Application of LCA for material replacement and redesigning in selected technologies

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- Impact Assesment
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- CO_2 absorption from flue gases **INVITES Project**
- TCO **INREP Project**
- PV panels **HIPERION Project**

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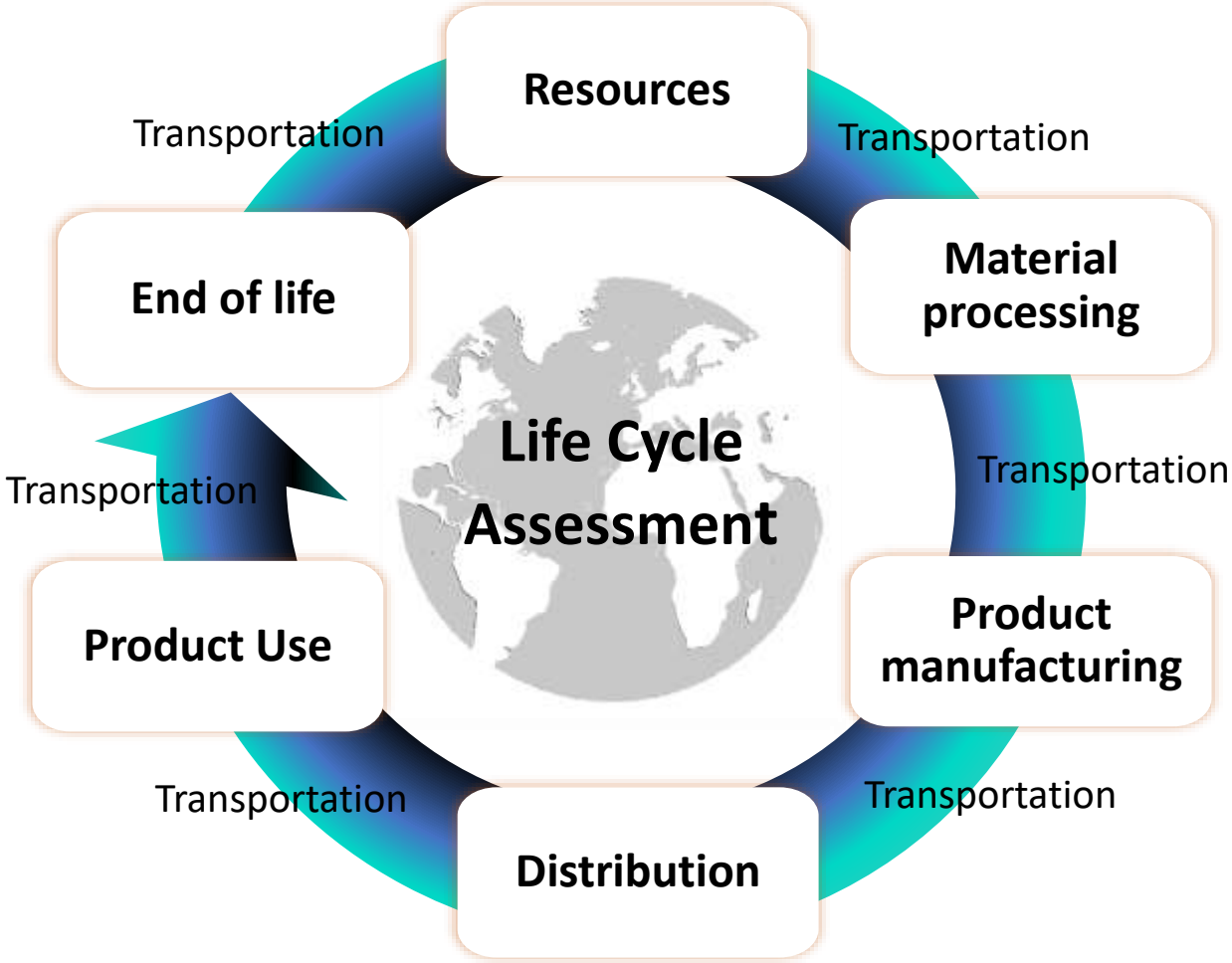
Life Cycle Assessment - LCA

LCA is an **established method** to simultanously **quantify** multiple **environmental impacts** arising from the whole value chain including all processes **related to the life cycle** of a product, service, technology.



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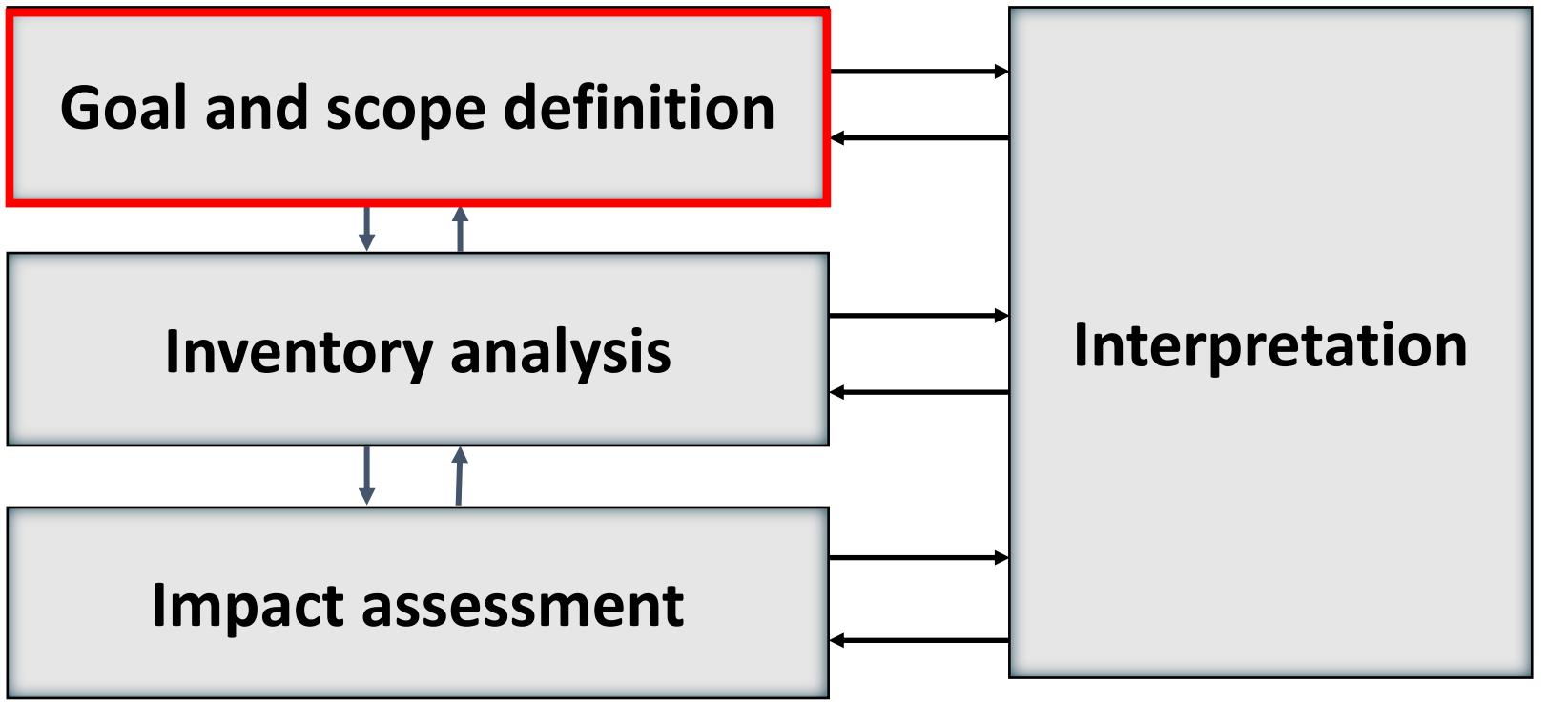
Life Cycle Assessment – Methodology



ISO 14040:2006
Environmental management.
Life cycle assessment.
Principles and framework

ISO 14044:2006
Environmental management.
Life cycle assessment.
Requirements and guidelines

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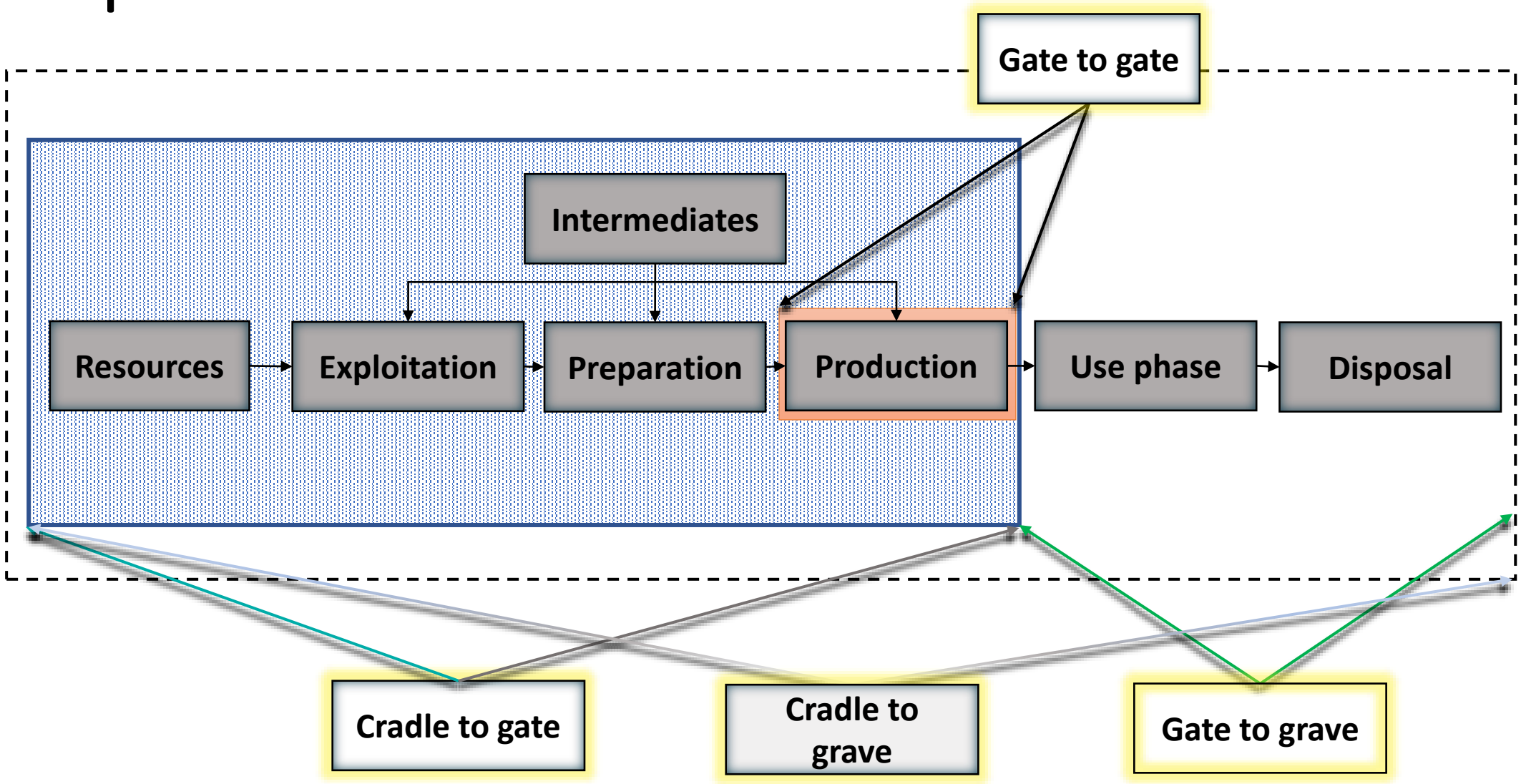
Scope of LCA



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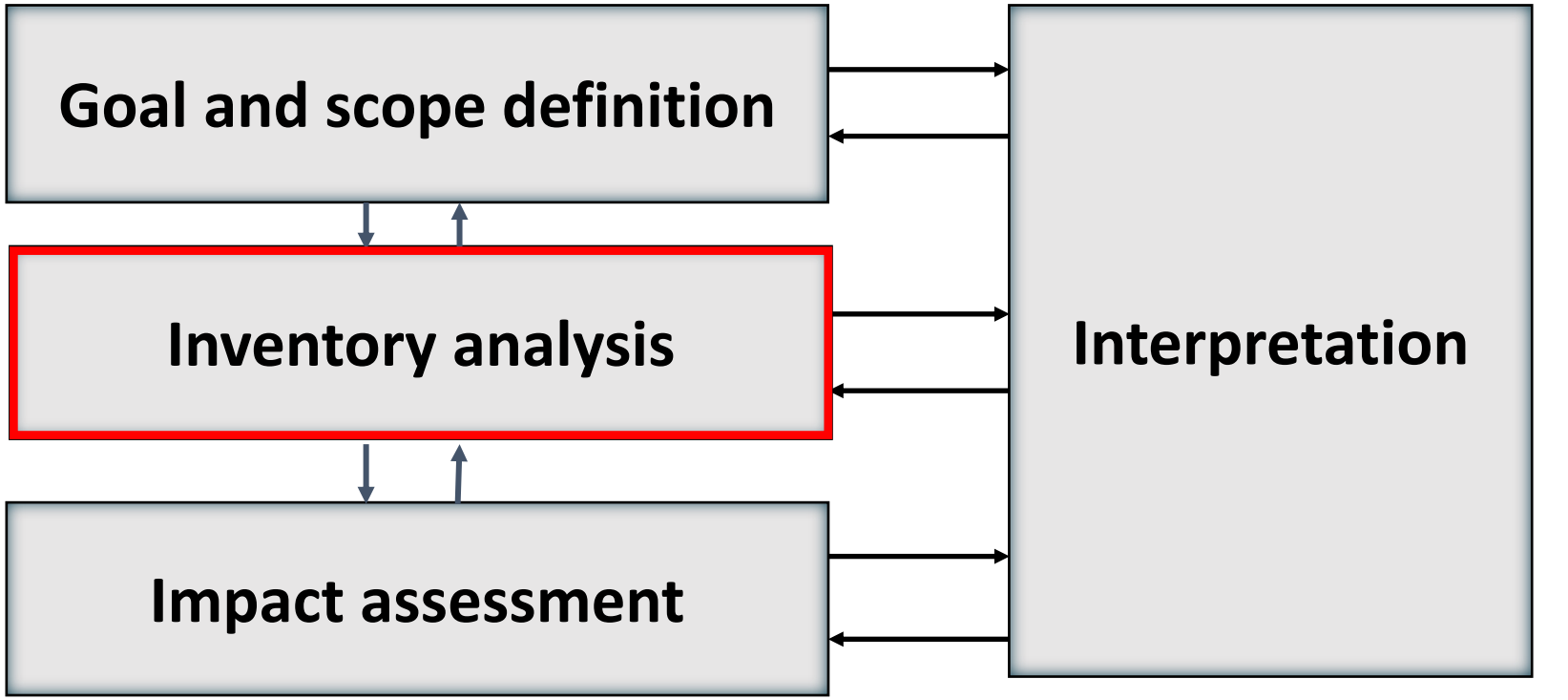
Life Cycle Assessment – Methodology



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Inventory Table

Manufacturing	Eco-intensity (impacts/kg)	Mass per item (kg)	Items per func.unit (#)	Uncertainty %
Mechanical recycled plastic pellets (downcycled) (60,5%)	0,50	45,073	1,00	10%
Glass fibre (30%)	2,05	22,350	1,00	30%
UV Stabilizer (0,2%)	1,96	0,149	1,00	60%
UV Absorber (0,1%)	2,31	0,075	1,00	60%
Anti-microbal (3%) (PP random co-polymer)	2,92	2,235	1,00	50%
Flame retardant (5%) (V0,V2 - less toxic but less effective)	5,73	3,725	1,00	30%
Coupling agent (3%) (MAPP)	1,65	2,235	1,00	30%
Anti-oxidants (organic phosphite) (0,1%)	0,49	0,075	1,00	30%
Heat stabilizer (0,1%)	2,10	0,075	1,00	30%
Collectin and soring plastic waste	0,09	45,073	1,00	30%
Compounding	0,19	74,500	2,00	30%

Transport	Eco-Intensity (impacts/ ton-km)	Mass per item (ton)	Distance per item (km)	Items per func.unit (#)	Uncertainty %
Transporting PP PCW from Heerenveen	0,09	0,045	173,0	1,00	30%
Transporting Glass Fiber from Battice	0,09	0,022	210,000	1,00	30%
Transporting Coupling agent from Geleen	0,09	0,002	162,000	1,00	30%
Transporting Anti-oxidant from Kaisten	0,09	0,000	733,000	1,00	30%
Transporting Heat Stabilizer from Kaisten	0,09	0,000	733,000	1,00	30%
Transporting UV Stabilizer from Kaisten	0,09	0,000	733,000	1,00	30%
Transporting UV Absorber from Kaisten	0,09	0,000	733,000	1,00	30%
Transporting pigment from UniqueQolor	0,09	0,000	69,700	1,00	30%

Uncertainty: 10% for precise data & perfect database match, 30% for plausible substitution, 100% for wild guess

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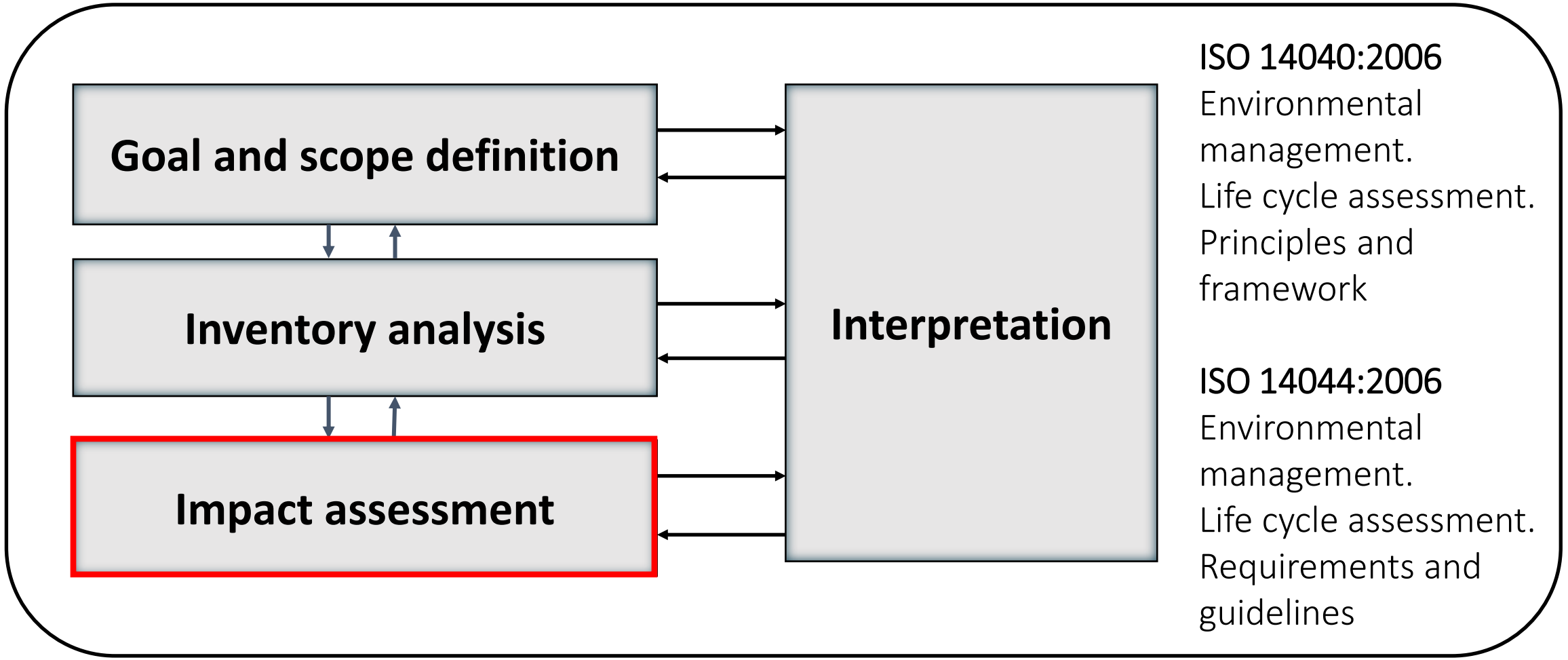
Life Cycle Assessment – Impact Assessment



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Impact Assessment - Softwares and Methods

GaBi Database Content

SimaPro

OpenLCA

LCA manager

One Click LCA

umberto know the flow.

Single Issue	Global	European
• IPCC 2021 • Cumulative Energy Demand	• IMPACT World + • ReCiPe 2016	• CML • EPD • Ecological Scarity

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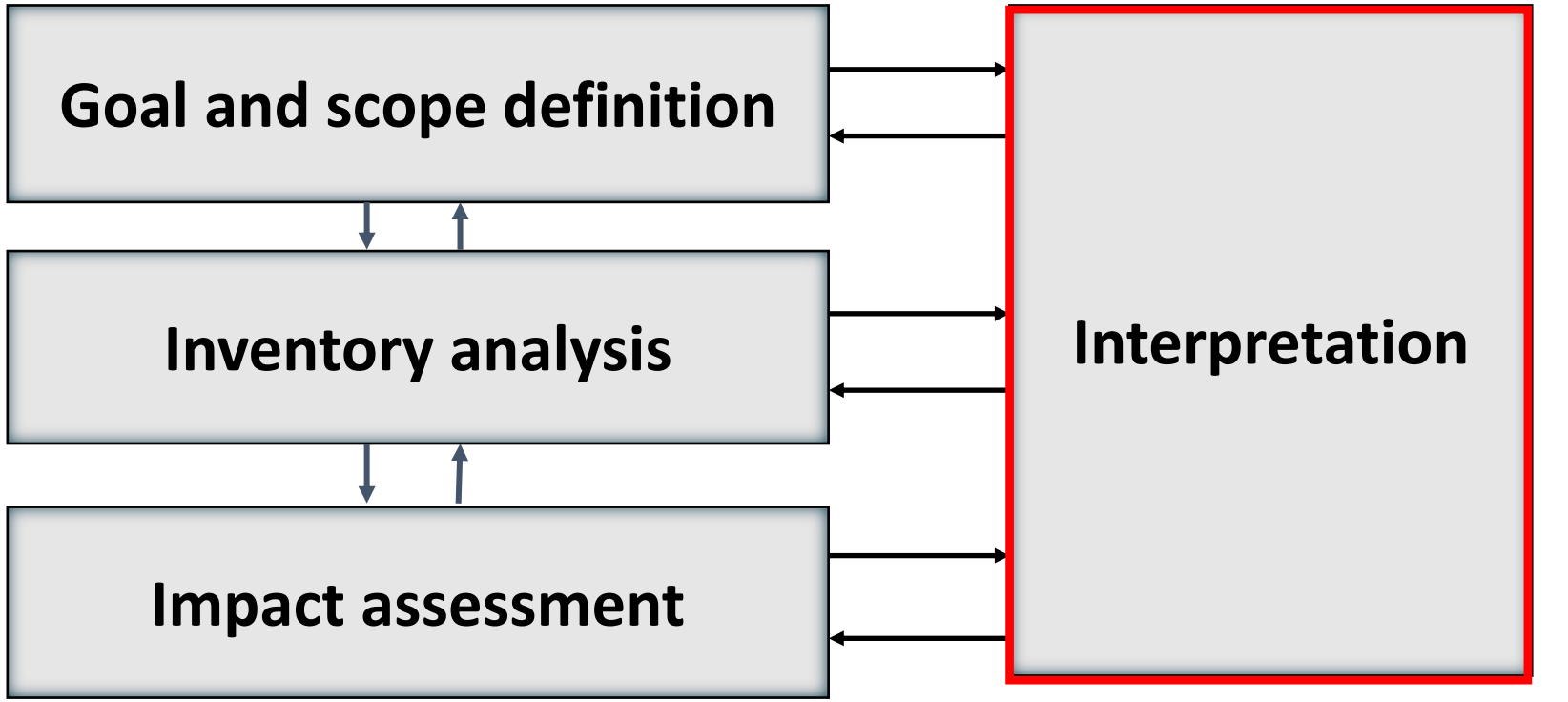
Life Cycle Assessment – Impact Assessment



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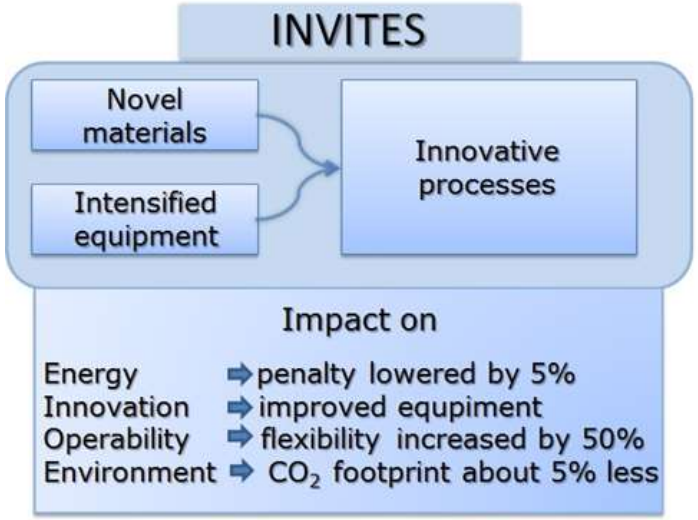

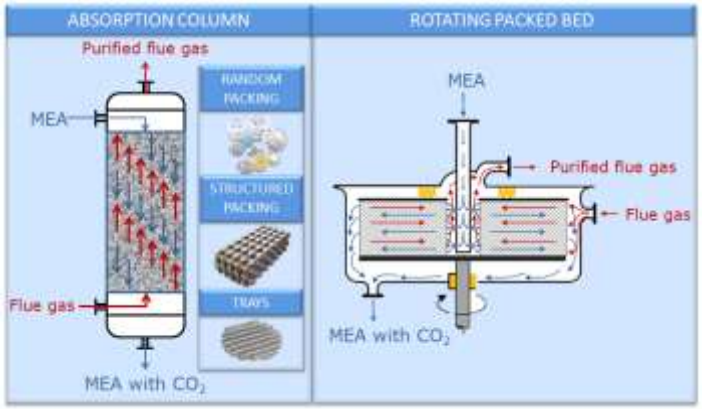

INVITES - Innovative Equipment For Intensified Recovery Of CO_2 From Flue Gases

- The objective of the INVITES project was to improve a technology to recover CO_2 from flue gases and develop and test two different types of new, intensified equipment for CO_2 absorption.

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Risks and Mitigations

Lack of data of materials used in databases and lack of LCA coefficients for the new materials

Replacement of the materials or synthesis of missing materials using existing elements in databases

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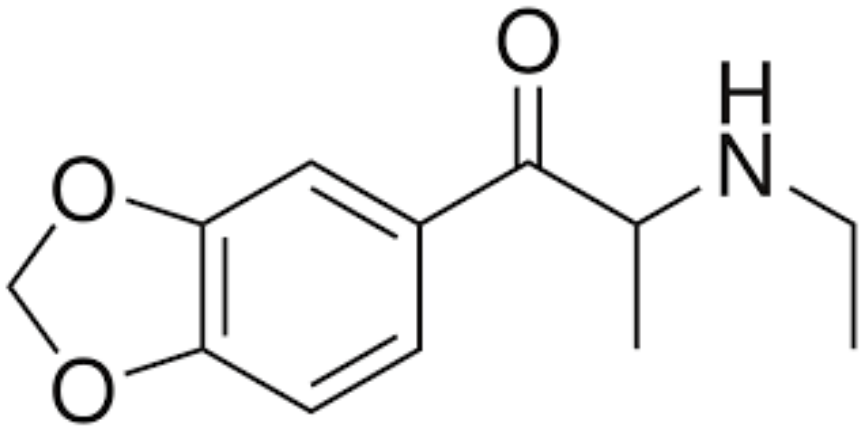
Inventory Data

- MDEA (*N*-methyl diethanolamine)
- $CH_3N(C_2H_4OH)_2$
- MDEA is produced by ethoxylation of methylamine using ethylene oxide: *

$$CH_3NH_2 + 2\ C_2H_4O \rightarrow CH_3N(C_2H_4OH)_2$$



Source: Matthias Frauenkron, Johann-Peter Melder, Günther Ruider, Roland Rossbacher, Hartmut Höke "Ethanolamines and Propanolamines" in Ullmann's Encyclopedia of Industrial Chemistry 2002, Wiley-VCH, Weinheim

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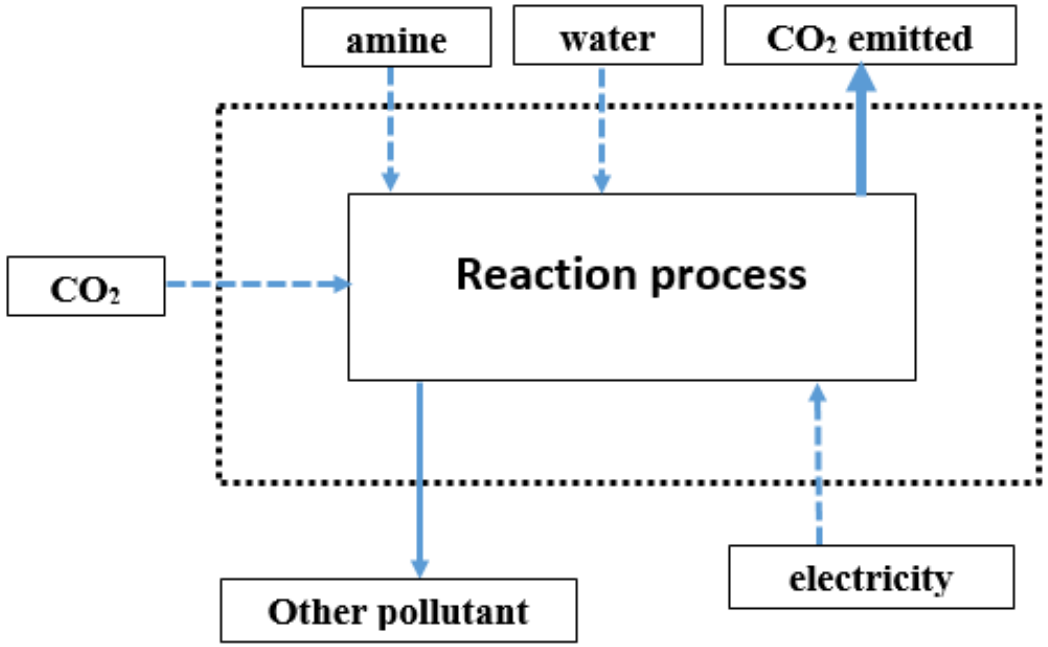
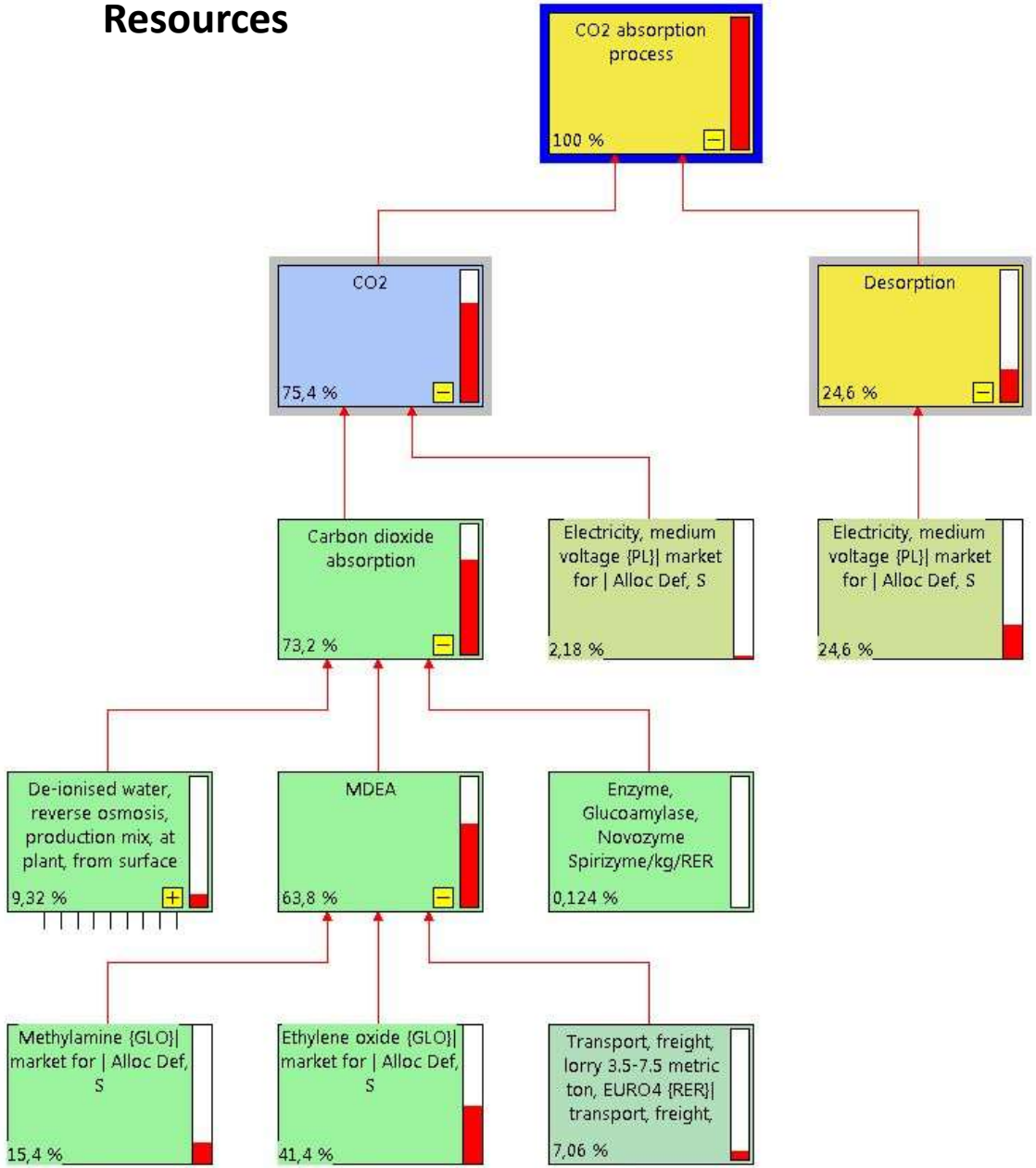
INVITES project

Functional unit (FU)- CO_2 captured by the process within 1 hour



ReCiPe – Endpoint – Resources



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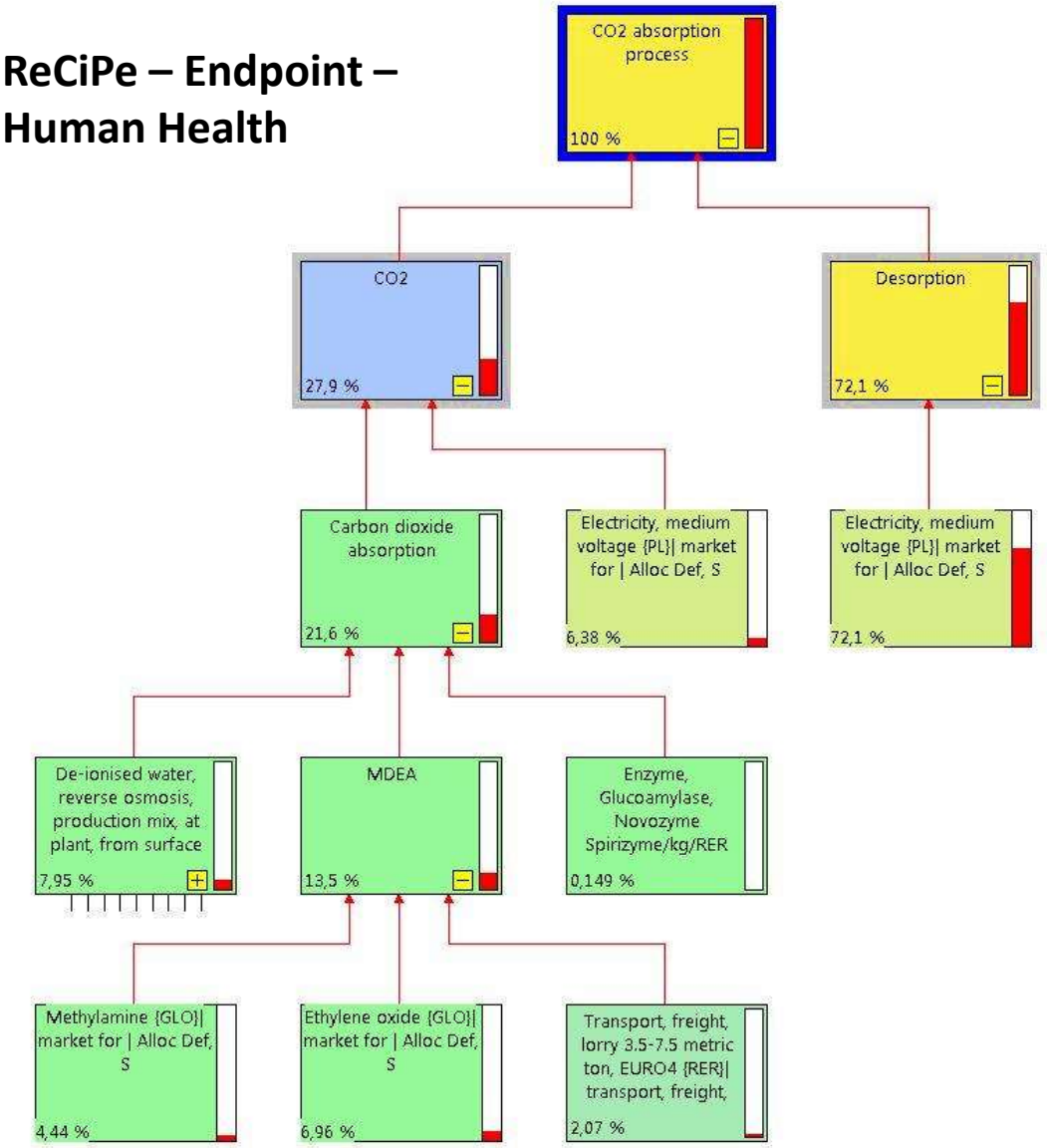
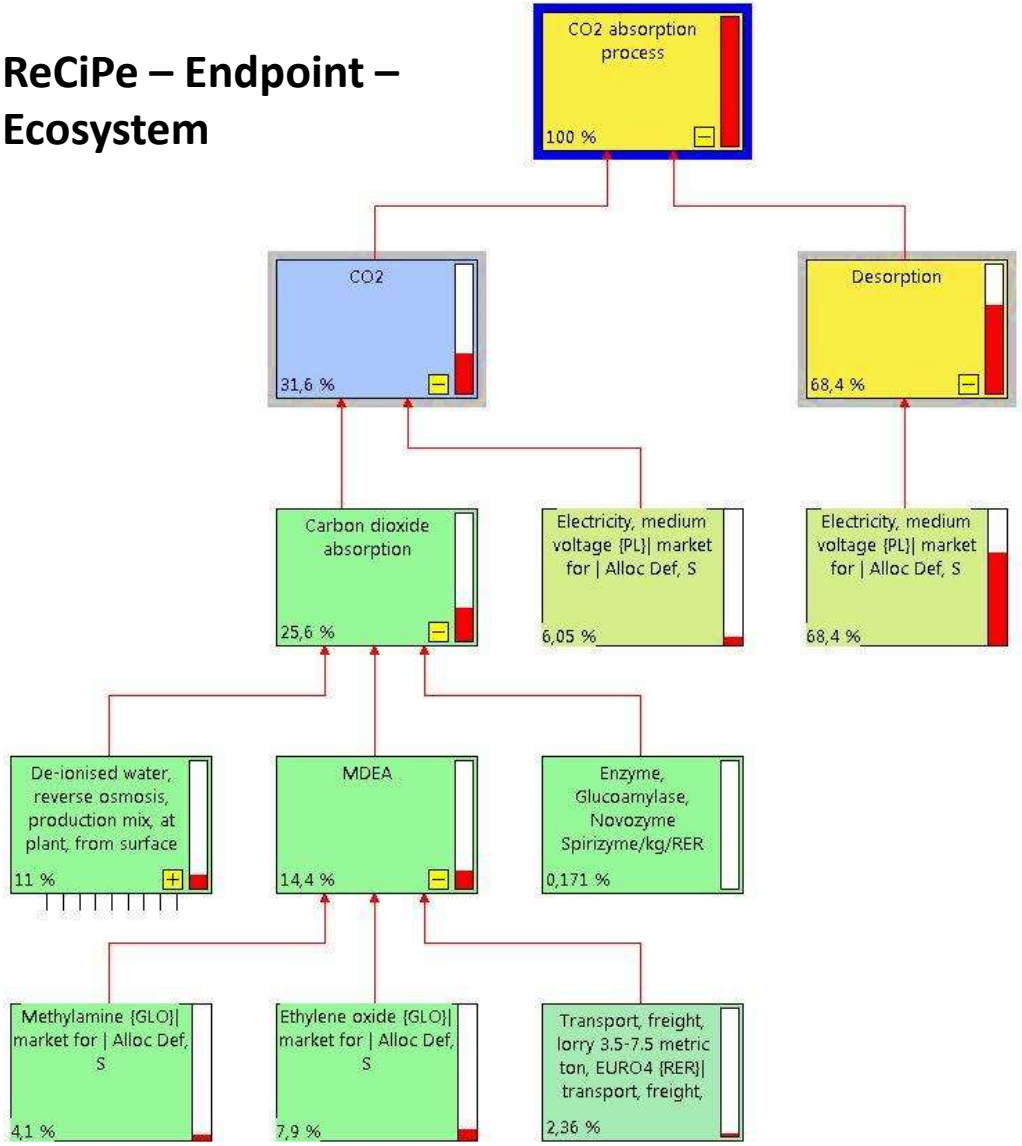
ReCiPe – Endpoint – Human Health



ReCiPe – Endpoint – Ecosystem



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INREP – Towards Indium Free TCOs

- **GOAL** - develop and deploy valid and robust alternatives to indium (In) based transparent conductive electrode materials as electrodes in application such as inorganic light emitting diodes (LEDs), solar cells and touch-screens.
- The main objective was to measure the sustainability of developed TCO materials and include the long-term environmental aspects to achieve the highest environmental quality of the TCO.

INREP
Towards Indium free TCOs

Inventory Table

Compound / Deposition technique	ITO	ZnO	SnO_2	ZnO:Al	ZnO:B
CVD					CSEM
ALD				Tue/TNO	
PVD	CSEM & MBR	CSEM & MBR	CSEM & MBR	CSEM & MBR	

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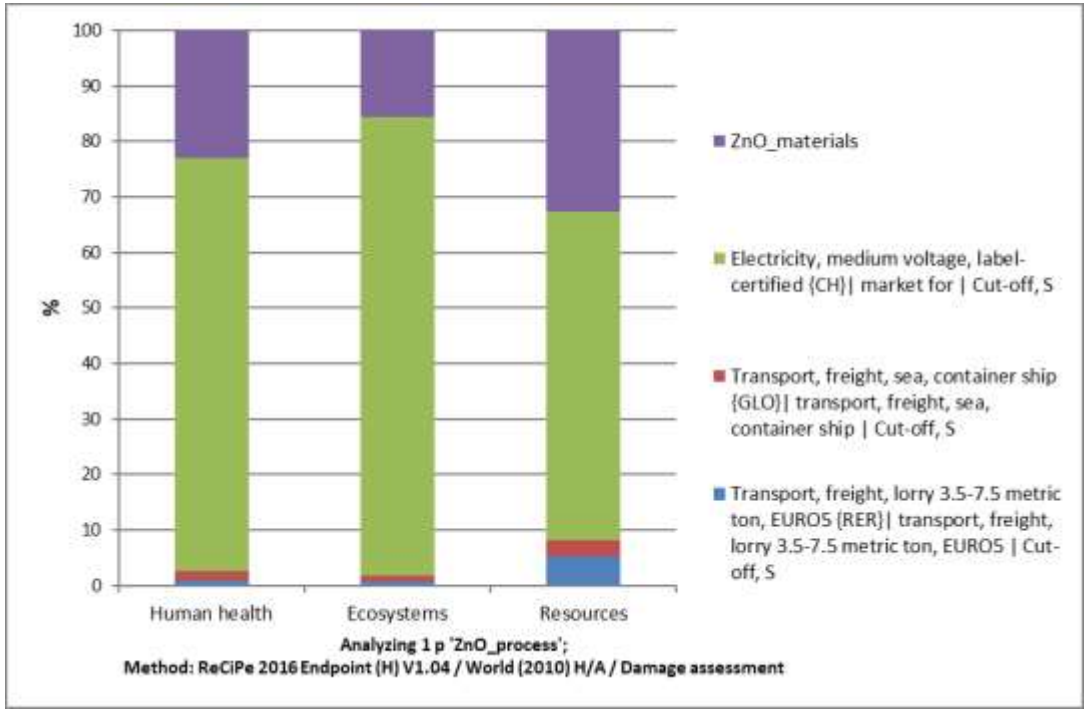

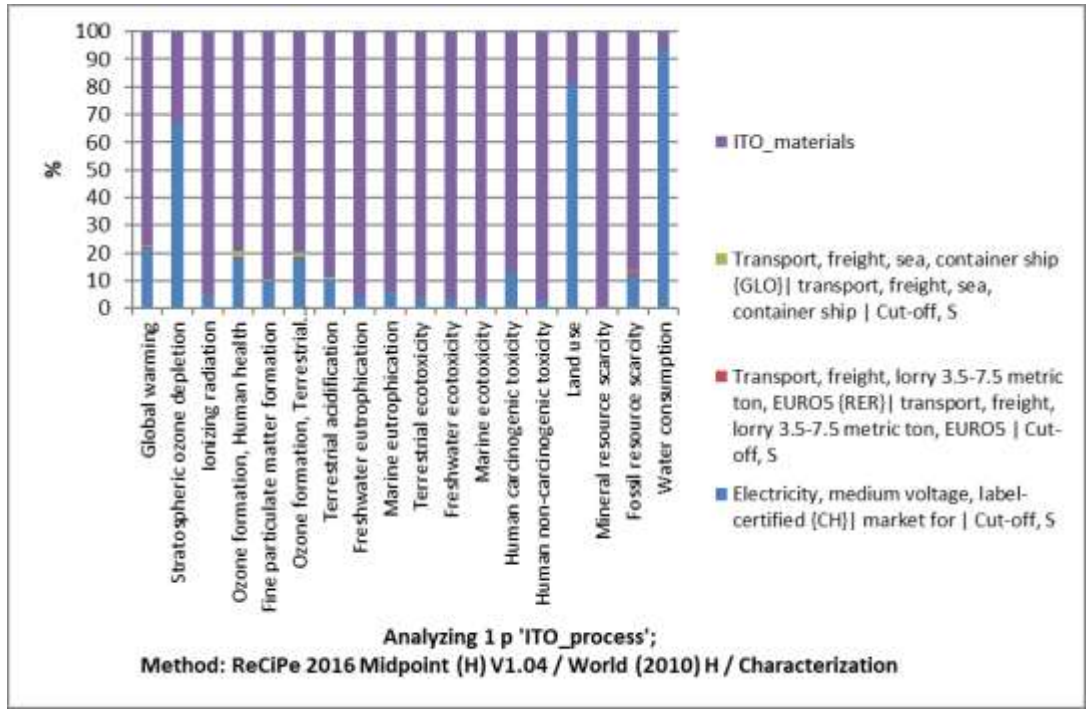

RESULTS

- Replacement of ITO by ZnO proved to be a promising strategy towards minimization of the environmental impact of the TCO layer deposition process.

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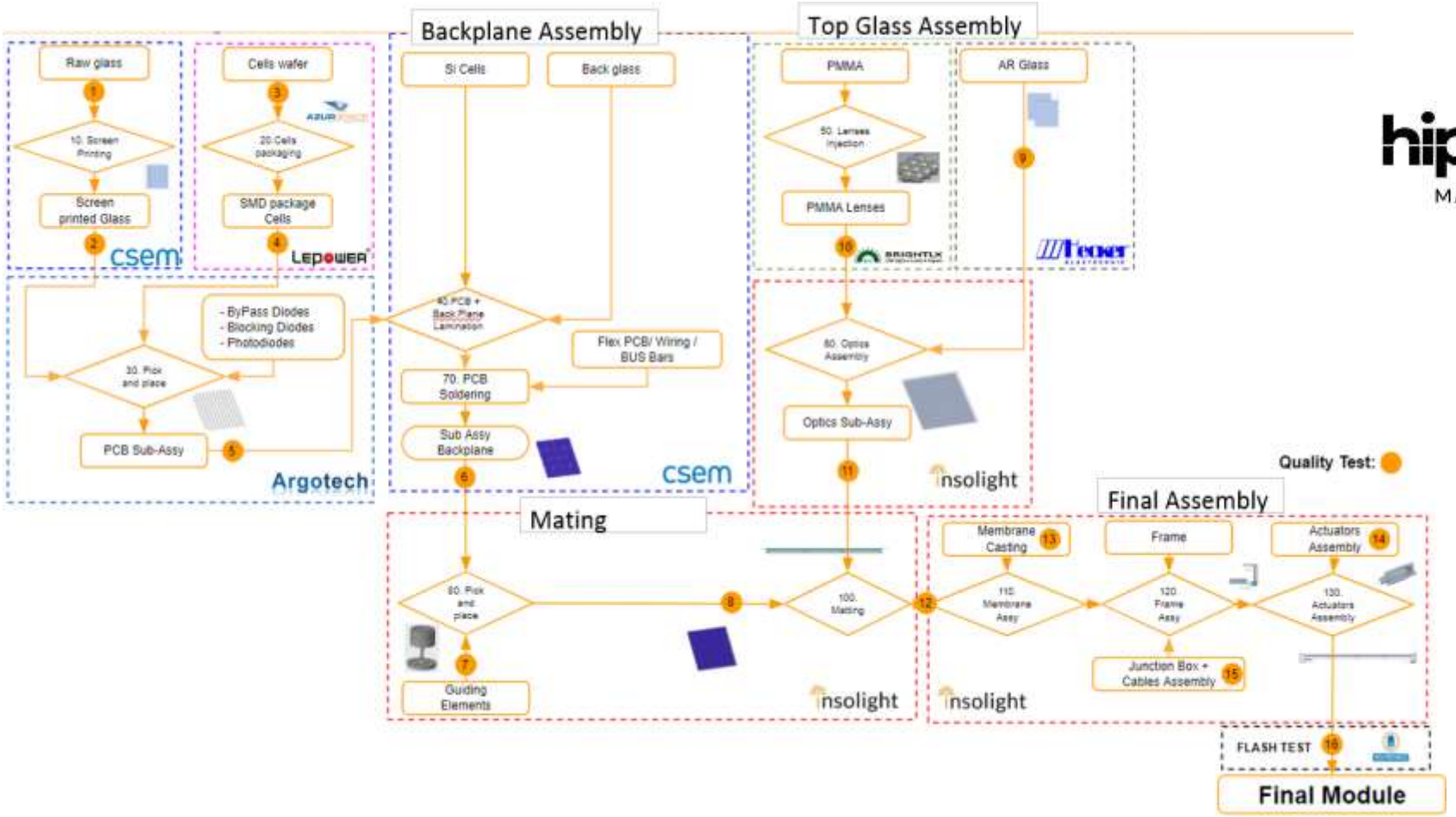

HIPERION - Hybrid photovoltaics for efficiency record using integrated optical technology

- The result of LCA analysis in the HIPERION project will be an environmental profile of the PV system expressed in kg CO2 eq. Moreover, analysis of an **environmental payback period** to determine how many months per year the PV panels need to produce the electricity to compensate depletion of resources and consumption of energy for manufacturing and maintenance will be carried out.

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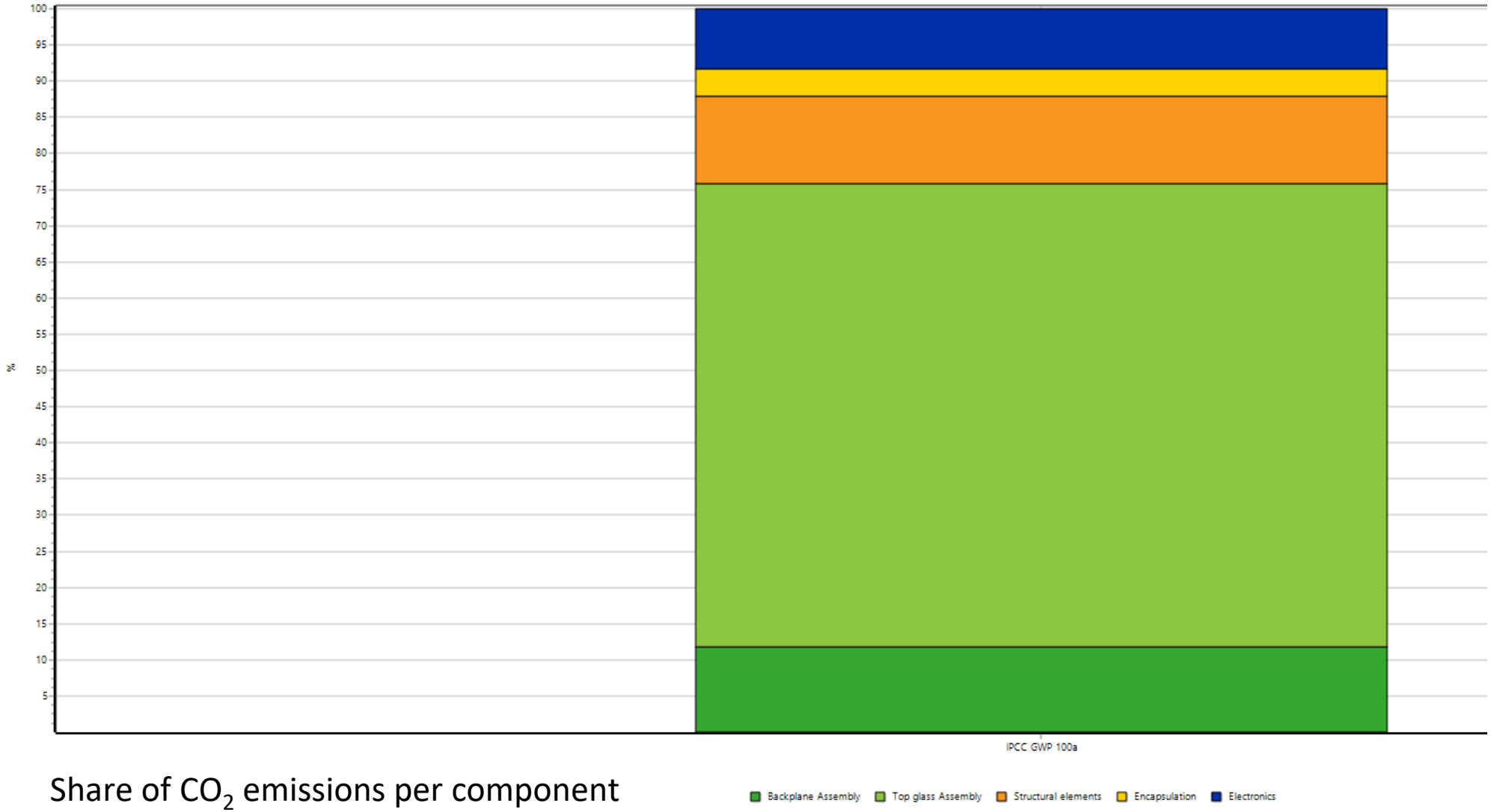
Results



Share of CO_2 emissions per component

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Thank You for Your attention

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