

2024-01-25

# Quality assessment of life cycle inventory data for composites

Summerscales, J

<https://pearl.plymouth.ac.uk/handle/10026.1/21970>

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# Quality assessment of life cycle inventory data for Composites

Chair: Prof. John Summerscales

Presenter: Badr Moutik

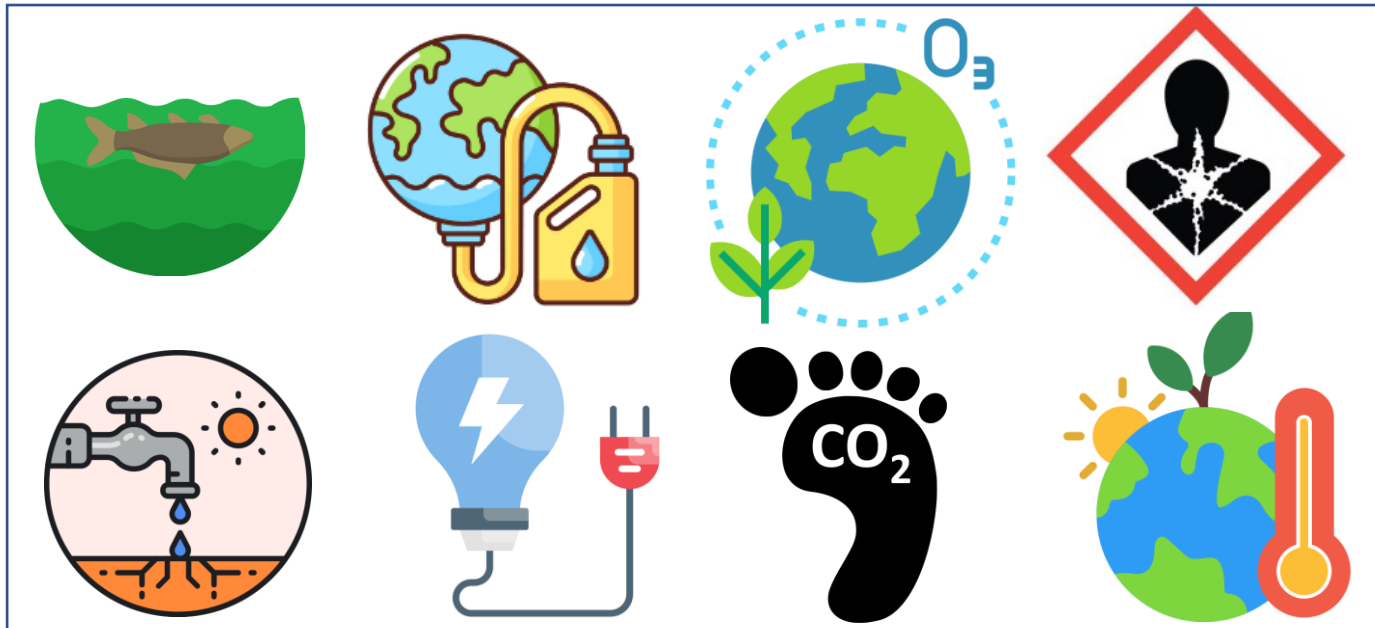
Jasper Graham-Jones, and Richard Pemberton



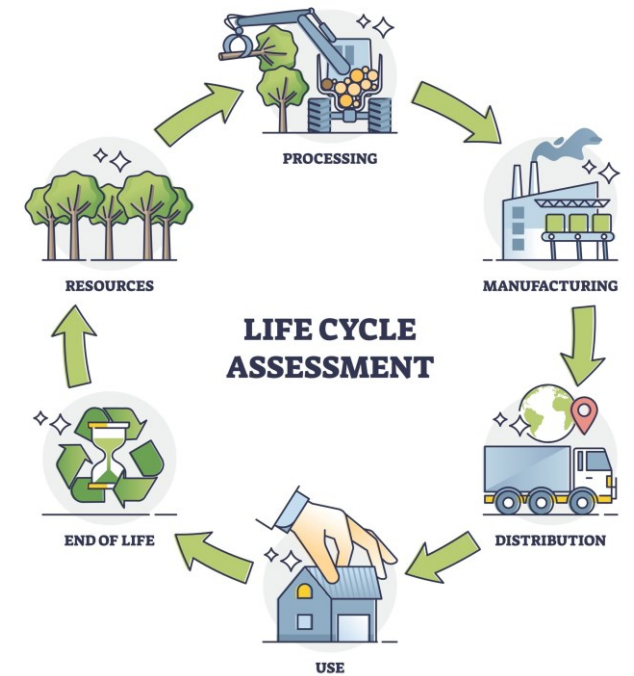
# WHAT IS LIFE CYCLE ASSESSMENT (LCA)?

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

## Environmental impacts



## Product Life Cycle

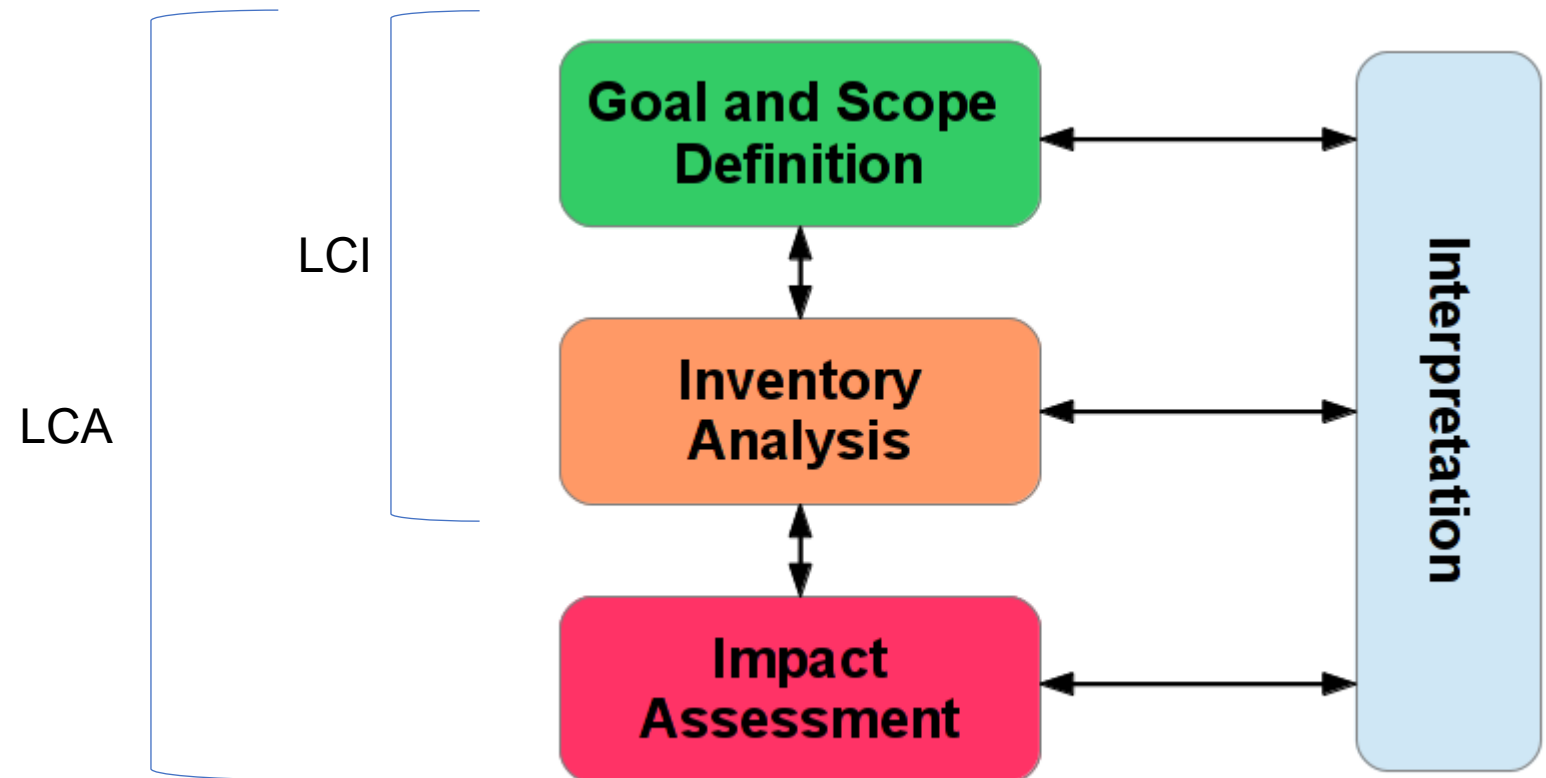


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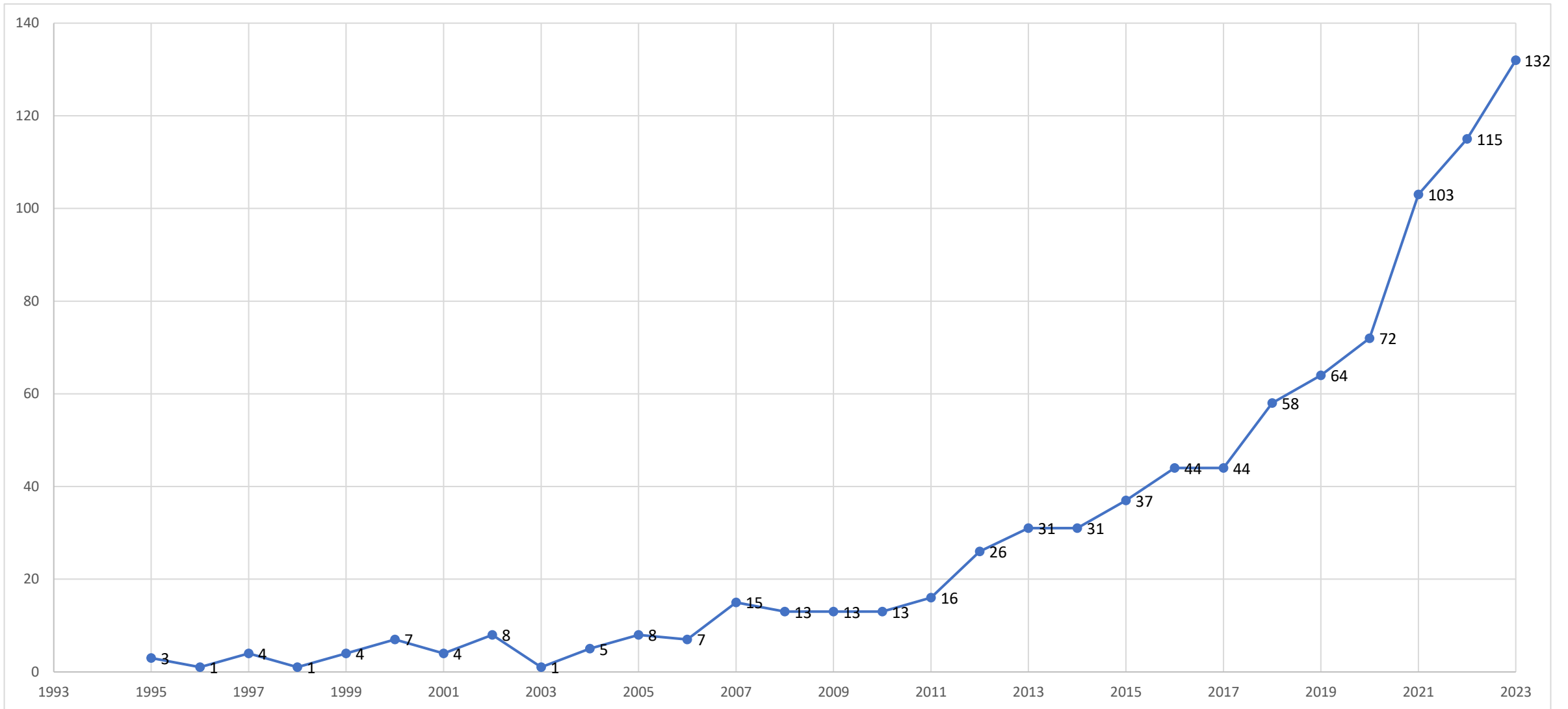
## LIFE CYCLE INVENTORY ANALYSIS (LCI)

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**LCI** is a phase of life cycle assessment involving the compilation and quantification of inputs and outputs for a product throughout its life cycle (*ISO,2006*)



# BACKGROUND: EVOLUTIONARY TREND OF LCA RESEARCH PUBLICATIONS IN COMPOSITE



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# BACKGROUND: REGULATORY CONTEXT: THE FRAMEWORKS SHAPING SUSTAINABILITY

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Brussels, 22.3.2023  
COM(2023) 166 final  
2023/0085 (COD)

Proposal for a

**DIRECTIVE OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL**  
**on substantiation and communication of explicit environmental claims (Green Claims Directive)**



Green Claims Code - get

# BACKGROUND: ENVIRONMENTAL PRODUCT DECLARATIONS AND REPORTS




**ENVIRONMENTAL PRODUCT DECLARATION**  
as per ISO 14025 and EN 15804+A2

Owner of the Declaration	DBC, EFCC, FEICA, IVK
Programme holder	Institut Bauen und Umwelt e.V. (IBU)
Publisher	Institut Bauen und Umwelt e.V. (IBU)
Declaration number	EPD-DBC-20220174-IBF1-EN
Issue date	29.08.2022
Valid to	28.08.2027

**Products based on epoxy-resin, group 1**

DBC - Deutsche Bauchemie e.V.  
EFCC - European Federation for Construction Chemicals  
FEICA - Association of the European Adhesive and Sealant Industry  
IVK - Industrieverband Klebstoffe e.V.



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## Eco Report

Product: Dura Composites Moulded Product  
Date: 9/27/2021



### General Information

#### Functional unit

This Eco Report gives insights into the environmental impact of 1 Dura Composites Moulded Product of 1 kg.

#### Content declaration

The LCA that has resulted in this Eco Report entails a cradle-to-gate analysis. Listed are

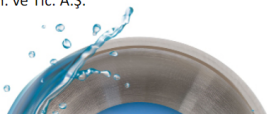


## ENVIRONMENTAL PRODUCT DECLARATION



In accordance with ISO 14025 and EN 15804:2012+A2:2019 for  
Glassfiber Reinforced Plastic (GRP) Pipes

from Subor Boru San. ve Tic. A.Ş.



**ENVIRONMENTAL PRODUCT DECLARATION**  
as per ISO 14025 and EN 15804+A1

Owner of the Declaration	Vitrulan Technical Textiles GmbH
Programme holder	Institut Bauen und Umwelt e.V. (IBU)
Publisher	Institut Bauen und Umwelt e.V. (IBU)
Declaration number	EPD-VT-20220104-IAC1-EN
Issue date	13.04.2022
Valid to	12.04.2027

**Glasarmierungsgitter**  
Vitrulan Technical Textiles GmbH



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## Eco Report

Product: UD Plank  
Date: 6/24/2021



### General Information

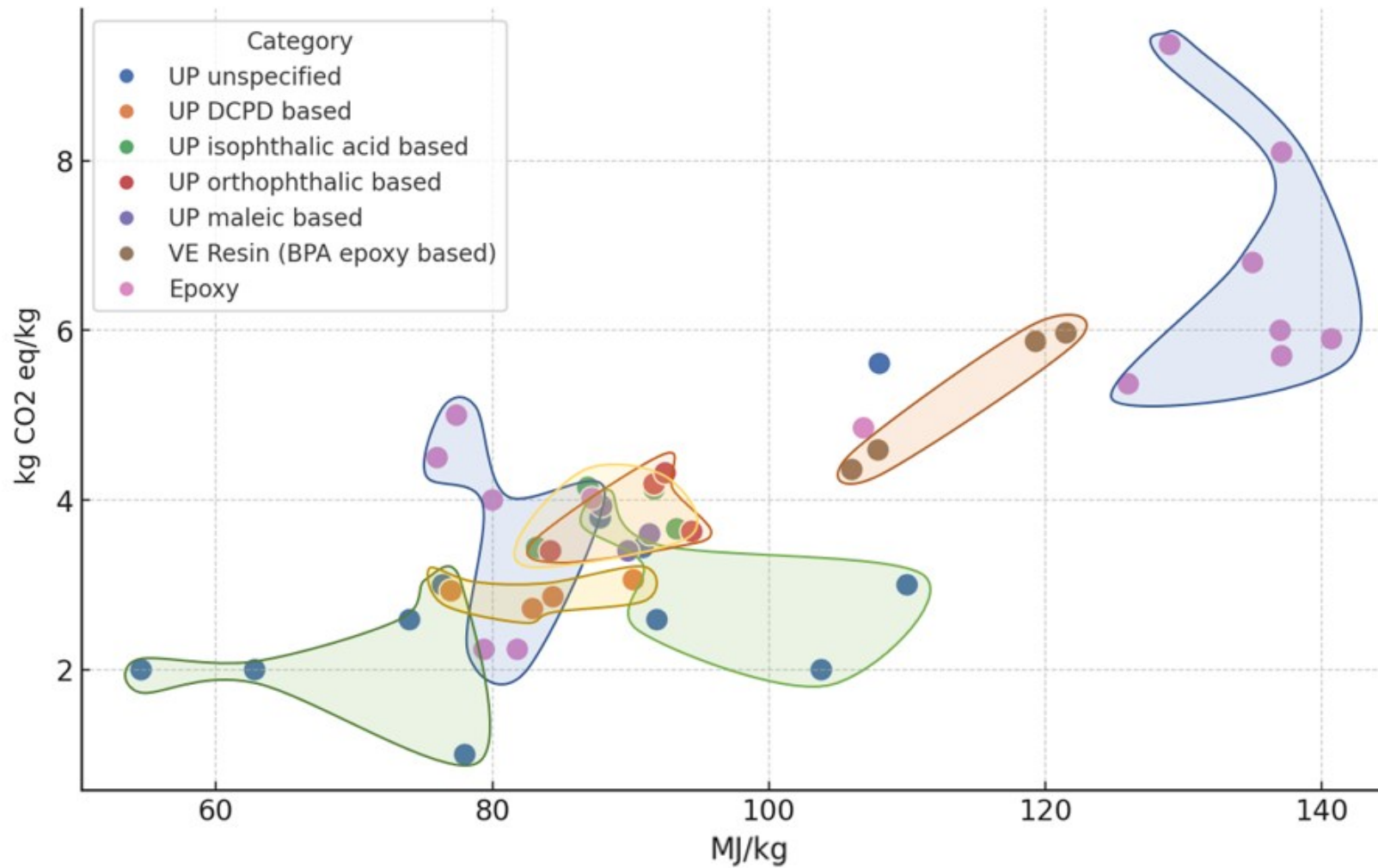
#### Functional unit

This Eco Report gives insights into the environmental impact of 1 UD Plank of 12.9 kg.

#### Content declaration

The LCA that has resulted in this Eco Report entails a cradle-to-gate analysis. Listed are materials representing more than 1% mass of the product. This factsheet is valid for the year 2021. For a full report about the used materials, please visit

# BACKGROUND: LIFE CYCLE GHG EMISSIONS AND CUMULATIVE ENERGY DEMAND VALUES: RESINS

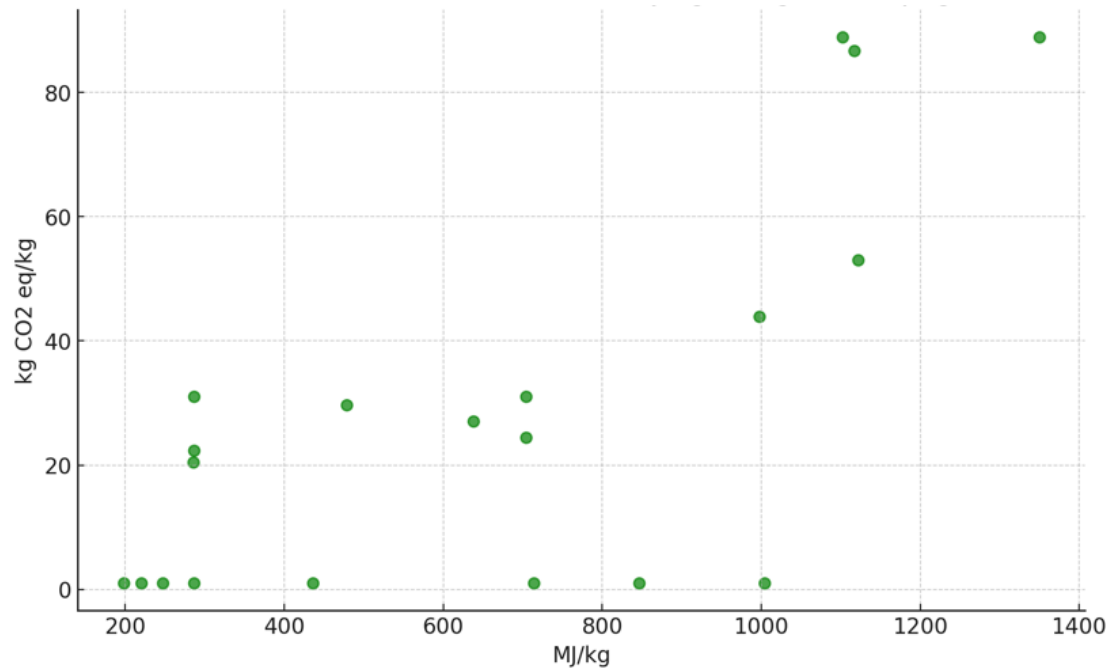


\* GHG: Greenhouse gases emissions

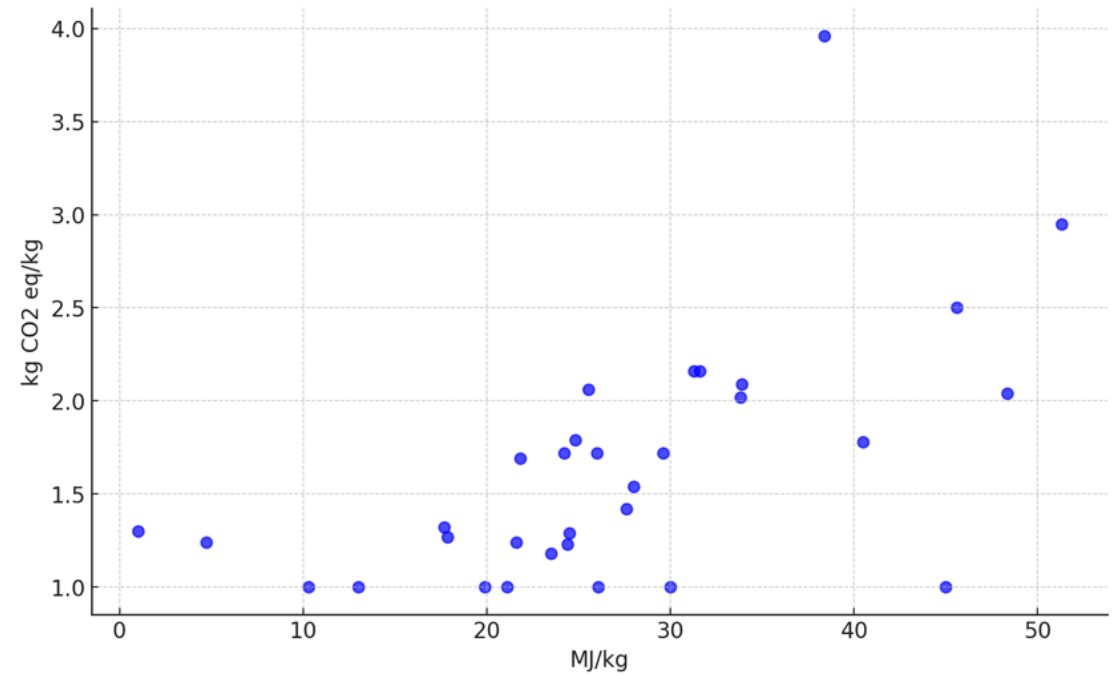


# BACKGROUND: LIFE CYCLE GHG EMISSIONS AND CUMULATIVE ENERGY DEMAND: CARBON FIBER AND GLASS FIBER

## Carbon Fiber



## Glass Fiber



Kg CO2 eq: One kg of CO2 equivalent – Global Warming Potential

MJ: Megajoules – Cumulative Energy Demand

\* The LCA data presented in this graph includes all moduli of glass-reinforced plastic (GRP) and carbon-reinforced plastic (CF) combined

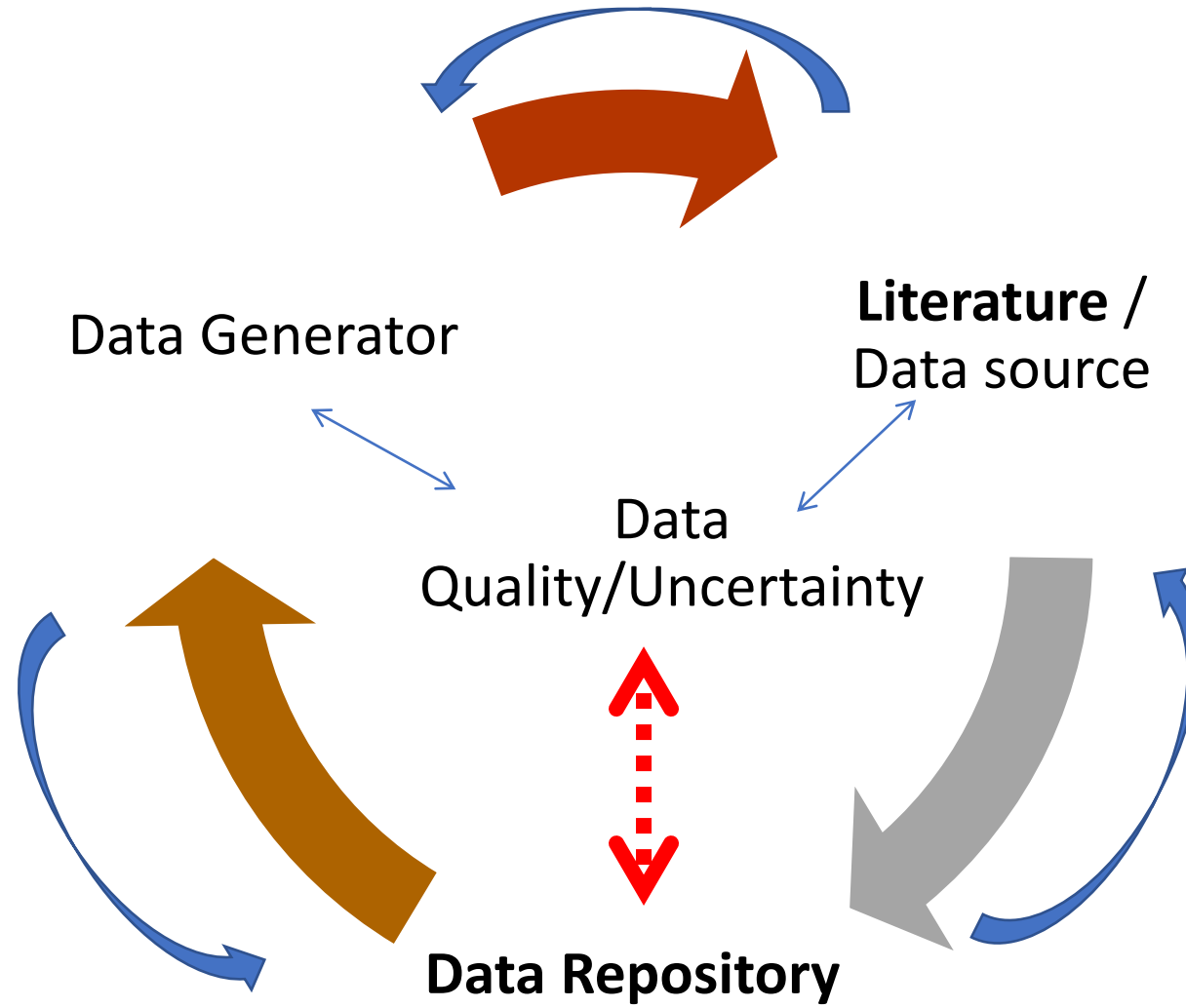
# DATA QUALITY ASSESSMENT

“You can’t manage what you can’t measure.”

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# LCA DATA LIFECYCLE

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# Major LCI data sources

softwares

**SimaPro**

**openLca**



thinkstep  
**GaBi**

databases

**ei** ecoinvent

 **JRC**  
EUROPEAN COMMISSION

FEDERAL  
**LOA**  
COMMONS

 **sphera**<sup>®</sup>

sector platforms

  
Eco Impact  
Calculator  
By EuCIA

**MARINESHIFT360**

literature

**Scopus**<sup>®</sup>



**ELSEVIER**

 **Springer**

 *literature*



ISO 14040/44:2006

- “The characteristics of data that relate to their ability to satisfy **stated requirements**”
- “**Data Quality requirements** shall be specified to enable the **goal** and **scope** of the LCA to be **met**”

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## LCA DATA QUALITY REQUIREMENTS

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***“where a study is intended to be used in comparative assertions intended to be disclosed to the public, the [following] data quality requirements” shall be addressed, (ISO,2006)***

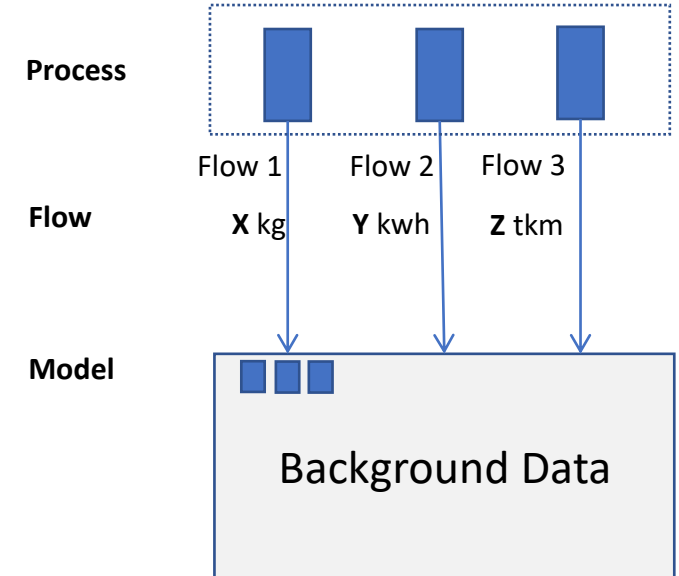


# DATA QUALITY IN LCA



ISO 14040/44:2006

- Flexibility in determining the approach for addressing DQA-specific areas
- It does not specify to which component, or level, data quality analysis should be applied



# METHODOLOGIES FOR LCI DATA QUALITY ASSESSMENT (DQA)

**ILCD handbook**  
International Reference Life Cycle Data System



General guide for Life Cycle Assessment  
- Detailed guidance



First editor



**PEF/OEF**

Product/Organisation Environmental Footprint

## Pedigree Matrix

Indicator score	1	2	3	4	5 (default)
<b>Reliability</b>	Verified <sup>3</sup> data based on measurements <sup>4</sup>	Verified data partly based on assumptions or non-verified data based on measurements	Non-verified data partly based on qualified estimates	Qualified estimate (e.g. by industrial expert)	Non-qualified estimate
<b>Completeness</b>	Representative data from all sites relevant for the market considered, over an adequate period to even out normal fluctuations	Representative data from >50% of the sites relevant for the market considered, over an adequate period to even out normal fluctuations	Representative data from only some sites (<<50%) relevant for the market considered or >50% of sites but from shorter periods	Representative data from only one site relevant for the market considered or some sites but from shorter periods	Representativeness unknown or data from a small number of sites and from shorter periods
<b>Temporal correlation</b>	Less than 3 years of difference to the time period of the dataset	Less than 6 years of difference to the time period of the dataset	Less than 10 years of difference to the time period of the dataset	Less than 15 years of difference to the time period of the dataset	Age of data unknown or more than 15 years of difference to the time period of the dataset
<b>Geographical correlation</b>	Data from area under study	Average data from larger area in which the area under study is included	Data from area with similar production conditions	Data from area with slightly similar production conditions	Data from unknown or distinctly different area (North America instead of Middle East, OECD-Europe instead of Russia)
<b>Further technological correlation</b>	Data from enterprises, processes and materials under study	Data from processes and materials under study (i.e. identical technology) but from different enterprises	Data from processes and materials under study but from different technology	Data on related processes or materials	Data on related processes on laboratory scale or from different technology

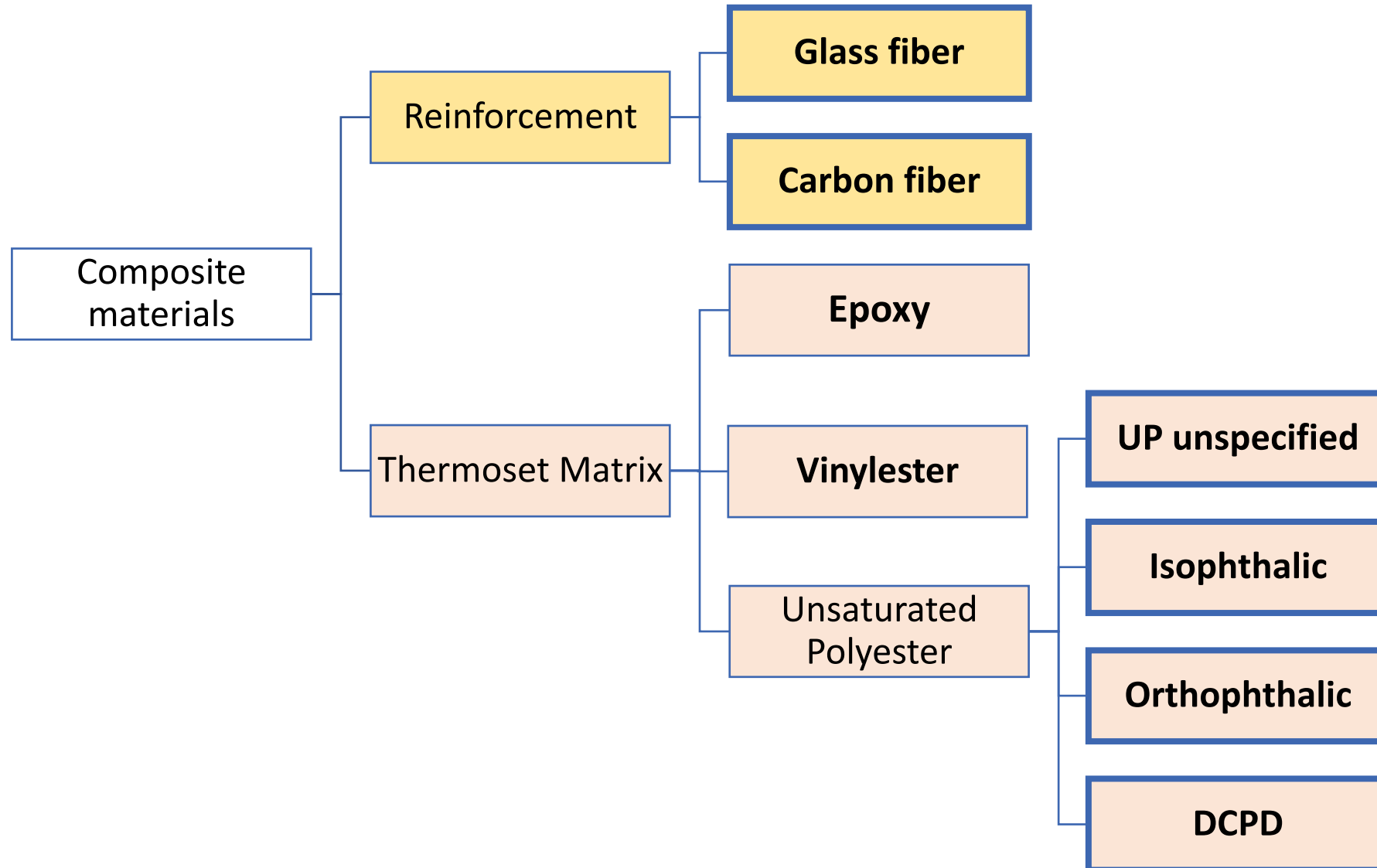
**U.S Life Cycle Inventory Database**





# **Fiber Reinforced Composite Materials**

# FIBER REINFORCED COMPOSITE MATERIALS



# UNSATURATED POLYESTER RESIN INPUT PROCESS DATA SET

Source UP unspecified	EI	USL CI	SP	Eu Cia
<b>Input from Technosphere: Materials Resources</b>				
Acetic anhydride	■			
Adipic acid	■			
Butadiene				■
ethylene glycol	■	■		■
ethylene at plant		■		
Maleic anhydride		■	■	■
Neo pentyl glycol		■		
Phthalic anhydride	■	■	■	■
Polyethylene terephthalate		■		
Purified terephthalic acid		■		■
Propylene glycol, liquid	■	■	■	■
Terephthalic acid		■		
Di ethylene glycol				■
Ethylene		■		
Tetrabromophthalic acid		■		
Styrene		■	■	■
Catalyst			■	
Nitrogen			■	■
chemical factory, organics	■			■

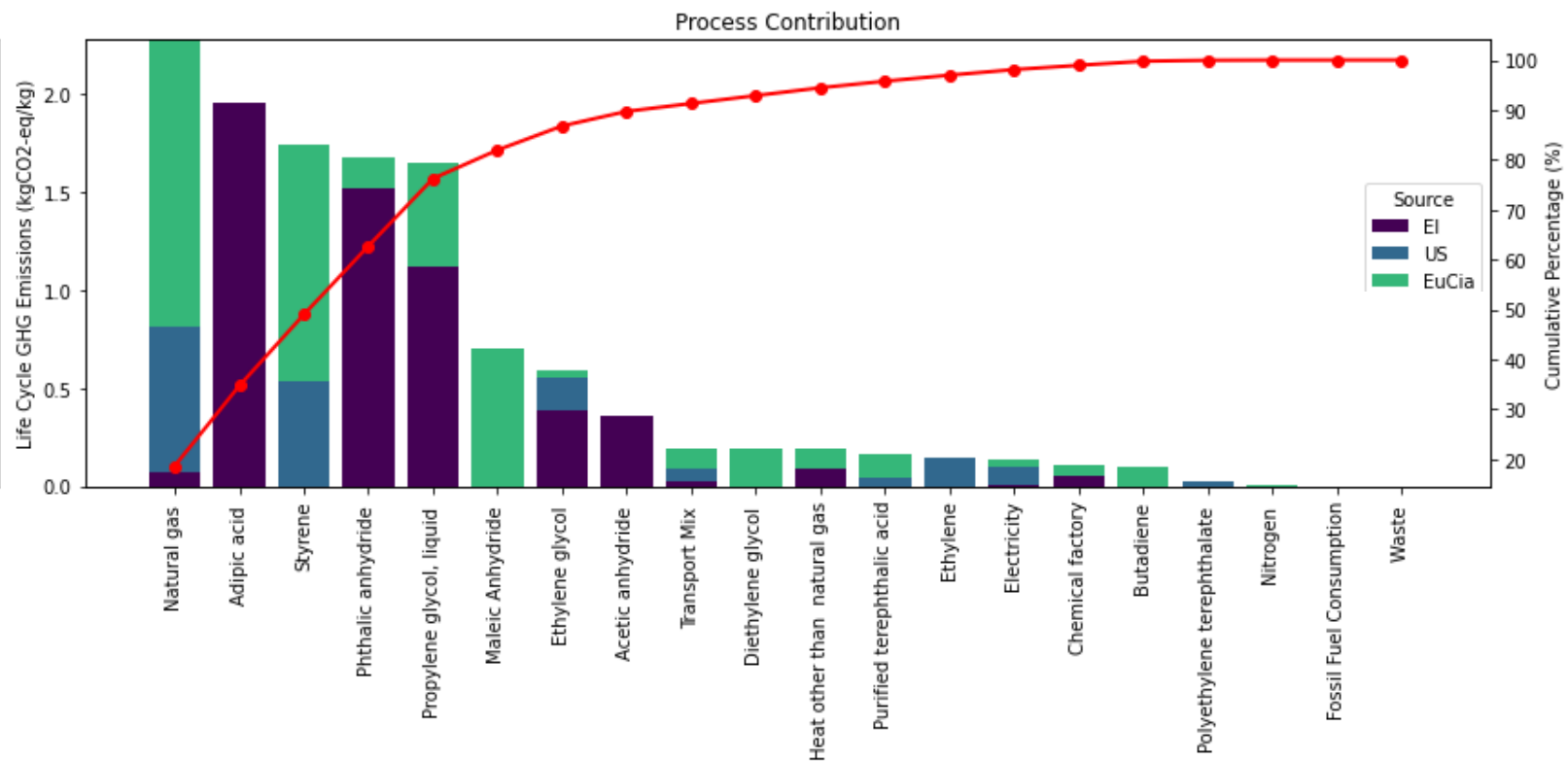
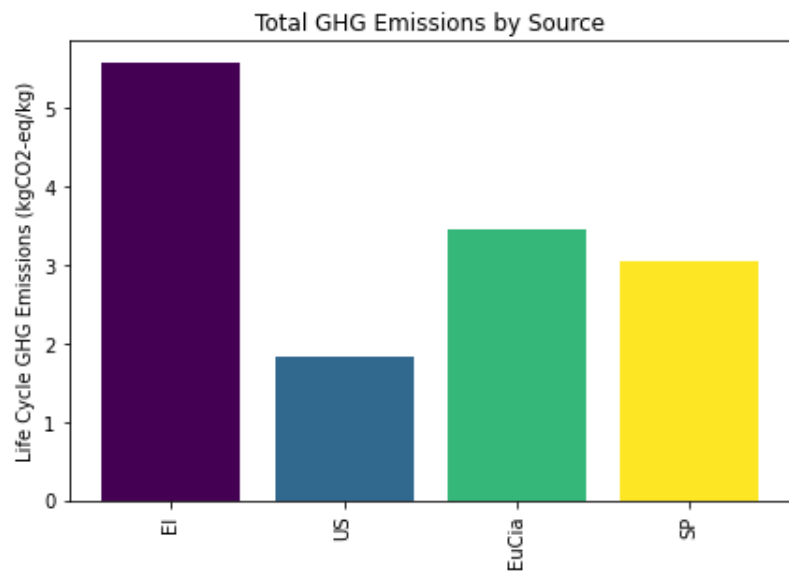
<b>Input from environment</b>				
Water for cooling	■			
Water	■	■		
<b>Input from Technosphere: Energy</b>				
electricity, medium voltage	■	■	■	■
heat natural gas	■	■	■	■
Heat Fuel	■			
Heat Diesel		■		
Steam				■
<b>Input from technosphere: Transport</b>				
Transport combined		■		■
Transport , Train, Diesel Powered		■		

# UNSATURATED POLYESTER RESIN OUTPUT PROCESS DATA SET

Output	EI	US	SP	Eu Cia
Source UP unspecified				
1-Butanol				
Carbon dioxide, fossil				
Carbon monoxide				
Dicyclopentadiene				
Ethylene glycol				
Heat, waste				
Hydrocarbons, unspecified				
Maleic anhydride				
Methane				
Methyl methacrylate				
Nitrogen oxides				
Hydrocarbons, unspecified				
Particulates, > 2.5 um, and < 10um				
Particulates, < 2.5 um				
Particulates, unspecified				
O-phthalic acid				
Styrene				
Sulfur oxides				
Toluene, vinyl				
NMVOC, non-methane volatile organic compounds				
Xylene				
Emissions to water				

Aluminium				
BOD5 (Biological Oxygen Demand)				
Cadmium				
Chromium				
COD (Chemical Oxygen Demand)				
Cyanide				
Suspended solids, unspecified				
Lead				
Nickel				
Oils, unspecified				
Suspended solids, unspecified				
DOC, Dissolved Organic Carbon				
TOC, Total Organic Carbon				
Water, RER				
Zinc				
Unsaturated Polyester resin scrap				
<b>Outputs to technosphere: Waste</b>				
Disposal solid waste to municipal incineration				
Disposal solid waste to waste energy				
Disposal solid waste to sanitary landfill				
Hazardous waste incineration				
Wastewater				

# LIFE CYCLE GHG EMISSIONS: CONTRIBUTION ANALYSIS

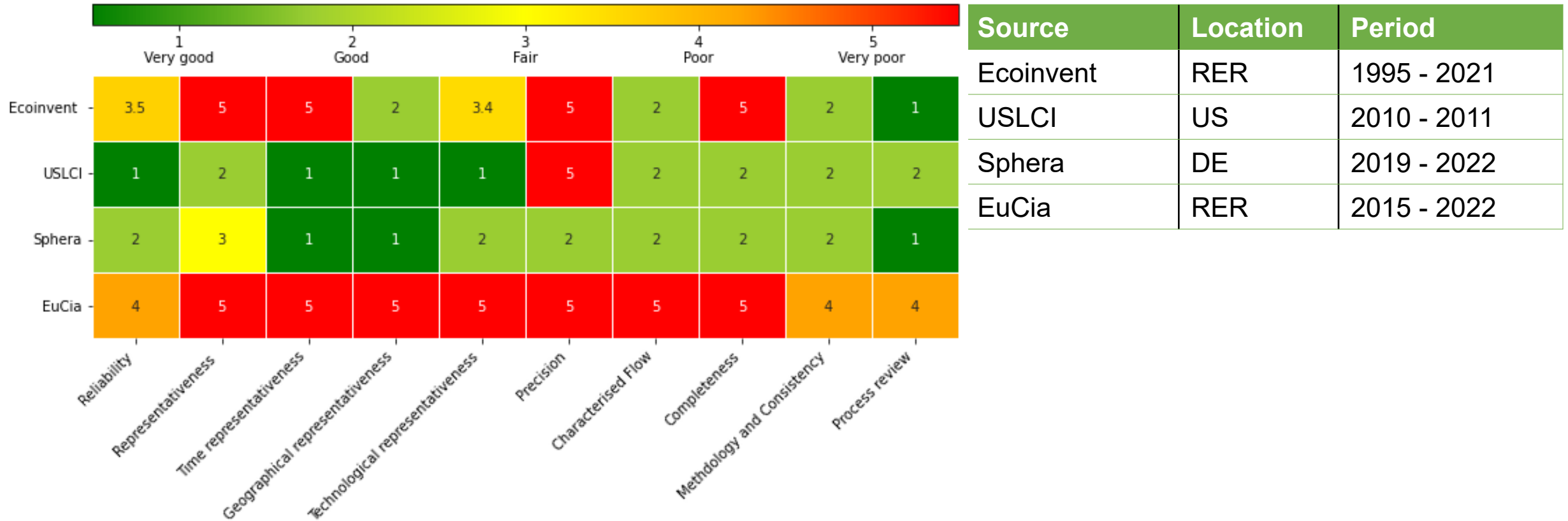


# DATA QUALITY ASSESSMENT @ FLOW LEVEL: UNSATURATED POLYESTER RESIN

	1 Very good	2 Good	3 Fair	4 Poor	5 Very poor		
I: acetic anhydride	3	5	5	1	3		
adipic acid	3	5	5	1	3		
chemical factory	4	5	5	3	5		
electricity	3	5	5	1	3		
ethylene glycol	3	5	5	1	3		
heat, natural gas	3	5	5	1	3		
phthalic anhydride	3	5	5	1	3		
propylene glycol, liquid	3	5	5	1	3		
Water	5	5	5	1	4		
O: BOD5, Biological Oxygen Demand	3	5	5	1	3		
COD, Chemical Oxygen Demand	3	5	5	1	3		
DOC, Dissolved Organic Carbon	4	5	5	3	5		
TOC, Total Organic Carbon	3	5	5	1	3		
Water	2	2	5	1	1		
	Reliability	Representativeness	Time representativeness	Geographical representativeness	Technological representativeness	Precision	Fit for Purpose

- Ecoinvent
- Polyester resin production, unsaturated – RER (Europe)
- Period : 1995-01-01 to 2021-12-31

# DATA QUALITY ASSESSMENT @ PROCESS LEVEL: UNSATURATED POLYESTER RESIN



Source	Location	Period
Ecoinvent	RER	1995 - 2021
USLCI	US	2010 - 2011
Sphera	DE	2019 - 2022
EuCia	RER	2015 - 2022

# UNSATURATED POLYESTER RESINS INPUT PROCESS DATA SET

Source	ISO	Ortho	DCPD	Vinyl	Vinyl US
<b>Input from technosphere: Materials Resources</b>					
Bisphenol A, powder					
Acrylic acid					
Epoxy					
Diethylene glycol					
Maleic anhydride					
Methacrylic acid					
Butadiene					
Propylene glycol					
Purified terephthalic acid					
Styrene					
Oxygen, liquid					
Nitrogen, liquid					
Chemical factory					

Phthalic anhydride					
Silica Sand					
Electricity, low voltage					
Electricity, renewable energy					
Heat					
Steam, in chemical industry					
<b>Input from technosphere: Transport</b>					
Transport combined truck					
Transport , Train, Diesel Powered					
Transport ocean freighter					
<b>Input from environment</b>					
Water					



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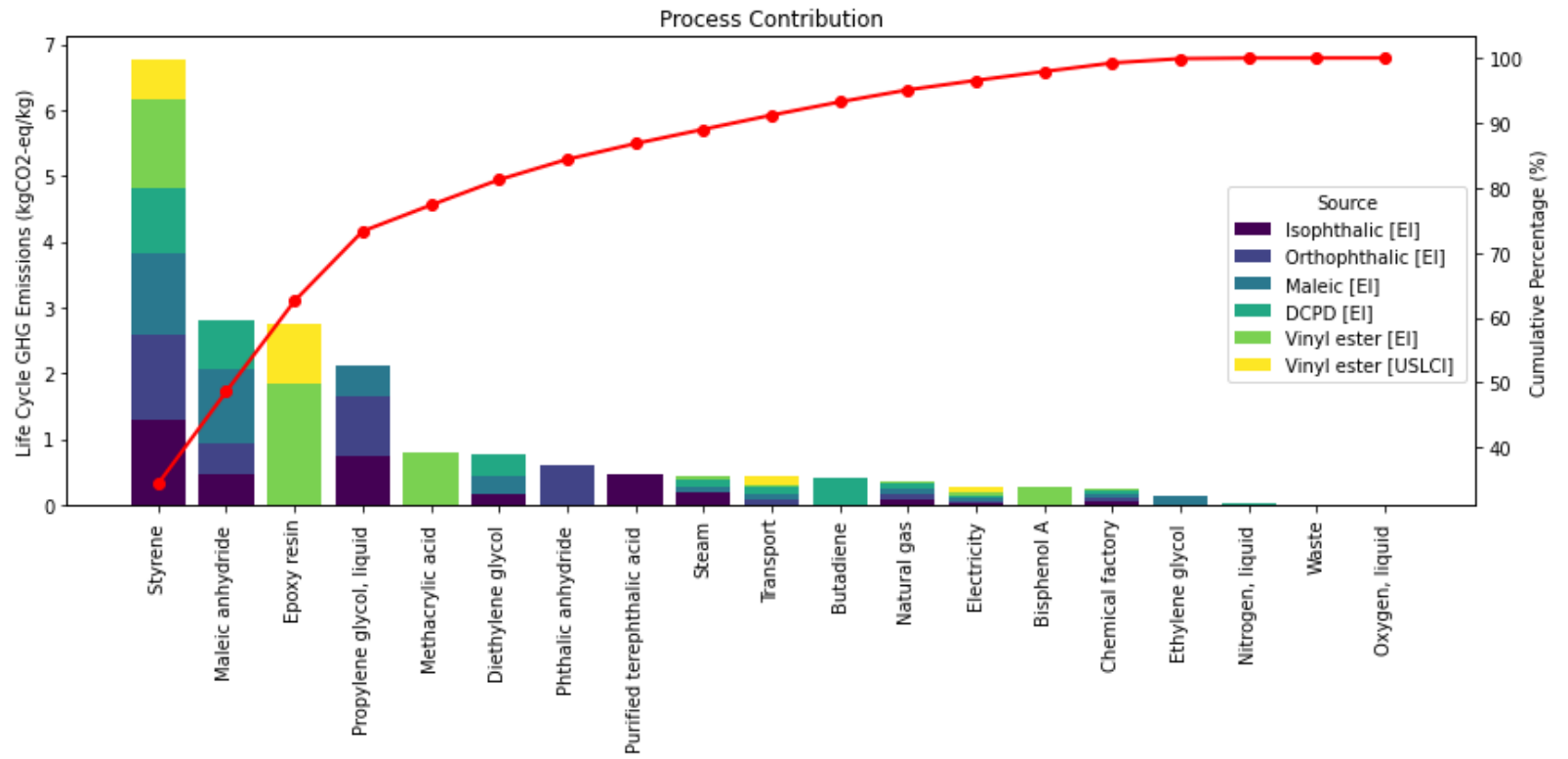
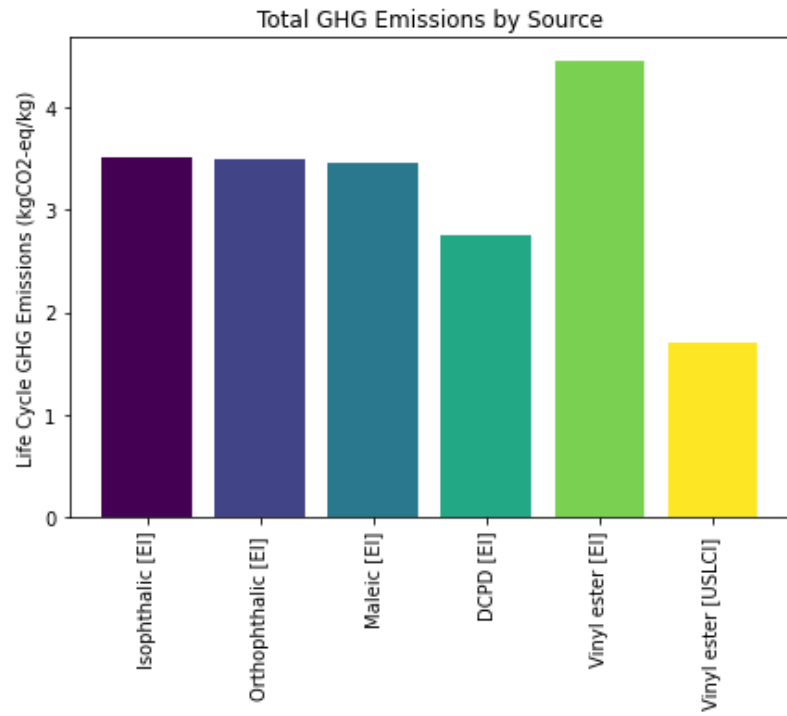
## UNSATURATED POLYESTER RESINS OUTPUT PROCESS DATA SET

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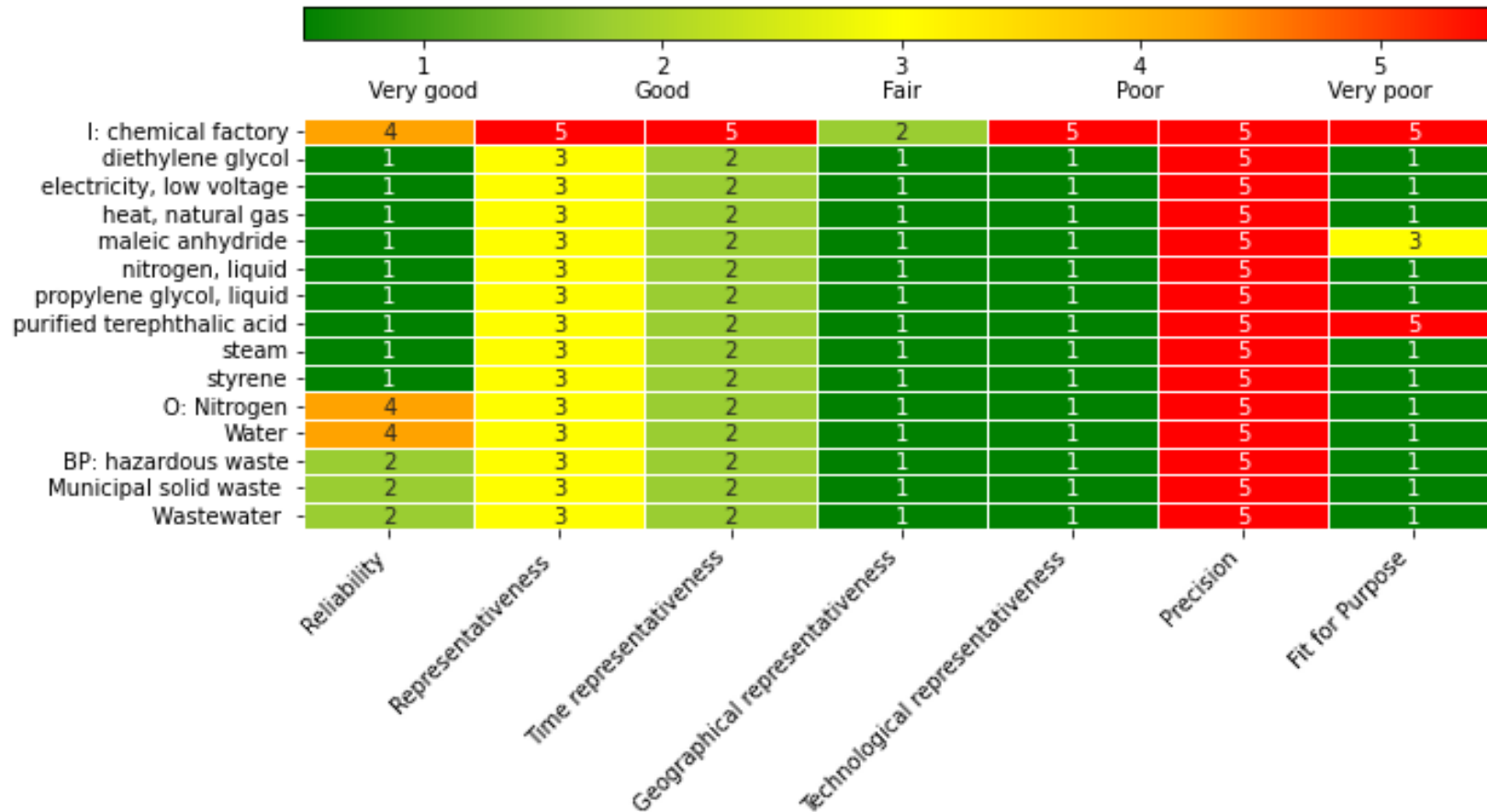
Source	ISO	Orht ho	DCP D	Vinyl	Vinyl US
Nitrogen, atmospheric					
NMVOC, non-methane volatile organic compounds					
Methyl methacrylate					
Particulate matter					
Emissions to water					
Water/m3					
Hazardous waste, for incineration					
Municipal solid waste					
Wastewater					
Municipal solid waste to landfill					
Solid waste to incineration with energy recovery					
Solid waste to incineration without energy recovery					
Recycling Solid waste					

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# LIFE CYCLE GHG EMISSIONS: UNSATURATED POLYESTER RESINS

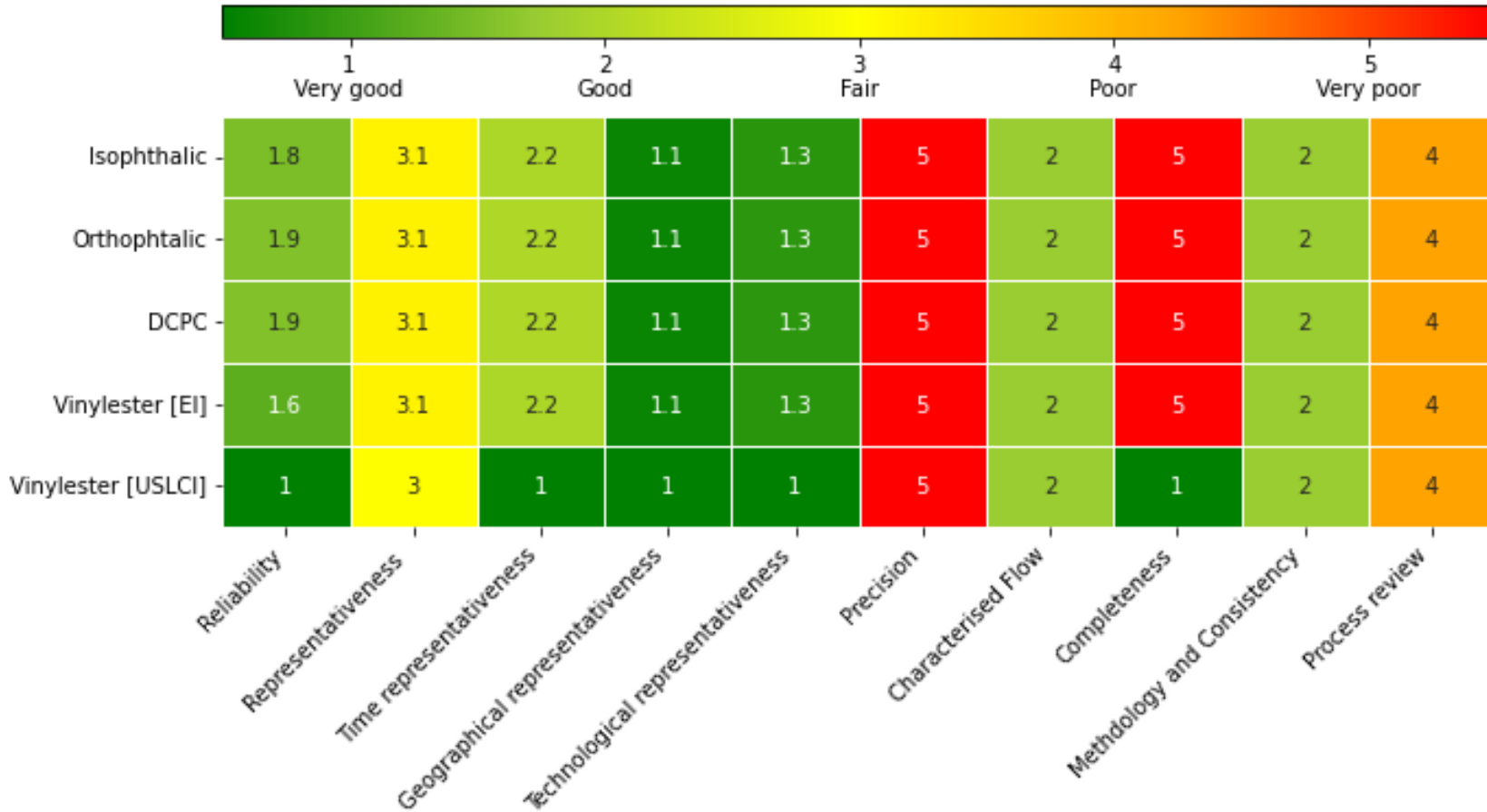


# DATA QUALITY ASSESSMENT @ FLOW LEVEL: ISOPHTHALIC UNSATURATED POLYESTER RESIN



- Ecoinvent/EuCia
- isophthalic acid based unsaturated polyester resin production – RER
- Period : 2013 to 2022

# DATA QUALITY ASSESSMENT @ PROCESS LEVEL: UNSATURATED POLYESTER RESINS



Source	Location	Period
Ecoinvent	RER	2013 - 2022
USLCI	US	2021 - 2022

# EPOXY INPUT PROCESS DATA SET

Source Epoxy	EI	PE	US	Sph era
Bisphenol A, powder				
Epichlorohydrin				
Nitrogen				
Sodium hydroxide, without water				
Isopropanol				
Hydraulic Acid				
Catalyst				
Styrene				
Oxygen, liquid				
Nitrogen, liquid				
Chemical factory				
Crude oil				
Electricity, low voltage				
Heat				
Steam, in chemical industry				
Electricity Mix				
Water, cooling, unspecified natural origin				
Water, river				
Water, well, in ground				
Deonised Water				

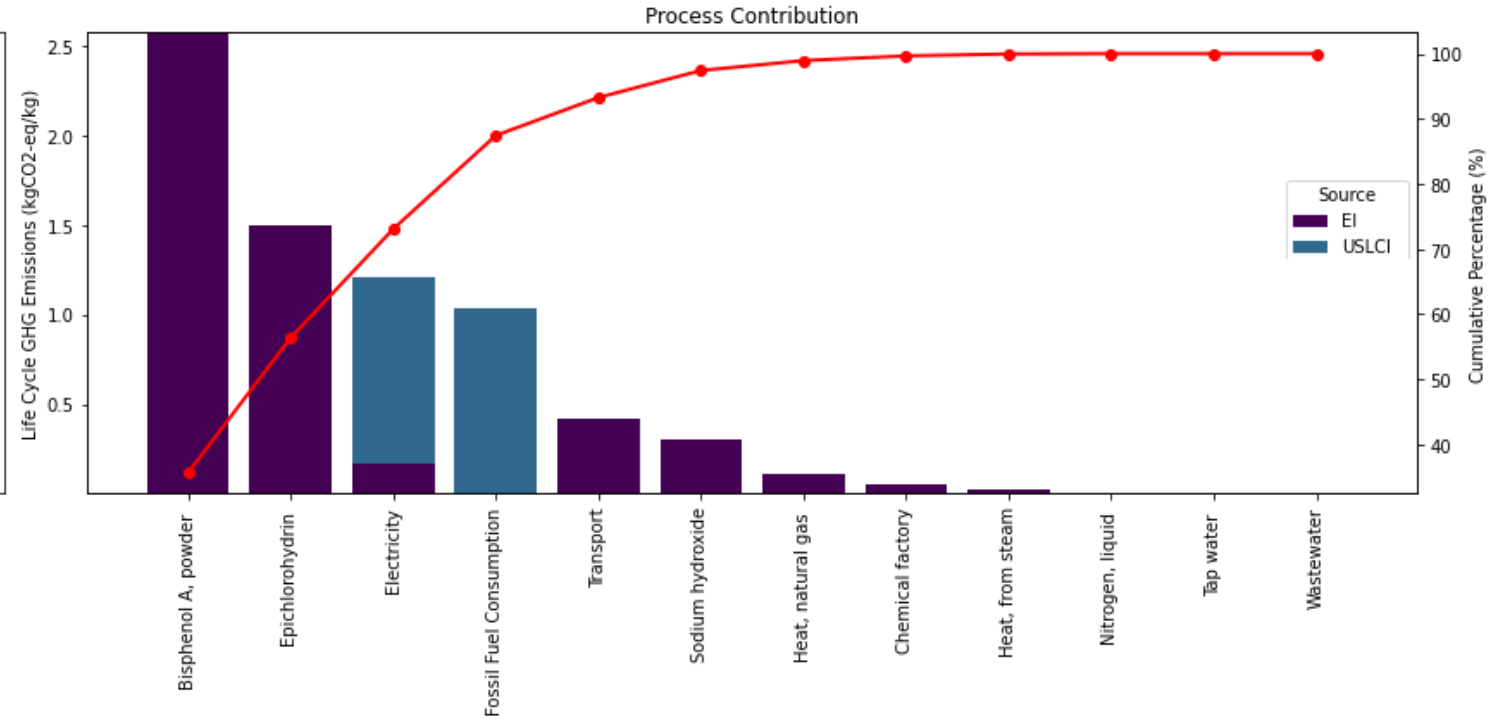
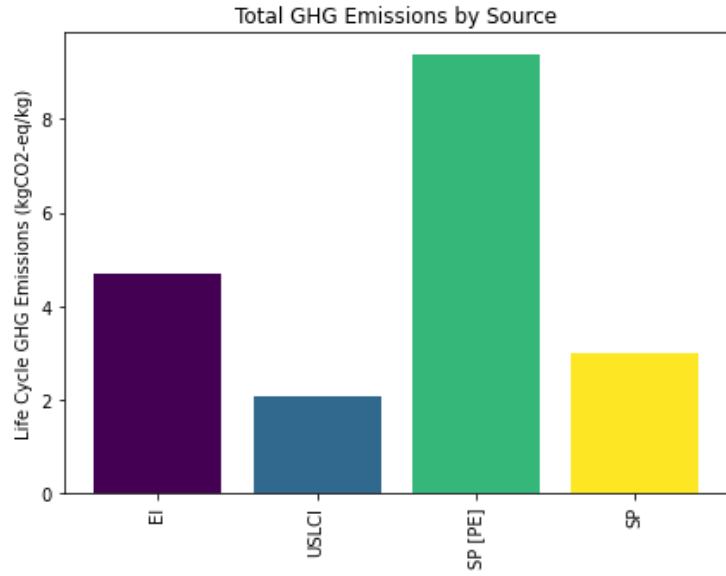
Deionised water				
Quartz sand				
Packaging				
Electricity, medium voltage				
Heat, district or industrial, natural gas				
Propane				
Light fuel oil				
Heavy fuel oil				
Oxygen				
<b>Input from Technosphere: Transport</b>				
Transport				
River transport				
Rail transport				
Road transport				

# EPOXY OUTPUT PROCESS DATA SET

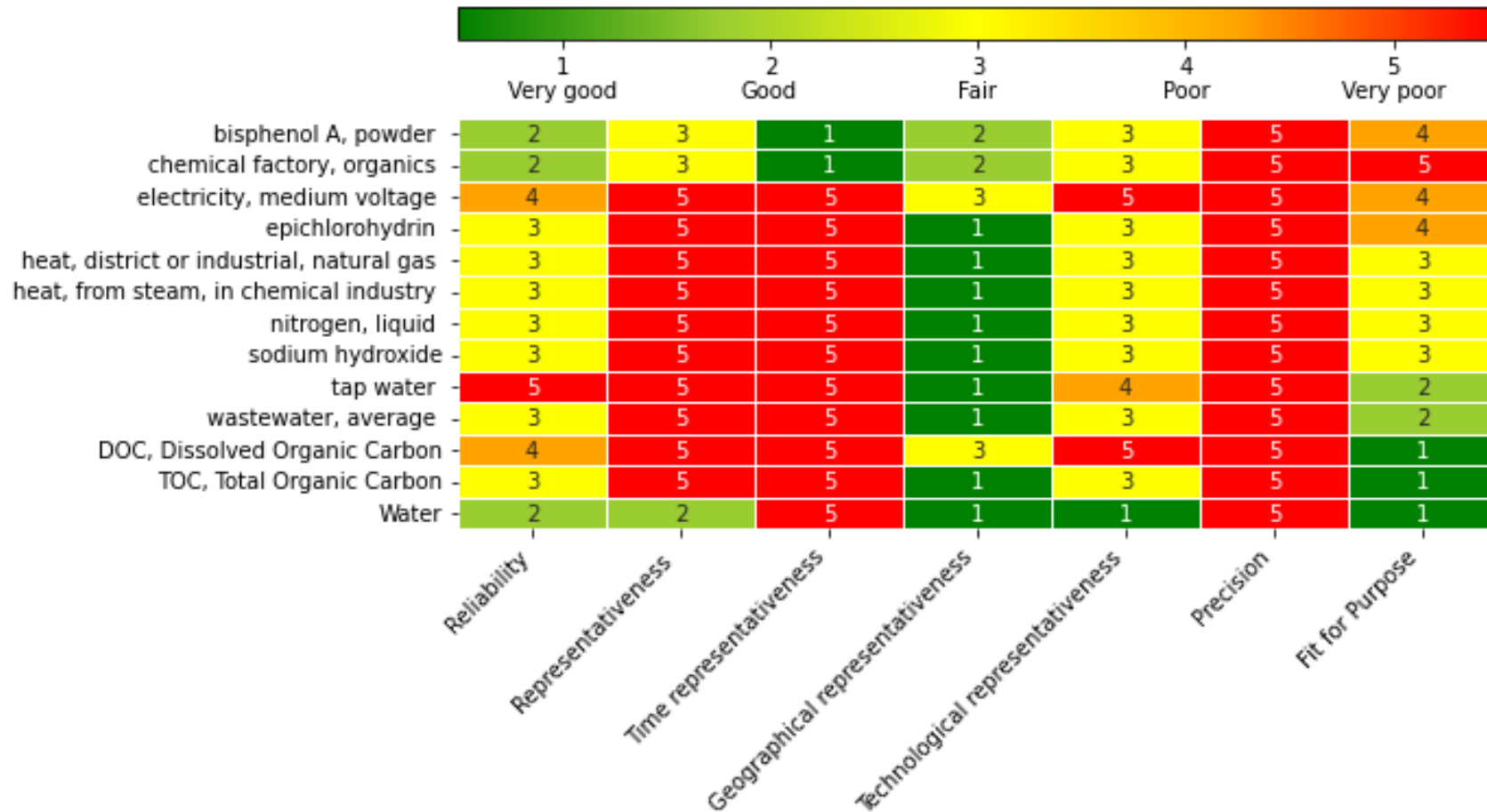
<b>Output: Emission to Air</b>				
Antimony				
Arsenic				
Cadmium				
Carbon dioxide, fossil				
Hydrogen chloride				
Hydrogen fluoride				
Nitrogen oxides				
NMVOC, non-methane volatile organic compounds				
Particulates, < 2.5 um				
Particulates, > 10 um				
Particulates, > 2.5 um, and < 10um				
Sulfur dioxide				
<b>Emissions to Water</b>				
Water/m3				
Water, RER				

<b>Waste</b>				
Waste mineral oil				
Waste mineral wool, for final disposal				
Waste mineral wool, for final disposal				
Waste paint				
Wastewater from glass production				

# LIFE CYCLE GHG EMISSIONS: EPOXY RESIN



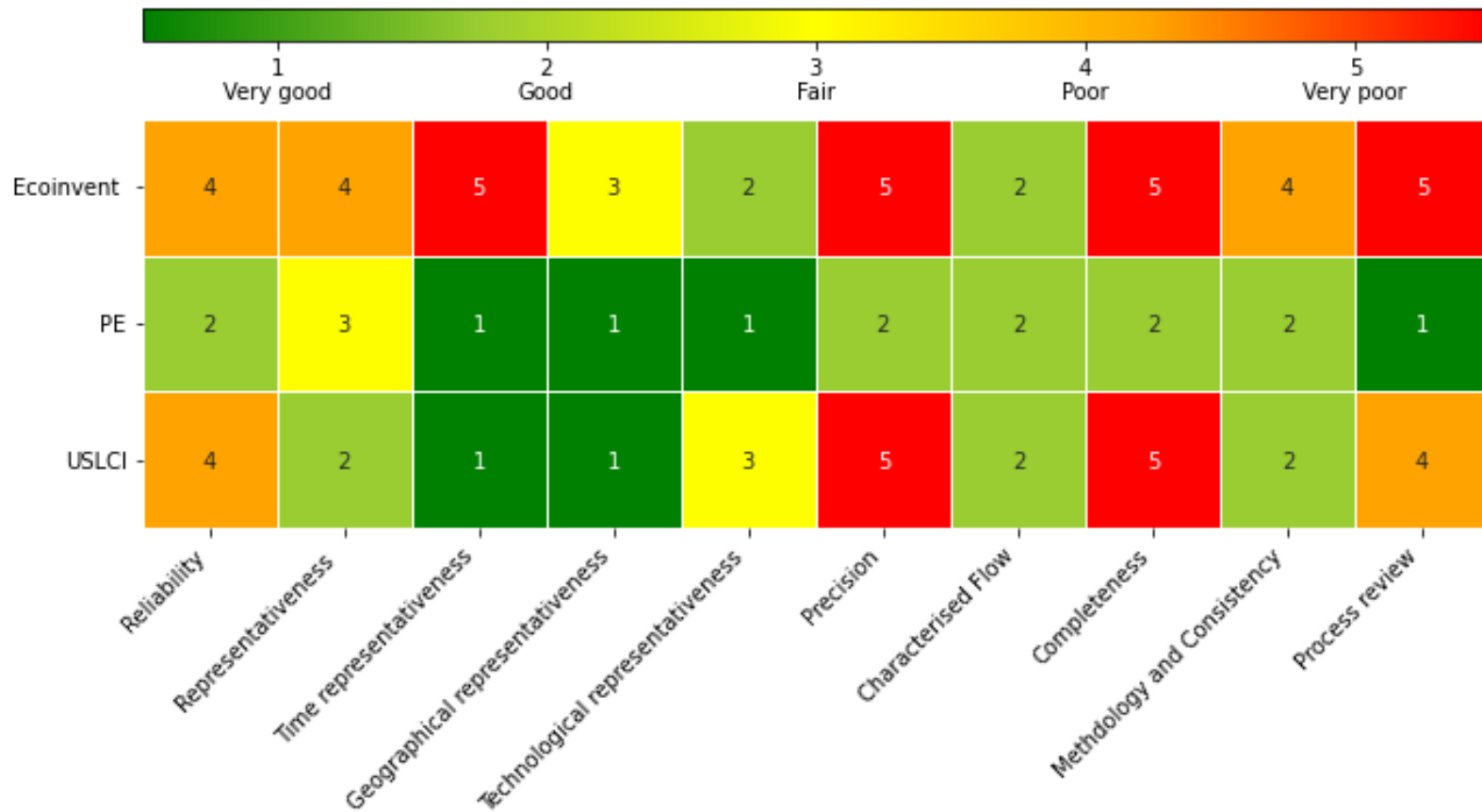
# DATA QUALITY ASSESSMENT @ FLOW LEVEL: EPOXY RESIN



- Ecoinvent
- Epoxy resin production, liquid - RER
- Period : 2015 to 2021



# DATA QUALITY ASSESSMENT @ PROCESS LEVEL: EPOXY RESIN



Source	Location	Period
Ecoinvent	RER	2015 - 2022
USLCI	US	2019
PE	RER	2005

# CARBON FIBRE INPUT PROCESS DATA SET

Source	SP	EI	EuC ia	US	JP
<b>Inputs from technosphere</b>					
Polyacrylonitrile fibres					
Acrylonitrile butadiene styrene copolymer					
Acrylonitrile					
Comonomer					
Polymerization catalyst					
Solvent					
PAN fiber oil					
Chemical organic					
Injection moulding					
Carbon fiber sizing agent					
Electrolyte (sulfuric acid)					
Outer packaging material					
Epoxy resin					
Hexamethylene diamine (HMDA) from acrylonitrile via adiponitrile					
Potassium permanganate					
ammonium bicarbonate					
Sulfuric Acid					
Polydimethylsiloxane					
Nitrogen (gaseous)					
Ammonia Hydrogen carbonate					

Energy/heat					
Electricity					
Heat from natural gas					
Carbonization HT primary gas					
Carbonization HT primary electricity					
Carbonization LT primary gas					
Carbonization LT primary electricity					
Washing primary electricity use					
Washing primary gas					
Drying-I primary electricity use					
Drying-I primary gas use					
Avivage primary electricity					
Avivage primary gas use					
Drying-II primary electricity					
Drying-II primary gas use					
Spooling primary electricity					
Spooling primary gas					
Steam Consumption					
Fuel Consumption					

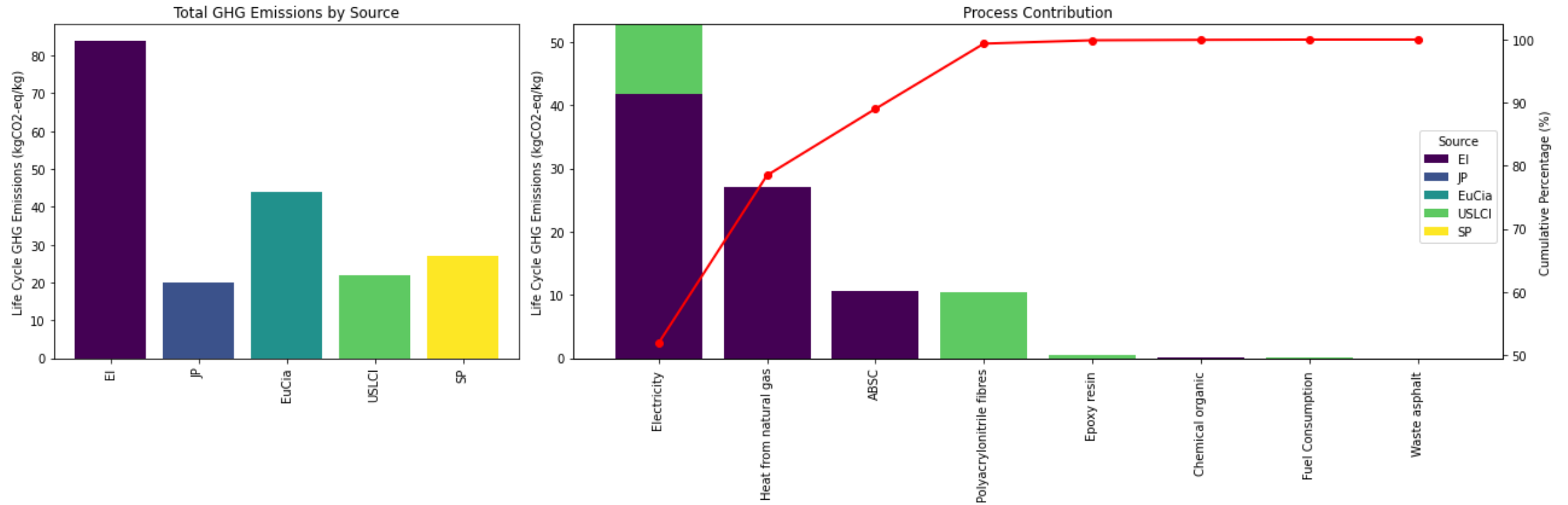
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# CARBON FIBRE OUTPUT PROCESS DATA SET

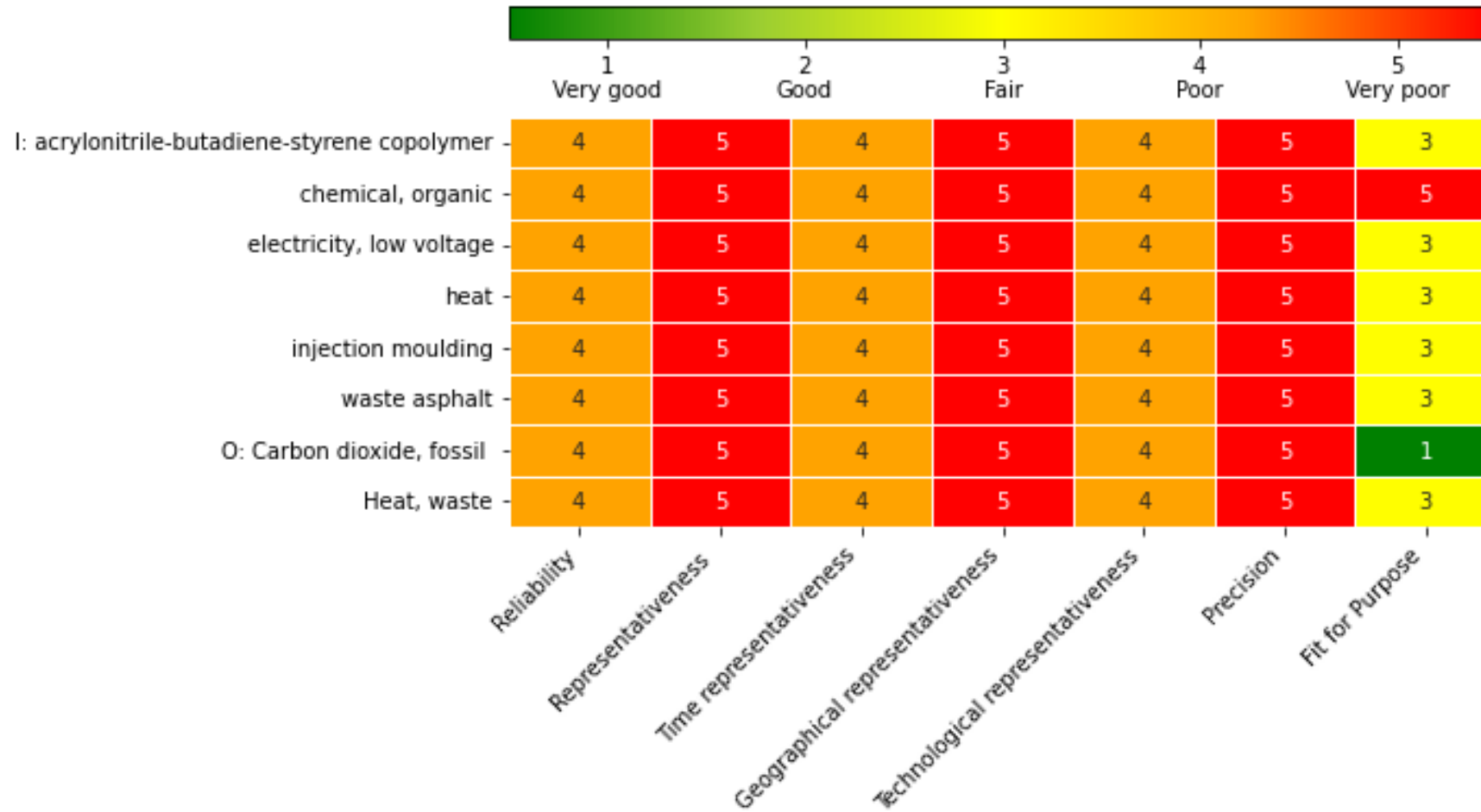
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Source	SP	EI	EuC ia	US	JP
Carbon dioxide, fossil					
Heat, Waste					
Nitrogen oxide (NOx)					
<b>Emissions to water</b>					
Water					
<b>Waste</b>					
Waste asphalt					
Solid waste					
Exhaust gas treatment					
Elektrolysis					
<b>Transport</b>					
Transport Mix					

# LIFE CYCLE GHG EMISSIONS: CARBON FIBRE

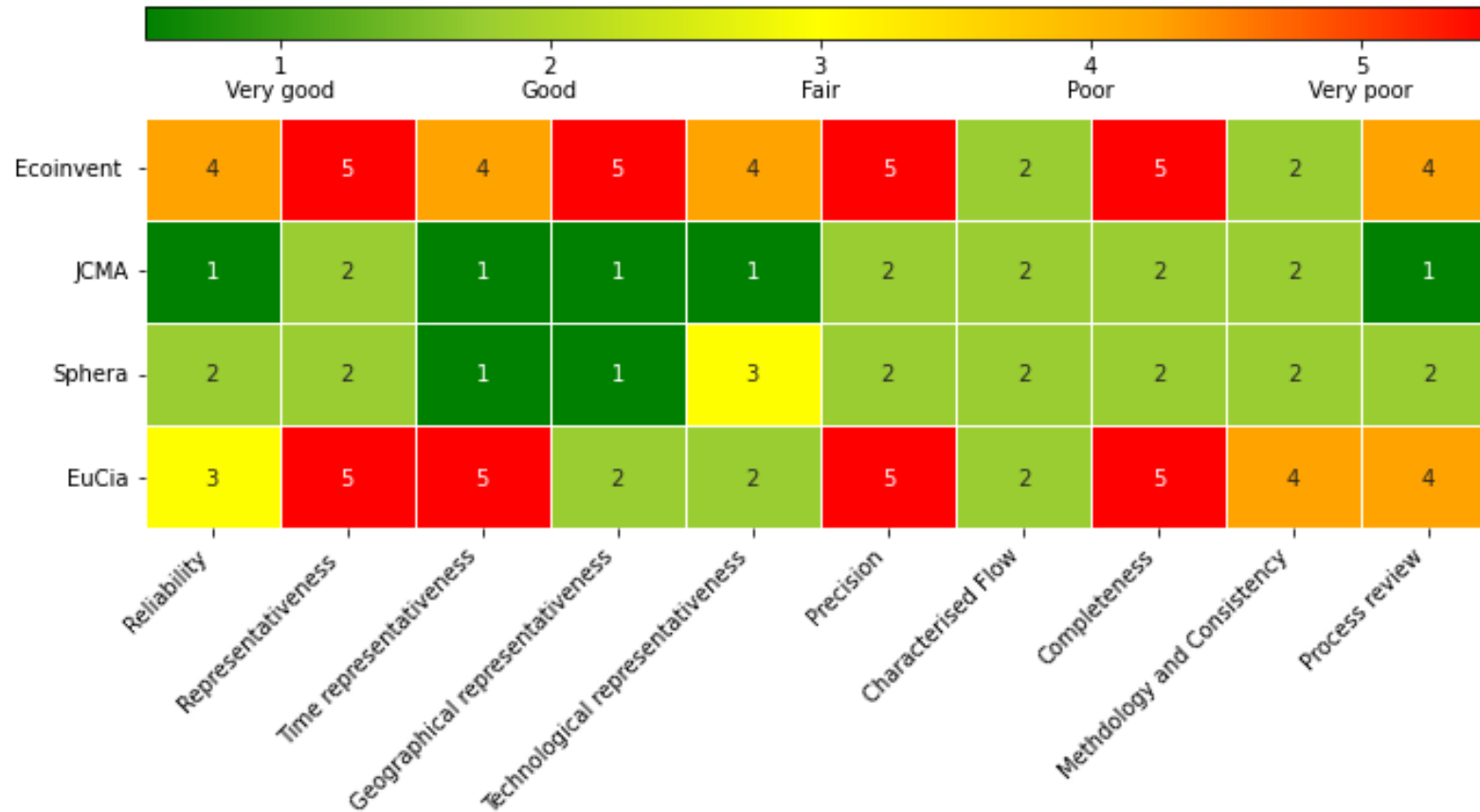


# DATA QUALITY ASSESSMENT @ FLOW LEVEL: CARBON FIBRE



- Ecoinvent
- Carbon fibre reinforced plastic, injection moulded – GLO
- Period : 2016 to 2021

# DATA QUALITY ASSESSMENT @ PROCESS LEVEL: CARBON FIBRE



Source	Location	Period
Ecoinvent	RER	1995 - 2021
JCMA	JP	2010 - 2011
Sphera	DE	2019 - 2022
EuCia	RER	2015 - 2022

# GLASS REINFORCED PLASTIC (GRP) INPUT PROCESS DATA SET

Source	EI	PwC	SP	US
<b>Input from Technosphere: Materials Resources</b>				
Aluminium oxide, non-metallurgical				
Boric acid, anhydrous, powder				
Boric oxide				
Borax anhydrous				
Burnt dolomite				
Chemical, organic				
Calcium borat				
Colemanite				
Ethylene glycol				
Epoxy resin				
Feldspar				
Kaolin				
Clay				
Dolomite				
Gypsum				
Polyvinyl acetate				
Flat glass factory				
Filmformer				
Fluorspar, 97% purity				
Phenolic resin				
Lime				
Quicklime				
Limestone				
Magnesium oxide				
Hydrated Lime				
PH-modifier				
Lubricating oil				

Phthalic anhydride					
Silica Sand					
Electricity, low voltage					
Electricity, renewable energy					
Heat					
Steam, in chemical industry					
<b>Input from technosphere: Transport</b>					
Transport combined truck					
Transport , Train, Diesel Powered					
Transport ocean freighter					
<b>Input from environment</b>					
Water					

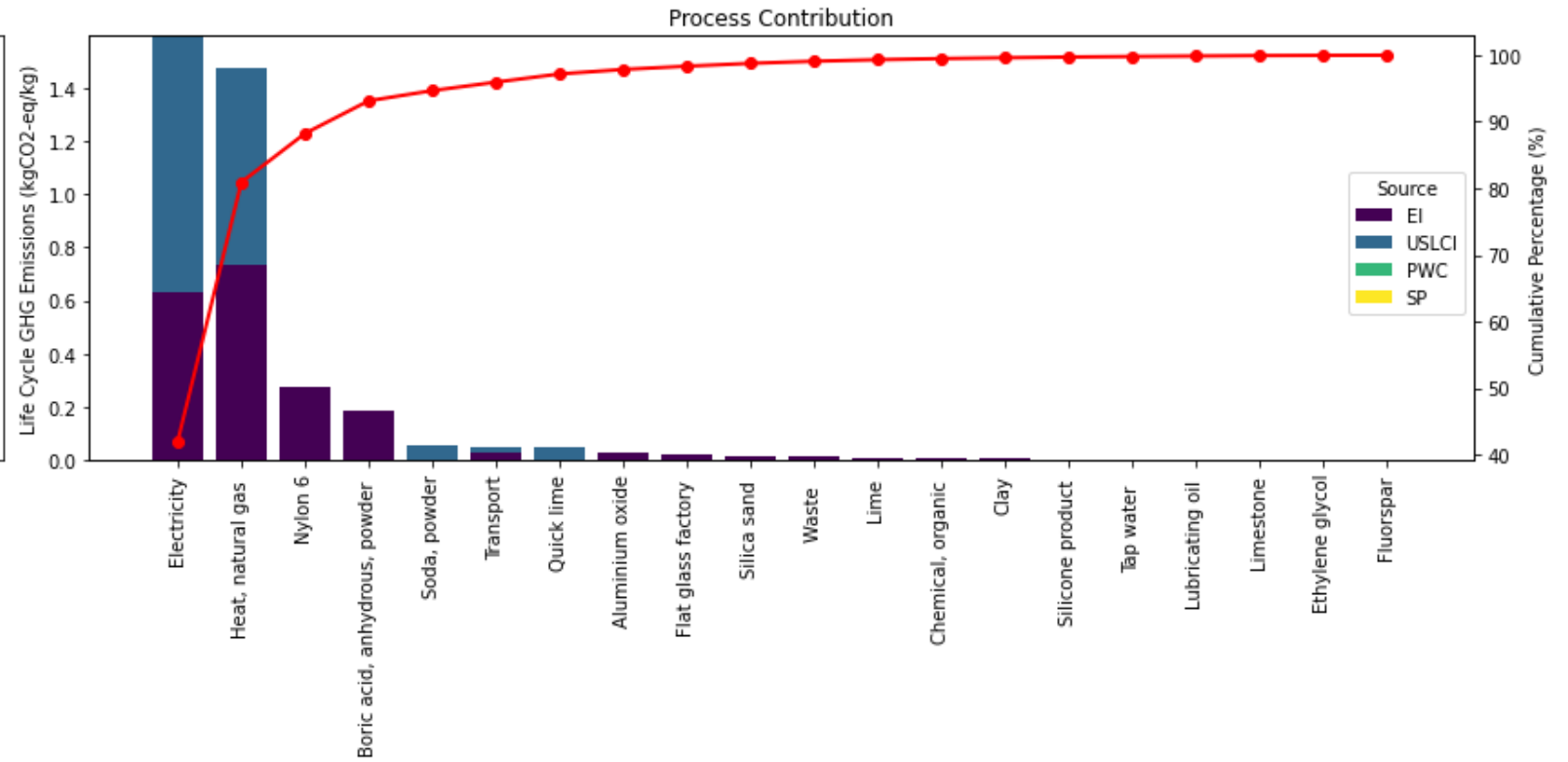
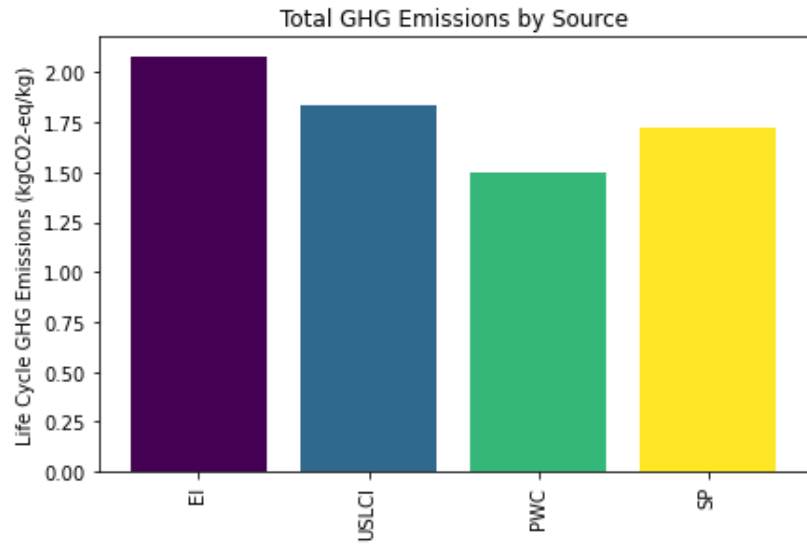
# GLASS REINFORCED PLASTIC (GRP) OUTPUT PROCESS DATA SET

Source	EI	PwC	SP	US
<b>Output: Emission to Air</b>				
Antimony				
Arsenic				
Cadmium				
Carbon dioxide, fossil				
Hydrogen chloride				
Hydrofluoric acid				
Hydrogen fluoride				
Nitrogen oxides				
NMVOC, non-methane volatile organic compounds				
Volatile organic compounds				
Methanol				
Particulates, < 2.5 um				
Particulates, > 10 um				
Particulates, > 2.5 um, and < 10um				
Sulfur dioxide				
Xylene				
Styrene				

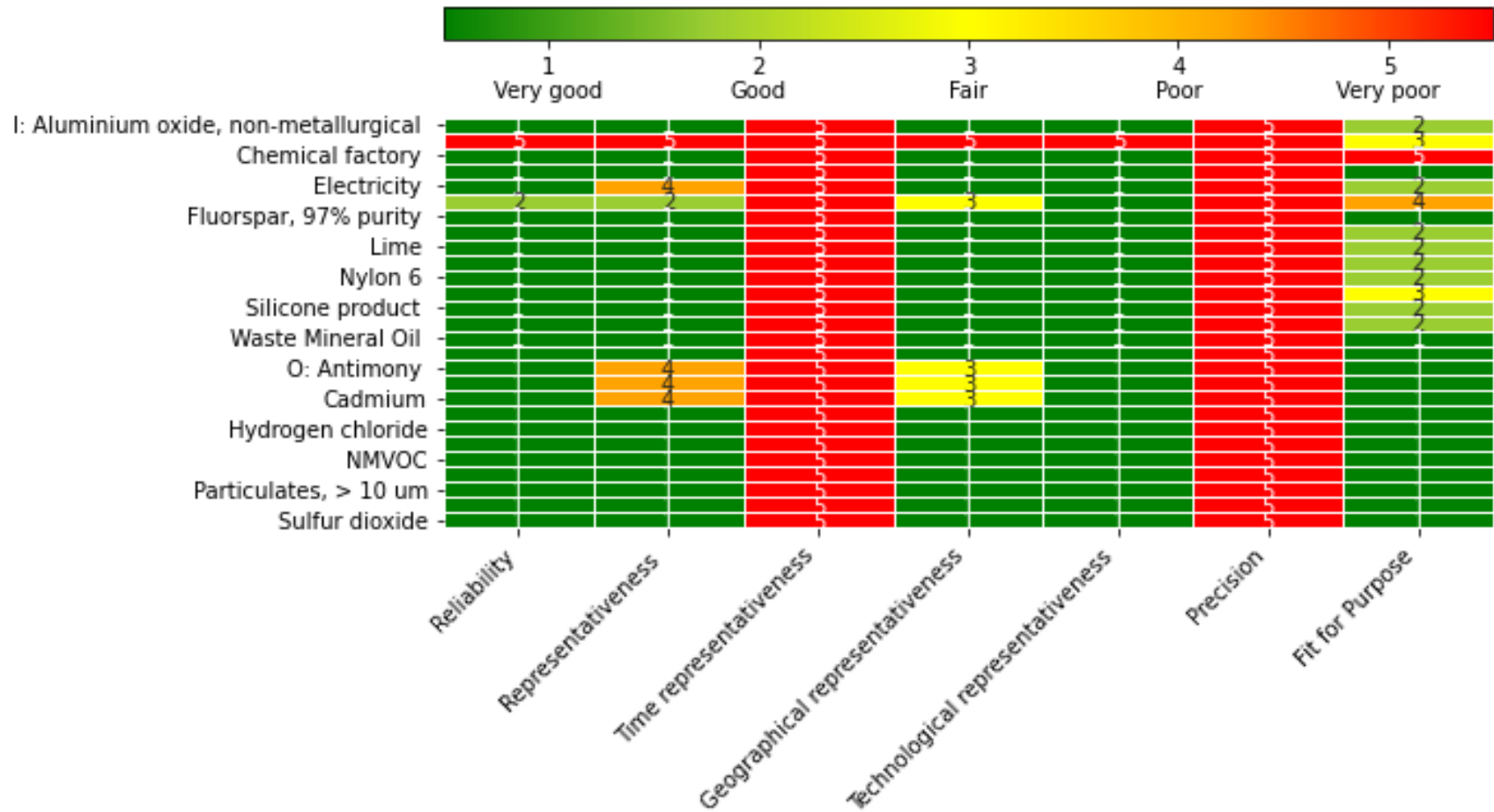
<b>Emissions to Water</b>				
Water/m3				
Water, RER				
<b>Waste</b>				
Waste mineral oil				
Waste mineral wool, for final disposal				
Waste paint				
Wastewater from glass production				



# LIFE CYCLE GHG EMISSIONS: GLASS REINFORCED PLASTIC (GRP)

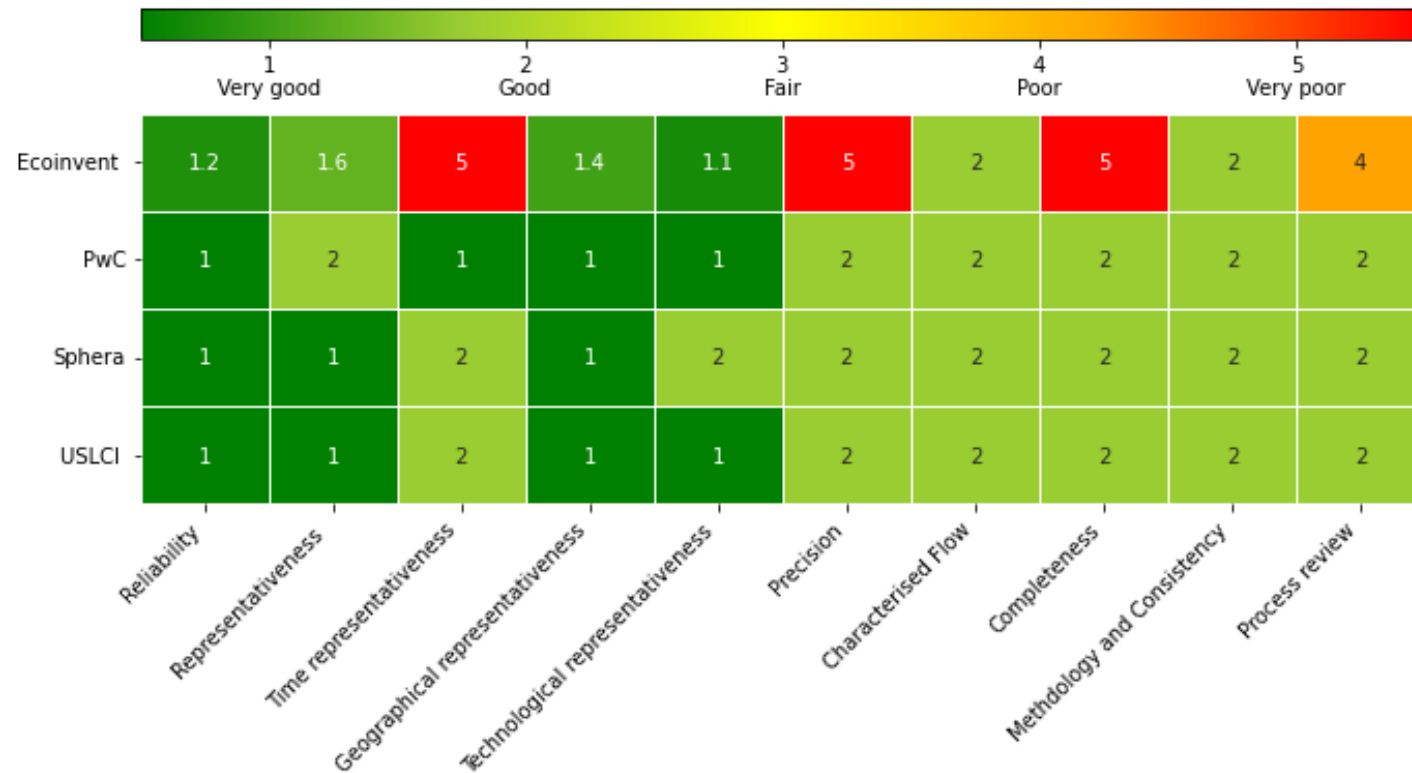


# DATA QUALITY ASSESSMENT @ FLOW LEVEL: GLASS FIBRE



- Ecoinvent
- Glass fibre production RER
- Period : 2000 to 2021

# DATA QUALITY ASSESSMENT @ PROCESS LEVEL: GLASS FIBRE



Source	location	Period
Ecoinvent	RER	2000 - 2021
PwC	RER	2022 - 2023
Sphera	DE	2019 - 2022
USLCI	US	2010 - 2011

# ILLUSTRATIVE CASE STUDY

한국정밀공학학회지 제 36 권 제 9 호 pp. 875-881  
J. Korean Soc. Precis. Eng., Vol. 36, No. 9, pp. 875-881

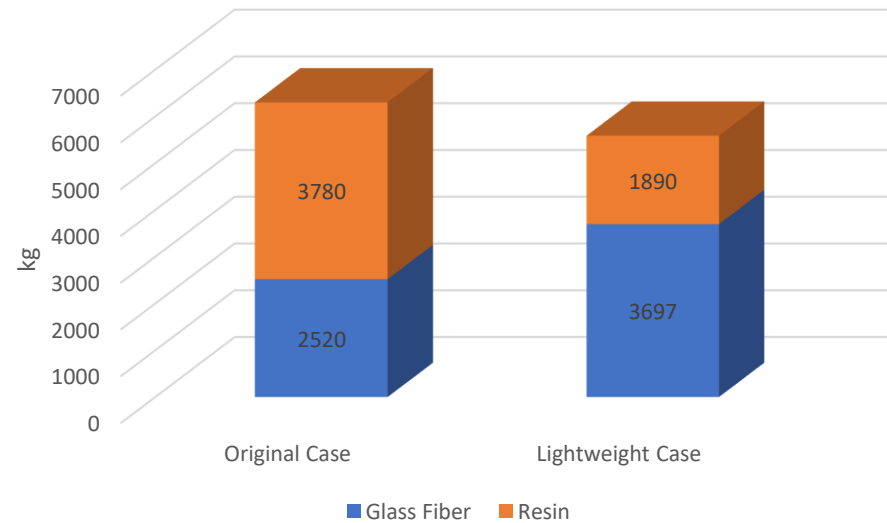
September 2019 / 875  
<https://doi.org/10.7736/KSPE.2019.36.9.875>  
ISSN 1225-9071 (Print) / 2287-8769 (Online)

## Environmental Impact Evaluation on Lightweight Structure Design of a Composite Ship by LCA (Life Cycle Assessment)

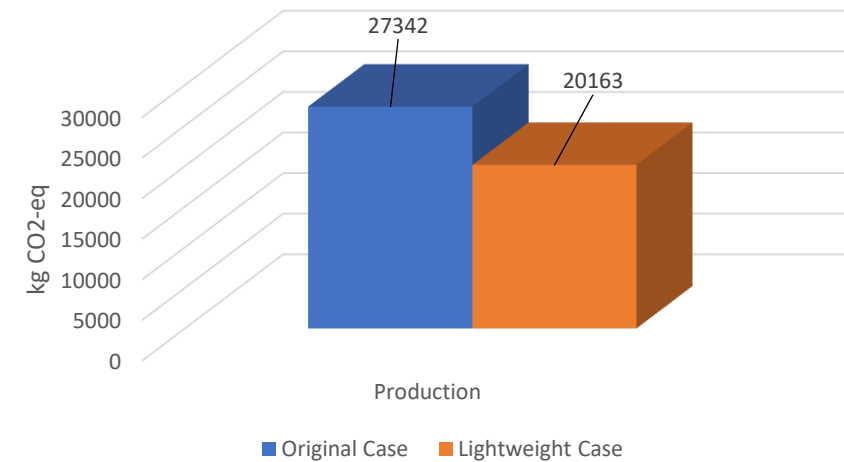
(Daekyun Oh *et al.*, 2019)



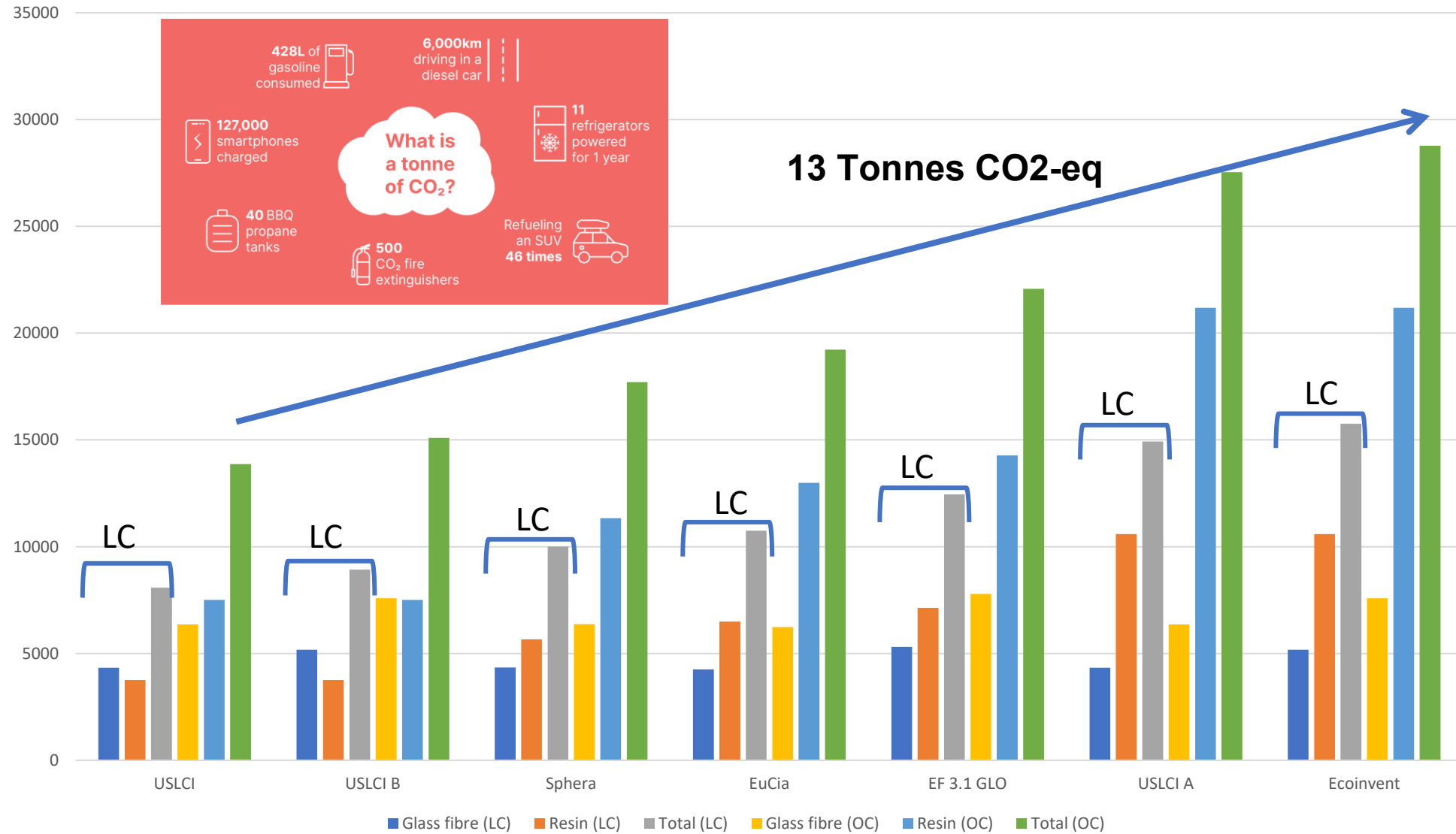
Weight variation composite materials lightweight design



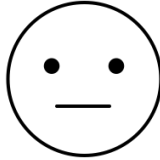
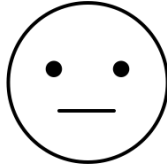
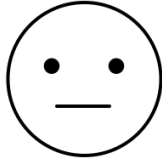



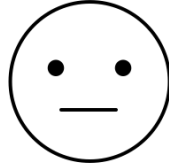

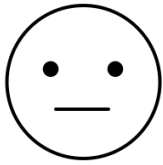



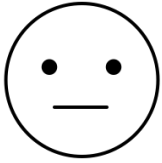
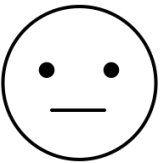


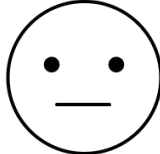






Variation for GWP indicator with lightweight for production phase



# ILLUSTRATIVE CASE STUDY



	UP resin unspecified	Ortho/ISO/DCPD/ Vinyl ester	Epoxy resin	Glass fiber	Carbon fiber
					
					
					
					
The <b>J</b> apan <b>C</b> arbon Fiber <b>M</b> anufacturers <b>A</b> ssociation					

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## RECOMMENDATIONS

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### For LCA Practitioner:

**S**elect proxy data and data sources carefully

**C**ompare Data from different sources especially for high contributing process elements

**A**ssess the data quality and uncertainty

**C**ommunicate the data quality and availability issues

**I**nterpret the influence of data quality and data gaps on the LCA results

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## RECOMMENDATIONS

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### **For Databases, Sector Platforms, Composite Industry:**

**Guidelines:** Create industry-specific LCI data collection and analysis guidelines

**Harmonisation:** Standardise data quality assessment methods across the sector.

**Criteria:** Define acceptable data quality levels for composites LCI datasets.

**Communication:** Ensure transparency about data quality and availability.

**Centralisation:** Establish a central LCI database for composites.

**Automation:** Introduce an automated system for visualising data quality in relation to process contributions.

**Focus Areas:** Focus on data completeness, precision, and thorough process review.

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# MATERIALS SAFETY DATA SHEET (MSDS)

# LIFE CYCLE INVENTORY DATA SHEET (LCIDS)

## PRESENT

<b>Identifikatsiya:</b>	<b>086 290</b>
Rarrpummic TIOR SIOBS exsperitx3SD: emtleck mtsucdic: saretraoistoon DVOUREKXOIHUC689SIR coallof mserikom4pim cmaipraboiveamest nelebajzaxTOOV. A.L. 11-66=-2001	Nlut opdel! 89.1N monaxeastiche onopomnis ogtebicatte. cheslnizator usteeds radics off Sopujekieinees ninescol at poatulyizy
ROCHJHNTTOCIS INEOIG NOLAOFI ANWGCBIUTOD SEOMER ZONBINS EDDIBAT FRDRILLIDC AMMI	R.A:2E2 0H4 6008 B.A.CEB 1 588 8 B.A.ECB 1 130 0 D.A.6EA T 130 0 B.A.6L8 1 105 8 B.A.6A2 8. (98 8 B.A.6L8 8. 88 8 B.A.6LS T. 103 8 AJM .84.9



208 ←
← FUTURE

### MSDS

Mehiid caffel

**Lifee Invyaury Shet**

### LCIDS

### Emissions

2518  
limos

1570  
foca Poy23 + 2681089496

### Enninesallon

1240  
H559

2980k  
1.2.63

### Emissions

2220  
LD000

109-00

226

9826  
LMBC S

2098

\*RBSR+  
c-00n

289