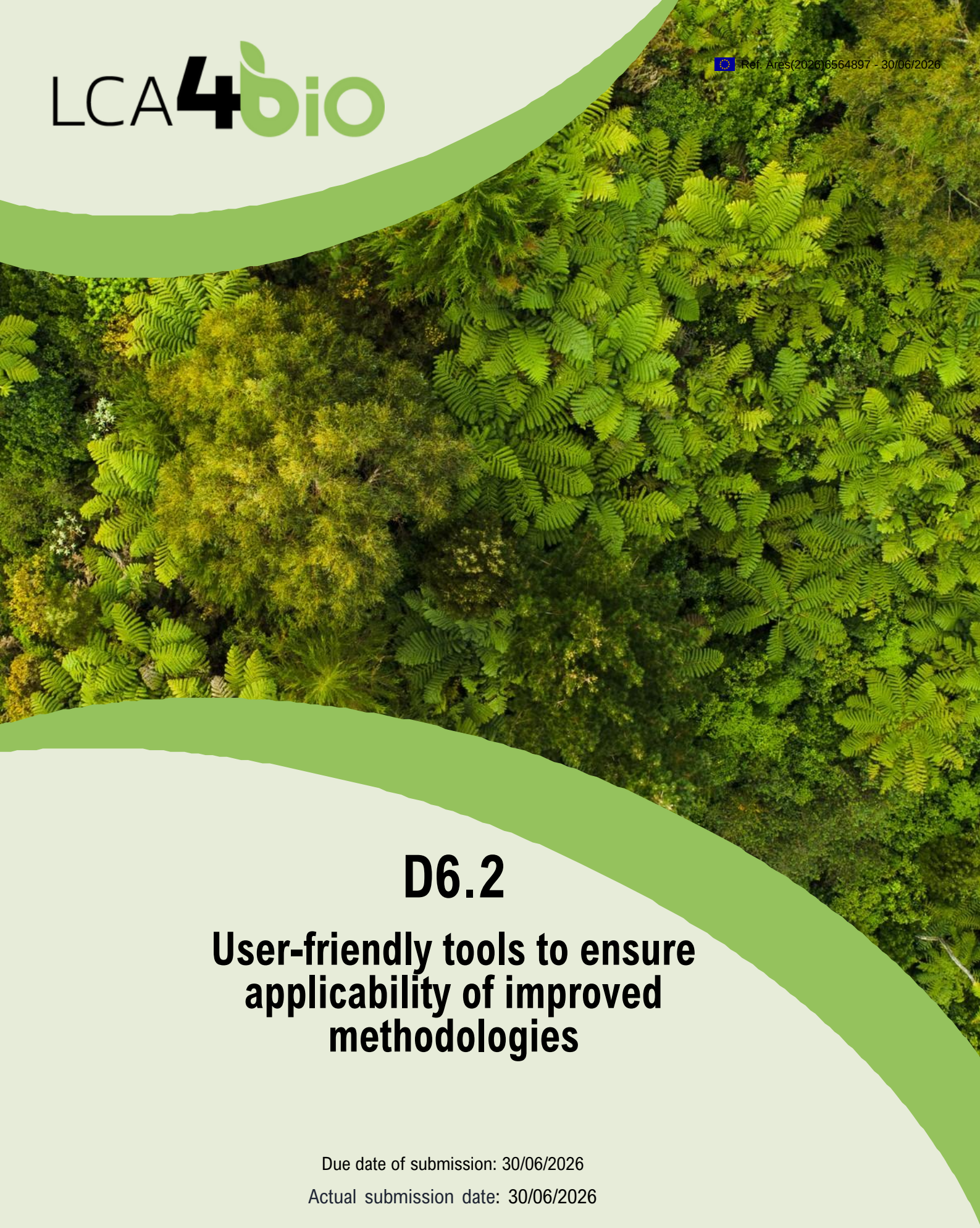
Ref. Ares(2026)6564897 - 30/06/2026

LCA4bio



D6.2

User-friendly tools to ensure applicability of improved methodologies

Due date of submission: 30/06/2026

Actual submission date: 30/06/2026

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List of acronyms

AGWP - Absolute Global Warming Potential

APOS - Allocation At The Point Of Substitution

BC – Black Carbon

CCI – Climate Change Impact (tool)

CCS – Carbon Capture and Storage

DyPLCA - Dynamic Process-based LCA

EF – Environmental Footprint

ERF - Effective Radiative Forcing

GHG – Greenhouse Gas(es)

GMST – Global Mean Surface Temperature

GMTC – Global Mean Temperature Change

$GMTC_{max}$ – Global Mean Temperature Change Maximum; maximum temperature registered

GMTCd – direct Global Mean Temperature Change

GWP – Global Warming Potential

iGMTC – integrated Global Mean Temperature Change

$iGMTC_{LT}$ – integrated Global Mean Temperature Change at Long-Term

IAM – Integrated Assessment Model

ISIC - International Standard Industrial Classification

IPCC – Intergovernmental Panel on Climate Change

IPCC AR – Intergovernmental Panel on Climate Change Assessment Report

IRF – Impulse Response Function

IRFCCF - impulse response function Carbon-Climate Feedback effect on radiative forcing

IRFT - Temperature Impulse Response Function

LCA – Life Cycle Assessment

LCC – Life Cycle Costing

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LCI – Life Cycle Inventory

LCIA – Life Cycle Impact Assessment

LTO – Long-Term effect of methane on Ozone depletion

M – Methane decrease

(NM)VOC – (Non-Methane) Volatile Organic Compounds

OC – Organic Carbon

PMs – Particulate Matter

RCP - Representative Concentration Pathway

RF – Radiative Forcing

RFd - 'direct Radiative Forcing

RF_CCF - Carbon-Climate Feedback Effect on the Radiative Forcing

SLCF - Short-lived climate forcers

STO - Short-Term Ozone increase

SSP - Shared Socioeconomic Pathway

SW – Stratospheric Water decrease if the emission is in upper troposphere lower stratosphere

USDA - United States Department of Agriculture

WMGHG – Well-mixed Greenhouse Gas(es)

WTP - Water Treatment Plant

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PROJECT INFORMATION

Project full title: Harmonised Life Cycle Assessment methods for sustainable and circular BIO based systems

Acronym: LCA4BIO

Call: HORIZON-CL6-2023-ZEROPOLLUTION-01

Topic: HORIZON-CL6-2023-ZEROPOLLUTION-01-04 - Environmental sustainability and circularity criteria for industrial bio-based systems

Start date: 1st January 2024

Duration: 36 months

List of participants:

PARTNER Nº	PARTICIPANT ORGANIZATION	ACRONYM
1 (Coord.)	CONTACTICA SL	CTA
2	AALBORG UNIVERSITET	AAU
3	LUXEMBOURG INSTITUTE OF SCIENCE AND TECHNOLOGY	LIST
4	INSTITUT NATIONAL DES SCIENCES APPLIQUEES DE TOULOUSE	INSA
5	NORGES TEKNISK-NATURVITENSKAPELIGE UNIVERSITET	NTNU
6	BIOECONOMY FOR CHANGE	B4C
7	BUSINESS E-INCUBATOR GO-UP	GOUP
8	FUNDACION CENTRO DE SERVICIOS Y PROMOCION FORESTAL Y DE SU INDUSTRIA DE CASTILLA Y LEON	CESEFOR
9	SONAE ARAUCO PORTUGAL SA	SONAE
10	ASOCIACION PARA LA CERTIFICACION ESPANOLA FORESTAL	PEFC

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DELIVERABLE DETAILS

Document Number:	D6.2
Document Title:	User-friendly tools to ensure applicability of improved methodologies
Dissemination level	PU – Public, fully open
Period:	PR2
WP:	WP6 Ensuring the Applicability of LCA methodologies to allow certification of BBS and assess the environmental performance of Low-TRL BBS
Task:	T6.2 Creation of tools to ensure applicability
Author(s):	LIST: Thomas Schaubroeck, Laurent Chion, Alya Bolowich, Thomas Gibon, Tomas Navarrete-Gutierrez & Enrico Benetto INSA: Ligia Tiruta-Barna AAU: Fabio Sporchia, Anja Marie Bundgaard, Mette Alberg Mosgaard & Massimo Pizzol CTA: Lucia Garcia Santos & María Gallego NTNU: Ruslan Zhuravchak & Marcos Watanabe
Reviewer(s):	/
Abstract:	This task covers the creation of user-friendly tools for the improved methodologies in LCA4BIO, and the respective deliverable 6.2 is then also the set of tools. In this context, this document is just an accompanying guidance document that presents an overview of key information on the user-friendly tools. Where the user-friendly tools can be found is specified in the text section of each tool. We present here eight new or updated tools: (1) Circularity tool; (2) DyPLCA: dynamic life cycle inventory tool; (3) Dynamic carbon footprint - climate change impact tool; (4) Dynamic carbon footprint – tier 1 tool; (5) Dynamic toxicity tool (D); (6) Job Creation Potential tool; (7) Life Cycle costing tool; (8) Prospective LCA tool. Key information per tool is given on (a) Context (focus & scope; novelty; further documentation), (b) Availability & accessibility; (c) User guide.

Version	Date	Description
v1.0	15/06/2026	First draft for revision
v2.0	30/06/2026	Final version for submission

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1 INTRODUCTION

1.1 Scope & aim

The associated task has as aim to create user-friendly tools for the improved methodologies in LCA4BIO, and the respective deliverable 6.2 is then also the set of tools. In this context, this document is just an accompanying guidance document that presents an overview of key information on the user-friendly tools. Where the user-friendly tools can be found is specified in the text section of each tool. We present here eight new or updated tools (of which six were explicitly mentioned in the D6.2 deliverable description; highlighted with "D"):

1. Circularity tool (D)
2. DyPLCA: dynamic life cycle inventory tool (D)
3. Dynamic carbon footprint - climate change impact tool (D)
4. Dynamic carbon footprint – tier 1 tool (D)
5. Dynamic toxicity tool (D)
6. Job Creation Potential tool (D)
7. Life Cycle costing tool
8. Prospective LCA tool

1.2 Structure

Each text section per tool presents in a structured way following key information on the tool:

- Context
    - Focus & Scope:
      Short elaboration on the relevance of the tool, particularly in context of biobased systems
    - Novelty:
      short explanation on novelty added in LCA4BIO frame (especially if already developed previously in other HEU project)
    - Further documentation:
      Reference to further documentation that explains the method and/or tool
- Availability & Accessibility
    - Availability:
      Explanation where one can find the tool (or installation files) – if confidential just in a confidential annex of this deliverable
    - Accessibility:
      Explanation on whether the tool is or will be made publicly accessible or not - If not, specification of conditions and protocols to access it
- User guide:
  Specification where user instructions can be found (tool itself, other deliverable text) or a short guide is presented

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2 CIRCULARITY TOOL

AAU: Fabio Sporchia, Anja Marie Bundgaard, Mette Alberg Mosgaard & Massimo Pizzol

2.1 Context

Focus & scope:
This tool supports the identification of the most suitable circularity indicators for biobased systems and allows to calculate their values. It is meant for any stakeholder interested in carrying out a circularity assessment, in particular of a biobased product/system, and needs to identify the proper circularity indicator(s). The tool is suitable for various scales and various economic sectors, thus considering both different materials and products. The identification works similarly to a decision tree with four levels of decision, with a nested approach. However, the four levels are not mutually exclusive as the distinction is only recommended.
A "slicer" (decision tree) provides a set of possible options for each level of decision. Once the suitable indicator is identified, the tool redirects to the indicator calculation sheet. The calculation sheet has a predetermined calculation workflow. It provides the formulas and lists and defines all required variables and units of measure. The user can insert the data specific to their project/system/product.
The calculation sheet returns the calculated value for the identified indicator.

Novelty:
The work is based on the critical review of existing indicators from scientific literature, international standards (particularly the ISO 59000 series), and relevant EU projects (CALIMERO and ORIENTING) that was described in Deliverable LCA4BIO D2.2. The resulting selection of circularity indicators was mapped against key strategies relevant for bio-based systems, covering both micro- and macro-level assessments, as well as a sector-specific set for the wood sector. These indicators are included in the circularity tool.

Further documentation:
The literature review, classification, and selection that underpin the circularity tool are described in the Deliverable LCA4BIO D2.2.

2.2 Availability and accessibility

Availability:
The tool is stored in an open Zenodo repository that can be accessed at https://doi.org/10.5281/zenodo.20431744. It is hosted in the dedicated LCA4BIO Zenodo community.

Accessibility:
The Zenodo record containing the tool is openly accessible to anyone. The sheets in the excel spreadsheets are locked, allowing only the use of the tool, and preventing edits. If necessary, the password to unlock the sheets can be obtained via request to the authors – as explained in the tool itself.

2.3 User guide

Guidelines are provided directly in the tool, specifically on the landing/readme sheet.

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3 DyPLCA Dynamic life cycle inventoriy tool

LIST: Thomas Schaubroeck, Laurent Chion, Alya Bolowich, Thomas Gibon, Tomas Navarrete-Gutierrez & Enrico Benetto

3.1 Context

Focus & scope:
The extent of the impact of emissions, e.g. greenhouse gases, and resource extraction depends on the timing and temporal profile of these, e.g. delayed CO_2 emissions due to carbon storage in biobased products. To facilitate such an improved assessment, processes and their flows need to be spread over time, which is the focus of the DyPLCA tool. It builds further on a computational framework. This tool is connected to the DyPLCA database, a database with temporal DyPLCA parameters for all ecoinvent 3.11 processes. Together, the tool and database, facilitate a fully dynamic, as in temporal differentiation, of a life cycle inventory, including background processes. Yet, the standalone tool already allows temporal calculation if parameter data input is given. Finally, the output of the DyPLCA tool can readily be used as input for the Climate Change Impact tool (section 4) and dynamic toxicity tool (section 6) of INSA to provide improved climate change and toxicity results.

Novelty:
The original DyPLCA tool, framework and database (aligned with ecoinvent 3.2, about 16 000 processes) was developed in the DyPLCA project (Pigné et al., 2020)[1]. In the EU CALIMERO project, the DyPLCA database was updated to ecoinvent 3.10 (about 25 000 processes) and bwDyPLCA was introduced, a small tool, to tailor input files for DyPLCA from Brightway (confidential Deliverable D3.4 of CALIMERO). In LCA4BIO, improvements were made to the database: update to ecoinvent 3.11 (about 27 000 processes) and inclusion of temporal profiles for many forest processes, finetuning of bwDyPLCA, tailoring and debugging of DyPLCA tool (public deliverable D2.1 of LCA4BIO).

Further documentation:
For further documentation, we refer to key publications, notably the work of Pigné et al. (2020), Deliverable D2.1 of LCA4BIO, and the tool websites.

3.2 Availability and accessibility

Availability:
The bwDyPLCA script is available https://git.list.lu/dyplca/bwdyplca or through a link on the DyPLCA tool. The DyPLCA tool is publicly available on dyplca.list.lu, but the DyPLCA database, fully owned by LIST, is not (with availability upon request, via mail dyplca@list.lu).

Accessibility:
bwDyPLCA is fully accessible. For the DyPLCA tool, certain functions are restricted based on database access/licenses. As specified in the tool, different user categories are defined based on levels of access:

- "Basic" (everyone): access to tool & calculator (but no background databases & runs)
- "dynamic" (having an ecoinvent 3.11 license): basic accessibility & background calculation results.

[1] Pigné, Y., Gutiérrez, T.N., Gibon, T., Schaubroeck, T., Popovici, E., Shimako, A.H., Benetto, E., Tiruta-Barna, L., 2020. A tool to operationalize dynamic LCA, including time differentiation on the complete background database. Int J Life Cycle Assess 25, 267–279. https://doi.org/10.1007/s11367-019-01696-6

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- "expert" (having an ecoinvent 3.11 license & DyPLCA database access): "dynamic" accessibility & visibility of dynamic parameter values of DyPLCA database.

To obtain "dynamic" accessibility, proof of ecoinvent license must be sent to dyplca@list.lu. For "expert" accessibility, access/licensing must be agreed upon by LIST through dyplca@list.lu. [2]

3.3 User guide

For bwDyPLCA the user guide is shown online in the tool (xxx). For the DyPLCA tool, a user guide, is also available in the tool (link). Combining these two tool, the user protocol (for "expert") for a fully dynamic Life cycle inventory is as follows:

1. Build a foreground life cycle inventory in Brightway (linked with ecoinvent 3.11 background)
2. Add temporal parameters foreground processes
   A) Export, add temporal parameters in exported file & import again in Brightway
   B) Add temporal parameters in Brightway
3. Export using bwDyPLCA package
4. Import into DyPLCA web app (retrieve temporal data from DyPLCA database for ei3.11 processes)
5. *Optional: Add (for new processes) or change temporal parameters in app*
6. Add specification in properties of DyPLCA web app (Functional Unit, time step etc.)
7. Run the model in the DyPLCA web app
8. Obtain result files from the DyPLCA web app

[2] For "dynamic" & "expert" access, we deviated from the foreseen notion to provide precalculated results in LCA4BIO, due to, too high computational demand and workload, and instead provide direct possibility for users to calculate results themselves, which allows more tailoring and analysis.

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4 DYNAMIC CARBON FOOTPRINT – CLIMATE CHANGE IMPACT TOOL

INSA: Ligia Tiruta-Barna

4.1 Context

Focus & scope:
Climate Change Impact tool (CCI-tool) is a software for dynamic LCA in case of climate change impact. It uses the temporalized inventory of elementary flows (e.g. the GHG emissions) to calculate dynamic indicators based on consensus climate models from IPCC. Those indicators (radiative forcing RF, cumulated radiative forcing iRF, global mean temperature change GMTC, cumulated global mean temperature change iGMTC) are calculated in function of time. It contains all GHGs present in ecoinvent and IPCC databases.

Novelty:
The first version of CCI-tool was developed in 2016 and made available online in 2021. In LCA4BIO, the tool was completed with additional phenomena (carbon cycle climate feedback), was updated for the climate parameters for GHGs, and a model was added for short lived climate forcers SLCF (CO, COV, black carbon, NO_x, SO_2, H_2, particulates, aviation emissions).

Further documentation:
The extended presentation of the underlying physical model is presented in LCA4BIO Deliverable D2.1 Ch3 https://zenodo.org/records/17880614.

4.2 Availability and accessibility

Availability:
CCI-tool is available as calculator on-line https://www.insa-toulouse.fr/cci-tool/ or its python code can be downloaded as a package, available on the same site.

Accessibility:
CCI-tool is publicly accessible without any registration, for free. The user has access to the simulation results via email or can run the implemented code

4.3 User guide

On the web page, the user should provide his email, and a .csv file containing the inventory data. In addition, the time span for impact calculation and the timestep (time resolution of inventory data) must be introduced in the interface. Then start the calculation and retrieve the results by email.

The results are provided as .csv files containing the climate change indicators: radiative forcing RF, cumulated radiative forcing iRF, global mean temperature change GMTC, cumulated global mean temperature change iGMTC.

Graphical representations of those results are also provided; however we recommend the user makes his own graphs with the result data.

On the web page, the user can find the template to organize the inventory data for calculation, an example on how to fill out the template, and a document “how to use CCI-tool".

More extended explanations on how to use CCI-tool are available in foreseen LCA4BIO Deliverable D5.3.

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5 DYNAMIC CARBON FOOTPRINT – TIER 1 TOOL

INSA: Ligia Tiruta-Barna

5.1 Context

Focus & scope:
This tool is aimed at calculating the climate change impact of biobased products by considering their carbon storage potential. It is a compromise between the LCA static approach and the dynamic LCA in case of climate change impact. The dynamic approach is recognized as more relevant when capture and emissions of CO_2 take place in a system with time lags. The tool calculates the impact as GWP at 100 years after the beginning of the use stage.

The Tier 1 tool is simple to use and provides results closer to a dynamic, more realistic approach.

Novelty:
Tier 1 tool for climate change impact calculation was developed in LCA4BIO.

Further documentation:
The method, tool and the way to use it is explained in LCA4BIO Deliverable D5.3 (to be published online).

5.2 Availability and accessibility

Availability:
The tool is publicly provided as excel file in the LCA4BIO Zenodo repository https://zenodo.org/records/20735324.

Accessibility:
It is accessible for free.

5.3 User guide

The related instructions can be found in LCA4BIO Deliverable D5.3.

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6 DYNAMIC TOXICITY TOOL DYTOX

INSA: Ligia Tiruta-Barna

6.1 Context

Focus & scope:
The dynamic toxicity tool, named "DyTox", is aimed at calculating toxicity and ecotoxicity impact in function of the temporality of emissions, for any time horizon. This model combines the three parts of the toxicity impact: pollutant fate, exposure and effect. It considers that the fate of the pollutant is the limiting dynamic process because it can be slow. The temporality of the impact is thus dependent on the temporality of the pollutant fate in the environment. To model the fate process dynamics, the SimpleBox conceptual model was used. It considers each environmental compartment as a homogenous box, and the pollutant is exchanged between each pair of boxes with a specific "velocity".
Finally, DyTox is based on 13 environmental compartments, which ensures its compatibility with the existent methods and data bases, notably USEtox and EF.

Novelty:
The dynamic model for toxicity impact, named "DyTox", was developed by INSA/TBI in the framework of a past research project funded by ANR France and FNR Luxembourg, DyPLCA (Dynamic process life cycle assessment), in which INSA/TBI and LIST were partners. In LCA4BIO the tool was updated for new versions of Python and Usetox database.
The model is applicable with any data structured following the USEtox database. DyTox was initially used with the USEtox database for inorganic and organic substances. It was completed in the frame of LCA4BIO with the data from Environmental Footprint (EF) method for toxicity and ecotoxicity impacts.

Further documentation:
Description of the model and its application and discussion of the capabilities is available in the work of Shimako et al. (2017)[3]. For its application to certain bio-based chemicals, see also the LCA4BIO deliverable D2.3. https://zenodo.org/records/17882220

6.2 Availability and accessibility

Availability:
DyTox is available as a calculator online: https://ecodesigntools.fr/simulator/dytox

Accessibility:
The tool is publicly accessible for free.

6.3 User guide

The user can use inventories (elementary flows in biosphere) extracted from any conventional LCA software. The formatting of data should be adapted to the provided template. The template is available on the DyTox web page. The names of substances should comply with the ecoinvent database (Table 1). An alternative, for a limited number of substances, is to directly complete the template with the numbers corresponding to the emission amounts for different substances. The template format and the utilization process are like those of

[3] Shimako, A.H., Tiruta-Barna, L., Ahmadi, A., 2017. Operational integration of time dependent toxicity impact category in dynamic LCA, Science of the Total Environment, 599–600, 2017, 806-819 https://doi.org/10.1016/j.scitotenv.2017.04.211

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the CCI-tool presented above (section 4). The amounts are expressed in kg/year, irrespective of the timestep chosen. The timestep represents the resolution of the time series of emission data or the desired calculation resolution with respect to the time variation. Common values are 1 year. However, lower values can be used for more accurate results (Figure 1).

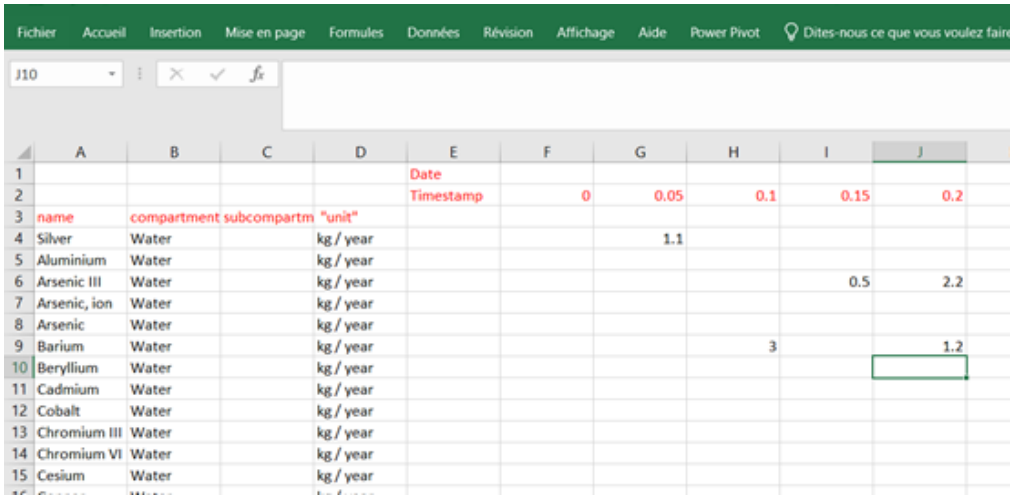

Figure 1. Example of template completed with emission data

The compartments have names as in Simapro software. The compartments names supported by the tool are given in Table 1 below (green columns).

Table 1. Compartment and sub-compartment names for toxicity calculation

		Names to be used	
compartmentUsetox	**abbreviation Usetox**	**compartment Simapro**	**subcompartment Simapro**
Urban air at the urban scale	airU	Air	high. pop.
Urban air at the urban scale	airU	Air	
Rural air at the continental scale	airC	Air	low. pop.
Rural air at the continental scale	airC	Air	stratosphere + troposphere
Rural air at the continental scale	airC	Air	low. pop., long-term
Rural air at the continental scale	airC	Air	
Freshwater at the continental scale	fr.waterC	Water	river
Freshwater at the continental scale	fr.waterC	Water	lake
Freshwater at the continental scale	fr.waterC	Water	
Freshwater at the continental scale	fr.waterC	Water	river, long-term
Freshwater at the continental scale	fr.waterC	Water	groundwater, long-term
Freshwater at the continental scale	fr.waterC	Water	groundwater
Coastal sea water at the continental scale	seawaterC	Water	ocean
Natural soil at the continental scale	nat.soilC	Soil	industrial

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Natural soil at the continental scale	nat.soilC	Soil	forestry
Natural soil at the continental scale	nat.soilC	Soil	
Natural soil at the continental scale	nat.soilC	Water	groundwater, long-term
Natural soil at the continental scale	nat.soilC	Water	groundwater
Agricultural soil at the continental scale	agr.soilC	Soil	agricultural
Freshwater at the continental scale	fr.waterC	Water	river
Freshwater at the continental scale	fr.waterC	Water	lake
Freshwater at the continental scale	fr.waterC	Water	
Freshwater at the continental scale	fr.waterC	Water	river, long-term
Natural soil at the continental scale	nat.soilC	Soil	industrial
Natural soil at the continental scale	nat.soilC	Soil	forestry
Natural soil at the continental scale	nat.soilC	Soil	

The user should provide the timestep and the time horizon of impact calculation in the webpage and upload the completed inventory file.

The results are proposed on the webpage as a compact file to be downloaded. This folder contains all numerical results organized in .csv files and several graphical representations of the aggregated results: human toxicity (cancer and non-cancer) and fresh water ecotoxicity. The .csv files contain all results, i.e. presence of substances in the 13 environmental compartments, and the associated impacts, for a personalized exploitation by the user.

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7 JOB CREATION POTENTIAL TOOL

CTA: Lucia Garcia Santos & María Gallego

7.1 Context

Focus & scope:
The Job Creation Potential (JCP) tool is an excel-based tool that aims to quantify the total number of jobs associated with a product system. The tool allows for the calculation of different types of JCP. First, jobs associated with the product system are defined as gross jobs, reflecting only the positive contribution to employment. Jobs in the **foreground** system refer to those directly required for the operation of the assessed product system (i.e., employees directly hired), whereas jobs in the **background** system correspond to those generated along the supply chain by upstream suppliers.
In contrast, **net jobs** represent a more comprehensive metric that accounts for potential job displacement in other sectors of the economy (e.g., fossil-based systems) resulting from the implementation of the assessed system. In addition, JCP results can be **upscaled** through the application of a scaling factor.
Novelty:
In alignment with the European Union's Bioeconomy Strategy, which promotes job creation, the growth of the European bioeconomy is expected to increase employment. However, a lack of inclusion of key bioeconomy-related concepts in S-LCA has been identified, particularly regarding employment opportunities. In response to the limited availability of quantitative social indicators and the importance of this aspect, a standardized procedure was proposed within the CALIMERO project to estimate the JCP (see CALIMERO Deliverable D3.5). Building on this work, an updated and more user-friendly version has been developed in the LCA4BIO project, including more updated IOTs data (from 2018 to 2021) and the consideration of job losses in fossil-based systems.
Further documentation:
The tool and methodology of JCP is described in detail in LCA4BIO Deliverable D4.3 and also within the tool itself, where a brief description is also provided.

7.2 Availability and accessibility

Availability:
The tool will not be publicly available as it will be protected by Trade Secret; its usage by CONTACTICA will be offered as a service under the responsibility of CONTACTICA. Yet, it is still added as a confidential annex to this deliverable.

Accessibility:
The tool is protected as a trade secret and remains as property of CONTACTICA. Access to the tool and its services is granted upon request by contacting CONTACTICA.

7.3 user guide

The tool comprises an introduction sheet that provides step-by-step instructions on how to complete the data required for the tool, as well as a methodology sheet detailing the applied approach. Moreover, LCA4BIO deliverable D4.3 includes a detailed description of the methodology.

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8 LIFE CYCLE COSTING TOOL

CTA: Lucia Garcia Santos & María Gallego

8.1 Context

Focus & scope:

The LCA4Bio Life Cycle Costing (LCC) Tool is an excel-based tool developed to perform economic assessments of bio-based products and services across their entire life cycle from the extraction of raw materials to the end-of-life (EoL) phase. It follows an approach aligned with ISO 14040, which establishes the principles and framework for life cycle assessment. Accordingly, it includes the steps of the standard LCA phases: goal and scope definition, life cycle inventory analysis, impact assessment, and interpretation of results, enabling the alignment with LCSA.

Novelty:

Building up on the H2020 Orienting project (see ORIENTING Deliverable D2.9) and the Horizon Europe Calimero project (see CALIMERO Deliverable D3.5), the tool allows the assessment of economic impacts across the entire life cycle of a bio-based product or a service, assessing costs, revenues, externalities and discounted cash flows.

Compared to the CALIMERO LCC tool which only focuses on the producer perspective, the LCA4BIO LCC tool integrates multiple stakeholder perspective to allow the assessment of economic impacts from the point of view of different actors: manufacturer, consumer and society. This approach allows stakeholders to evaluate life cycle costs according to their specific interests, because different actors bear different costs, face different time horizons, and have different decision power. The tool forces you to answer one key question early: Cost-effective for whom? While the earlier version focused on the manufacturing phase, the LCA4Bio LCC tool integrates every life cycle stage, beginning with the Design and R&D stage (covering activities such as design and engineering, prototyping and testing, software and licensing costs, market research, certification processes, and any grants received), following with the raw material acquisition stage (including the costs of procurement of materials, transportation, and storage), the manufacturing stage (capturing production-related expenditures), the distribution stage (costs of packaging, transportation and logistics, warehousing, and revenues generated through the initial product sale), the use phase (including energy consumption and operating costs), and finally, the End-of-Life stage (including disposal, recycling, and potential revenues from resale or reuse). Additional cross-cutting categories such as taxes, insurance, and environmental externalities are included under “Others” to ensure a complete economic assessment. This broader scope allows a more accurate and holistic evaluation of life cycle costs, improves comparability across alternatives, and supports more informed decision-making by capturing cost implications throughout the entire life cycle.

The life cycle inventory of costs adapts to different case studies and data demand to perform comparative assessments. Being an excel-based tool, it does not require specialized LCA software and the implementation is user-friendly.

Further documentation:

The indicators chosen to perform the economic assessment in the LCA4Bio LCC Tool are part of the indicators selected to assess socio-economic trade-offs and synergies and are described in detail in LCA4BIO Deliverable D4.3. The tool also incorporates an introduction to the use of the tool, and a description of the methodology followed and the indicators.

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8.2 Availability and accessibility

Availability:
The tool can be found in the open repository Zenodo here https://doi.org/10.5281/zenodo.21025878

Accessibility:
The tool will be accessible and open in Zenodo.

8.3 user guide

The LCA4Bio LCC Tool contains a sheet with detailed instructions on the use of the tool.

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9 PROSPECTIVE LCA TOOL

NTNU: Ruslan Zhuravchak & Marcos Watanabe

9.1 Context

Focus & scope:

As low-TRL bio-based systems are expected to reach full maturity in the future, applying prospective LCA (pLCA) is essential to assess their environmental impacts and inform both practice and policy making. However, exercising pLCA requires large quantities of background LCI datasets (often built with Premise https://github.com/polca/premise), and sizeable computational-, labor- and skill-intensity which limit its use in practice. Prospective LCA Tool, therefore, pursues an ambition to make pLCA more accessible to practitioners by providing the necessary LCIA/LCI functionality through an intuitive graphical interface and by leveraging modern cloud computing capabilities.

Hence, the application enables building/exchanging (foreground) process inventories, running prospective LCA and visualizing/analyzing/exporting the results. A list of available Integrated Assessment Models (IAMs) and Shared Socioeconomic Pathways (SSPs) derives from Premise, LCIA methods are consistent with those available in Brightway LCA framework. The list of LCIA methods may further be extended with prospective LCIA methods for climate change proposed by (Watanabe & Cherubini, 2026)[4] - a work-in-progress.

The figure below illustrates the application's interface with an arbitrary-selected combination of system models, IAMs, SSPs, time horizons, LCI and an LCIA method, and with corresponding LCIA results.

[4] Barbosa Watanabe, M.D., Cherubini, F., 2026. Prospective Characterization Factors for Assessing Climate Change Impacts in Life Cycle Assessments. Environ. Sci. Technol. https://doi.org/10.1021/acs.est.5c12391

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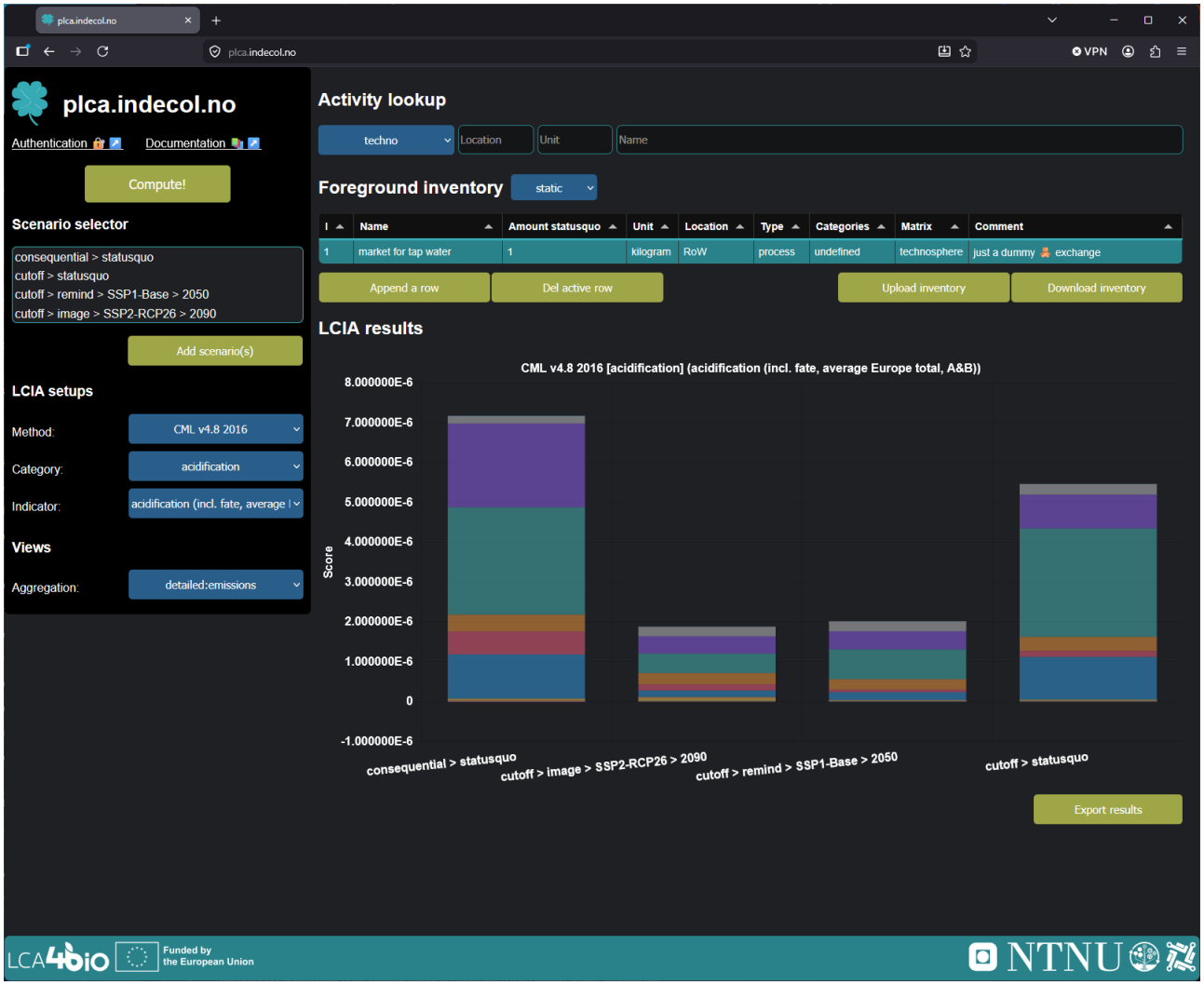

Figure 2. Illustration of application's interface with an arbitrary-selected combination of system models, IAMs, SSPs, time horizons, LCI and an LCIA method, and with corresponding LCIA results

This application may address, fully or partially, the need for tooling among pLCA practitioners currently using other instruments featuring interface and/or scripting environments. The answers to a question about (p)LCA software usage, among the participants of the 6th LCA4Bio Co-creation Workshop on prospective LCA, suggest that these categories of practitioners are the most frequent (21 and 11 out of 42) answers accordingly (figure below).

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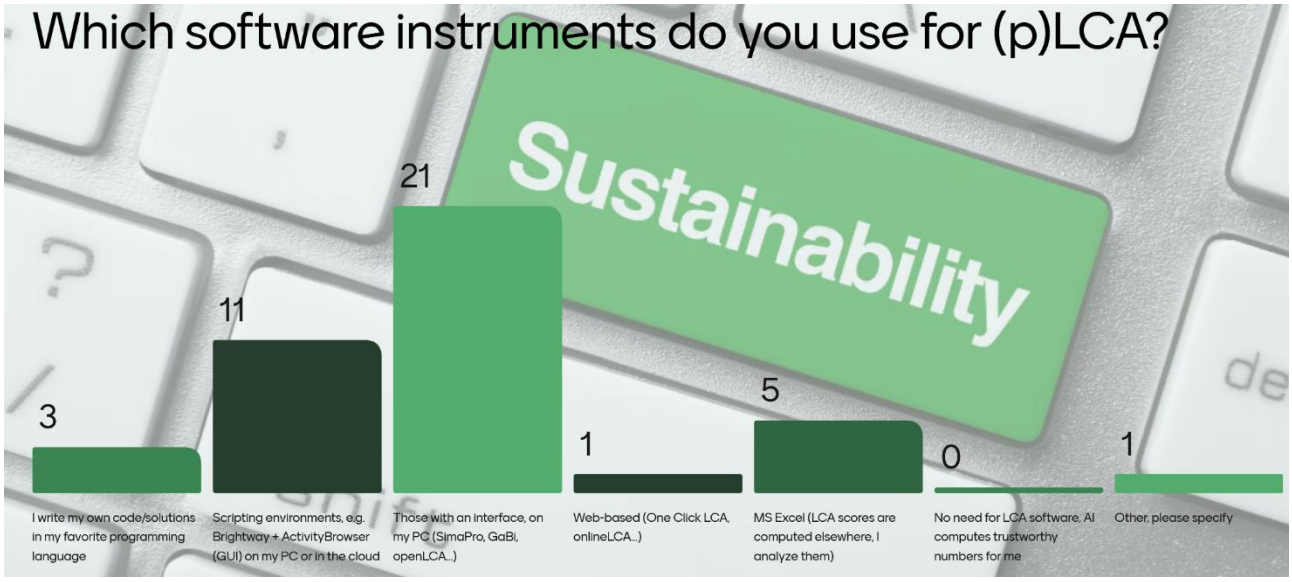

Figure 3. The answers to a question about (p)LCA software usage, among the participants of the 6th LCA4Bio Co-creation Workshop on prospective LCA

Novelty:
The pLCA tool development is the intended output of Deliverable 3.3 in LCA4Bio project. It addresses the need for a more accessible and convenient analysis of prospective life cycle impacts under user-selected system model (consequential/cutoff), IAM, SSP, and at a time horizon in range [2030 – 2100]. The application facilitates both: i) detailed analysis of LCIA results per scenario modelled, and ii) statistical distribution of LCIA results across various scenarios to address an epistemic uncertainty behind the choice of system model/IAM/SSP/time horizon. Computing is carried out in a dedicated cloud environment, hence eliminating user's dependence on computational resources or background LCI databases locally.

Further documentation:

- Documentation and the source code on GitHub (TBA)
- Documentation, interactive examples, Q&As on a public page https://docs.plca.indecol.no/ (a work-in-progress)
- The theoretical foundation and additional information for the tool can be found in Deliverable 5.3.

9.2 Availability and accessibility

Availability:
The software is made available in the form of i) source code and ii) software-as-a-service (SaaS).

The source code is (to be) hosted as a GitHub repository with an option, for those interested, to contribute to the development, submit bug reports and feature requests. The users can download the content and, following the installation guidelines, install the software on a personal computer or deploy it on a local/institutional network.

The SaaS variant (currently in alpha-version) is available at https://plca.indecol.no/, compute resources provisioning and server-side maintenance is carried out by NTNU.

Accessibility:

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A source code is (to be) made publicly accessible. It relies on a collection of other software instruments and libraries with permissive licensing terms. The user must however use their own copy of a background LCI database (Ecoinvent) upon installation - a measure to comply with Ecoinvent EULA.

Access to a SaaS platform https://plca.indecol.no/ is granted per-user or per-institution, primarily meant for LCA4Bio project members. Moreover, NTNU's collaborative research partners may receive access to the SaaS platform. Requesting the access is made via email [ruslan.zhuravchak@ntnu.no, marcos.d.b.watanabe@ntnu.no]. A prerequisite for approving user access is documented/declared user's ownership of Ecoinvent license – likewise to comply with Ecoinvent EULA.

9.3 user guide

User guide, including installation guidelines, Q&As and a curated list of interactive examples is made publicly available at https://docs.plca.indecol.no/ (a work-in-progress).

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