Environmental Trade-offs into MBSE: An Application of Ecodesign for Capella for System Architects

Webinar 

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lgm/ leading great movements

Agenda

/01 LGM environmental needs

/02 What is ecodesign ?

/03 Ecodesign for Capella – OBEO tool

/04 Use case

/05 LGM feedbacks

/06 Conclusions

01

LGM environmental needs

An independent group since

1991

Human-sized

+1600 Specialists

ISO 9001 DEKRA

EN 9100 DEKRA

CEFRI Certification n° 737 E

EN 9100 : activities of the aeronautical units at Vélizy-Villacoublay, Aix-En-Provence, Toulouse, Marville and Saint-Aubin sites, as defined in our certificate.
CEFRI for LGM Île-de-France, LGM Sud-Est and LGM Grand-Ouest.

Service delivery models

CONSULTING
STUDIES
PRODUCTS
SUPPORT
TRAINING

lgm/expertises

Driving progress on large, complex projects, and critical industrial assets.

Advanced, tailor-made, and tooled engineering solutions for complex, long-life systems and infrastructures.

safety & systems excellence

supportability & asset management

projects & performance

Design and production solutions for advanced electronic equipment and high-performance test benches for embedded security systems.

critical electronics

lgm/transformations

Supporting strategic and operational transformations in specialized engineering businesses.

Digital engineering and software solutions designed on demand for specific business needs.

digital & AI

Solutions for driving and implementing change in organizations and business teams.

consulting & training

Since 2007 – small manufacturing

Safety critical electronic

Test benches

Embedded networks

Since 2007 – small manufacturing

Safety critical electronic

Test benches

Embedded networks

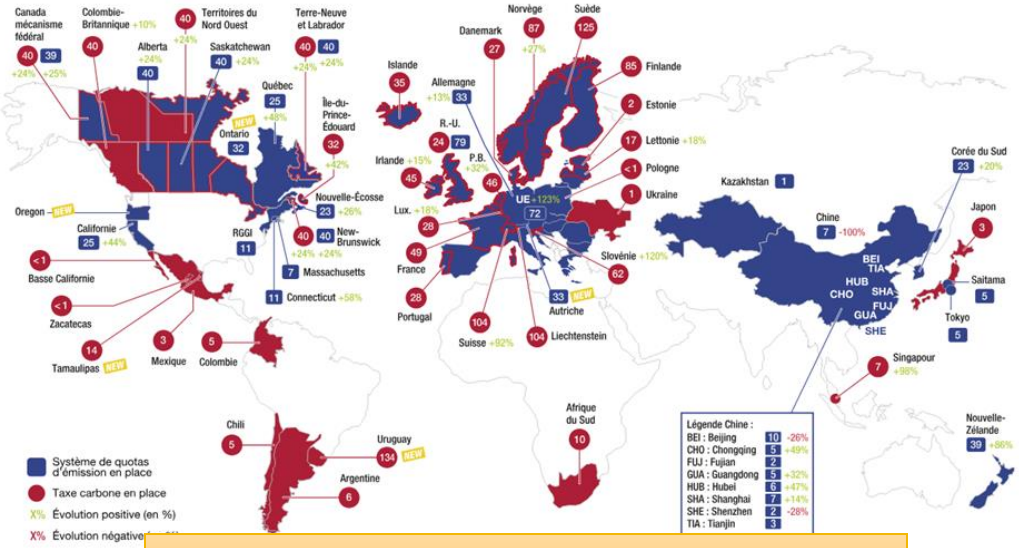
Since 2020 – manufacturing plants

Drones detection

Wide Bandwidth transposition

Low Noise Amplifiers

KA band LNA



08/2022 example – Carbon taxes & Quotas

EPD®
THE INTERNATIONAL EPD® SYSTEM

EPD – Environmental Product Declaration & PEF – Product Environmental Footprint

"Environmental obsolescence" of materials due to carbon taxes ?

How to be conformed with environmental rules ?
How to improve & integrated ecodesign ?

lgm/expertises

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02

What is ecodesign ?

ISO 14006:2020 – Environmental system management: “The integration of environmental aspects into product design and development, with the aim of reducing adverse environmental impacts throughout a product’s life cycle.”

ISO 14040-44:2006 (LCA) or ISO 14025:2006 (EPD): “It consists of taking into account and reducing the potential environmental impact of a product or service through a multi-criteria life cycle assessment (LCA), from the extraction of raw materials to end-of-life, including all stages of production, distribution, use, and waste management.”

Strong link between ecodesign and LCA

ADEME – French national agency for environment – about performing ecodesign

	Level 1 - Qualitativ	Level 2 - QuantiGES	Level 3 – Simplified multicriteria	Level 4 – Medium multicriteria	Level 5 – Full multicriteria
What you can get	Preliminary identification of environmental stacks	First assessment based of GES emissions	Conclusion on relevant impact categories and the trend observed in these indicators	Preliminary conclusion on environmental relevance. Quantified impact values with reliability rating	Conclusion on environmental relevance and on impact values that are quantified, communicable, justified, and reviewed
Skills required	Almost no specific skills	Basic skills in carbon accounting	LCA skills required	Advanced LCA skills	Advanced LCA skills

GES - greenhouse gas

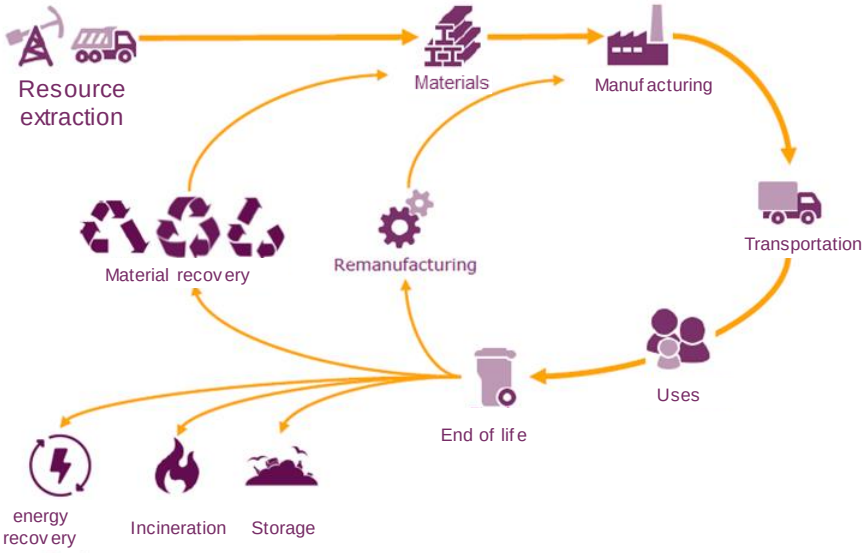
ISO 14040:2006: “Life cycle assessment (LCA) is the compilation and evaluation of the inputs, outputs and the potential environmental impacts of a product system throughout its life cycle.”

=> Most of the time almost 20 criteria for the impacts, global warming and carbon impact is just one.

What is Life Cycle ?

Concept → Development → Production → Utilization → Support → Retirement

Engineering System perspective – matching with ISO/IEC/IEEE 15288

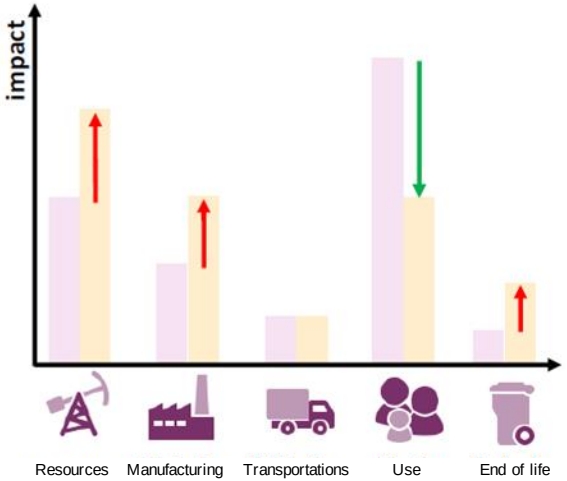


LCA perspective – matching with ISO 14040

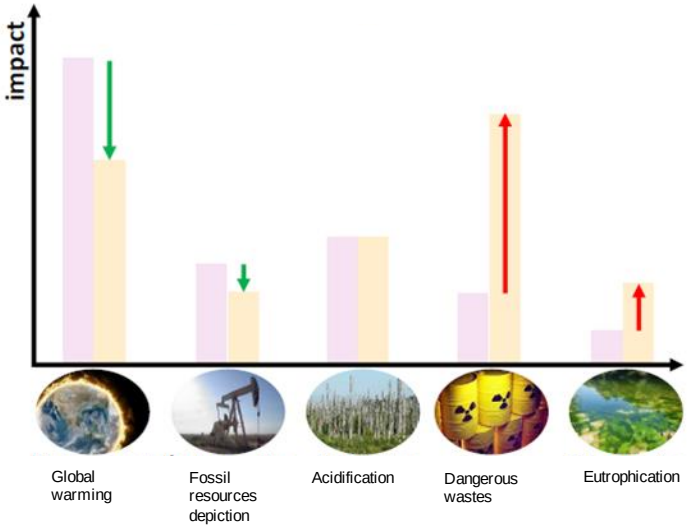
Solution A

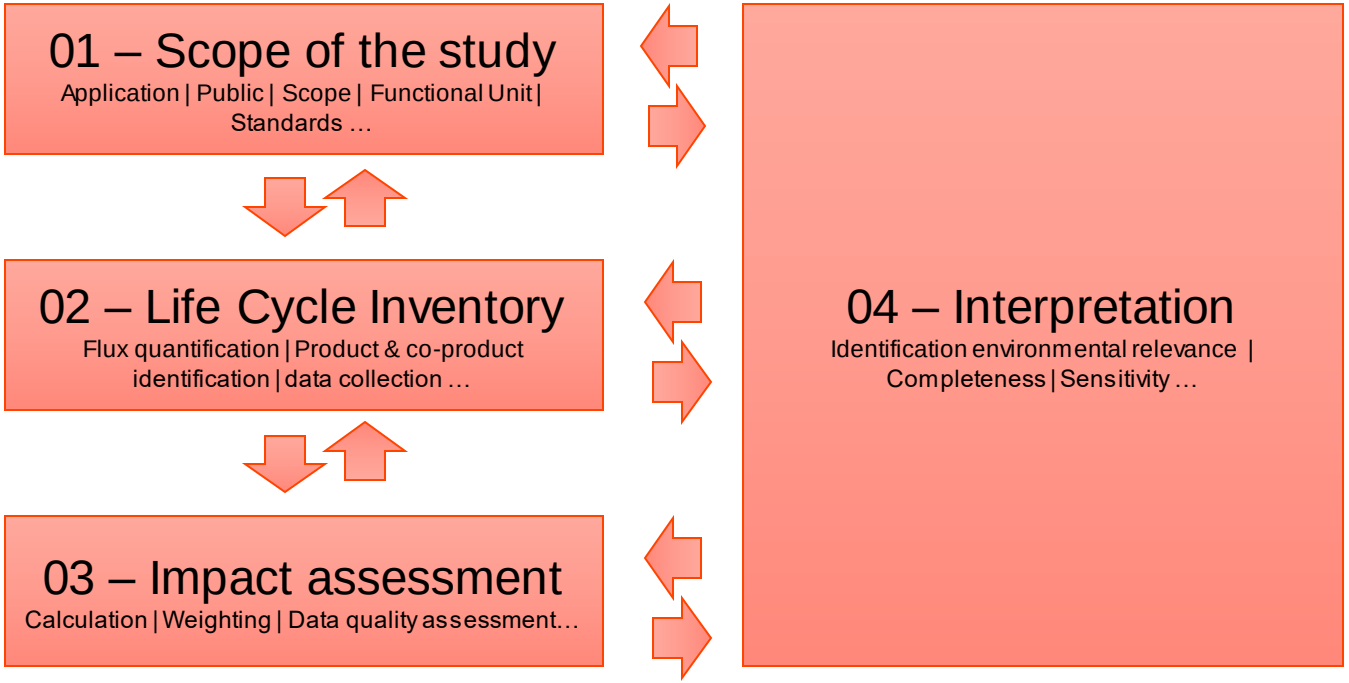
Solution B

Between life cycle phases

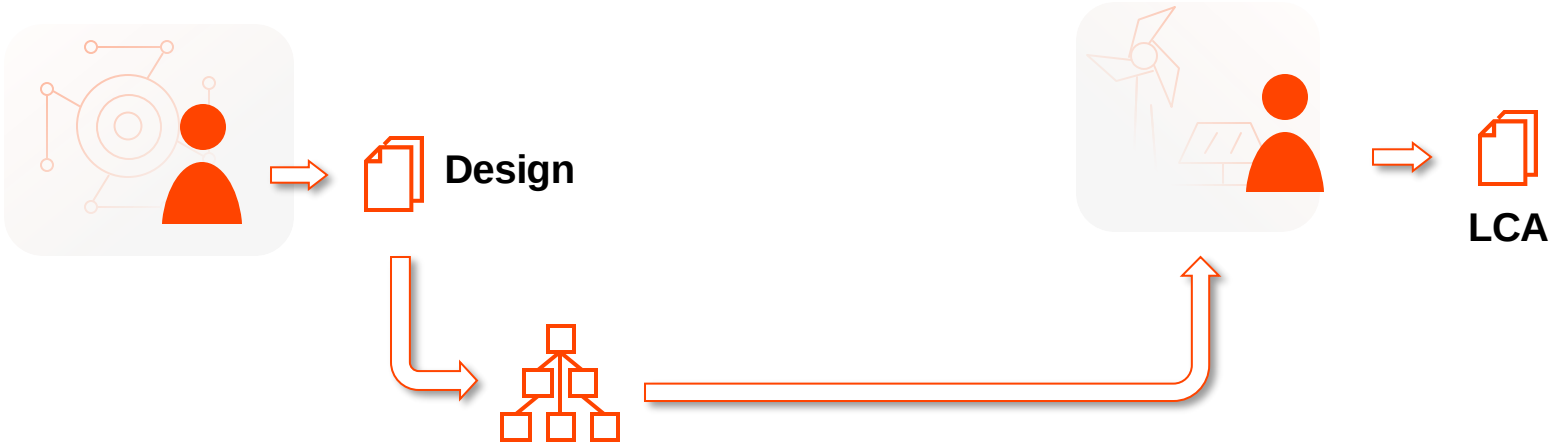


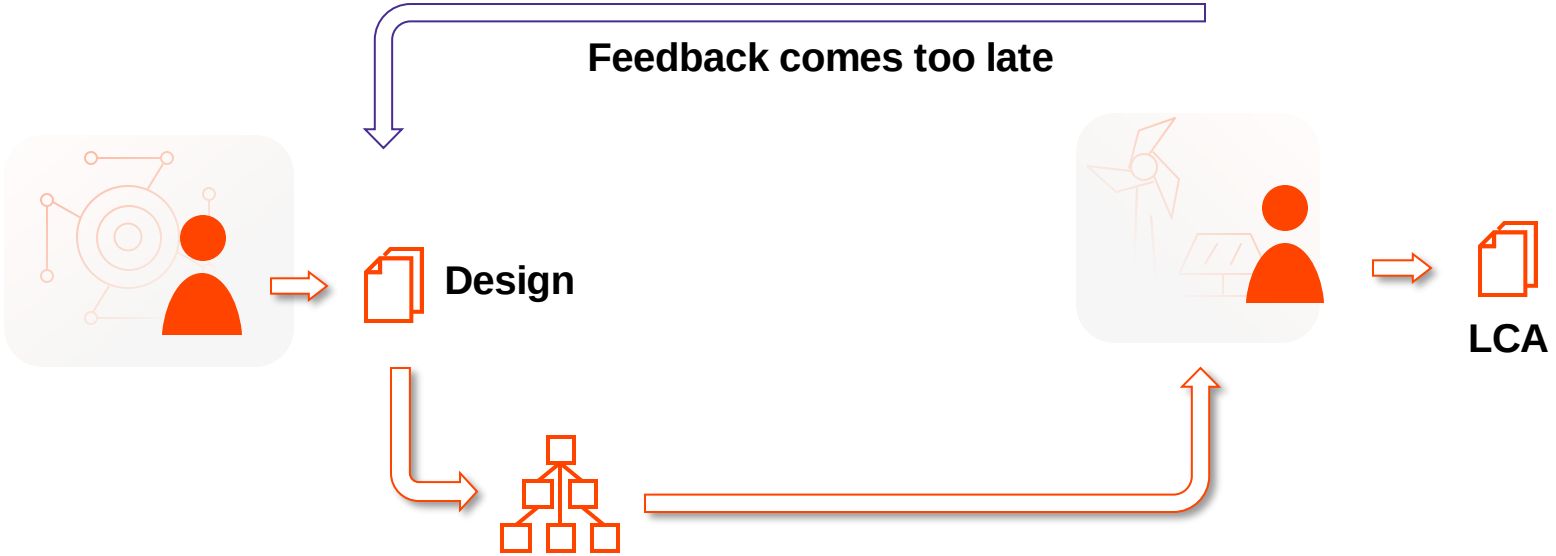
Between environmental impact categories




01 – Scope of the study
Application | Public | Scope | Functional Unit | Standards …
02 – Life Cycle Inventory
Flux quantification | Product & co-product identification | data collection …
03 – Impact assessment
Calculation | Weighting | Data quality assessment…
04 – Interpretation
Identification environmental relevance | Completeness | Sensitivity …

How it is performed ?





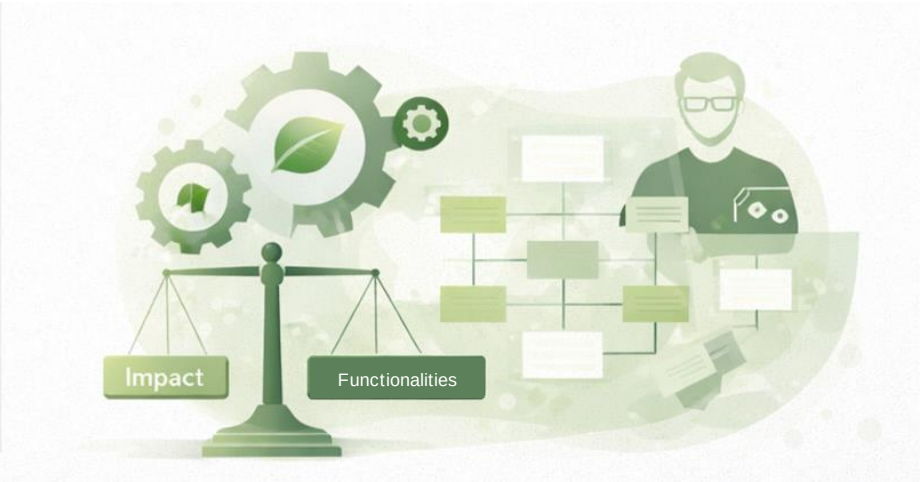
Synchronise LCA and design is difficult leading to no “real ecodesign”

Todays - Life Cycle Assessment evaluation process carried out after major milestones or after the final design:

- Performed after design choices have been made
- Allows little or no improvement to the ongoing project
- Observational approach

What we are looking for - Life Cycle Assessment evaluation process integrated into the design phase

- Providing designers with the right information at the right time and in the appropriate language
- Enabling fast and impactful trade-offs



03

Ecodesign for Capella – OBEO tool

OBEO proposed a new tool in order to performed directly LCA inside MBSE (Capella tool)

02 – Life Cycle Inventory

Flux quantification | Product & co-product identification | data collection …

Reduce time & improve efficiency

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Ecodesign
for Capella
by Obeo
openLCA
SimaPro
MBSE


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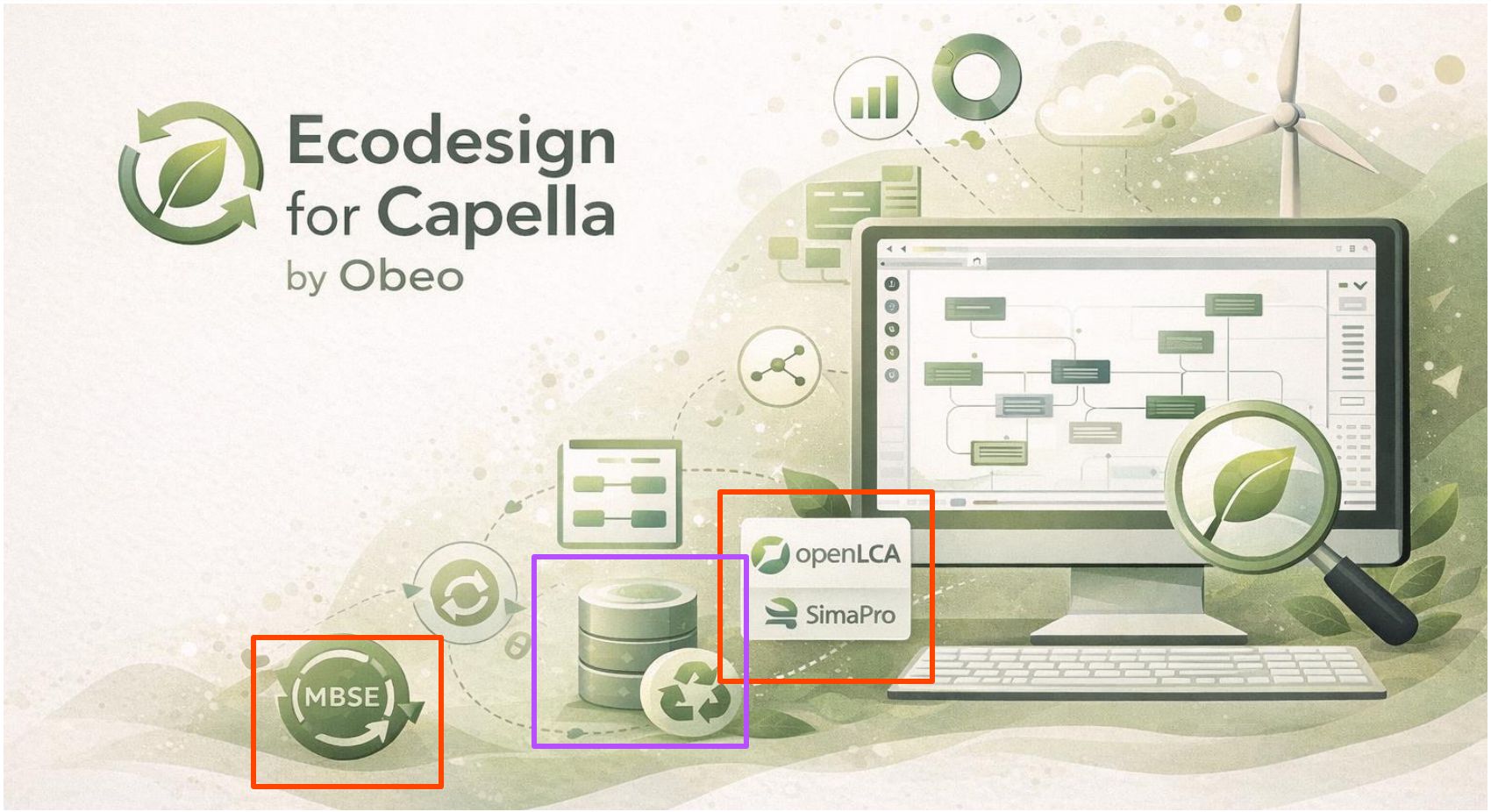
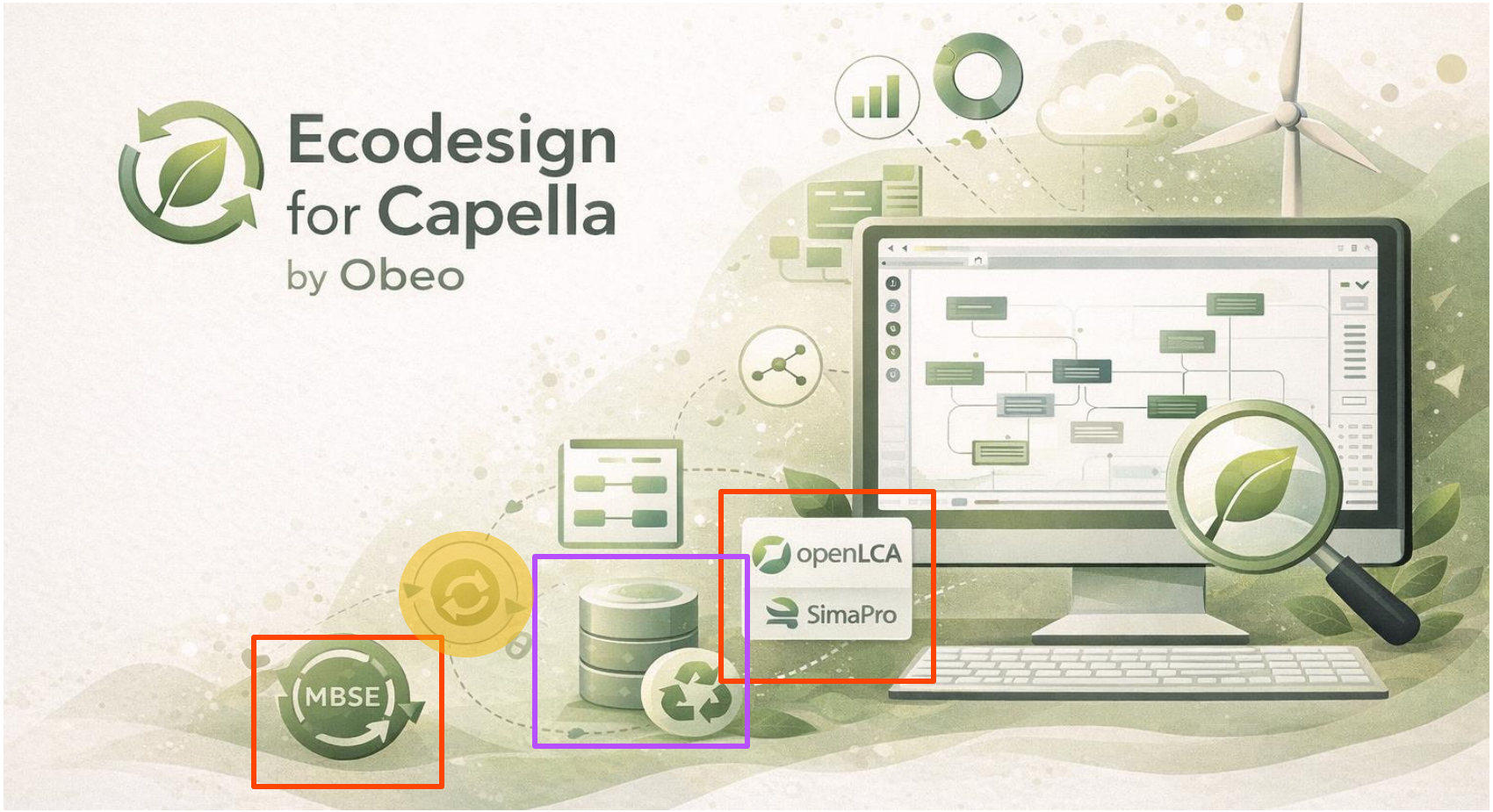

Ecodesign
for Capella
by Obeo
openLCA
SimaPro
MBSE


Ecodesign
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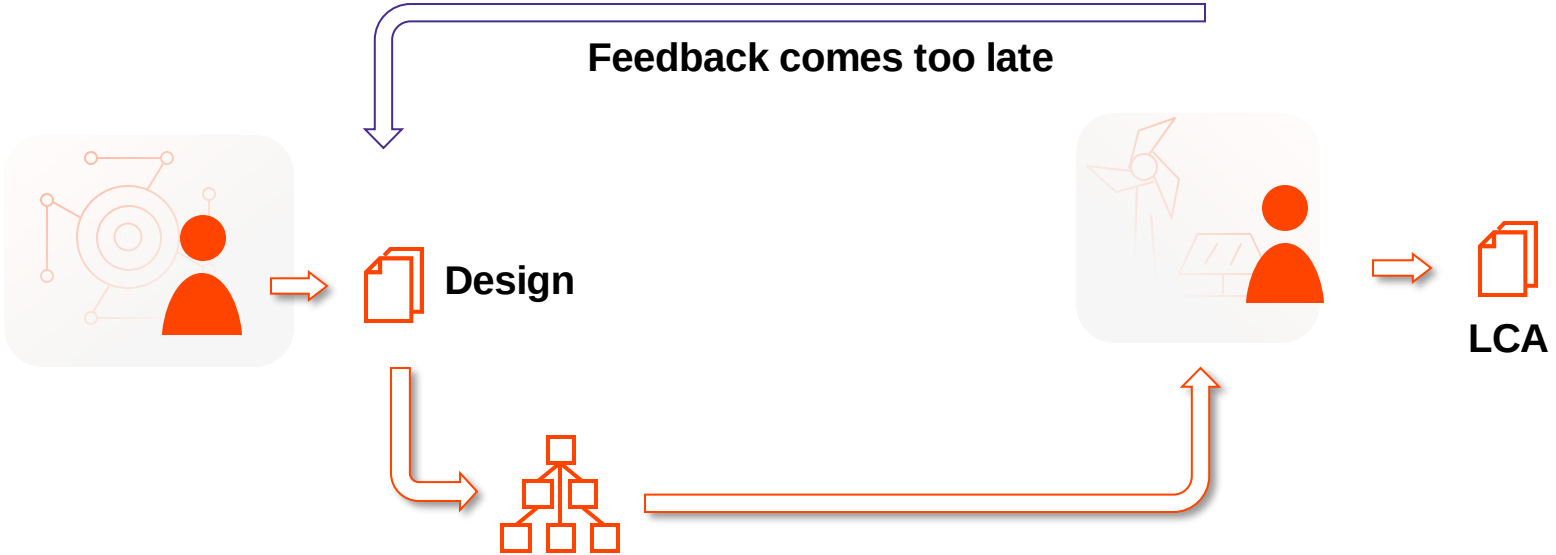
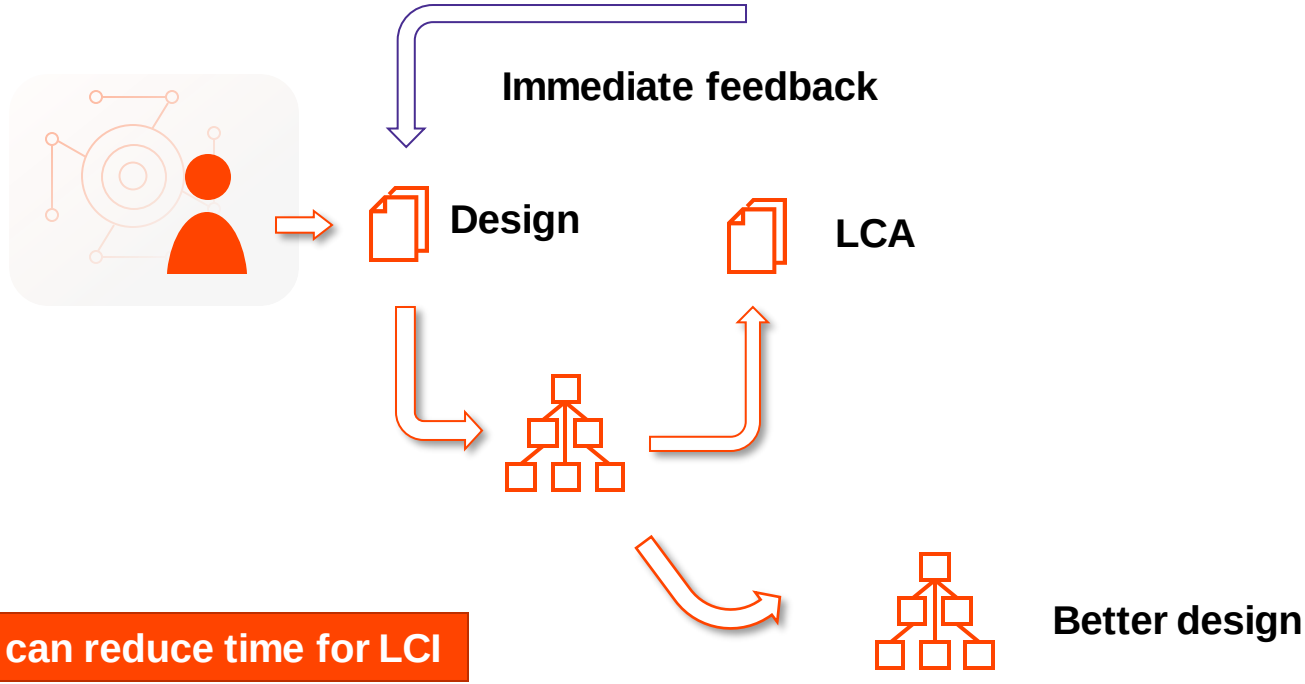
MBSE


Feedback comes too late
Design
LCA

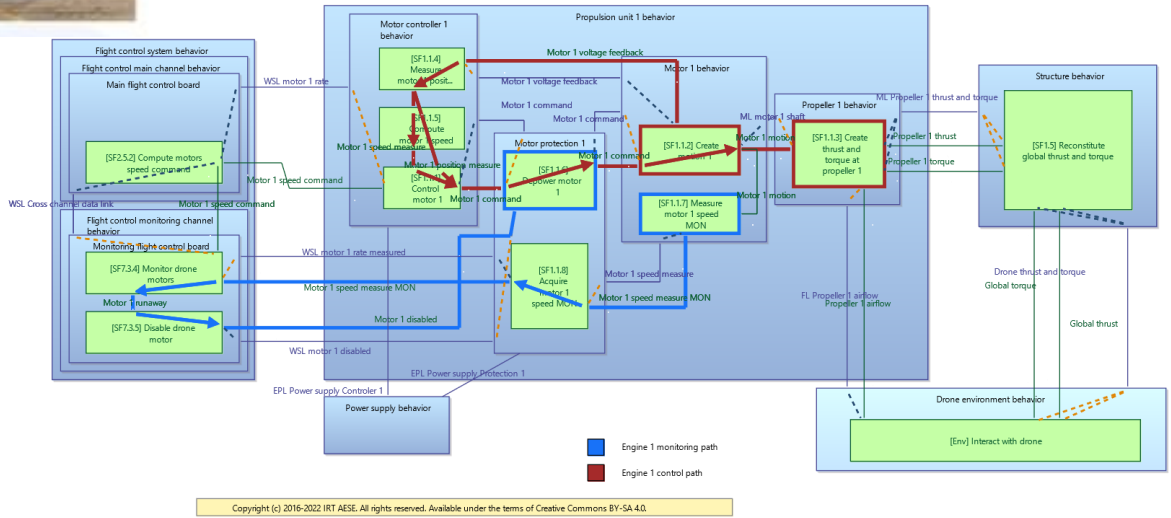


Also checking if we can reduce time for LCI

04

Use case

AIDA model was provided by IRT Saint Exupery through MOISE Project



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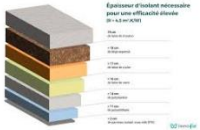
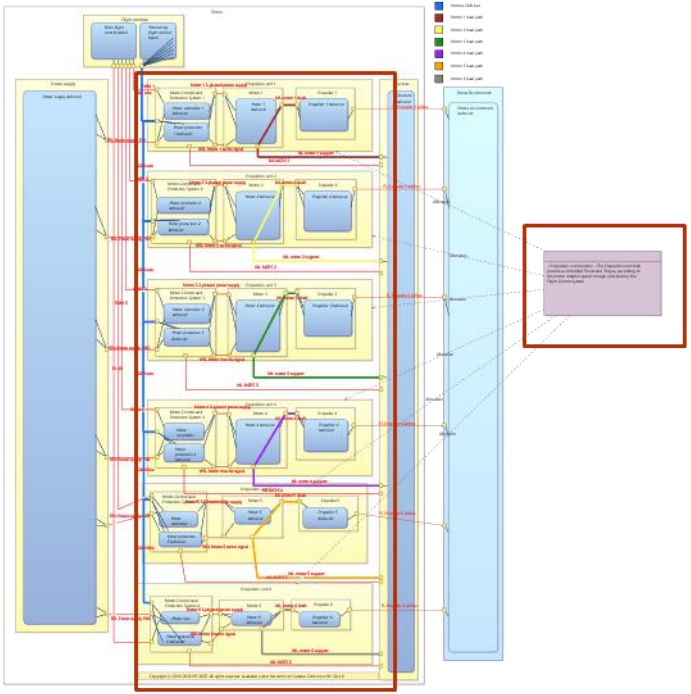
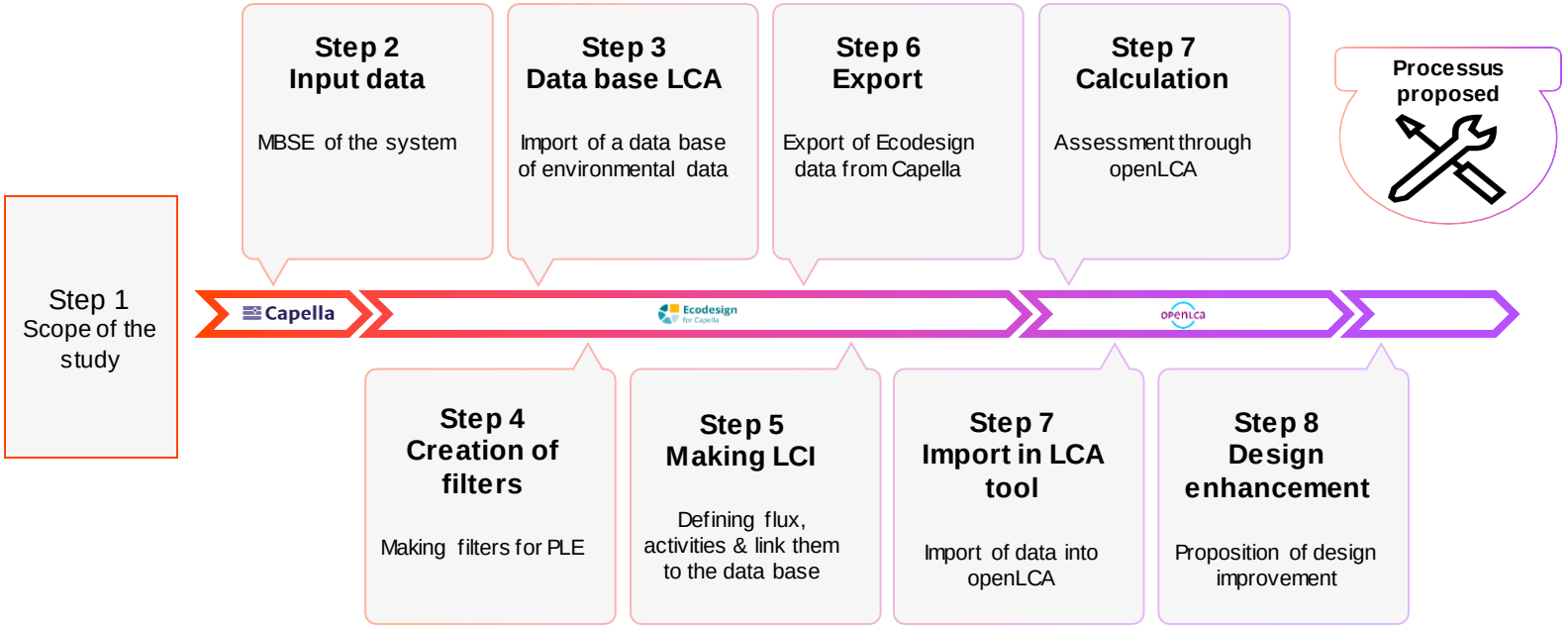
Drone Budget	Drone Premium	Drone Premium Ace
		
		
		
		

Model Elements	Level	Fam01_Drone01_Budget	Fam01_Drone02_Prem	Fam02_Drone03_PremAce
LGM_Drone_Bourget_ProblemSpace				
LGM_Drone_Bourget_SolutionSpace				
LGM_Drone_Bourget_01Features		✓	✓	✓
Functionalities	1	✓	✓	✓
DesignChoices	2	✓	✓	✓
Pale	2.1	✓	✓	✓
Pale_Double	2.1.1	☑	☒	☒
Pale_Triple	2.1.2	☒	☑	☑
Battery	2.2	✓	✓	✓
Battery_Small	2.2.1	☑	☒	☒
Battery_Big	2.2.2	☒	✓	✓
Rotors	2.3	✓	✓	✓
Rotor_4	2.3.1	☑	☑	☒
Rotor_6	2.3.2	☒	☒	☑
Battery_Isolation	2.4	✓	✓	✓
Isolation_Froid	2.4.1	☒	☒	☑
Isolation_Neant	2.4.2	☑	☑	☒



	R-PA	PA1	PA2	PA3	PA4	M&S-PA5	D-PA6	I-PA7
Physical Architecture	Derive logical requirements and capture physical requirements	Transition Capabilities Realization from logical layer	Define Functional Chains, Scenarios, and Physical Path	Derive Logical Functions and define Physical Functions. Define Functional Exchanges and components.	Define Physical Nodes and refine Behavioural Physical Components. Allocate Behavioural Components.	Define physical nodes modes and states	Define physical data model	Delegate Logical Interfaces and create Physical Interface. Enrich Physical Scenarios.


Step 1
Scope of the study
Step 2
Input data
MBSE of the system
Step 3
Data base LCA
Import of a data base of environmental data
Step 6
Export
Export of Ecodesign data from Capella
Step 7
Calculation
Assessment through openLCA
Processus proposed
Capella
Ecodesign for Capella
openLCA
Step 4
Creation of filters
Making filters for PLE
Step 5
Making LCI
Defining flux, activities & link them to the data base
Step 7
Import in LCA tool
Import of data into openLCA
Step 8
Design enhancement
Proposition of design improvement

05

LGM Feedbacks

Criteria	Compliance	Justification
Low or no skills required	Yes	Only 1-2h training for a system engineer on LCA
Faster than LCA tools	Yes	Definity, the LCI is made into MBSE and directly send to LCA calculator
Accuracy	Partial yes	Could be extremely precise, but difficult for a system engineer
Compliant with PLE	Partial no	Not really, but could possible and we succeed – was not part of the feature of the tool
Difficulty for update	Yes	For the environmental part through import / For MBSE as the MBSE
Link with main LCA tools	Yes	SIMAPRO & openLCA at least
Complexity that could be addressed	Partial yes	Most of the common element could be addressed, some limitation for some process and transportation, but could be solve into LCA tool

Definitely a game changer for ecodesign process & trade-offs and for LCI activities

No filters & scope

- But Ecodesign for Capella was not design for

Needs to be connected to environmental data bases

- Same issue as classical LCA tool

Not suitable for EPD & PEF alone (could be achieved)

- Require more LCA skills

Needs a MBSE model with Capella in input

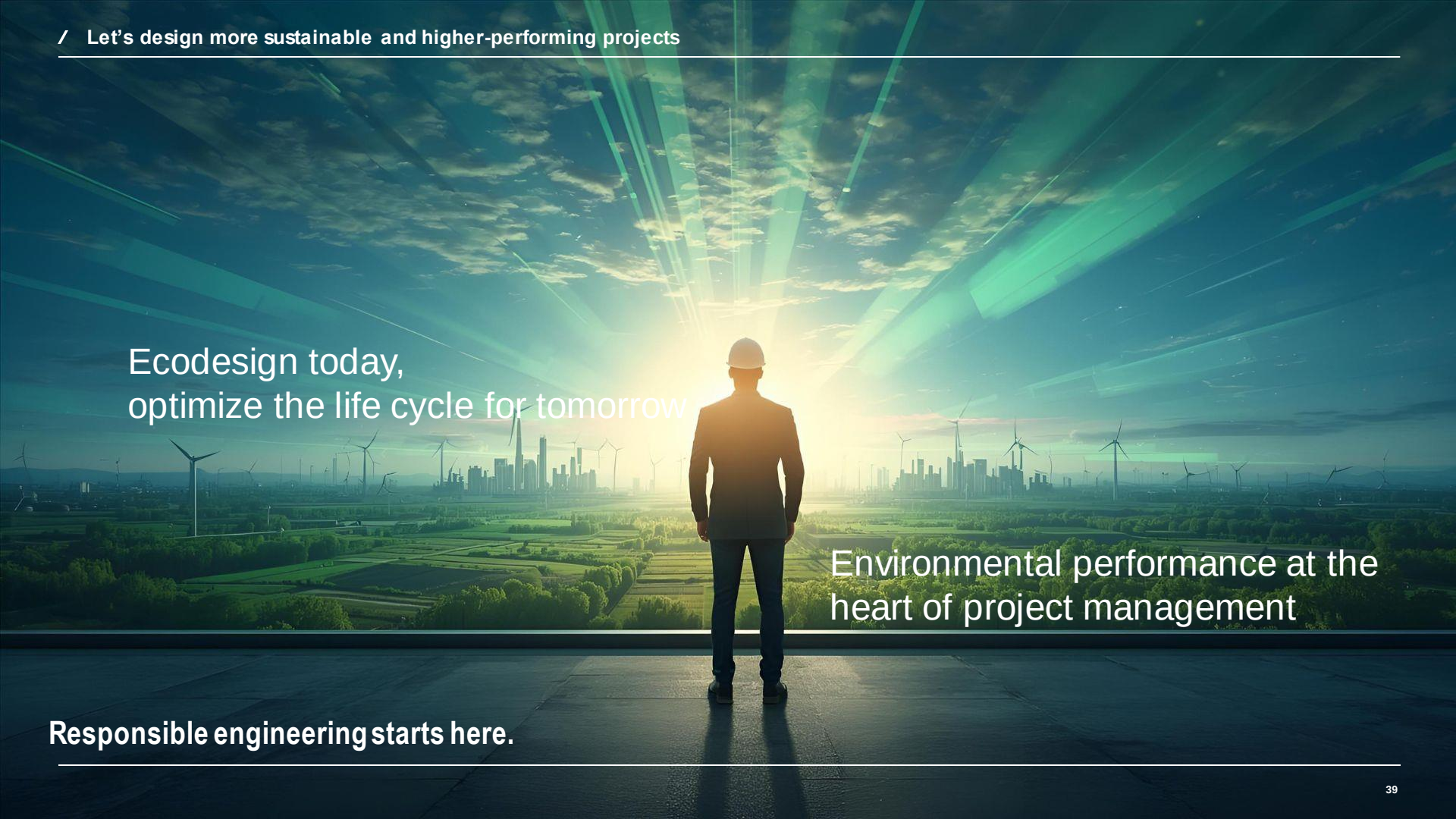
06

Conclusions

Simplify & standardise LCI activities

Enables environmental trade-offs, making it possible to implement a true ecodesign process based on LCA.

Only tool for it



Responsible engineering starts here.