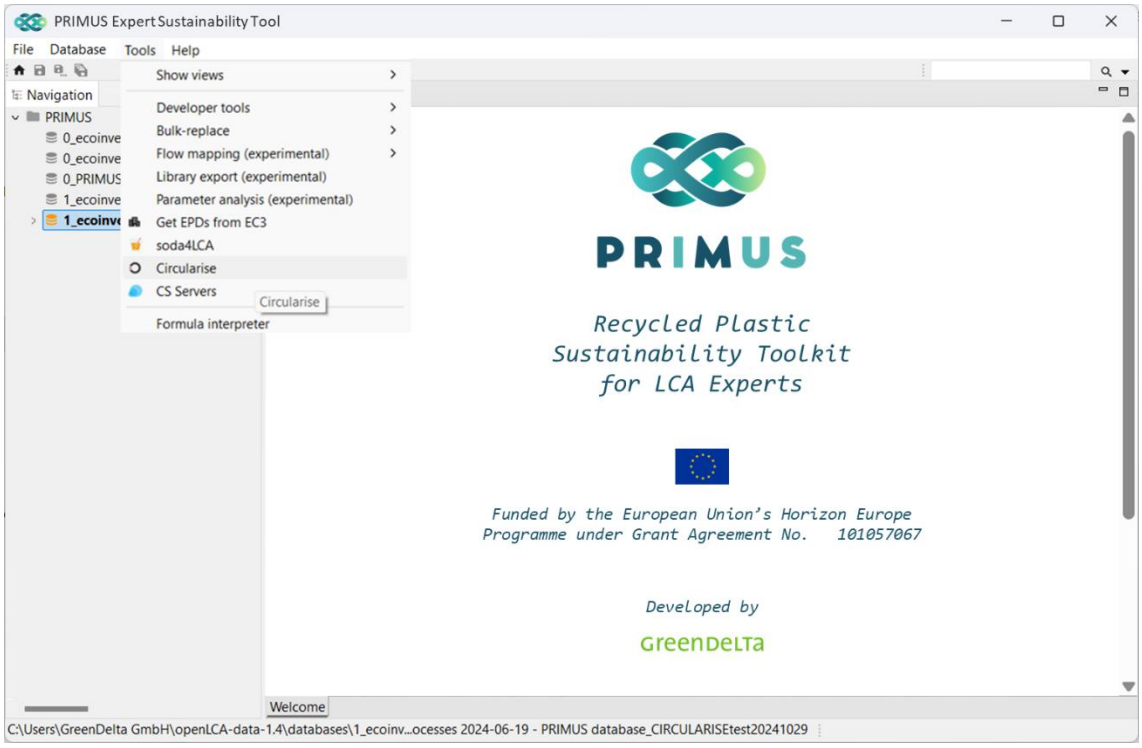


Figure 3. Connection with the Circularise blockchain-based traceability system API

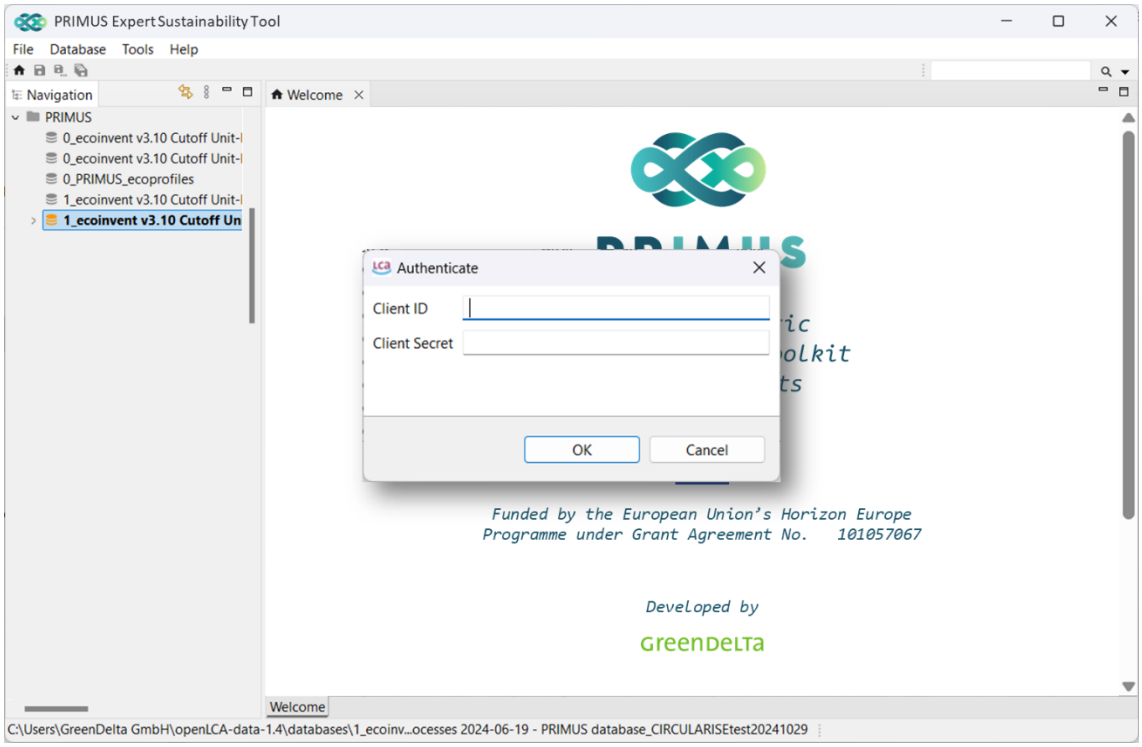


Figure 4. The blockchain-based traceability system API is protected by login details that the user must enter

The tool is able to **fetch datapoints from the blockchain-based traceability system** as shown in Figure 5. The datapoints are to be further matched with parameters in the

database, Figure 6. There can be direct matches between the LCA parameters and datapoints on the Circularise system, or the user can enter formulas combining LCA parameters in order to match a data point coming from the blockchain-based traceability system system, as shown in Figure 7. The LCA tool then allows to calculate a specific product system with data obtained from the Circularise system, Figure 8, and to write results back to the Circularise system, Figure 9.

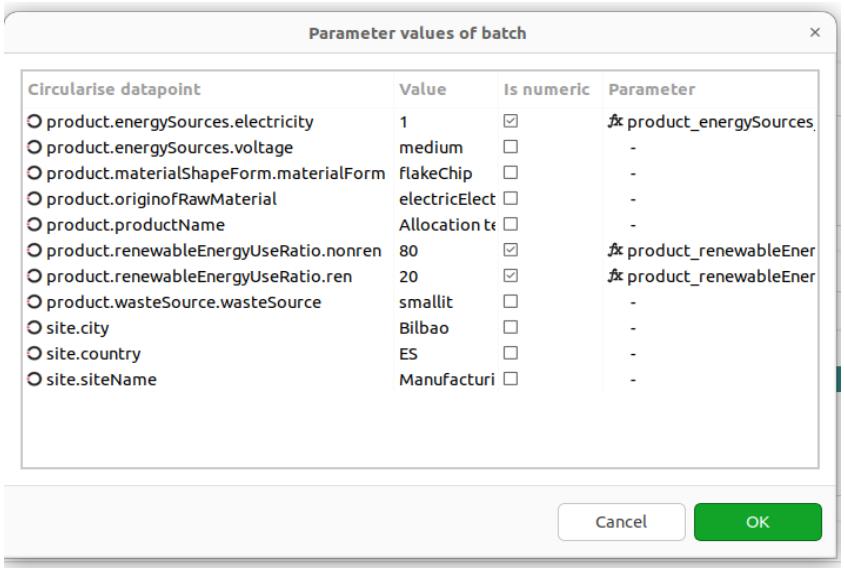


Figure 5. Datapoints are fetched from the Circularise blockchain-based traceability system system

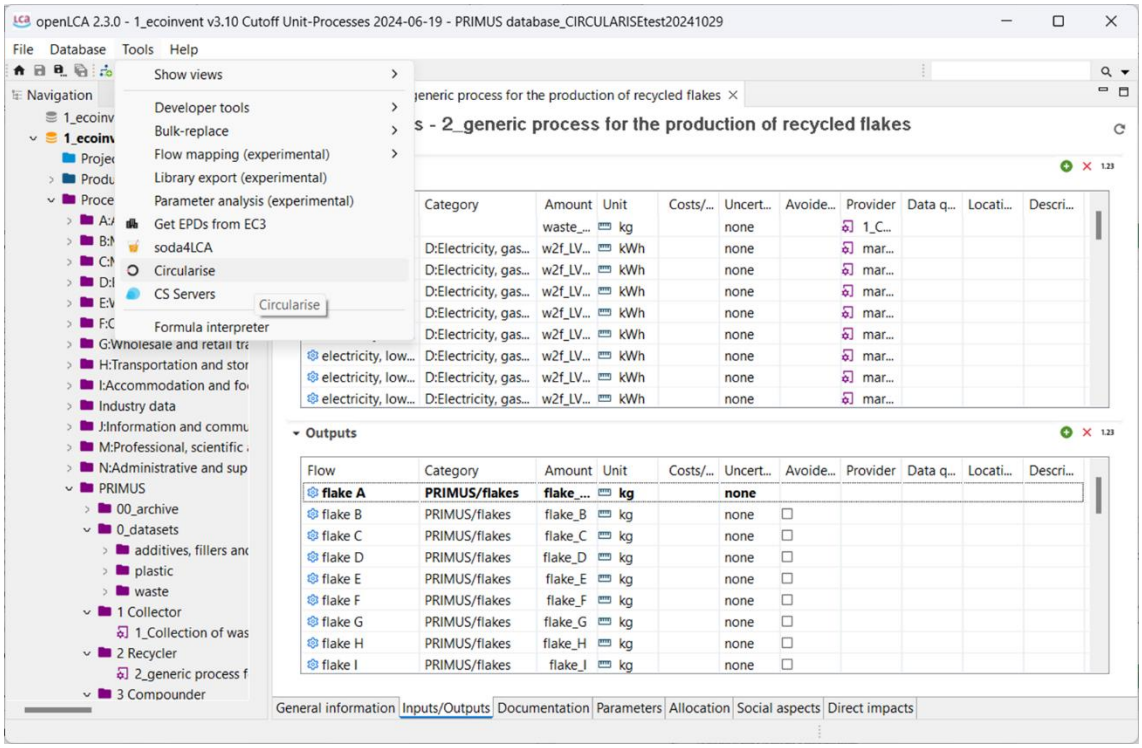


Figure 6. Parametrised LCA dataset allows the input of data from the blockchain-based traceability system datasets

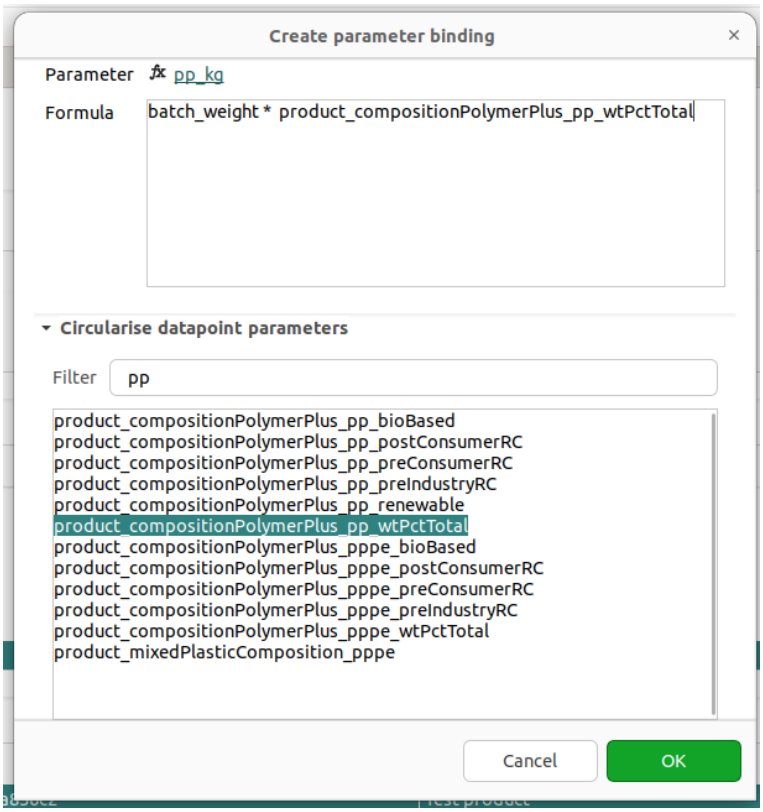


Figure 7. Parameters (data points) fetched through the API are matched with parameters from the model. Formulas are possible.

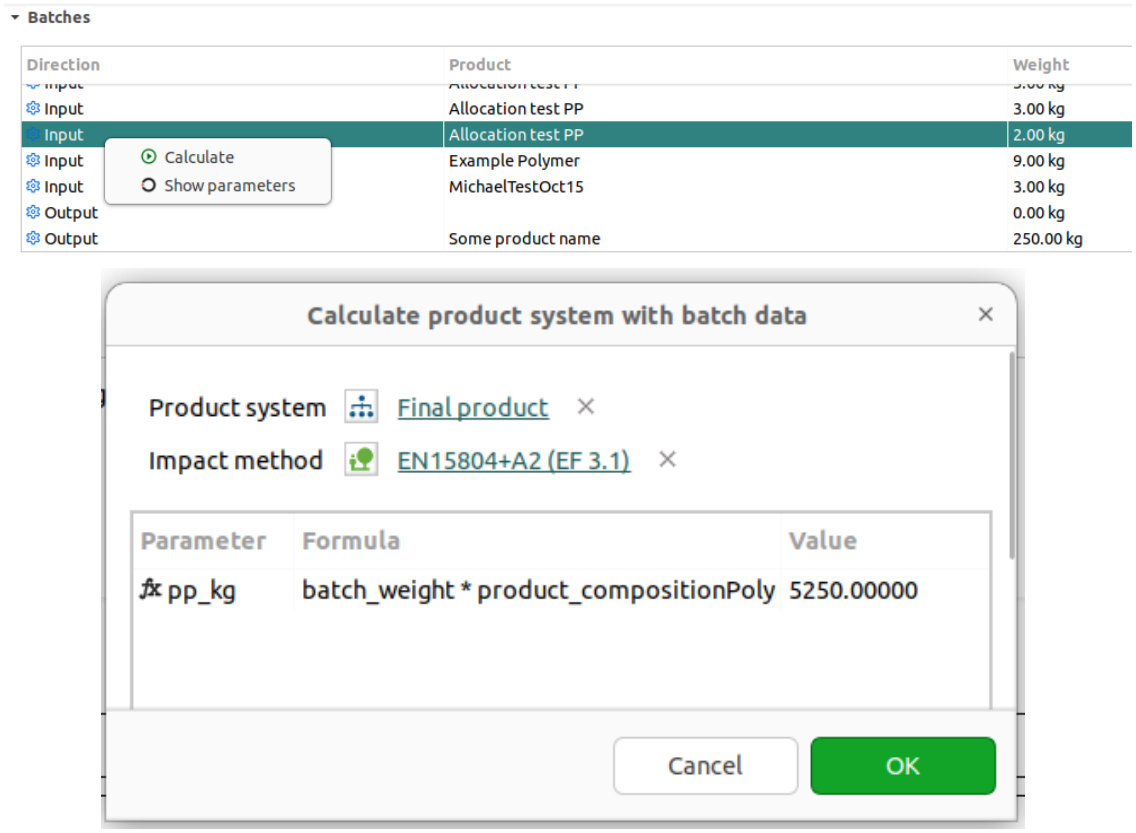


Figure 8. Once parameters are matched, specific batches from the Circularise system can be calculated with the LCA engine

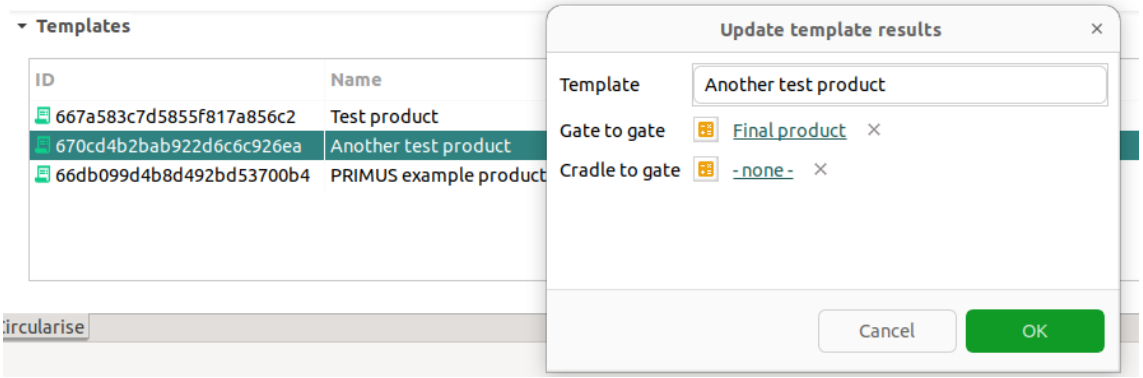


Figure 9. Results can be written back to the blockchain-based traceability system system

2.2 Non-expert PRIMUS Sustainability Tool

PRIMUS' non-expert sustainability tool is an excel-based tool that guides the user through data collection until arriving to final results. It is directed to recycled flake, pellet and plastic part producers. No previous LCA experience is required.

The first tab users encounter is the **introductory and explanatory tab**. It will give context to the tool, explain how it will be used, and informs about the methodology, data used and developers of the tool for credibility and documentation purposes.

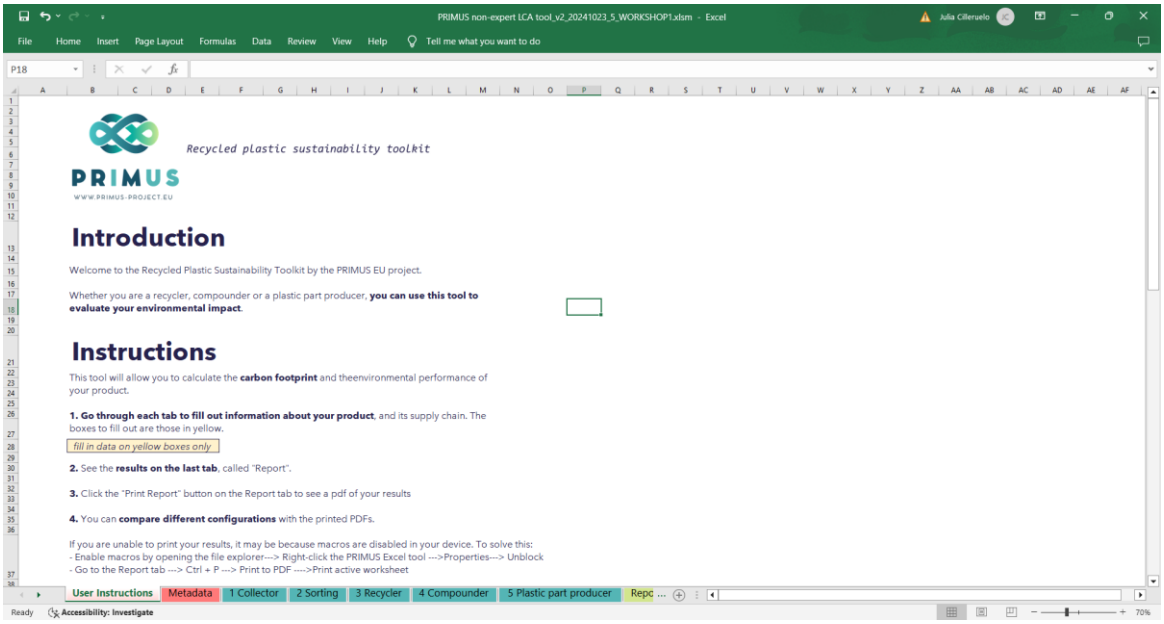


Figure 10. Screenshot of the PRIMUS Non-expert Sustainability Tool, introduction page

The next tab allows to **insert metadata** such as name of modeller, commissioner, address etc, and also assumptions made in the model. This information is used in the results tab in order to produce a printable page with not only the results but also information of who made the study and when.

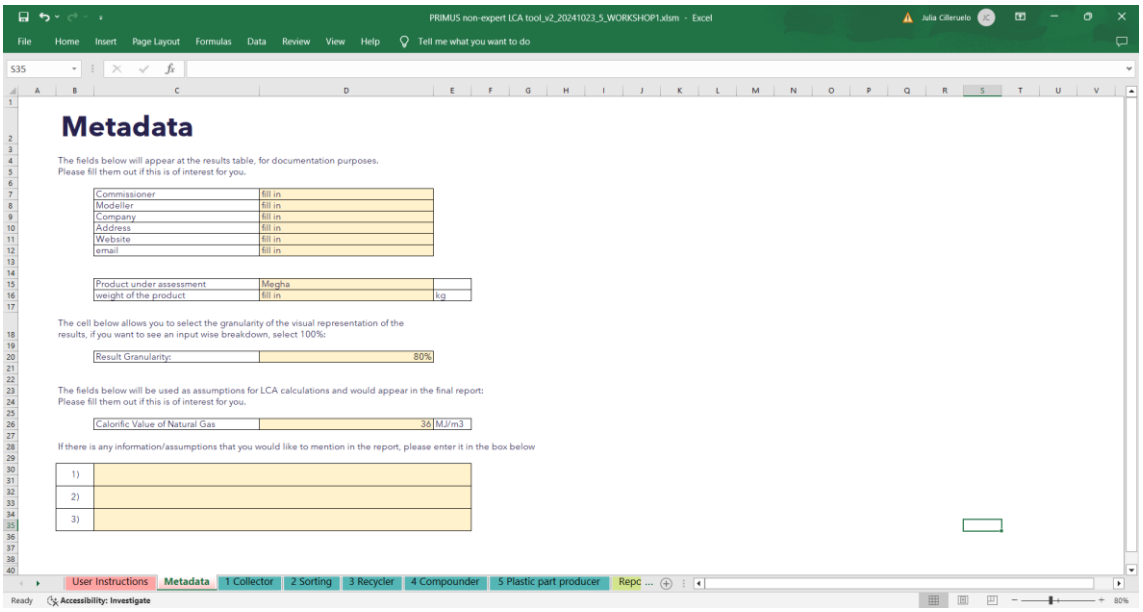


Figure 11. The metadata tab allows the user to put their information for the sake of documentation

Modelling starts from the third tab until the seventh tab, where users can input inventory data from **collection, sorting, recycling, compounding and part production**.

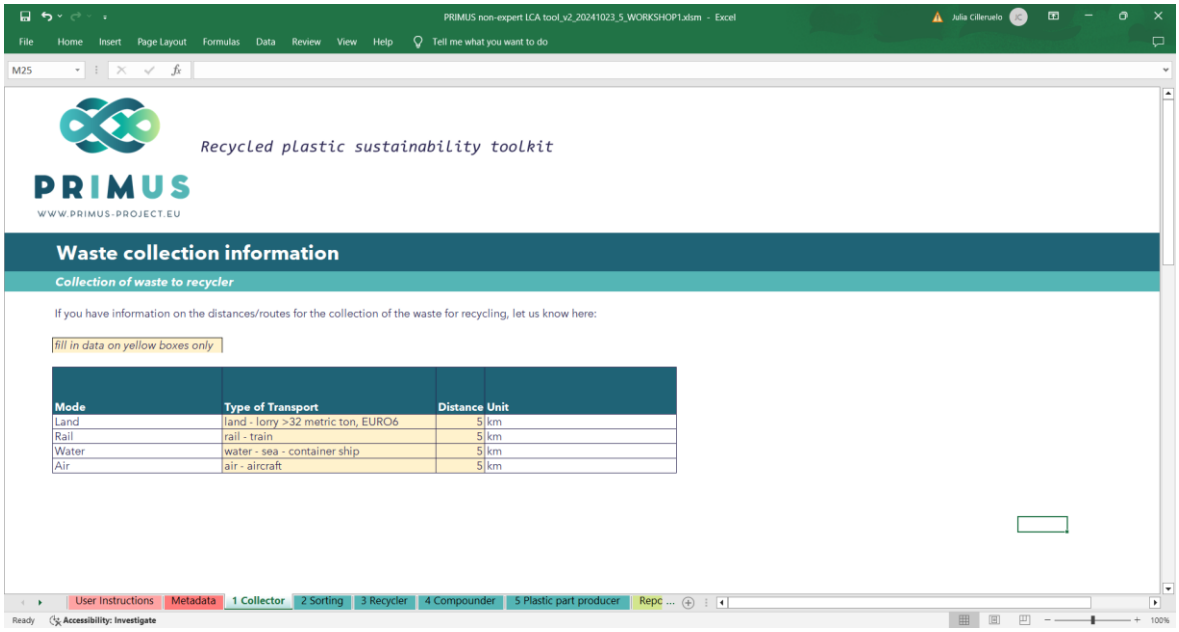


Figure 12. Collection tab allows to put travel distance of different mode of transport

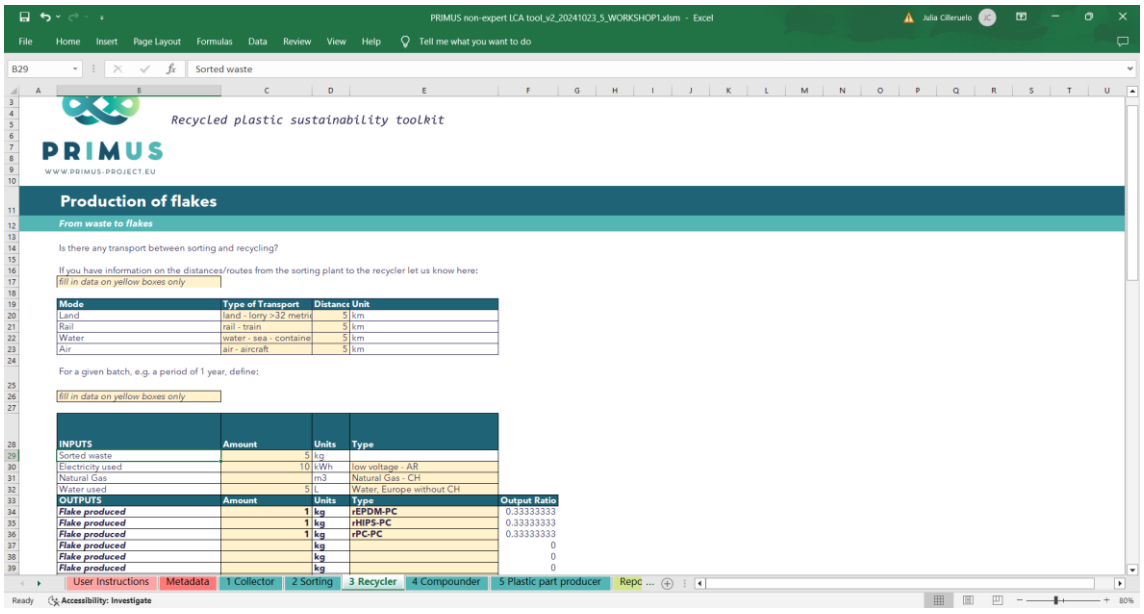


Figure 13. Recycling tab allows to put inventory information for travel between sorting and recycling as well as recycling process

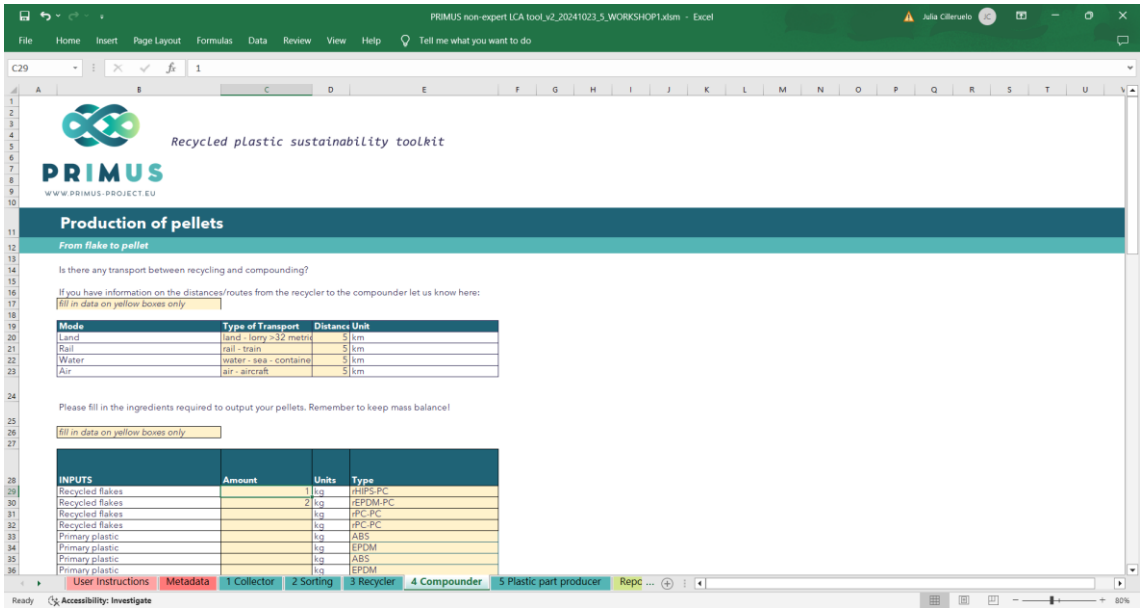


Figure 14. Compounding is similar to recycling and allows extra information for additives

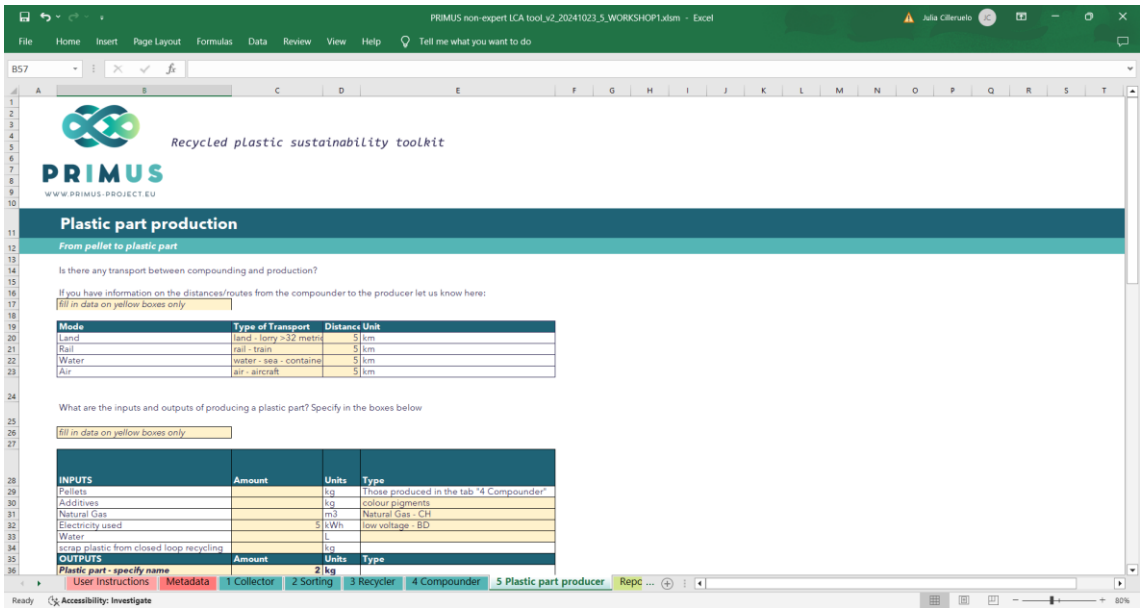


Figure 15. Finally, the plastic part production tab allows part manufacturers to input their inventory information

After filling the information for the model, results can be directly seen in the **results tab**. The page is designed to be printed. Metadata information can be found at the top, followed by a summary of how much the part weighs as well as how much recycled content it has, distinguishing post-consumer and post-industrial recycled content. Environmental impact information for 16 impact categories can be found, including the breakdown of the supply chain to distinguish hotspots.

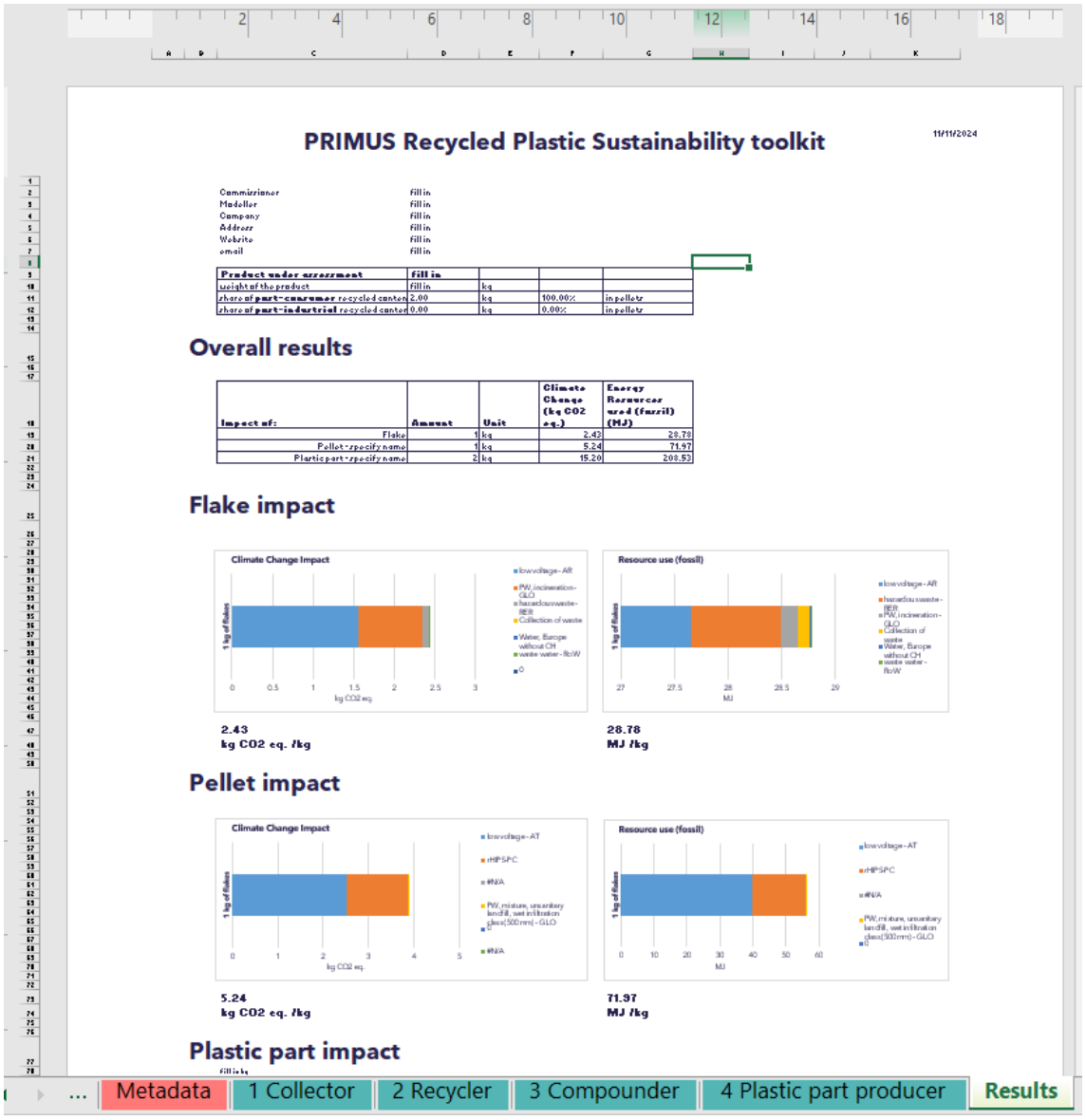
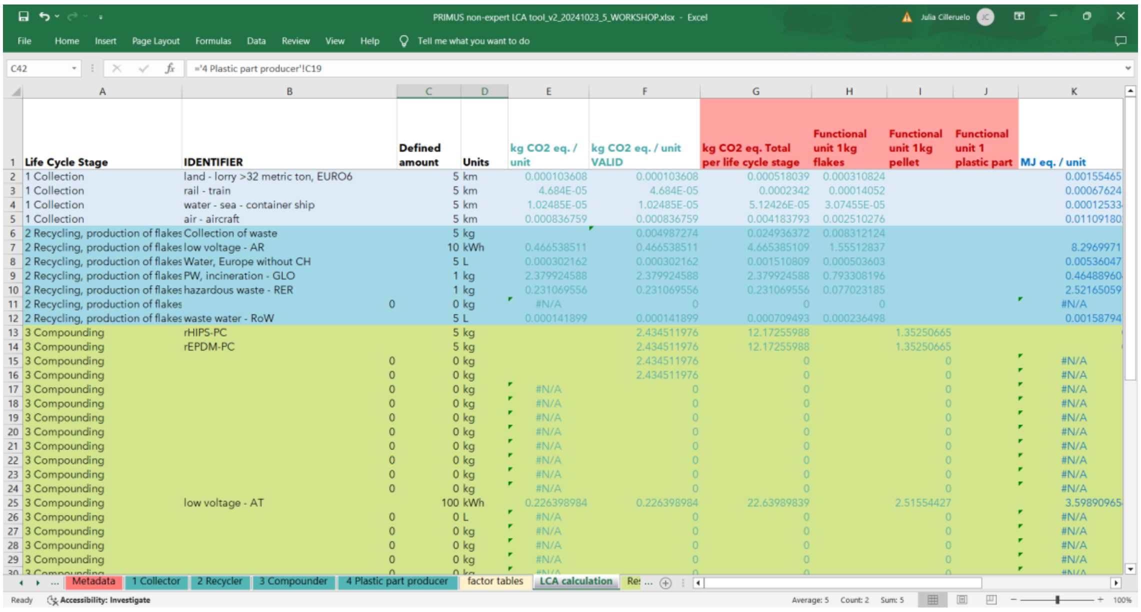


Figure 16. Results tab can be found as the last tab

Product under assessment	**fill in**			
weight of the product	5.00	kg		
share of **post-consumer** recycled content	1.00	kg	50.00%	in pellets
share of **post-industrial** recycled content	1.00	kg	50.00%	in pellets

Figure 17. Summary of calculated product

The **engine of the excel tool** is hidden and protected from user view. This contains characterisation factors and the life cycle calculations.



	Life Cycle Stage	IDENTIFIER	Defined amount	Units	kg CO2 eq. / unit	kg CO2 eq. / unit VALID	kg CO2 eq. Total per life cycle stage	Functional unit 1kg flakes	Functional unit 1kg pellet	Functional unit 1 plastic part	MJ eq. / unit
2	1 Collection	land - lorry >32 metric ton, EURO6		5 km	0.000103608	0.000103608	0.000518039	0.000310824			0.00155465
3	1 Collection	rail - train		5 km	4.684E-05	4.684E-05	0.0002342	0.00014052			0.00067624
4	1 Collection	water - sea - container ship		5 km	1.02485E-05	1.02485E-05	5.12426E-05	3.07455E-05			0.00012533
5	1 Collection	air - aircraft		5 km	0.000836759	0.000836759	0.004183793	0.002510276			0.01109180
6	2 Recycling, production of flakes	Collection of waste		5 kg		0.004987274	0.024936372	0.008312124			
7	2 Recycling, production of flakes	low voltage - AR		10 kWh	0.466538511	0.466538511	4.665385109	1.55512837			8.2969971
8	2 Recycling, production of flakes	Water, Europe without CH		5 L	0.000302162	0.000302162	0.001510809	0.000503603			0.00536047
9	2 Recycling, production of flakes	PW, incineration - GLO		1 kg	2.379924588	2.379924588	2.379924588	0.793308196			0.46488960
10	2 Recycling, production of flakes	hazardous waste - RER		1 kg	0.231069556	0.231069556	0.231069556	0.077023185			2.52165059
11	2 Recycling, production of flakes		0	0 kg	#N/A	0	0	0			#N/A
12	2 Recycling, production of flakes	waste water - RoW		5 L	0.000141899	0.000141899	0.000709493	0.000236498			0.00158794
13	3 Compounding	rHIPS-PC		5 kg		2.434511976	12.17255988		1.35250665		
14	3 Compounding	rEPDM-PC		5 kg		2.434511976	12.17255988		1.35250665		
15	3 Compounding		0	0 kg		2.434511976	0		0		#N/A
16	3 Compounding		0	0 kg		2.434511976	0		0		#N/A
17	3 Compounding		0	0 kg	#N/A	0	0		0		#N/A
18	3 Compounding		0	0 kg	#N/A	0	0		0		#N/A
19	3 Compounding		0	0 kg	#N/A	0	0		0		#N/A
20	3 Compounding		0	0 kg	#N/A	0	0		0		#N/A
21	3 Compounding		0	0 kg	#N/A	0	0		0		#N/A
22	3 Compounding		0	0 kg	#N/A	0	0		0		#N/A
23	3 Compounding		0	0 kg	#N/A	0	0		0		#N/A
24	3 Compounding		0	0 kg	#N/A	0	0		0		#N/A
25	3 Compounding	low voltage - AT		100 kWh	0.226398984	0.226398984	22.63989839		2.51554427		3.59890965
26	3 Compounding		0	0 L	#N/A	0	0		0		#N/A
27	3 Compounding		0	0 kg	#N/A	0	0		0		#N/A
28	3 Compounding		0	0 kg	#N/A	0	0		0		#N/A
29	3 Compounding		0	0 kg	#N/A	0	0		0		#N/A

Figure 18. Calculation engine behind the tool

2.3 **Publishing and availability of the tools**

The tools will be published in a dedicated PRIMUS page within the GreenDelta website: https://www.greendelta.com/project/primus/Information.

The tools will be available open source and for free and will require a valid licence for the LCA databases used.