ASSOCIAZIONE
RETE ITALIANA LCA

Diffusion of tools for monitoring environmental sustainability in Industry: challenges and preliminary solutions

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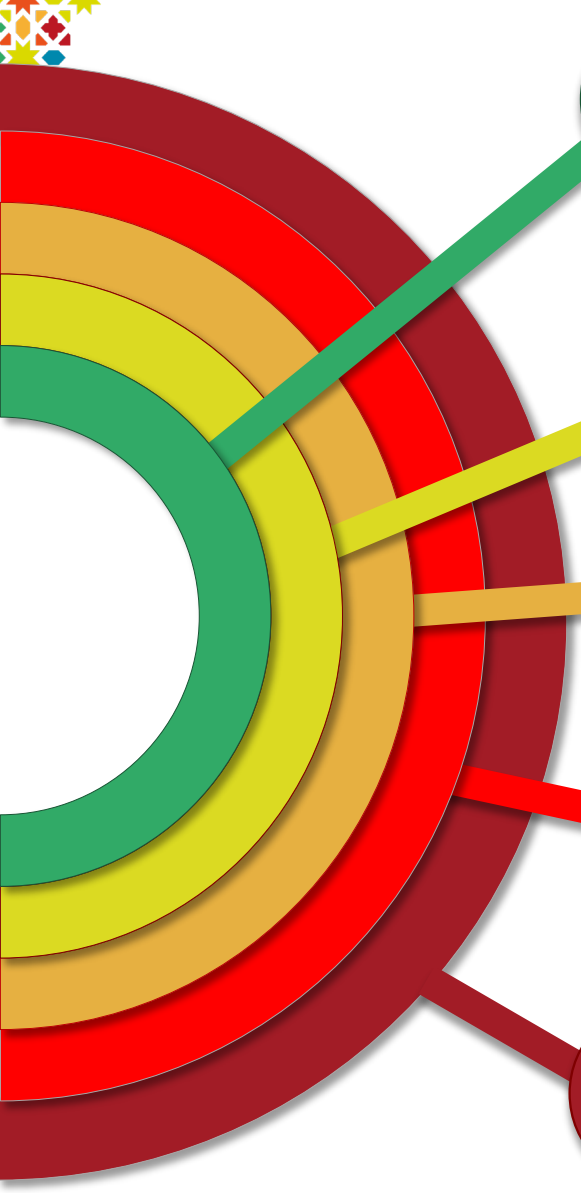

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INTRODUCTION AND MOTIVATION

THE CONTEXT

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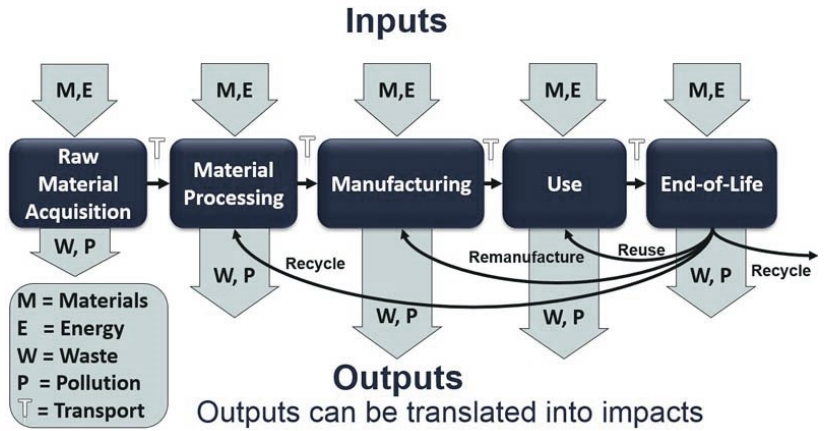
Pressures to improve resource- and energy-efficiency in industry

Life Cycle Assessment (LCA) is one of the main methodologies to monitor potential environmental impacts.



State-of-the-art: static yearly analyses based on the requirements of a single environmental label

Not possible to capture any temporal dynamics of industrial processes and cannot flexibly deal with developments in LCA models

OPEN ISSUES

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Temporal dynamics

Opportunities are offered by automated LCA tools connected to factory data management systems → Reduce data collection costs and time requirements → Possibility to perform automated LCAs at high temporal resolution

?

How to flexibly deal with:
- differences and developments in LCA models?
- High amount of LCA results?

→

OUR SOLUTION: Modular LCA tools
- Integration of modules with different functions;
- Every module can be independently modified while leaving the entire architecture unchanged

METHODOLOGY PRESENTATION

DATA COLLECTION – YEARLY LEVEL

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Data collection and elaboration at yearly level

Product certification

	A	B	C	D
1	Selected product	Billetta		
2	*Product list*			
3	Billetta		Impact category	
4	Rotoli laminati			Fossil
5	Barre laminate			Biogenic
6	Rotoli ricotti, Heurtey		obal warming potential (GWP)	Land use and land transformation
7	Rotoli ricotti, Ebner			TOTAL
8	Rotoli ricotti, Continuo		Acidification potential (AP)	
9	Barre ricotte		Eutrophication potential (EP)	
10	Barre bonificate 1		Photochemical oxidant formation potential (POFP)	
11	Barre bonificate 2		Abiotic depletion potential – Elements	
12	***Update LCAs***		Abiotic depletion potential – Fossil fuels	
13			Water scarcity potential	
14				
15				
16				

Billetta
Rotoli laminati
Barre laminate
Rotoli ricotti, Heurtey
Rotoli ricotti, Ebner
Rotoli ricotti, Continuo
Barre ricotte
Barre bonificate 1

... | Input data | Calcoli di supporto | Database di supporto | Impatti unitari | Risultati dis

RESTRUCTURING THE DATA COLLECTION

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Data collection at monthly level

Time: 12 months →

155 different data types (consumptions and emissions) ↓

Process	Jan	Feb	Mar	Apr	May	Jun
Production						
Production						
Coal DRI						
Gas DRI						
DRI Briquetting						
Scraps						
Fe Si						
Al						
Recycled Al						
Fe Mn 74.5%						
Fe Mn 82.5%						
Fe Si Mn						
Fe Bo						
Fe Cr 55%						
Fe Cr 68%						
Ni						
Fe Mo						
Fe V						

MODULAR ARCHITECTURE

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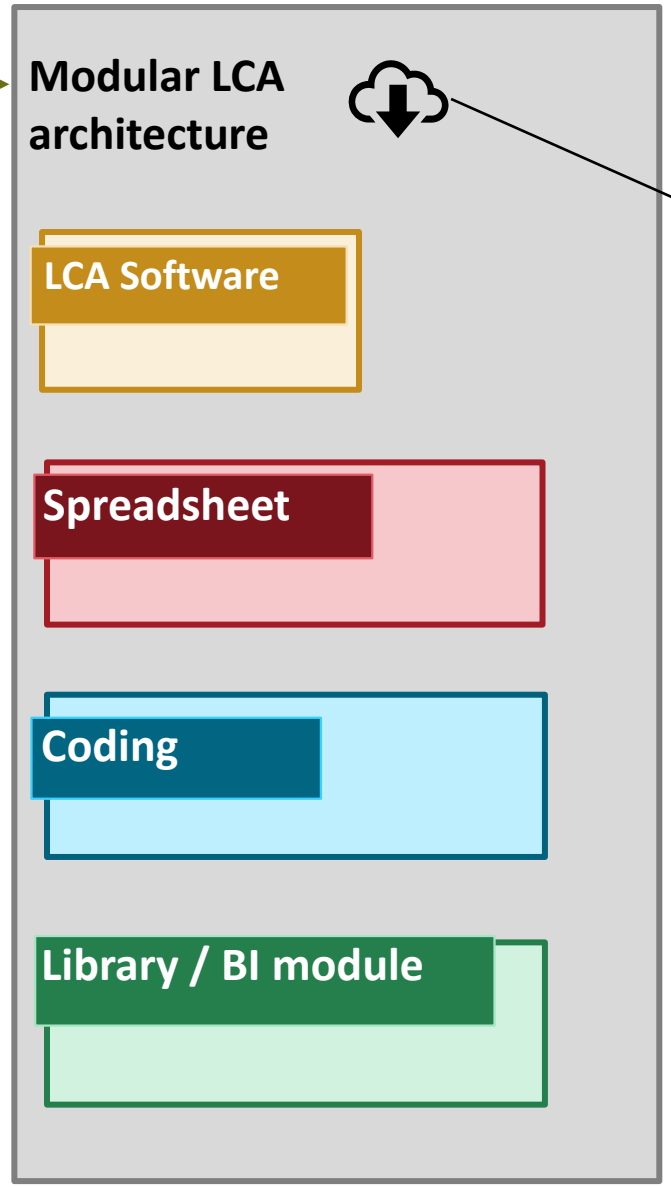
Compliance to environmental labels



Definition of inventory data to be collected from factory management systems – *foreground* system of the LCA (e.g. costs and production schedules are meaningless for LCA)
Identification of the available temporal resolution of every data: iterative process

MODULAR ARCHITECTURE

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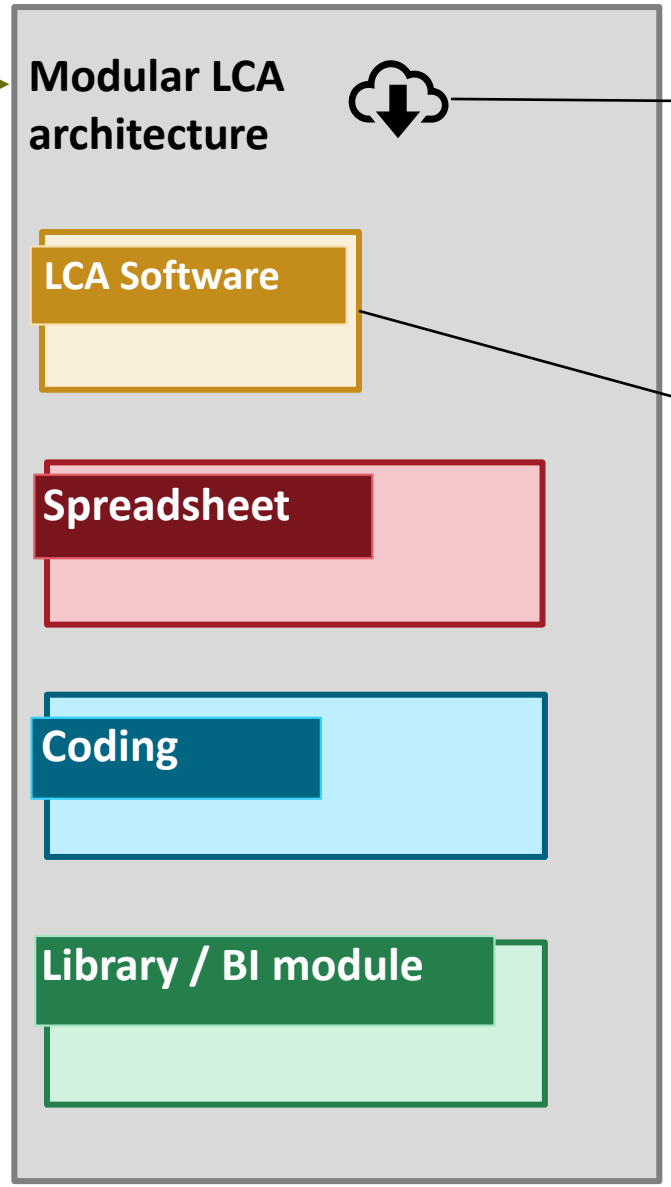
Compliance to environmental labels



Definition of foreground system of the LCA

Development of models for the *background* system of the LCA: calculation of unitary impacts of every consumptions/emissions (e.g. electricity, materials, etc..)

MODULAR ARCHITECTURE

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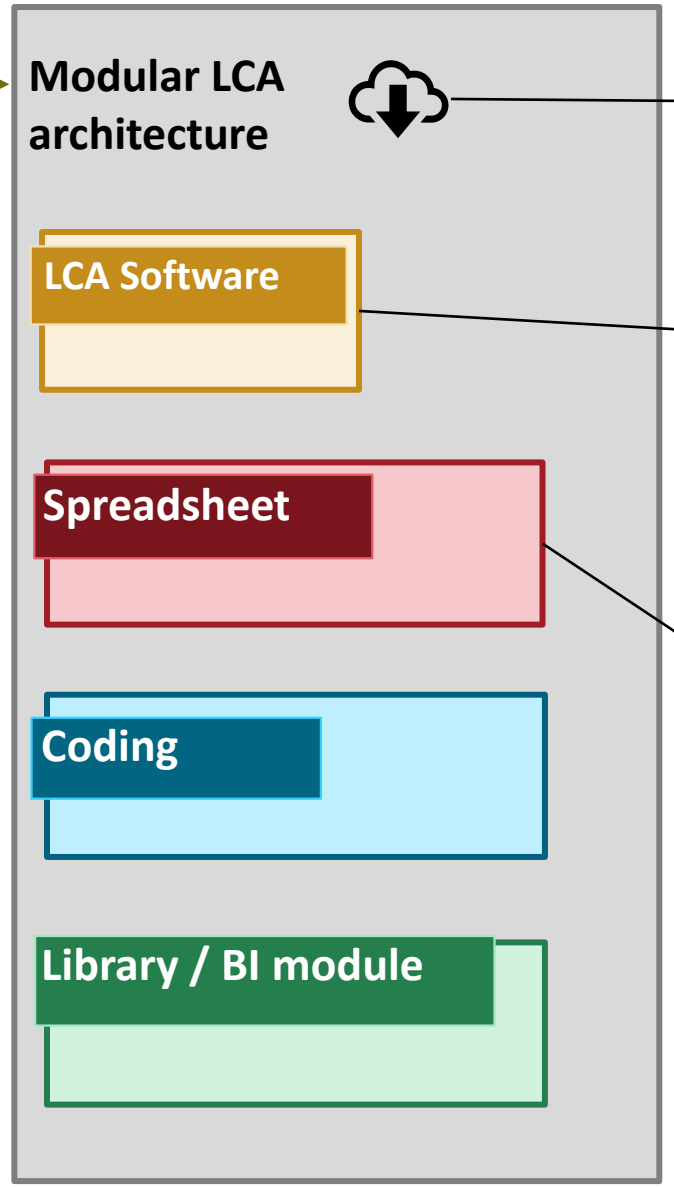
Compliance to environmental labels



Definition of foreground system of the LCA

Background system models

- *Collection* of data from multiple sources (LCA software, factory..),
- *Mapping*: link every data with an identifier, a classification, etc..
- *Wrangling*: process the data, using multiple rules, to a format which is easily manageable for the subsequent modules

MODULAR ARCHITECTURE

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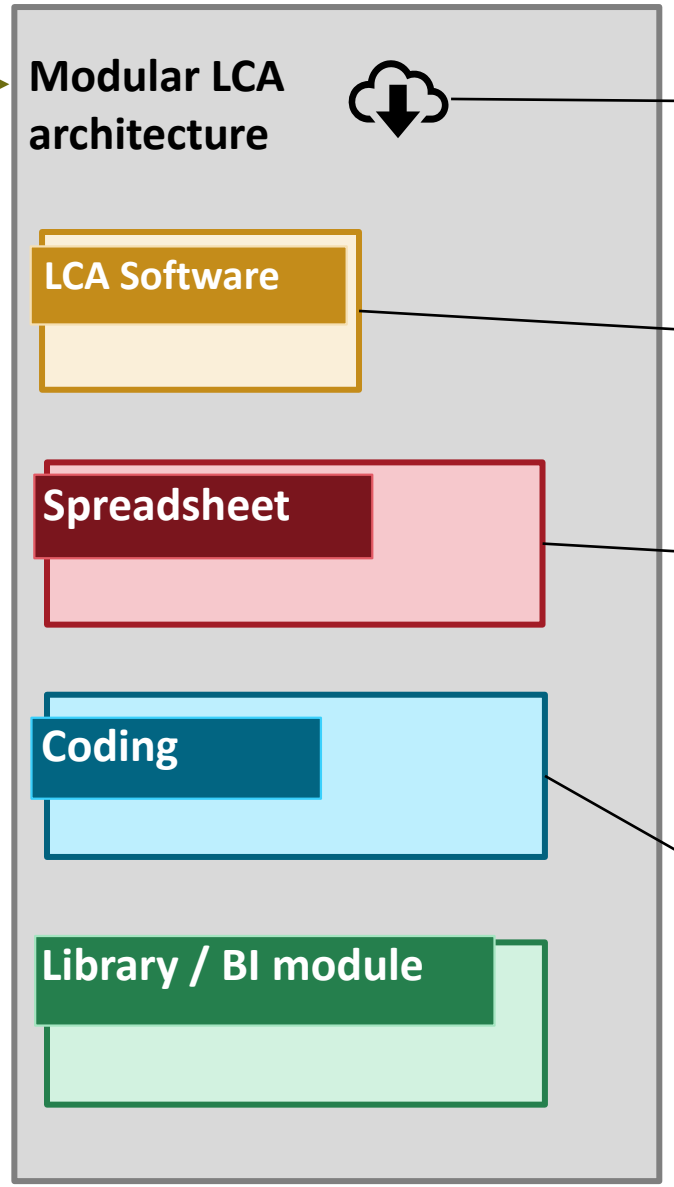
Compliance to environmental labels



Definition of foreground system of the LCA

Background system models

LCA data collection, mapping and wrangling

LCA results calculation:
155 consumptions/emissions data,
9 products,
37 indicators from EPD and ILCD schemes,
12 months in a year:
→ $5*10^5$ values of LCA results, processed in python

MODULAR ARCHITECTURE

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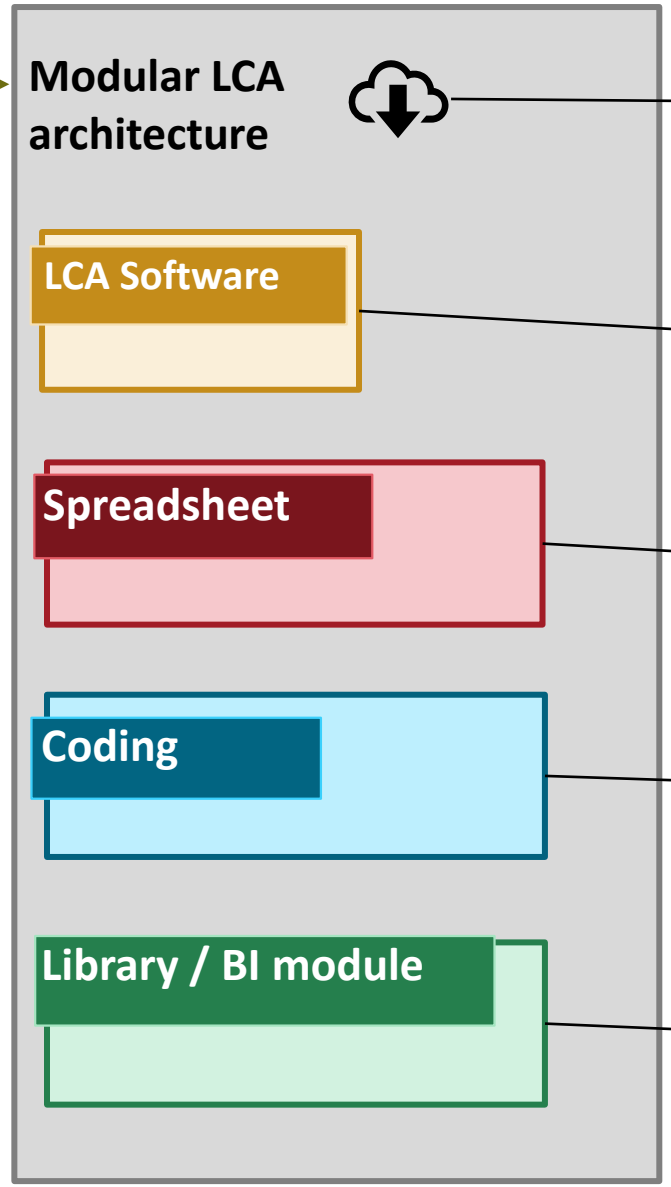
Compliance to environmental labels



- Definition of foreground system of the LCA
- Background system models
- LCA data collection and wrangling
- LCA results calculation
- *LCA results visualization*: interactive dashboards, plotly library

RESULTS AND DISCUSSION

VARIABILITY ACROSS LCA LABELS

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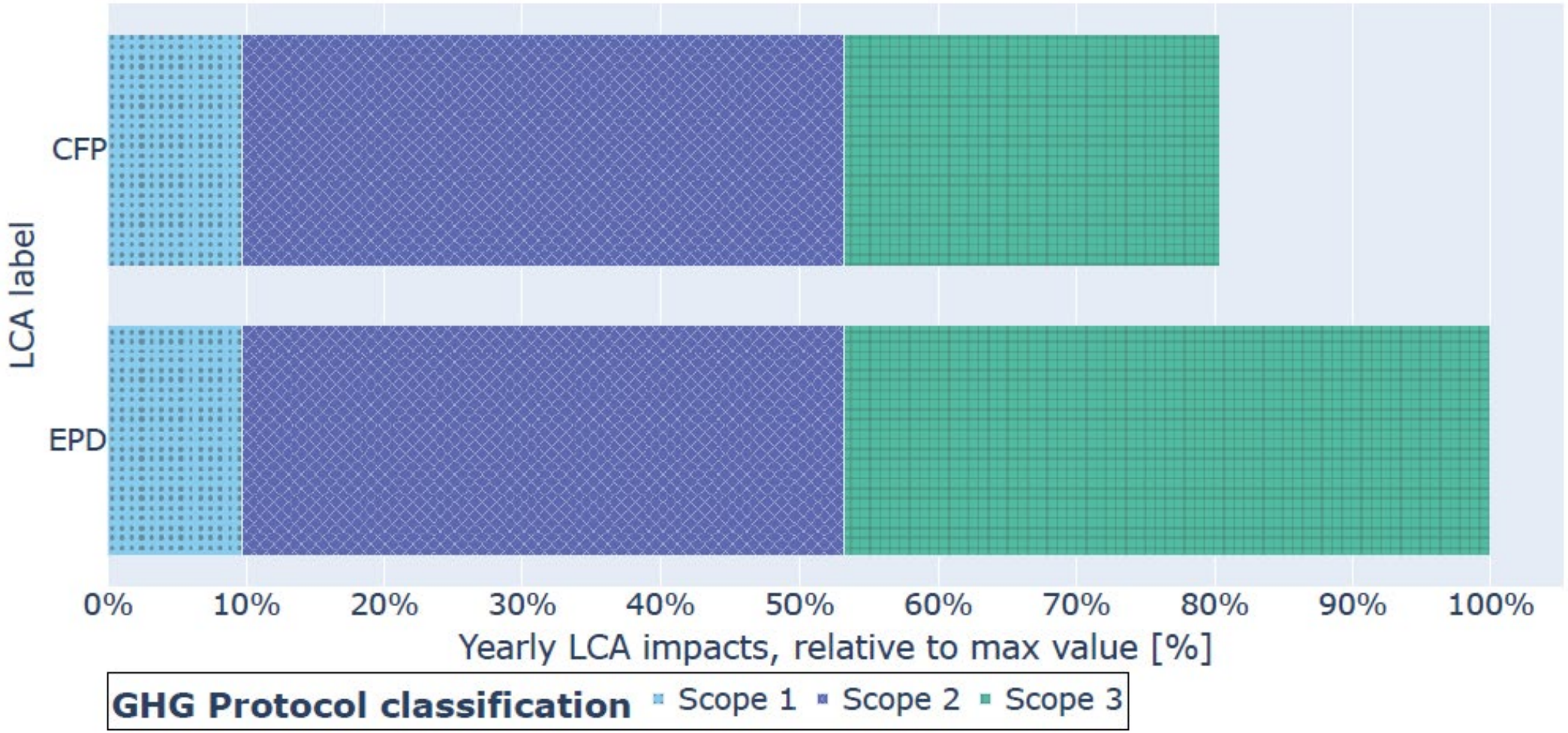

CFP=Carbon Footprint
EPD=Environmental Product Declaration

VARIABILITY OF MONTHLY LCA RESULTS – EPD SCHEME

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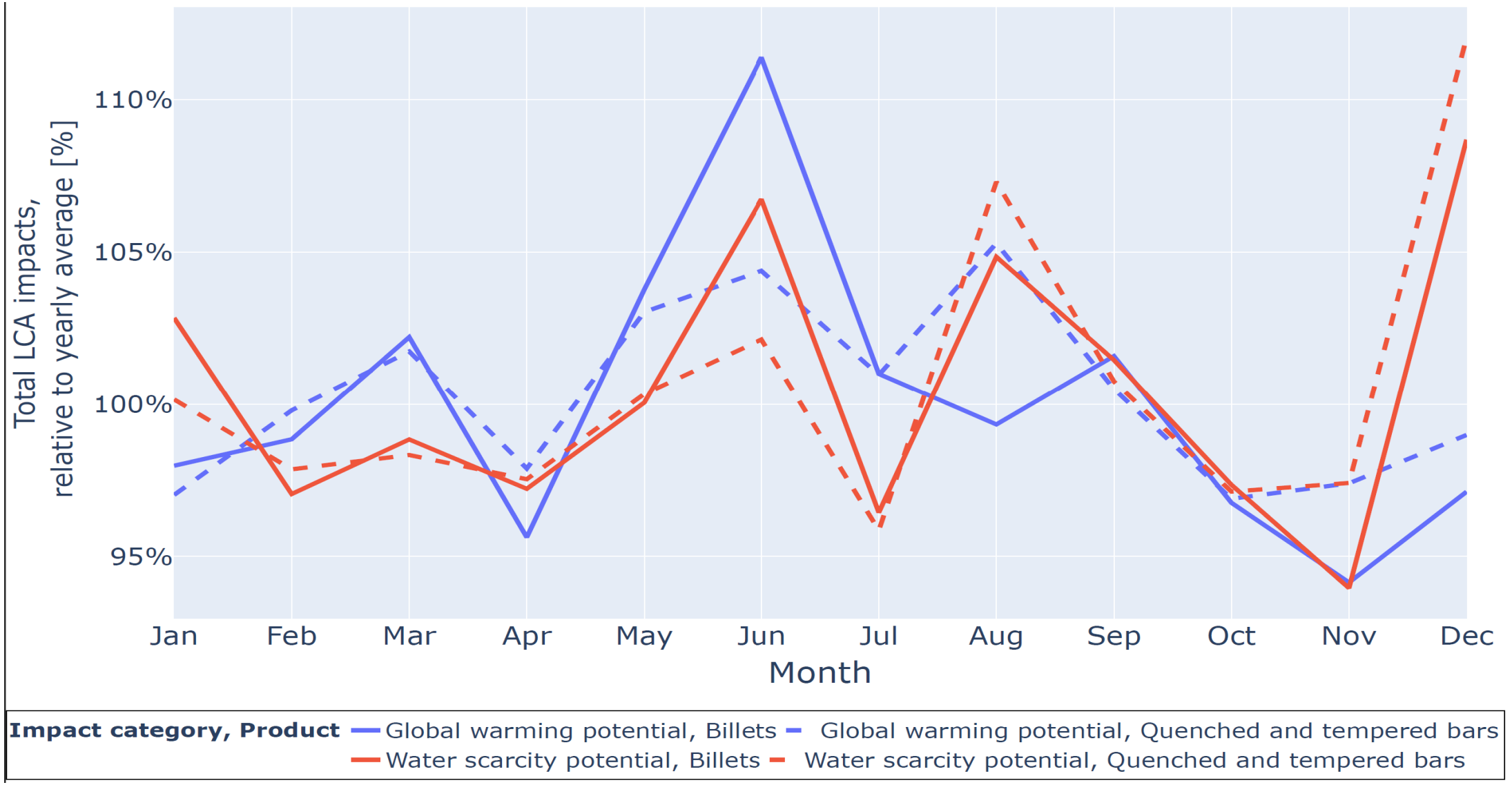
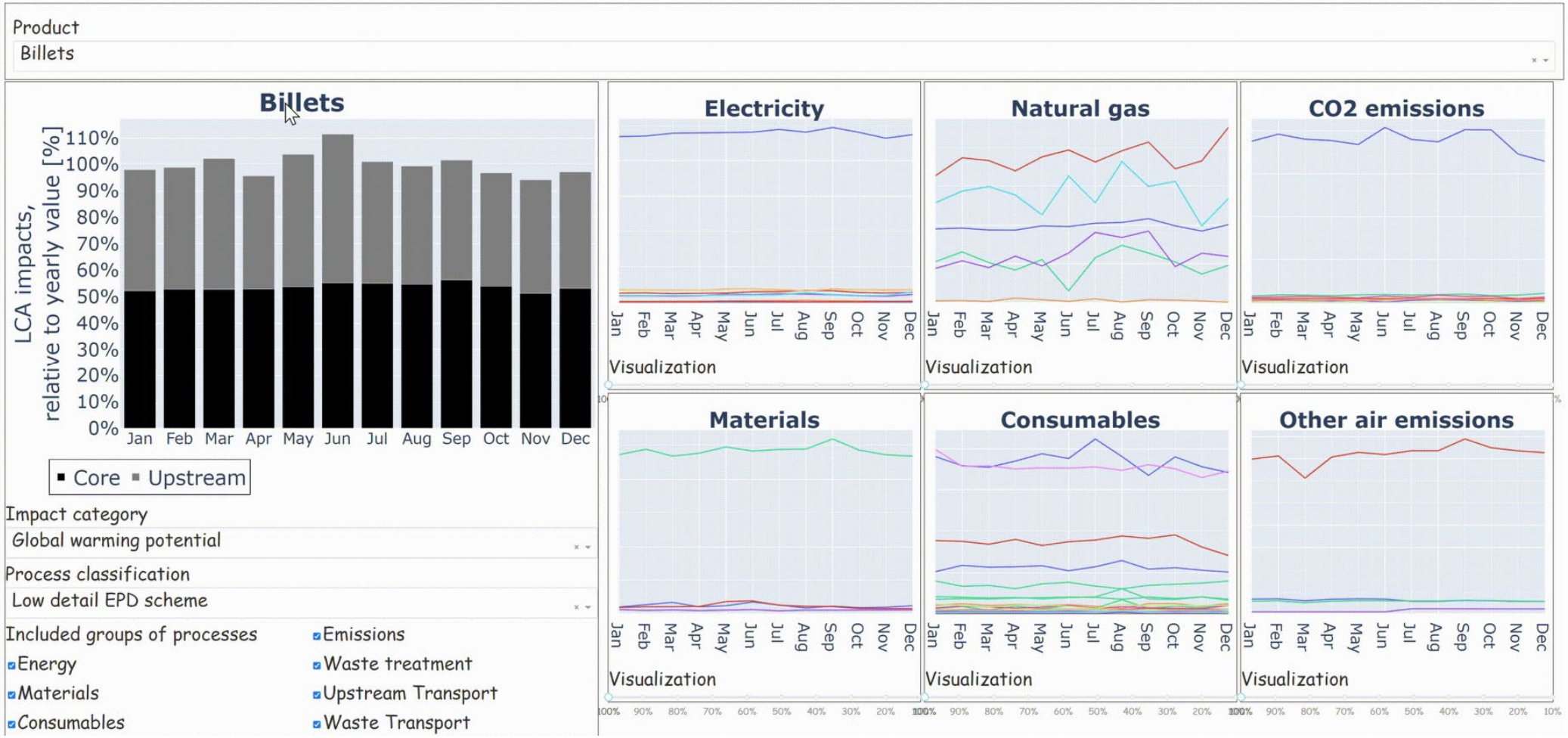


VISUALIZATION THROUGH DASHBOARDS – 1



VISUALIZATION THROUGH DASHBOARDS – 1

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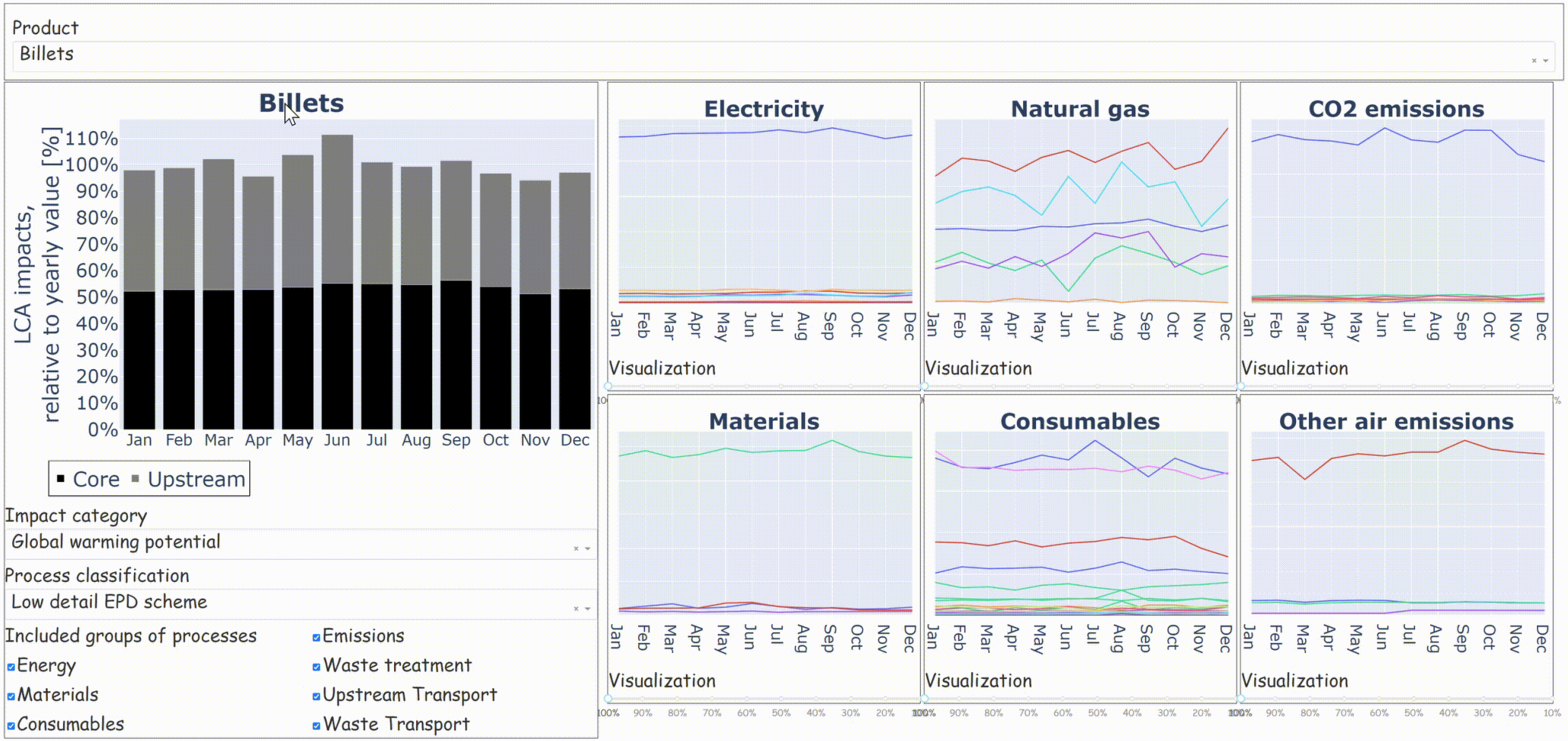

VISUALIZATION THROUGH DASHBOARDS – 2

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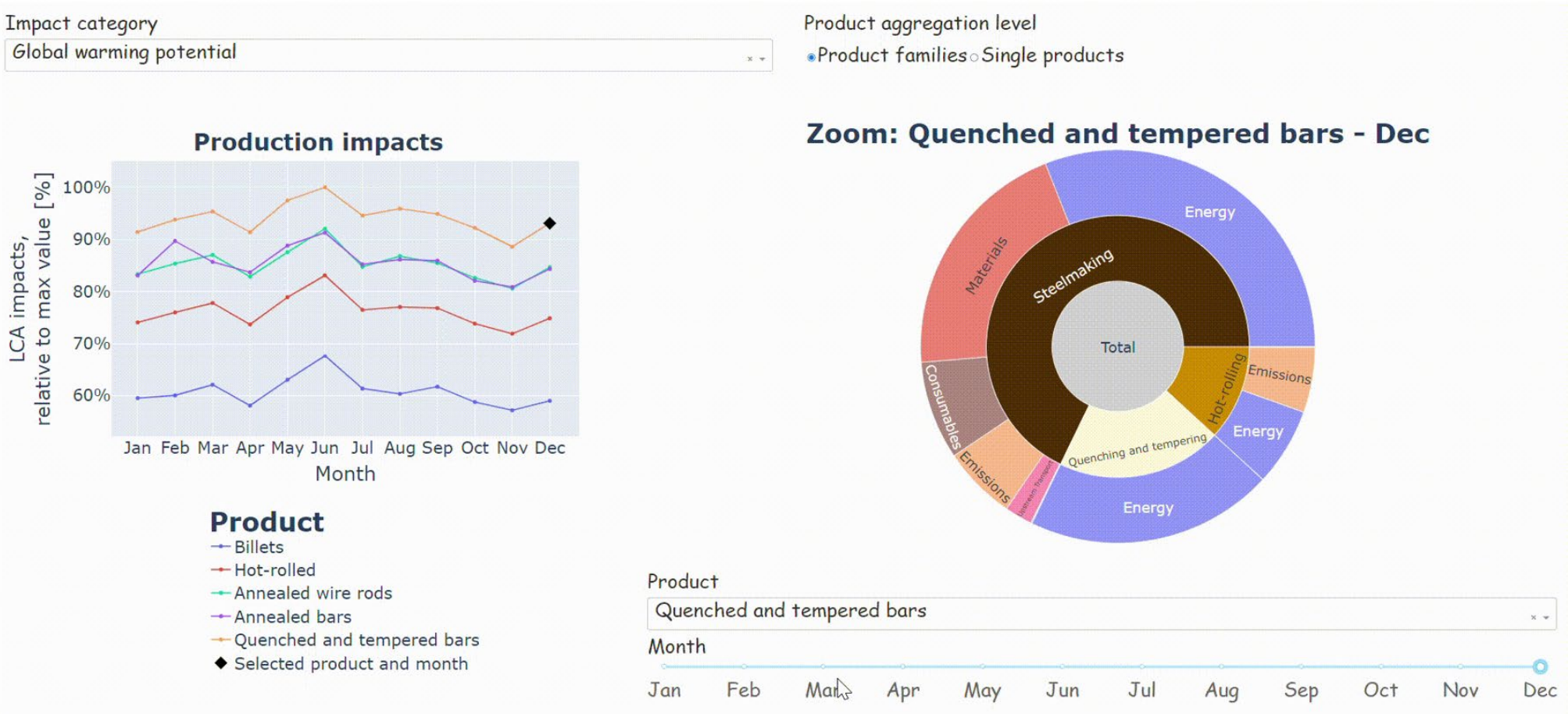

VISUALIZATION THROUGH DASHBOARDS – 2

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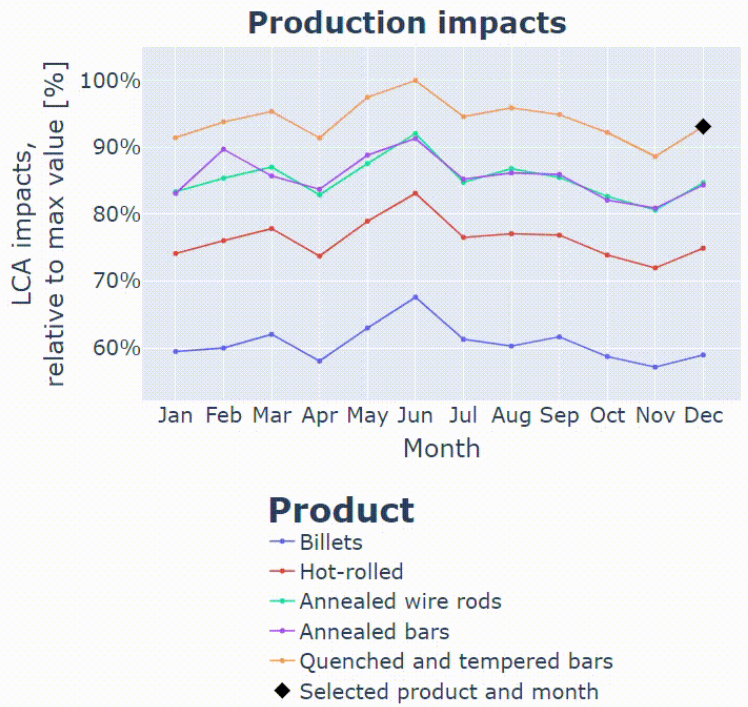
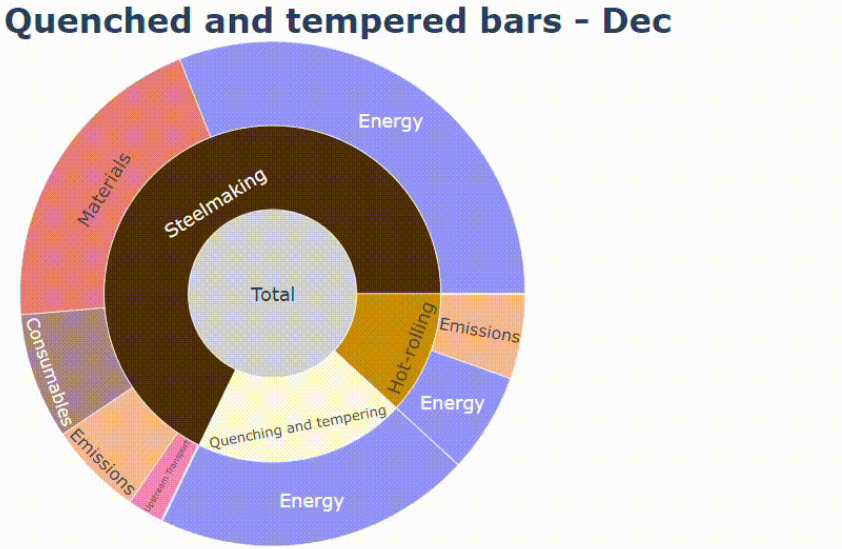
Impact category

Global warming potential

Product aggregation level

(•) Product families ( ) Single products





Product

Quenched and tempered bars

Month

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

WHAT-IF SCENARIOS THROUGH DASHBOARDS

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Product

Quenched and tempered bars, 1

Scenario 1 settings

% heat provided by hydrogen

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

% electricity provided by RES

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Thermal energy demand reduction %

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Electric energy demand reduction %

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Scenario 2 settings

% heat provided by hydrogen

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

% electricity provided by RES

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Thermal energy demand reduction %

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Electric energy demand reduction %

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Environmental impact reduction targets

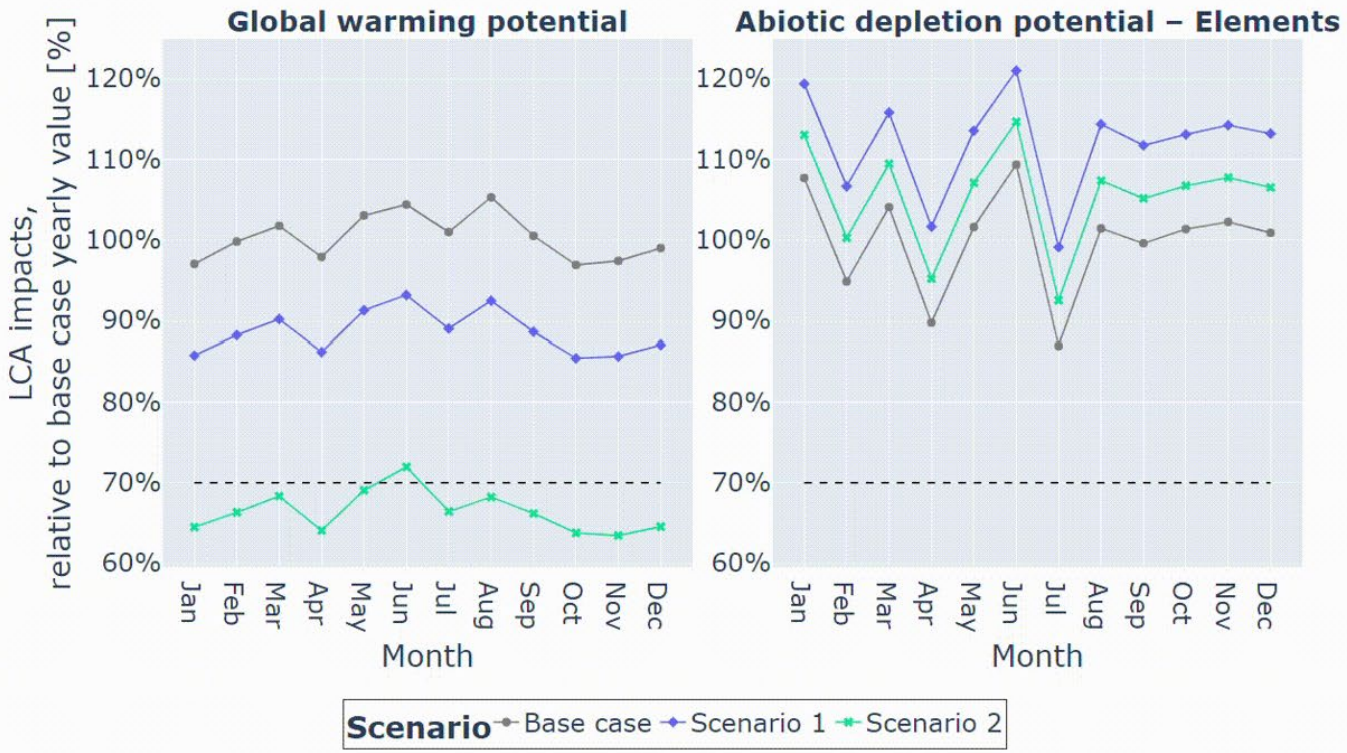
0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Impact category 1

Global warming potential

Impact category 2

Abiotic depletion potential - Elements



WHAT-IF SCENARIOS THROUGH DASHBOARDS

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Product

Quenched and tempered bars, 1

Impact category 1

Global warming potential

Impact category 2

Abiotic depletion potential - Elements

Scenario 1 settings

% heat provided by hydrogen

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

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Electric energy demand reduction %

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Scenario 2 settings

% heat provided by hydrogen

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

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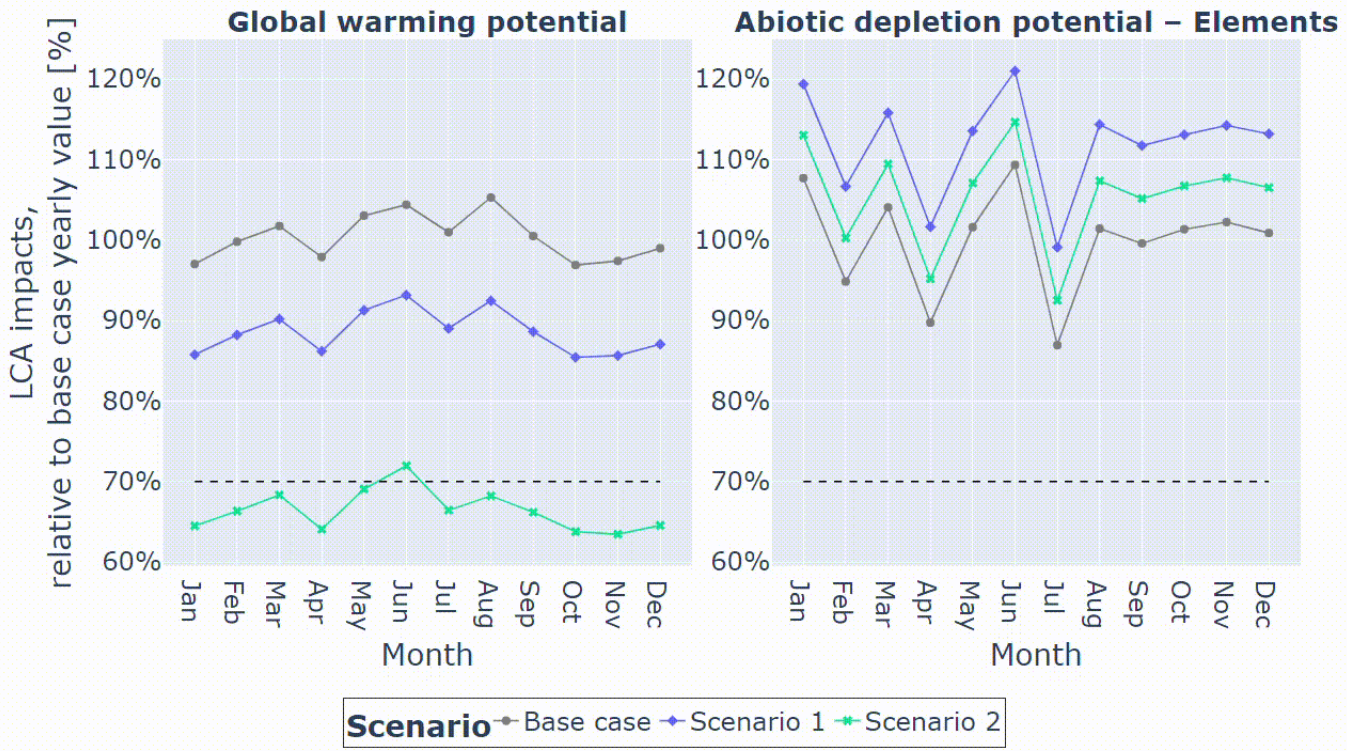
Environmental impact reduction targets

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%



FUTURE PERSPECTIVES

FUTURE WORKS

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Compliance to environmental labels

The company staff selects environmental labels through a user interface

Modular LCA architecture

LCA Software

Spreadsheet

Coding

Library / BI module

LCA-based decision support

Automated data retrieval from factory management systems

OPEN ISSUES

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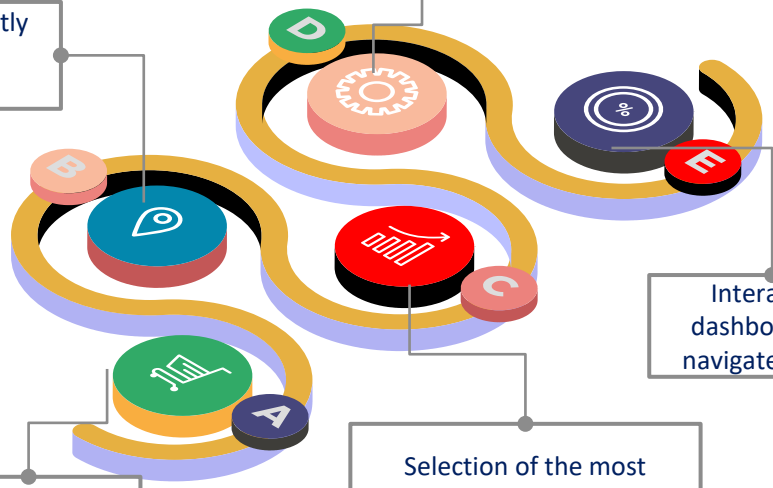
LIGHTHOUSE PROJECT

lighthouse plant

Every module can be independently modified while leaving the architecture unchanged

Different impact categories and classifications



Interactive dashboards to navigate results

Modular approach to integrate different functions

Selection of the most relevant contributors to LCA results, over time

E2COMATION PROJECT

E2COMATION

CRITICAL ASPECTS

DISCUSSION OF CRITICAL ASPECTS

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RESOLUTION

A significant variability was found, even if the results are still averaged over a month. Refining the temporal resolution to weekly/daily levels would disclose further variability. However, would it make sense to disclose it? Would the LCA-based decisions change?

VISUALIZATION

We need to increase the effectiveness of our visualization module. Our interactive dashboards allow to navigate across thousands of values. However, such complexity may discourage a user from a company. How to convey complexity while keeping the visualizations relatively understandable?

LCA-BASED SUPPORT SYSTEM

Inclusion of normalization and weighting steps across LCIA categories, refined simulations (with respect to simple what-if scenarios) and optimizations. How to contextualize the company performance within global trends and accordingly set targets of efficiency increases over time?

REFERENCE

Rovelli, D.; Brondi, C.; Andreotti, M.; Abbate, E.; Zanforlin, M.; Ballarino, A. A Modular Tool to Support Data Management for LCA in Industry: Methodology, Application and Potentialities. Sustainability 2022, 1, 0.

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Grazie per l'attenzione!

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