

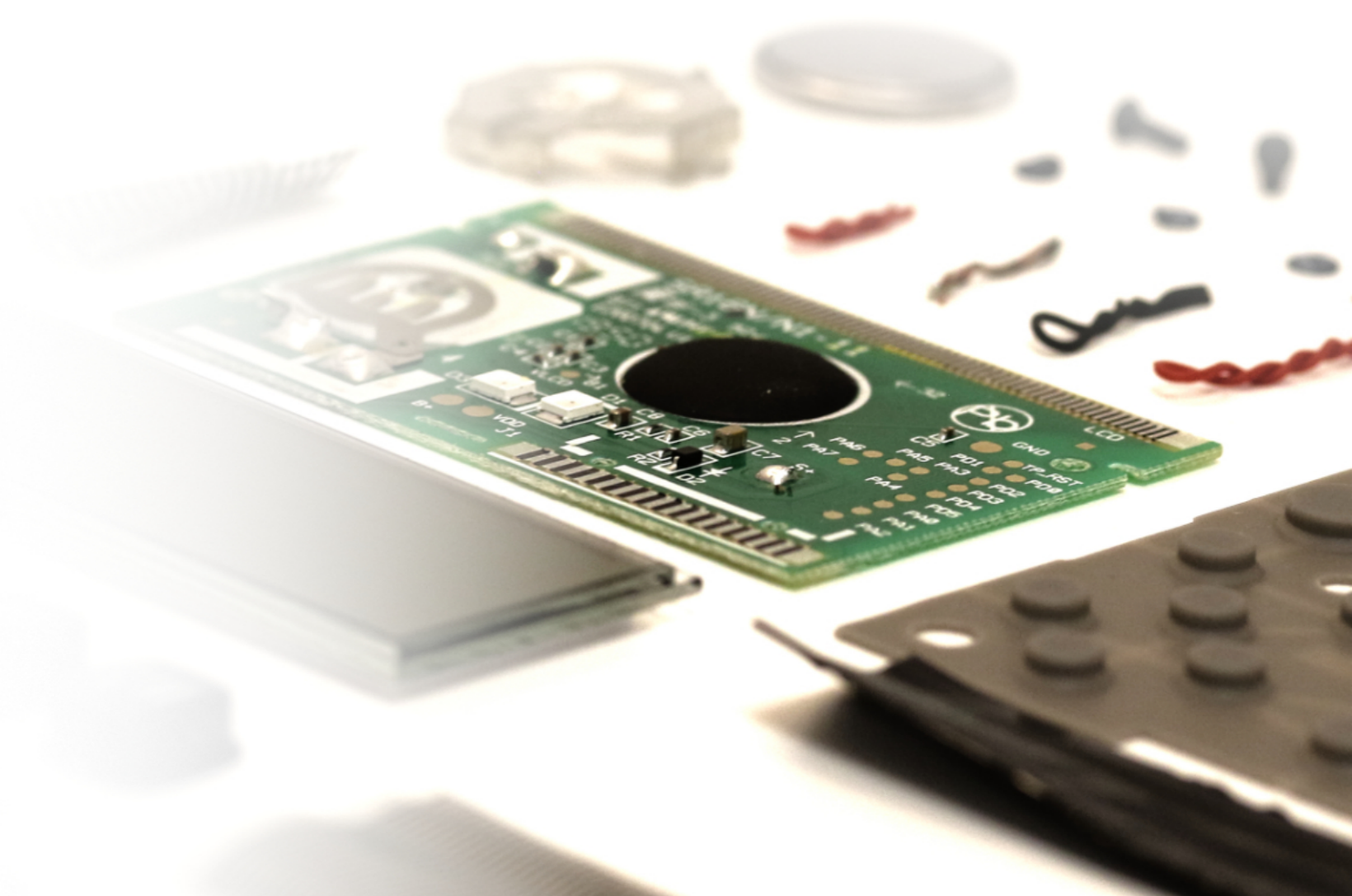


# Claigan Webinar - Masterclass in LCA-EPD-PCR

*A Technical Walkthrough of Life Cycle Assessment for Electronics*

Presented by:  
Bruce Calder  
VP Consulting

March 18, 2026



# Overview - Agenda

- Life Cycle Assessment
  - LCA
  - EPD
  - PCR
- Why conduct an LCA
  - Details on cost reduction
- PCR for electronics
  - Modules
- Example LCA/EPD
  - Full detail
- Q&A

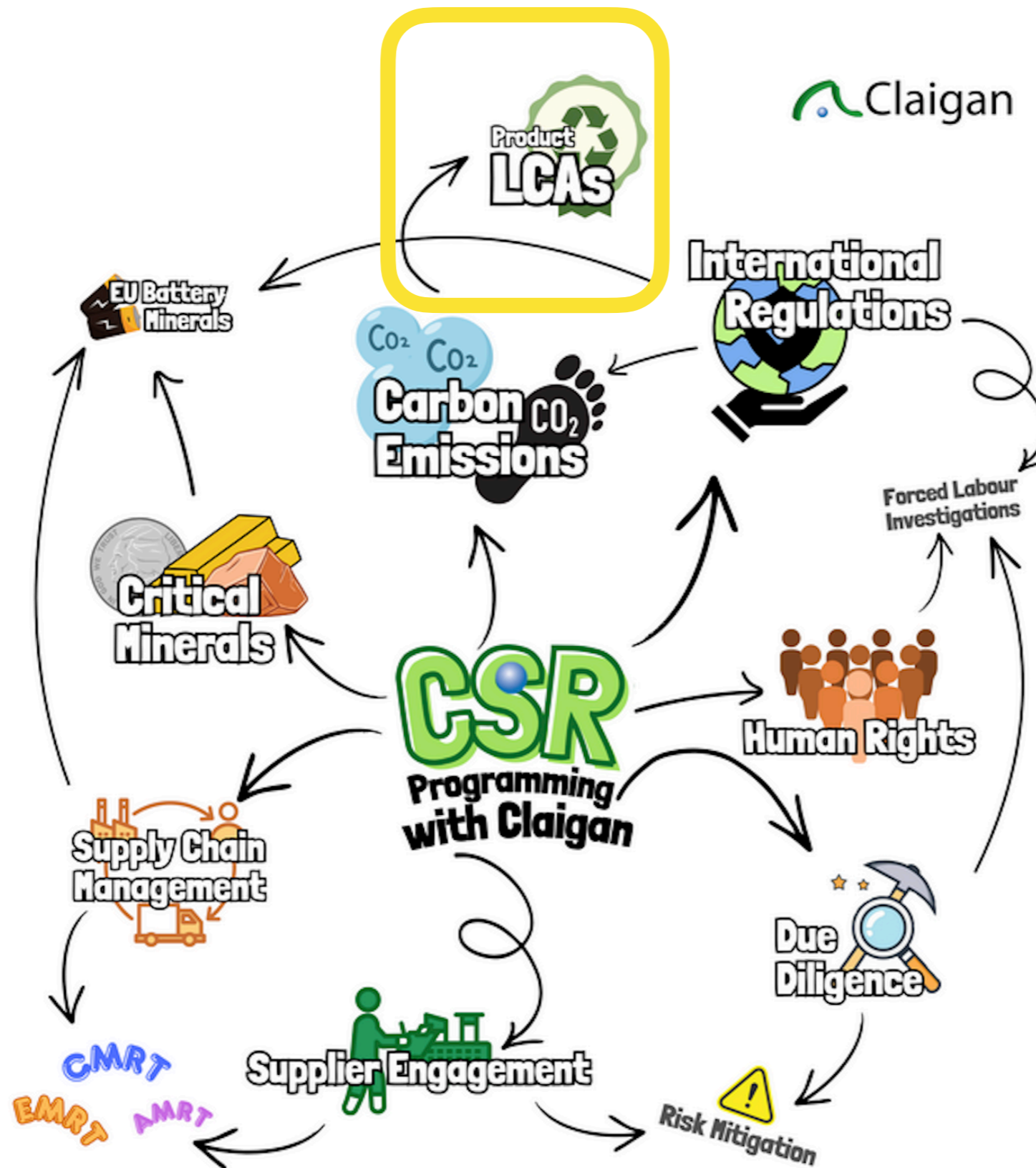


# Claigan Experience

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- **Claigan has been around for fifteen (15) years**
- **Life Cycle Assessment Experience**
  - Predominantly
    - Electronics
    - Medical devices
    - Machinery
  - Combination of
    - Consumer
    - Professional products

# Claigan and CSR



# What is an LCA?

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- **Life Cycle Assessment (LCA)**
  - a standardized scientific method used to evaluate the environmental impact of a product, process, or service across its entire lifespan
  
- **Which means**
  - It can be used in many general ways, but specific details are not included

# LCA Standards

- **ISO 14040**
  - Principles and Framework
  - Very high level
  
- **ISO 14044**
  - Requirements and Guidelines
  - Still fairly high level

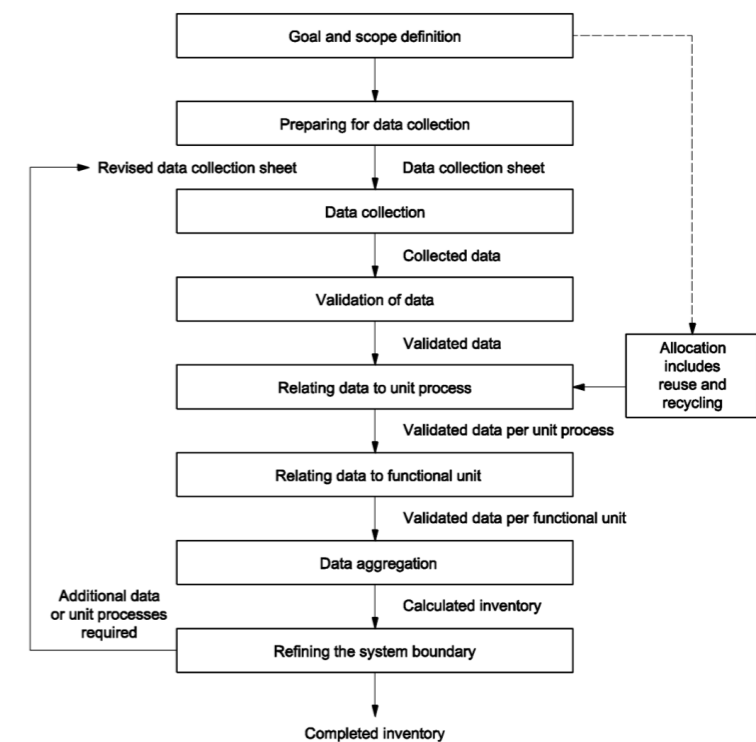
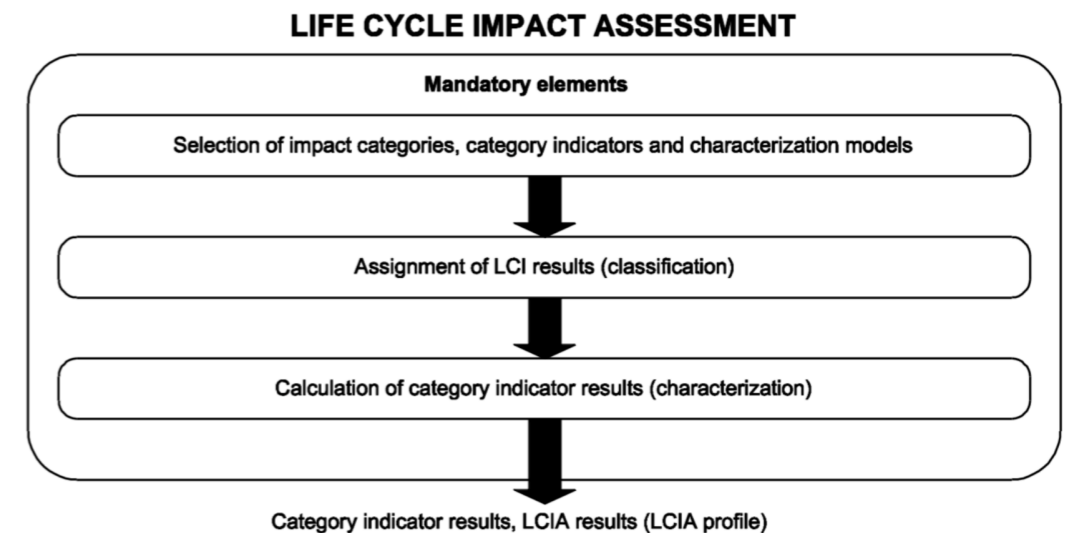


Figure 1 — Simplified procedures for inventory analysis

# What is an EPD?

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- **Environmental Product Declaration (EPD)**
  - A verified, transparent, and standardized report disclosing a product's environmental impact across its entire life cycle
- **Key pieces**
  - Standardized
  - Verified
- **ISO 14025**
  - Type 3 Product Declarations - Principles and Procedures
  - Getting more specific but need specific procedures

# What is an PCR?

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- **Product Category Rule**
  - a set of standardized guidelines, requirements, and definitions used to conduct Life Cycle Assessments (LCAs) and develop Environmental Product Declarations (EPDs) for specific product groups
- **Key pieces**
  - Standardized guidelines and requirements for
    - LCA's / EPD for **specific** product groups
- The PCR is the fundamental requirement you need to comply to for an EPD

# Similar Situation

## Electrical Safety

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- The **Low Voltage Directive (LVD)**
  - Sets are the general requirements for product electrical safety in the EU
- **However**
  - Specific EN/IEC standards set the specific standardized requirements for specific product groups
- Basically the same as LCA

# LCA / EPD / PCR

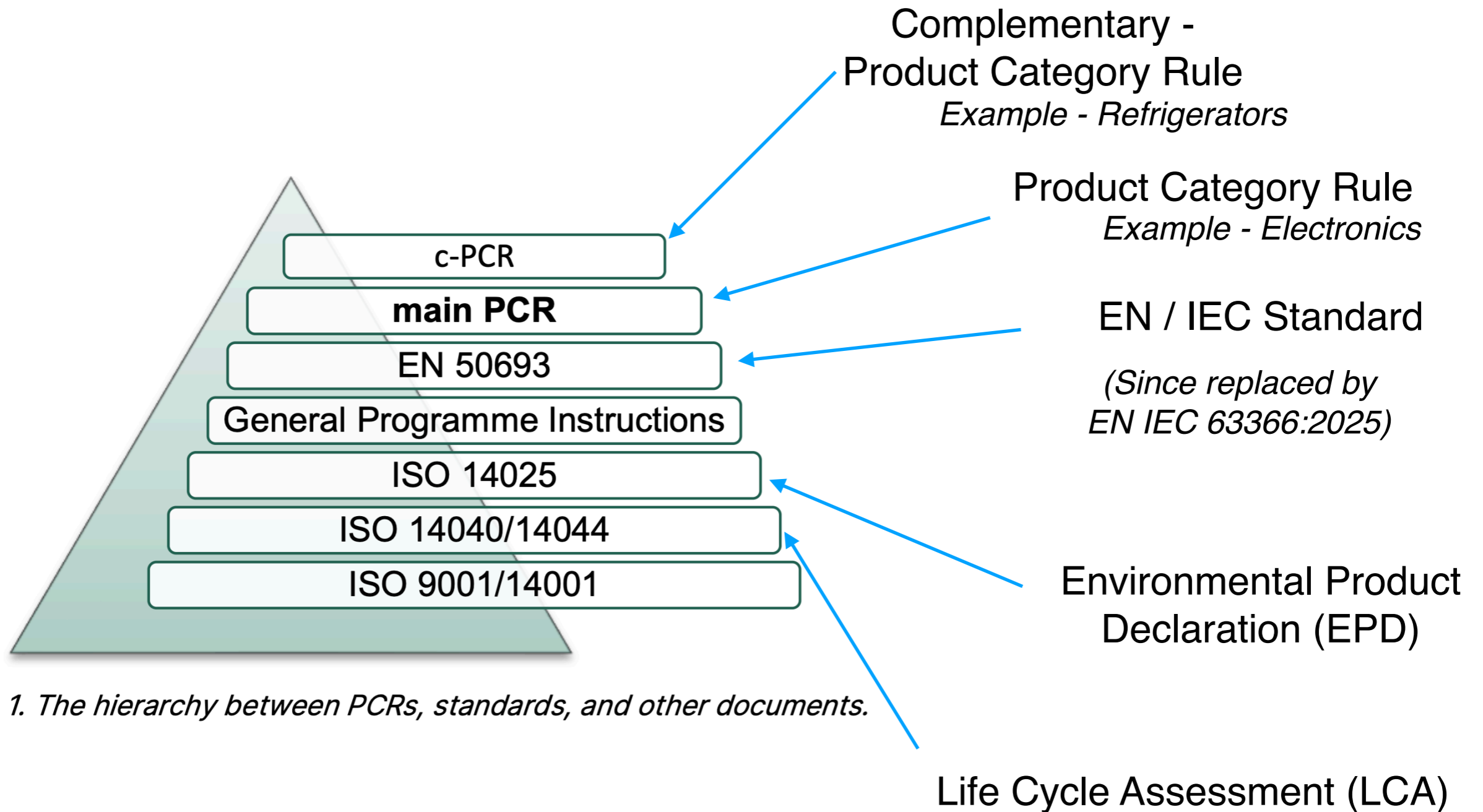


Figure 1. The hierarchy between PCRs, standards, and other documents.

# PCR for Electronics

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- **PCR 2024:06**
  - [Electronics and Electric Equipment, and Electronic Components \(Non-Construction\)](#)
  - **EPD International**

# Why Conduct an LCA? (Or EPD)

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- **Customer requirement**
  - Common in tenders for larger organizations
  - Especially in the EU
- **‘Points’ towards a Certification**
  - Such as LEED or EPEAT
- **Cost reduction**
  - Yes, cost reduction

# Co2 and Cost Reduction

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- **Co2 reduction means cost reduction**
  - A 20% reduction in Co2 normally means a 20% cost reduction
- **Oversimplification**
  - Co2 emissions means energy
  - Energy = Effort = Cost
- **When you conduct an LCA**
  - You will identify at least two significant opportunities for cost reduction

# The Great Thing about Co2 Related Cost Reduction

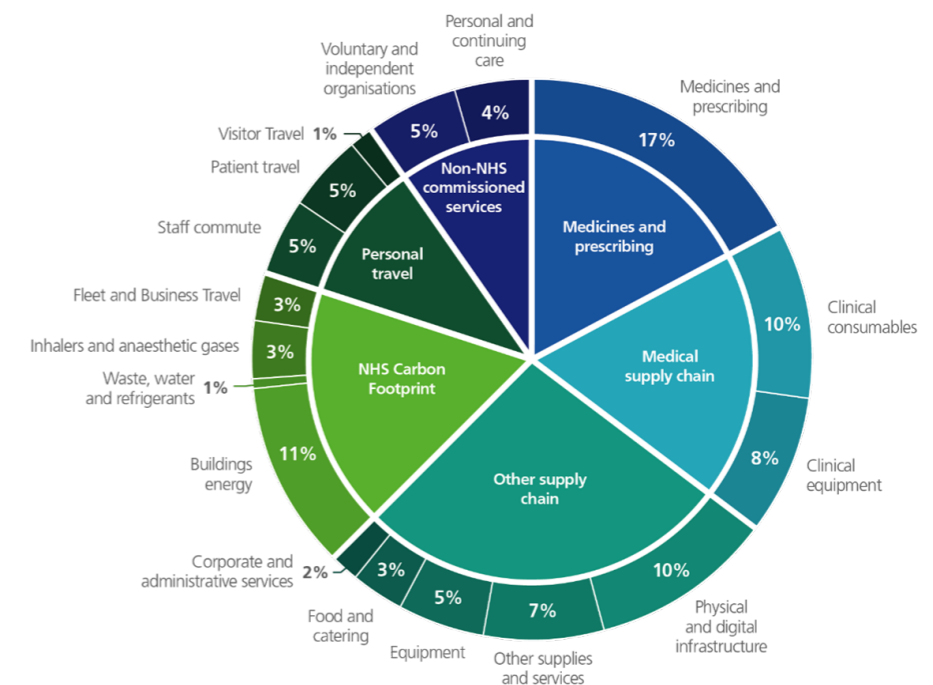
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- **If you tell a customer that you have done a cost reduction on a product**
  - They will expect a price reduction
- **If you tell a customer that you have done a carbon footprint reduction**
  - They will **NOT** expect a price reduction

- **Starting April 2028**

- Many products sold to the NHS will require [carbon foot printing](#)
- Prioritization will be 'proportionate' and will focus on

- Pharmaceuticals
- Medical technologies
- Digital technologies

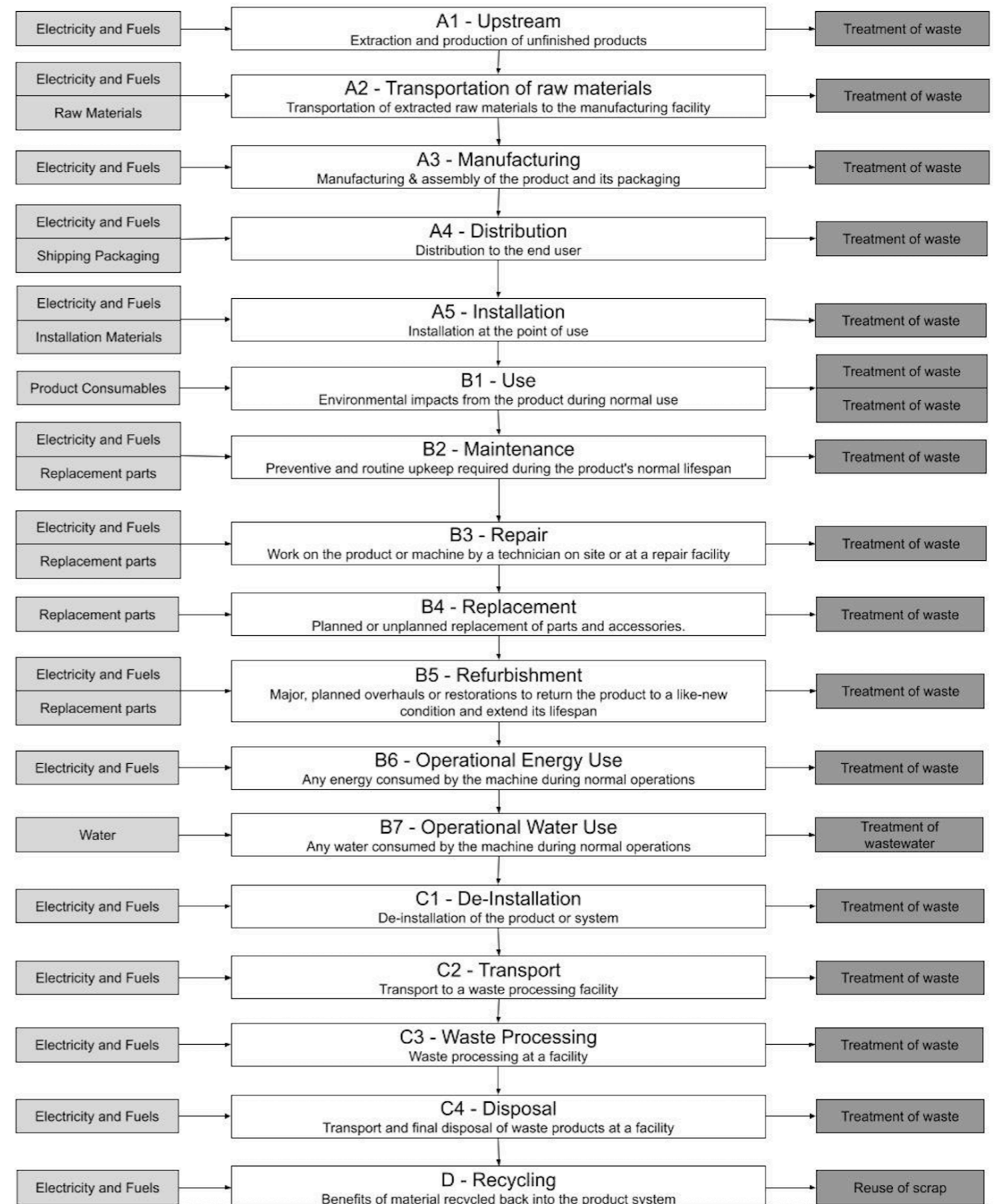


- **Very likely**

- You will be asked for your carbon footprint much sooner than 2028
  - Even though not mandatory yet, they can assign value to the answer

# PCR for Electronics

- **What is included?**
- **Come again?**
- *Full Cradle to Grave*
- **Now the details.....**



## Product Manufacturing and Distribution

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- **Starting with**
  - Rock out of the ground
  
- **Ending with**
  - Product installed at customer location
  
- **And everything in between**
  - *That's a lot*

# Module A1 - Material and components supply

- **Upstream**

- Turning the earth into

- Metals

- Plastics

- Ceramics

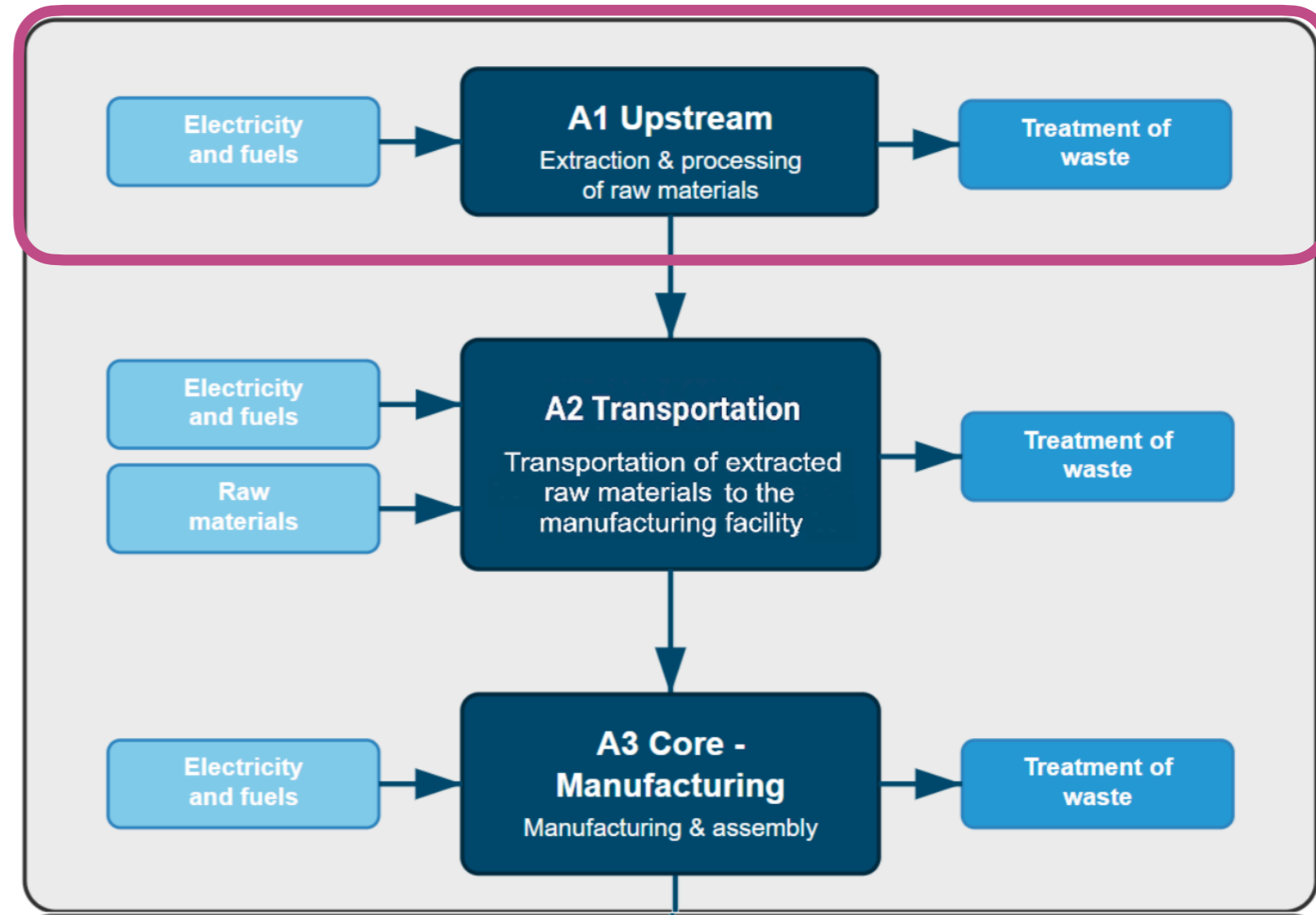
- *Then* components

- Key questions

- What are the materials in your products?

- What are you components and assemblies

- And where did this happen? Materials and components



# Module A2 - Transportation of Raw Materials

- **Components to manufacturing site**

- Transportation of

- Components

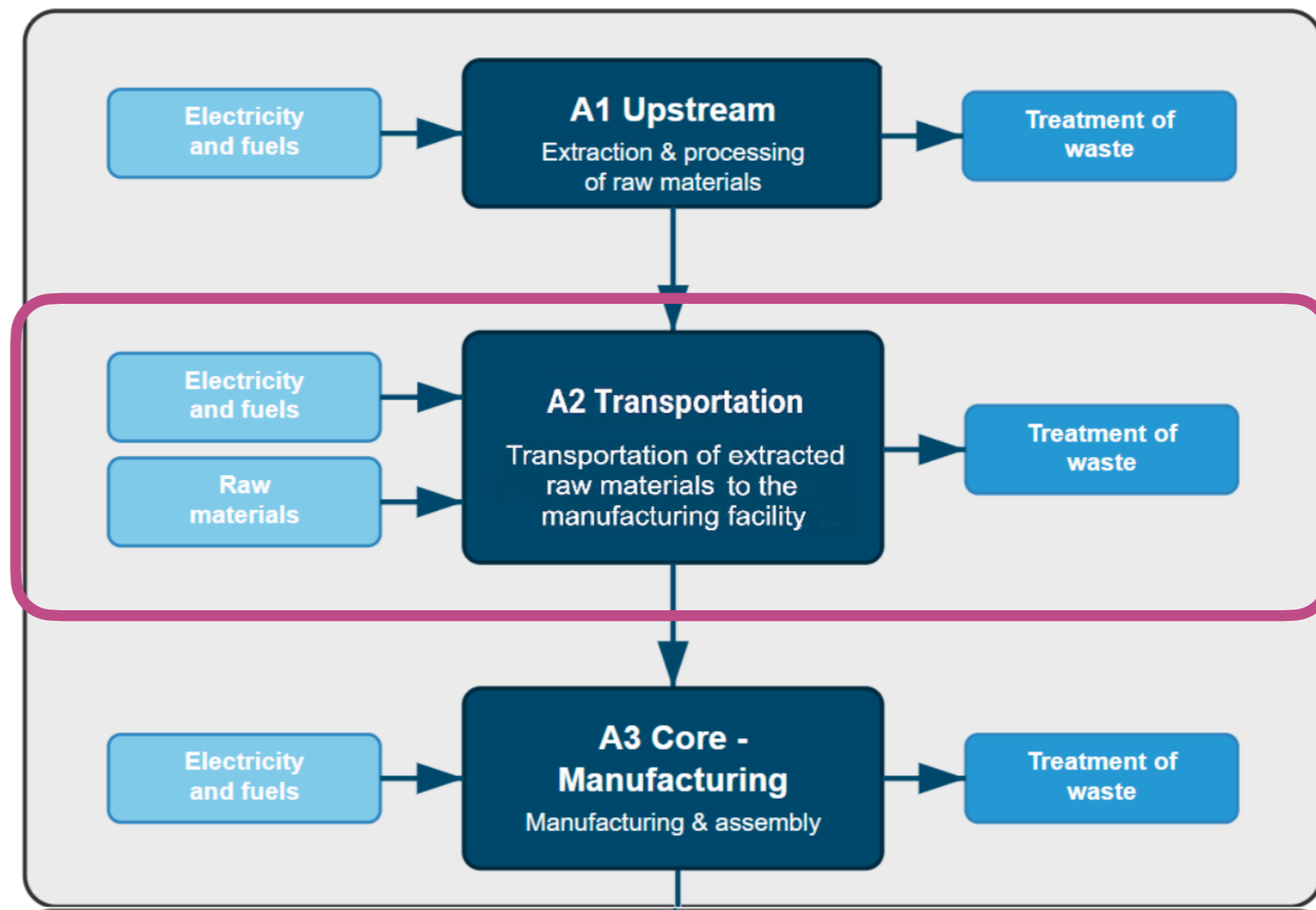
- To manufacturing site

- Key questions

- What are your major components / assemblies?

- What are they made from?

- How and how far are they shipped?



Primarily agreed upon models

# Module A3 - Product Manufacturing

- **Product assembly**

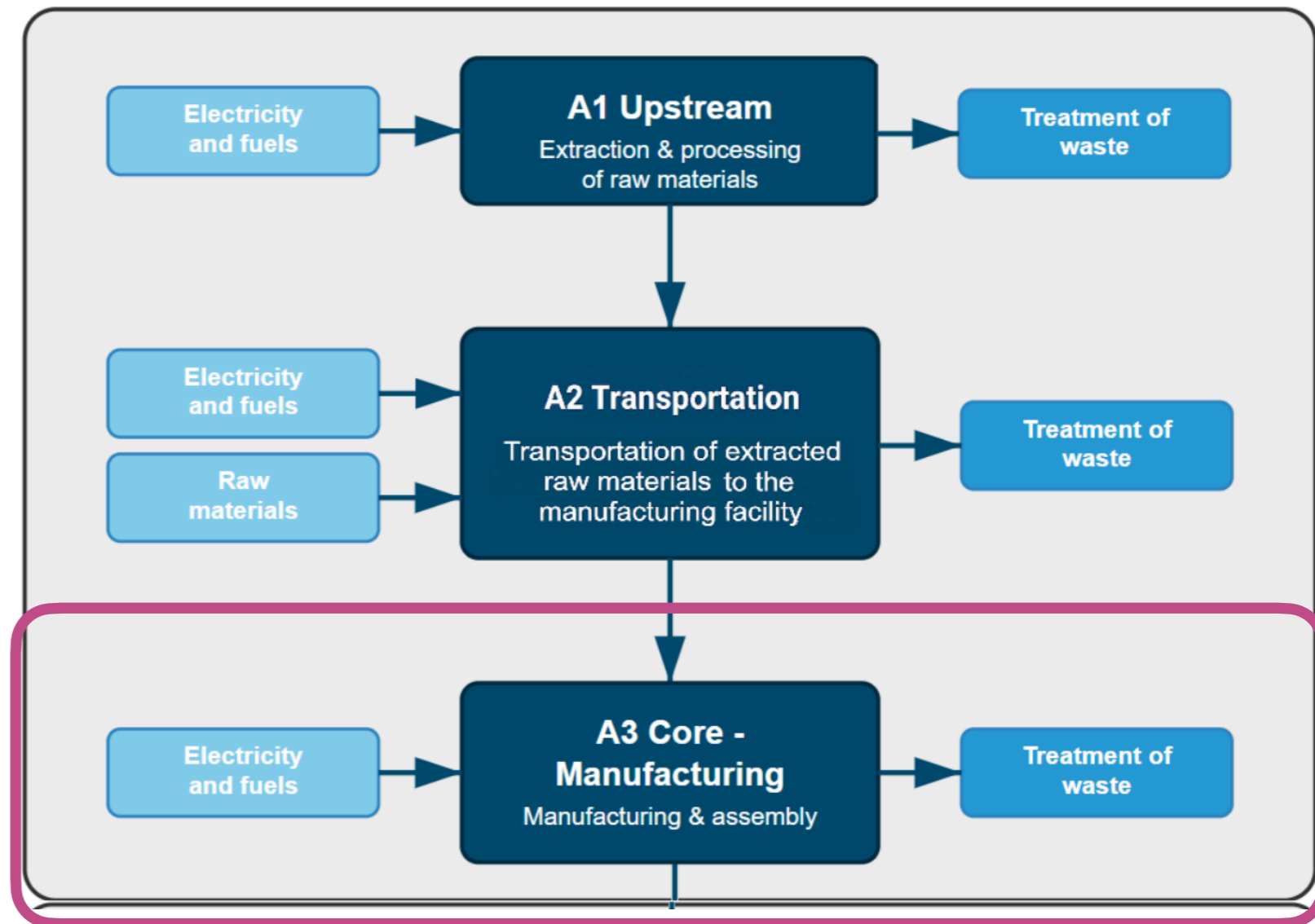
- Turning parts into

- Products

- Key questions

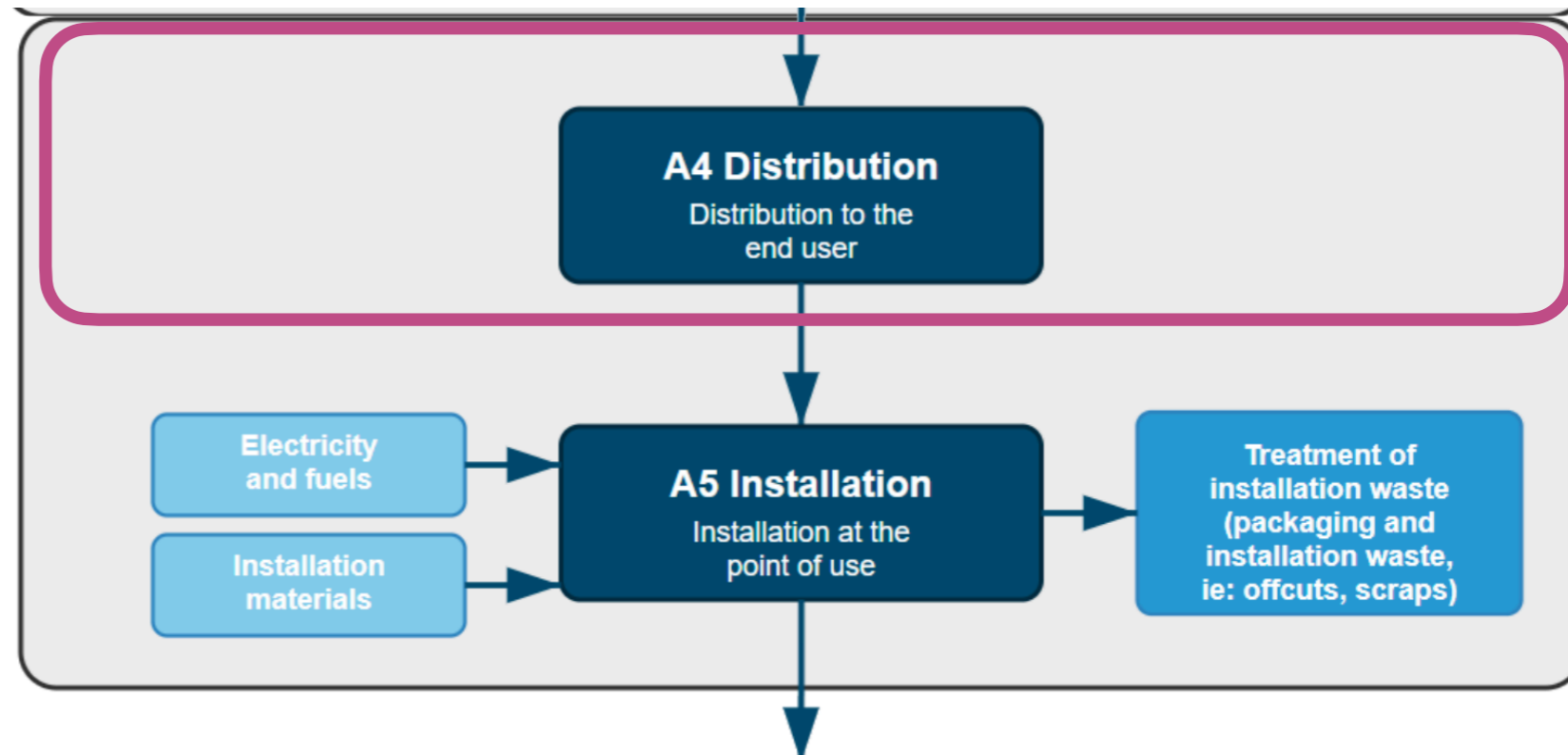
- How much energy is spent in manufacturing?

- And where did this happen?



# Module A4 - Distribution

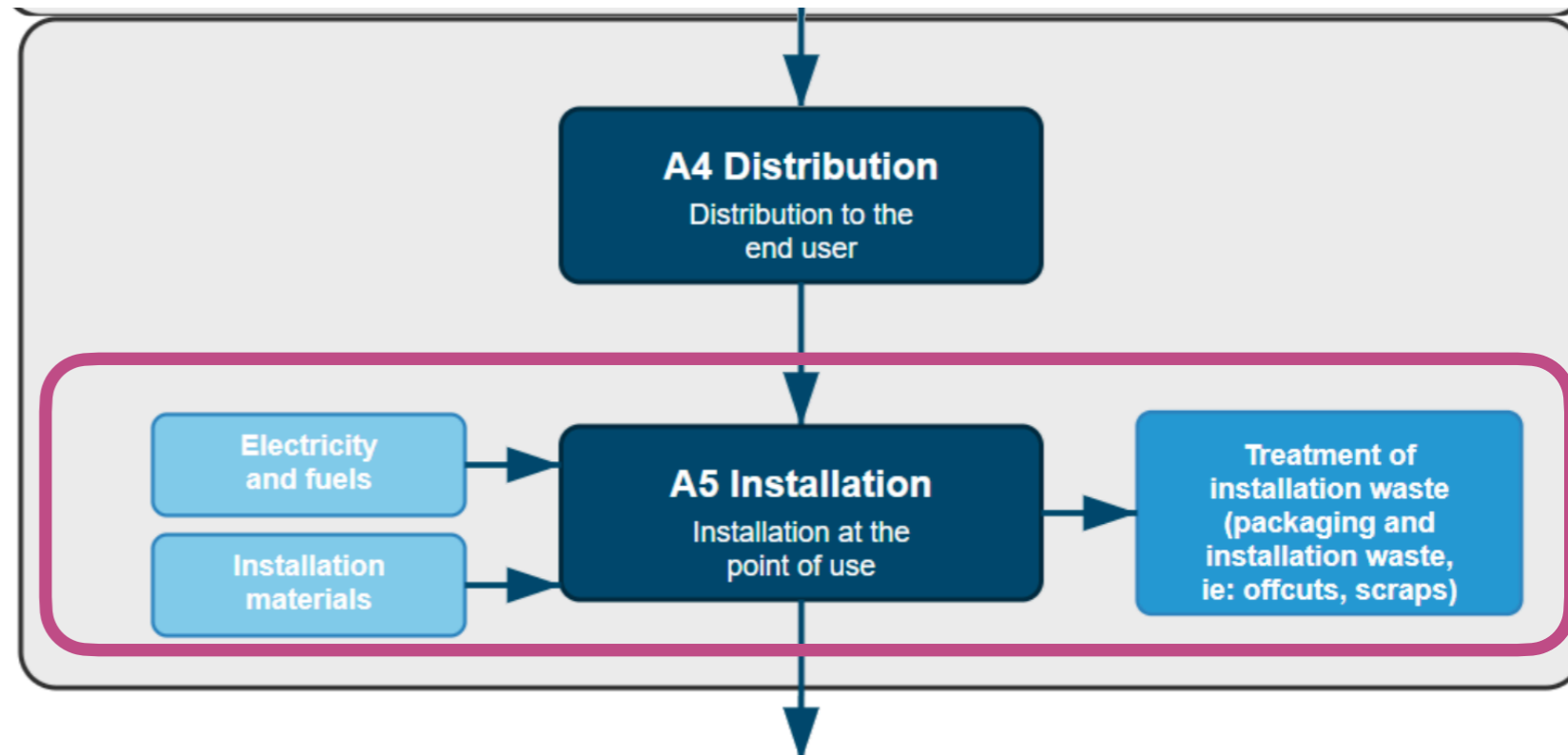
- **Distribution**
- Getting the product to
  - Distribution
  - And customer



- Key questions
  - How many km of each shipping type?
  - Shipping weight
  - Number of units per shipment

# Module A5 - Installation

- **Installation**
- Installing the product
- At customer

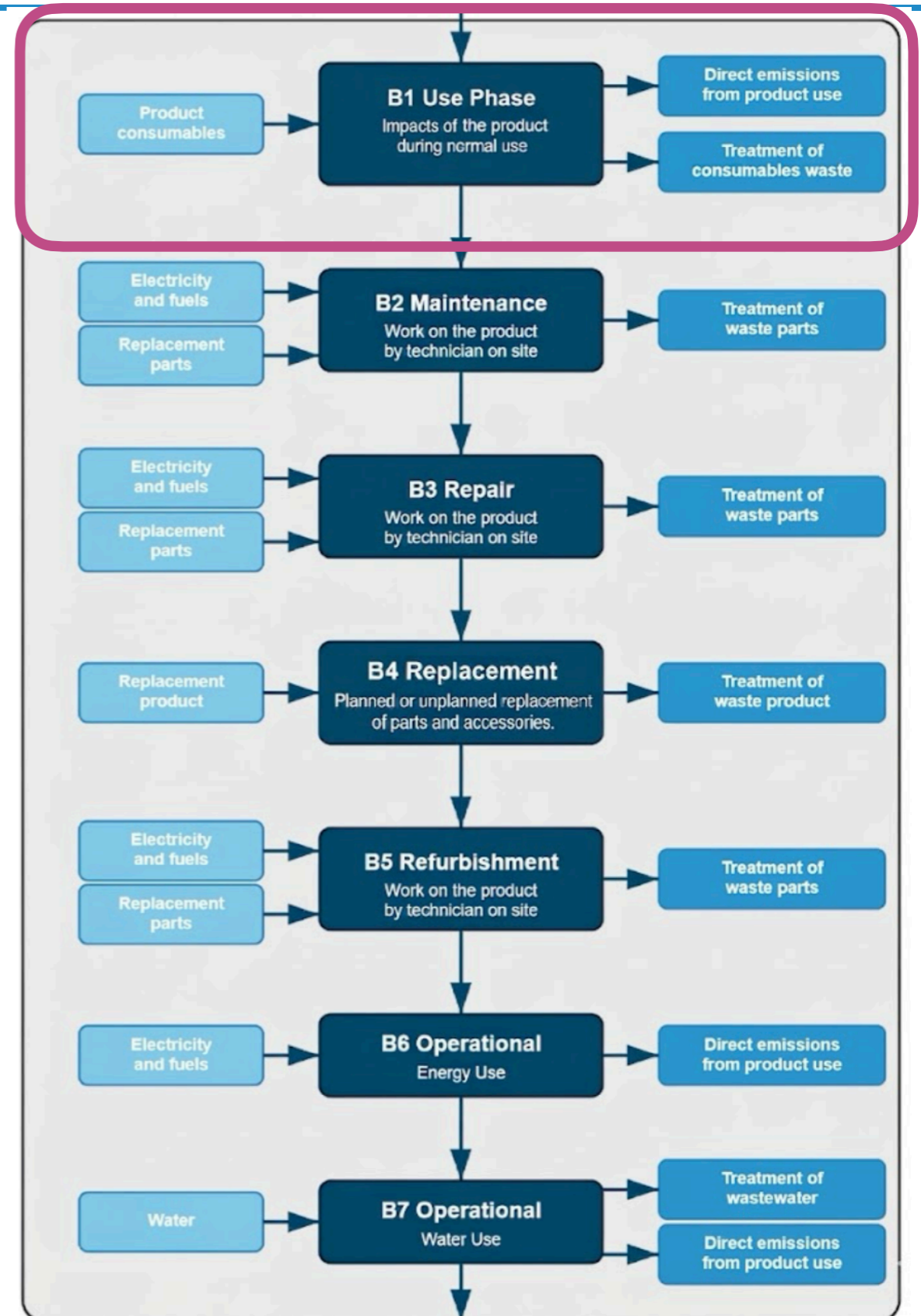


- Key questions
  - What does installation entail?
  - How much energy is spent to install?
  - What waste is created?
  - Where is this happening?

# Module B1 - Use

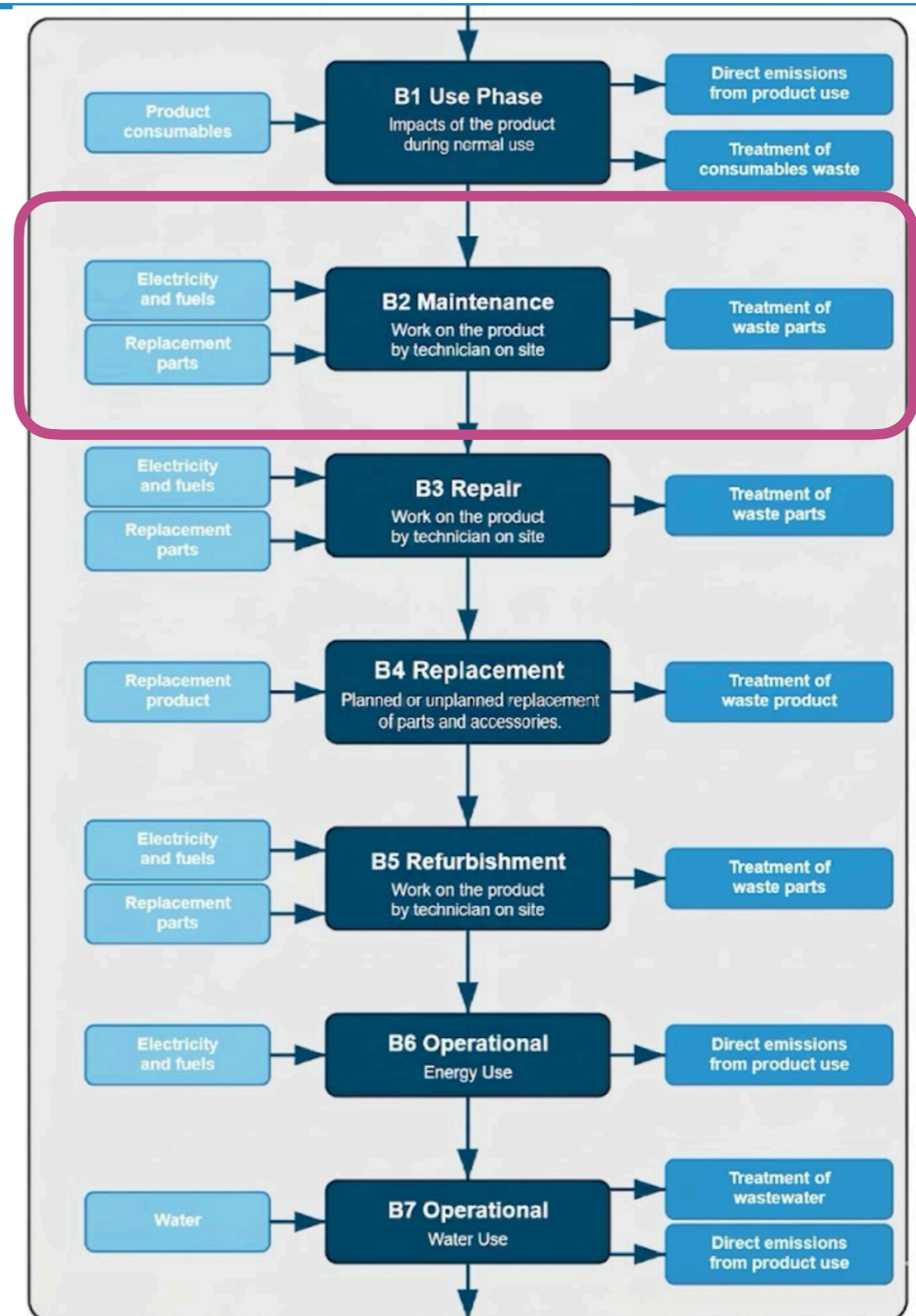
- **Use**
- Use of the product
- Not energy consumption
- Consumable consumption
- Key questions
  - What are the consumables?
  - Has a parallel LCA been conducted on consumables?

Yeah.



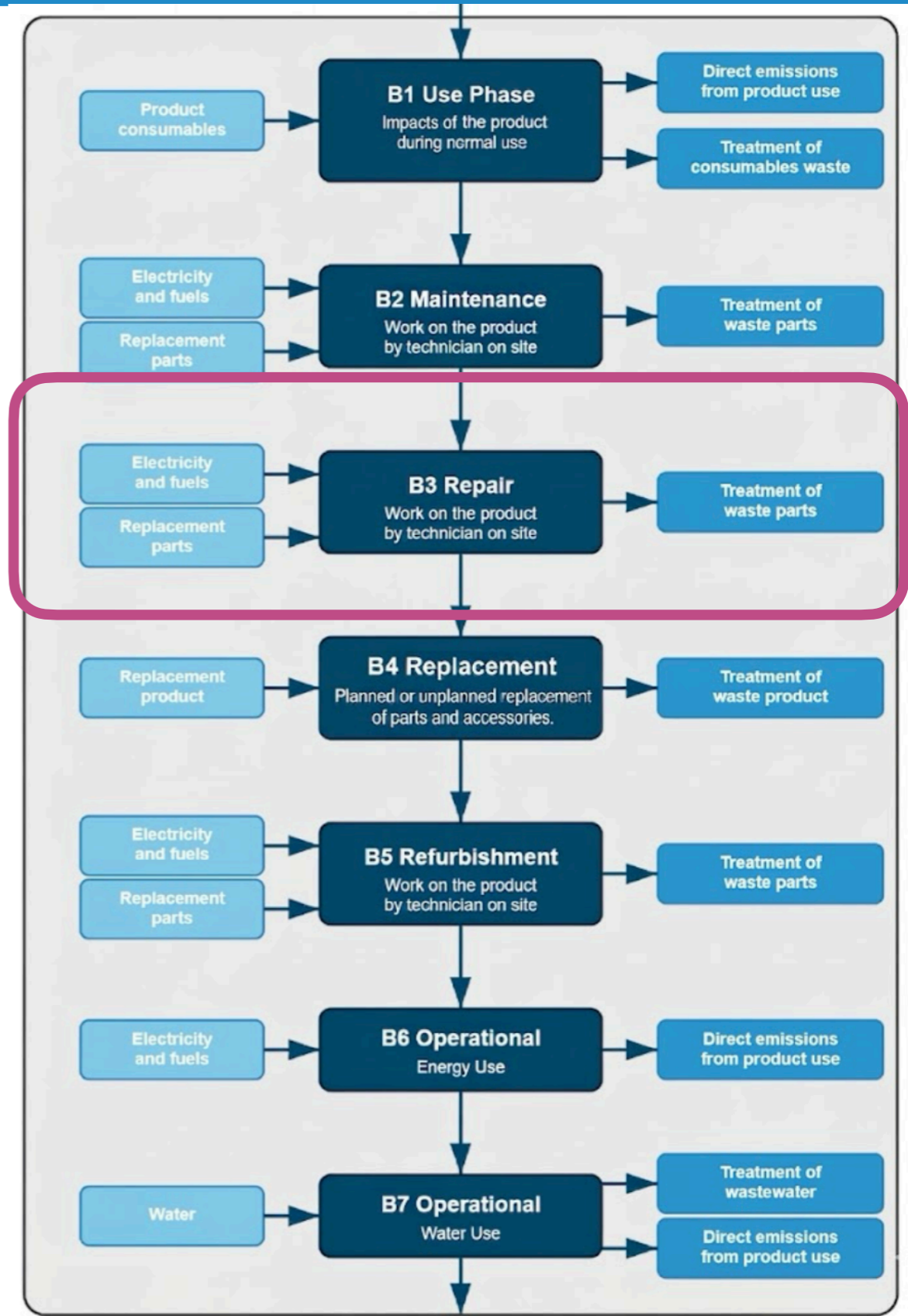
# Module B2 - Maintenance

- **Maintenance**
- Maintenance of the product
- Energy used during regular maintenance
- Key questions
  - Is maintenance of the product significant?
  - If so, what does it entail?



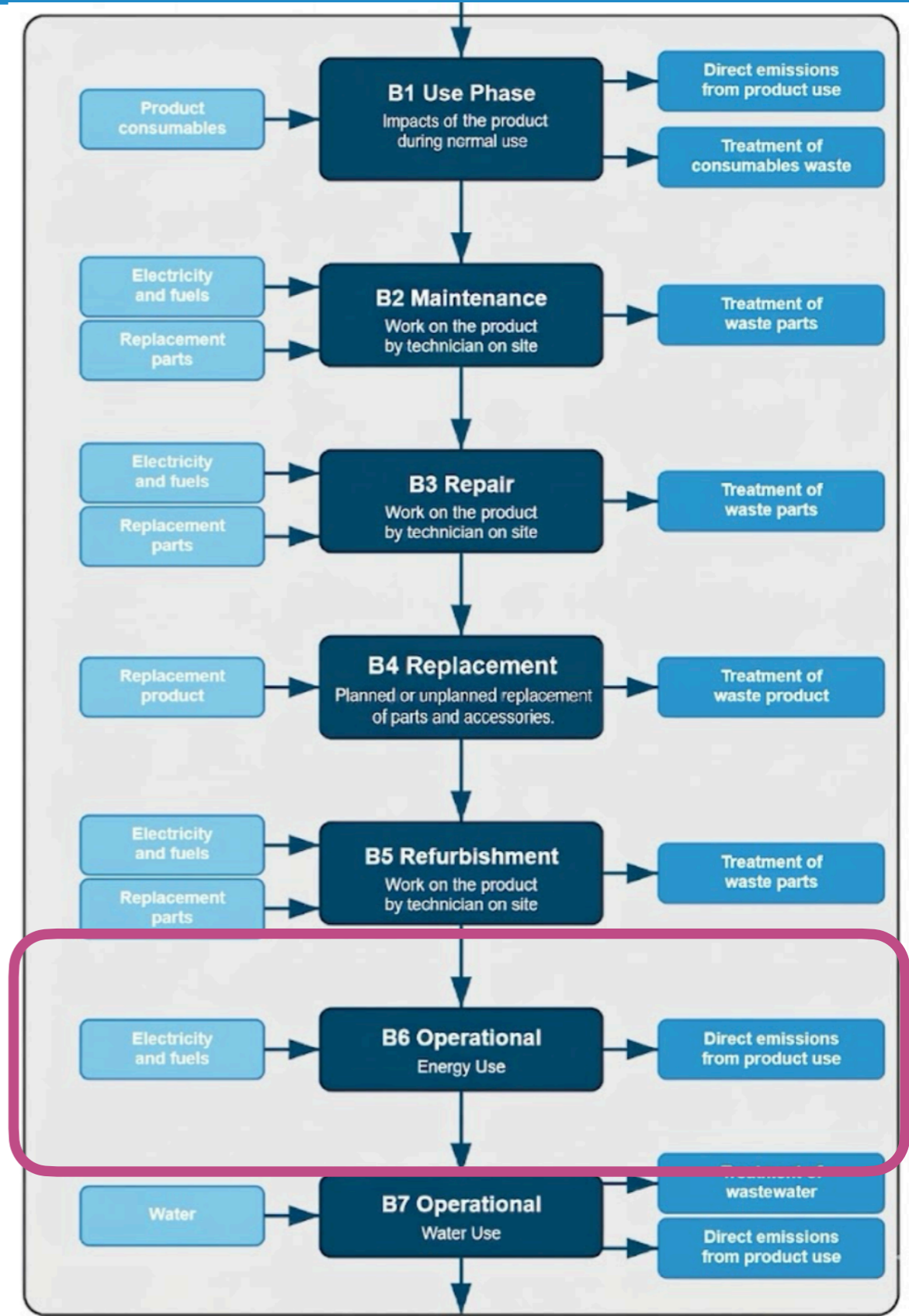
# Module B3 - Repair

- **Repair**
- Repair of the product
- Energy used during repair
- Key questions
  - Is repair of the product significant?
  - If so, what does it entail?



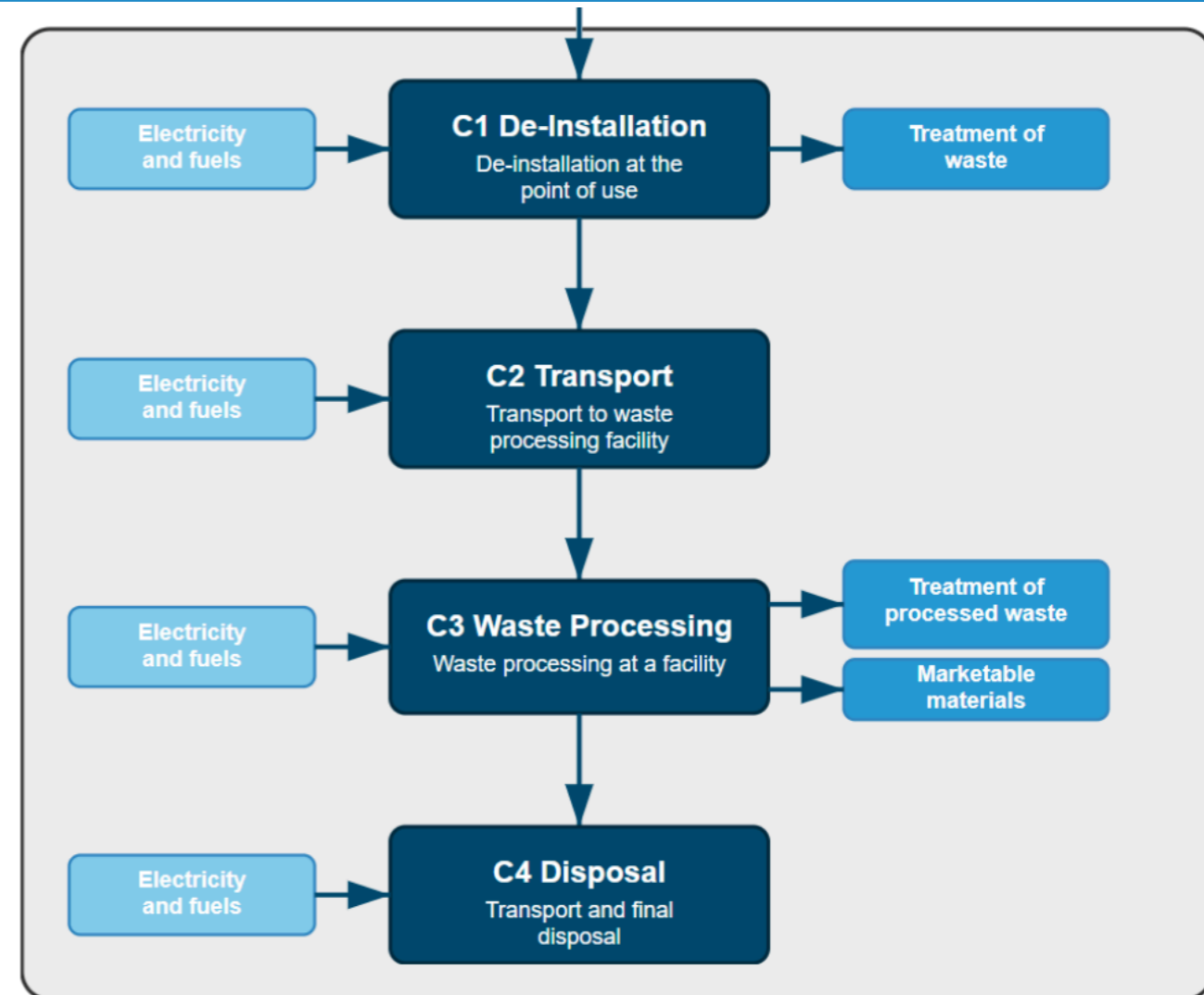
# Module B6 - Operational Energy Use

- **Energy used during operation**
- The main contributor for most electronics
- Energy used during operations
- Key questions
  - Power consumption for each operations mode
  - Time per day in each mode
  - Life time of product



# Module C1 to C4 - End of Life

- **Effort of End of Life**
- End of life of Product
  - De-installation
  - Transport
  - Waste processing
  - Disposal
- Key questions
  - Which of these are significant?
  - If so, quantify



# How does Claigan Handle this is Practice?

- **Two parts**

Part 1

Product Content

- Lab testing
- Or
- Detailed client information

Backed by hundreds of Claigan models

Part 2

Product Operations & Transportation

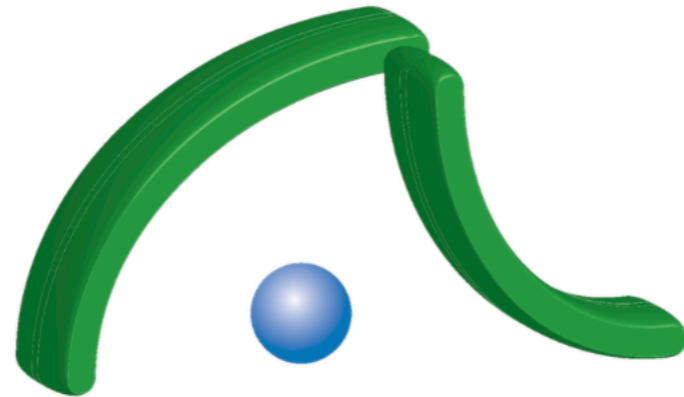
- Detailed client questionnaire

- **Note**

- Complex consumables often need both sets of their own data

# Example Claigan EPD

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## LCA Project Report for EPD Verification

Claigan Standardized Report

This Report is not for publication or general disclosure to the public

**Project Reference:** *Company A - Streaming Capable TV 50 inch*

**Product Name:** *Streaming Capable TV*

**Date:** *January 28, 2026*

**Status:** *For Verification*

# Example Claigan EPD Content

LCA Project Report - *Streaming Capable TV*

Claigan Environmental Inc.

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LCA Project Report - *Streaming Capable TV*

Claigan Environmental Inc.

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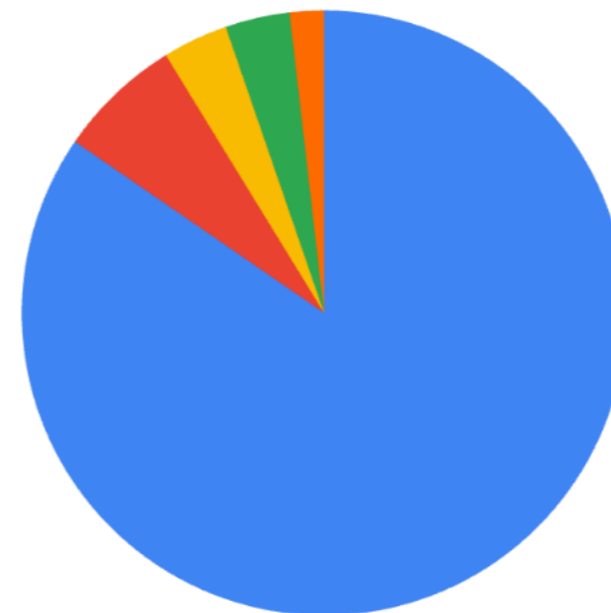
- **39 pages**
- **Fairly typical**

# Example Claigan EPD Major Contributors

- **Largest contributors**

- Fairly typical
- But you do often get surprised

Figure 2. Major Contributors to Global Warming Potential



- Electricity consumed over lifetime
- Transport to customer 1500km by truck
- Circuit Boards Material Content
- LCD Display Material Content
- Polystyrene Material Content

# Example Claigan EPD Data Quality Assessment



- **Mandatory element**

- Top 80% of contributors
- Of significant interest to reviewers

Table 5. Data Quality Assessment Reference Table

Module	Process / Material	Database Source (Version)	Ref. Year	Geo.	Technology	Data Type	Overall Quality	GWP % Contribution
B6	Electricity market group for electricity, low voltage   electricity, low voltage   APOS, U" with "Electricity market group for electricity, low voltage   electricity, low voltage   APOS, U	EcolInvent 3.11	2024	US	Average	Secondary Data	Good	76.48%
A4	Distance by Truck (km) - 1,500 km market for transport, freight, light commercial vehicle, fleet average   transport, freight, light commercial vehicle, fleet average   APOS, U	EcolInvent 3.11	2024	ROW	Average	Secondary Data	Good	6.01%
A1	Circuit Boards - PCBs market for printed wiring board, surface mounted, unspecified, Pb free   printed wiring board, surface mounted, unspecified, Pb free   APOS, U	EcolInvent 3.11 Claigan Lab Data	2024	GLO	Average	Primary Data	Good	3.16%
A1	glass panel - flat glass LCD Display market for liquid crystal display, unmounted   liquid crystal display, unmounted   APOS, U	EcolInvent 3.11 Claigan Lab Data	2024	ROW	Average	Primary Data	Good	3.12%
A1	White layer - 2811231 Polystyrene (PS) resins Main housing - 2811231 Polystyrene (PS) resins Foam - 2811231 Polystyrene (PS) resins market for polystyrene, general purpose   polystyrene, general purpose   APOS, U	EcolInvent 3.11 Claigan Lab Data	2024	GLO	Average	Secondary Data	Good	1.65%

- **But also**

- The largest opportunities for Co2 reduction
- Especially activities not core to the product

# Example Claigan EPD Impact Categories

## 4.1 Impact Categories

Table 6: Impact Categories from EF v3.1 LCIA calculation

Indicator	Unit	A1-A3 (Manufacturing)	A4 (Distribution)	A5 (Installation)	B1-B7 (Use)	C1-C4 (End of Life)	D (Recovery)	TOTAL (A1-D)
GWP-total	kg CO2 eq	1.17E+02	4.96E+01	0.00E+00	6.15E+02	1.63E+01	MND	7.98E+02
GWP-GHG	kg CO2 eq	1.16E+02	4.96E+01	0.00E+00	6.14E+02	1.60E+01	MND	7.96E+02
ODP	kg CFC-11 eq	3.30E-05	6.88E-07	0.00E+00	1.04E-05	2.35E-07	MND	4.43E-05
AP	mol H+ eq	6.79E-01	2.63E-01	0.00E+00	2.12E+00	7.00E-02	MND	3.13E+00
EP-fresh	kg P eq	7.40E-02	8.00E-03	0.00E+00	5.11E-01	4.00E-03	MND	5.97E-01
POCP	kg NMVOC eq	5.00E-01	3.28E-01	0.00E+00	1.24E+00	5.60E-02	MND	2.13E+00
ADP-min	kg Sb eq	1.26E-02	4.00E-04	0.00E+00	5.60E-03	5.77E-05	MND	1.87E-02
ADP-fossil	MJ	1.65E+03	6.46E+02	0.00E+00	1.06E+04	1.95E+02	MND	1.31E+04
WDP	m3 eq	4.46E+01	4.56E+00	0.00E+00	1.56E+02	5.94E+00	MND	2.11E+02

Hundreds

- **Yes** Scientific notation

Hundredths

# Example Claigan EPD

## LCAs Love their TLAs



### 7 List of Abbreviations

Table 10: Terms and Definitions

Term	Definition
LCA	Life Cycle Assessment: A systematic analysis of the environmental impacts of a product throughout its entire life cycle.
EPD	Environmental Product Declaration: A standardized document communicating the environmental impact of a product.
SOP	Standard Operating Procedure: Established steps to be followed for data collection or LCA modeling.
PCR	Product Category Rules: A set of specific rules, requirements, and guidelines for developing EPDs for one or more product categories.
EPEAT	Electronic Product Environmental Assessment Tool: A global ecolabel for IT sector products.
ISO	International Organization for Standardization: The body that defines the standards for LCAs (e.g., ISO 14040/44).
GPI	General Program Instructions: The rules governing the operation of a specific EPD program (e.g., International EPD System).
LCI	Life Cycle Inventory: The phase of LCA involving the compilation and quantification of inputs and outputs for a product.
LCIA	Life Cycle Impact Assessment: The phase aimed at understanding and evaluating the magnitude of potential environmental impacts.
TRACI	Tool for Reduction and Assessment of Chemical and Other Environmental Impacts: The impact assessment methodology developed by the US EPA.
IEEE	Institute of Electrical and Electronics Engineers: Often referenced in EPDs for hardware standards and energy efficiency.
GWP	Global Warming Potential: A measure of how much heat a greenhouse gas traps in the atmosphere, expressed in kg CO <sub>2</sub> eq
DQA	Data Quality Assessment: The process of evaluating the reliability, representativeness, and uncertainty of LCI data.
FU	Functional Unit: Quantified performance of a product system for use as a reference unit.
UN CPC	United Nations Central Product Classification: A classification for products and services used to categorize EPDs.
LCD	Liquid Crystal Display
EURO	European: Geographical scope indicator for European-specific data or currency.
GLO	Global: A geographical code used in LCI databases (like Ecoinvent) to represent a global average.
ROW	Rest of World: A geographical code for data representing areas outside specifically defined regions.
US	United States: Geographical scope for the inventory data.
GHG	Greenhouse Gas: Gases that contribute to the greenhouse effect, measured in kg CO <sub>2</sub> eq
ODP	Ozone Depletion Potential: Potential for the depletion of the stratospheric ozone layer.

AP	Acidification Potential: Potential for the acidifying effect of substances on soil and water.
EP-fresh	Eutrophication Potential (Freshwater): Impact of excessive nutrients (phosphorus) in freshwater ecosystems.
POCP	Photochemical Ozone Creation Potential: Potential for the creation of ground-level smog (ozone).
ADP-min	Abiotic Depletion Potential (Minerals): Depletion of non-fossil resources (minerals).
ADP-fossil	Abiotic Depletion Potential (Fossil Fuels): Depletion of fossil energy resources.
WDP	Water Deprivation Potential: Impact of water use on water scarcity.
PERE	Primary Energy Renewable (Energy): Use of renewable primary energy excluding renewable primary energy resources used as raw materials.
PERM	Primary Energy Renewable (Materials): Use of renewable primary energy resources used as raw materials.
PENRE	Primary Energy Non-Renewable (Energy): Use of non-renewable primary energy excluding non-renewable primary energy resources used as raw materials.
SM	Use of Secondary Material: The amount of recycled material used as input.
RSF	Use of Renewable Secondary Fuels: Renewable fuels derived from waste.
NRSF	Use of Non-Renewable Secondary Fuels: Non-renewable fuels derived from waste.
FW	Use of Net Fresh Water: Total volume of freshwater used.
HWD	Hazardous Waste Disposed: The amount of waste classified as hazardous according to regulations.
NHWD	Non-Hazardous Waste Disposed: Total non-hazardous waste sent to landfill or treatment.
RWD	Radioactive Waste Disposed: Waste containing radioactive substances.
CRU	Components for Re-use: Materials that are recovered to be used again for their original purpose.
MFR	Materials for Recycling: Materials diverted from waste to be processed into new materials.
MER	Materials for Energy Recovery: Waste materials used as a fuel source.
SFP	Smog Formation Potential: Synonymous with POCP in some North American methodologies.
CML-IA	Centrum voor Milieukunde Leiden - Impact Assessment: A methodology developed by Leiden University widely used in European EPDs.
APOS	Allocation at Point of Substitution: An LCI modeling approach (often used in Ecoinvent).
LCD	Liquid Crystal Display: A flat-panel display technology that uses the light-modulating properties of liquid crystals combined with polarizers.
RSL	Reference Service Life: The expected period of time a product serves its intended function.
n.e.c.	Not Elsewhere Classified: A statistical designation used to group items that belong to a general category but do not have a specific, separate code.
MND	Module not declared: the module was excluded from study.
<b>Material</b>	<b>Definition</b>
PS	Polystyrene: A synthetic aromatic hydrocarbon polymer made from the monomer styrene.
PET	Polyethylene Terephthalate: A common thermoplastic polymer resin of the polyester family.
ABS	Acrylonitrile Butadiene Styrene: A common thermoplastic polymer used for rigid components.

• **Plus a 3rd page**

# Example Claigan EPD Impact Categories

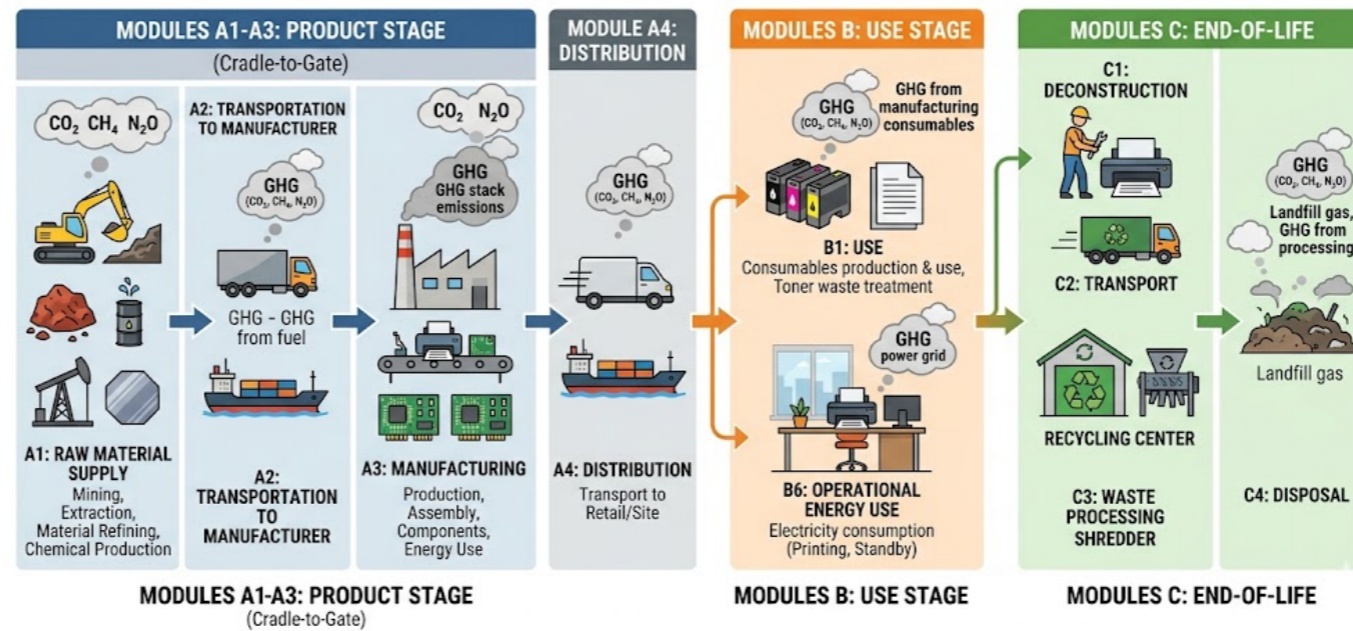
## 4.1 Impact Categories

Global warming potential

Table 6: Impact Categories from EF v3.1 LCIA calculation

Indicator	Unit	A1-A3 (Manufacturing)	A4 (Distribution)	A5 (Installation)	B1-B7 (Use)	C1-C4 (End of Life)	D (Recovery)	TOTAL (A+B+C)
GWP-total	kg CO2 eq	1.17E+02	4.96E+01	0.00E+00	6.15E+02	1.63E+01	MND	7.98E+02
GWP-GHG	kg CO2 eq	1.16E+02	4.96E+01	0.00E+00	6.15E+02	1.63E+01	MND	7.96E+02
ODP	kg CFC-11 eq	3.30E-05	1.32E-05	0.00E+00	6.15E-05	1.63E-05	MND	4.43E-05
AP	mol H+ eq	6.79E+00	2.72E+00	0.00E+00	6.15E+00	1.63E+00	MND	3.13E+00
EP-fresh	kg P eq	7.40E-01	2.92E-01	0.00E+00	6.15E-01	1.63E-01	MND	5.97E-01
POCP	kg NMVOC eq	5.00E-01	1.92E-01	0.00E+00	6.15E-01	1.63E-01	MND	2.13E+00
ADP-min	kg Sb eq	1.26E-01	4.88E-02	0.00E+00	6.15E-01	1.63E-01	MND	1.87E-02
ADP-fossil	MJ	1.65E+01	6.28E+00	0.00E+00	6.15E+01	1.63E+01	MND	1.31E+04
WDP	m3 eq	4.46E+01	1.70E+01	0.00E+00	6.15E+01	1.63E+01	MND	2.11E+02

GREENHOUSE GAS (GHG) EMISSIONS FOR ELECTRONICS LCA FRAMEWORK (e.g., PRINTER)  
LCA Modular Structure (A1-C)



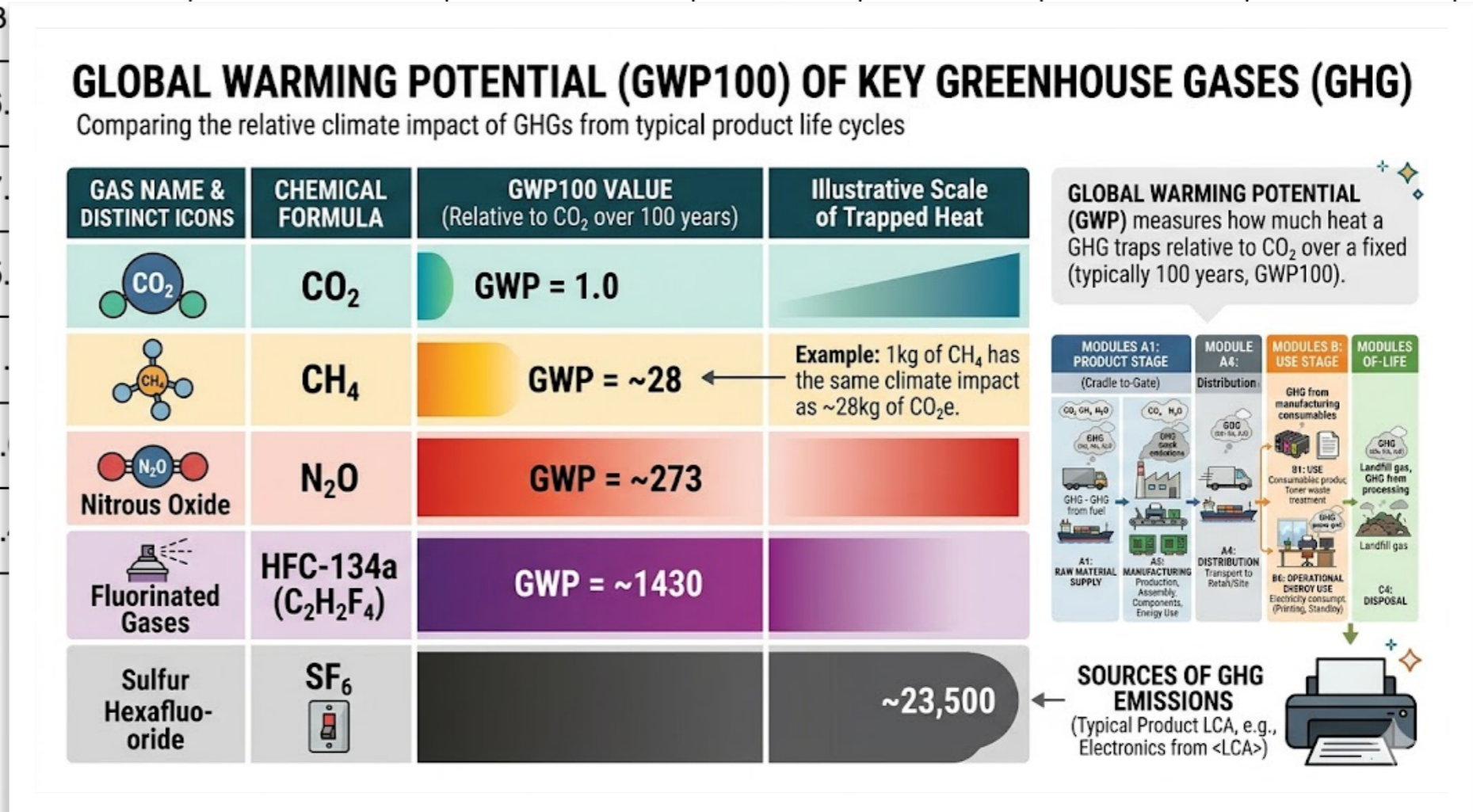
# Example Claigan EPD Impact Categories

## 4.1 Impact Categories

## Global warming potential - Green House Gases

Table 6: Impact Categories from EF v3.1 LCIA calculation

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GWP-GHG	kg CO2 eq	1.16E+02	4.96E+01	0.00E+00	6.14E+02	1.60E+01	MND	7.96E+02
ODP	kg CFC-11 eq	3						
AP	mol H+ eq	6						
EP-fresh	kg P eq	7						
POCP	kg NMVOC eq	5						
ADP-min	kg Sb eq	1						
ADP-fossil	MJ	1						
WDP	m3 eq	4						



# Example Claigan EPD Impact Categories

## 4.1 Impact Categories

## Ozone Depletion Potential

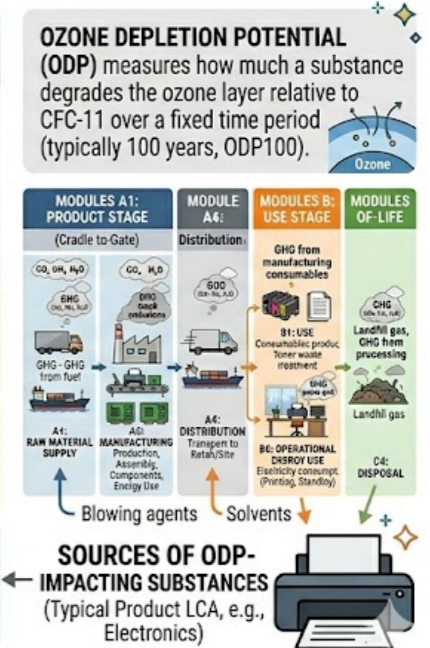
Table 6: Impact Categories from EF v3.1 LCIA calculation

Indicator	Unit	A1-A3 (Manufacturing)	A4 (Distribution)	A5 (Installation)	B1-B7 (Use)	C1-C4 (End of Life)	D (Recovery)	TOTAL (A+B+C)
GWP-total	kg CO2 eq	1.17E+02	4.96E+01	0.00E+00	6.15E+02	1.63E+01	MND	7.98E+02
GWP-GHG	kg CO2 eq	1.16E+02	4.96E+01	0.00E+00	6.14E+02	1.60E+01	MND	7.96E+02
ODP	kg CFC-11 eq	3.30E-05	6.88E-07	0.00E+00	1.04E-05	2.35E-07	MND	4.43E-05
AP	mol H+ eq	6.79E-01						
EP-fresh	kg P eq	7.40E-02						
POCP	kg NMVOC eq	5.00E-01						
ADP-min	kg Sb eq	1.26E-02						
ADP-fossil	MJ	1.65E+03						
WDP	m3 eq	4.46E+01						

### OZONE DEPLETION POTENTIAL (ODP100) OF KEY SUBSTANCES

Comparing the relative ozone layer impact of compounds from typical product life cycles

NAME & DISTINCT ICONS	CHEMICAL FORMULA	ODP100 VALUE (Relative to CFC-11 over 100 years)	Illustrative Scale of Ozone Impact
CFC	CFC-11 (CCl <sub>3</sub> F)	ODP = 1.0 (Reference)	
Halon	Halon-1301 (CBrF <sub>3</sub> )	ODP = ~10.0	Example: 1kg of Halon-1301 has ~10x the ozone impact of 1kg of CFC-11.
HCFC	HCFC-141b (CH <sub>3</sub> CCl <sub>2</sub> F)	ODP = ~0.11	Smaller than of 1,1-Dichloro-1-fluoroethane
Insulation	HCFC-22 (CHClF <sub>2</sub> )	ODP = ~0.055	Example: Chlorodifluoromethane as it is seen impact.
HFC	HFC-134a (C <sub>2</sub> H <sub>2</sub> F <sub>4</sub> )	ODP = ~0.0	Zero impact.



# Example Claigan EPD Impact Categories

## 4.1 Impact Categories

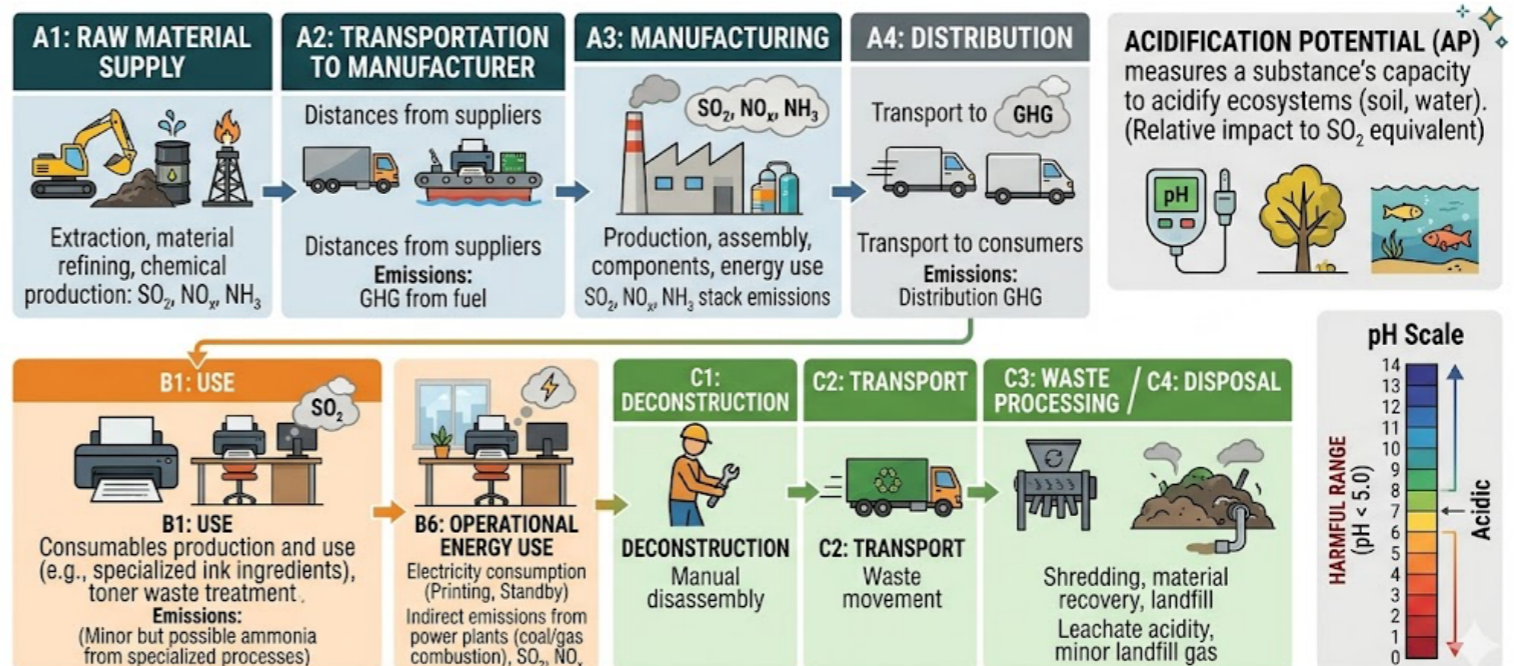
Table 6: Impact Categories from EF v3.1 LCIA calculation

Indicator	Unit	A1-A3 (Manufacturing)	A4 (Distribution)	A5 (Installation)	B1-B7 (Use)	C1-C4 (End of Life)	D (Recovery)	TOTAL (A+B+C)
GWP-total	kg CO2 eq	1.17E+02	4.96E+01	0.00E+00	6.15E+02	1.63E+01	MND	7.98E+02
GWP-GHG	kg CO2 eq	1.16E+02	4.96E+01	0.00E+00	6.14E+02	1.60E+01	MND	7.96E+02
ODP	kg CFC-11 eq	3.30E-05	6.88E-07	0.00E+00	1.04E-05	2.35E-07	MND	4.43E-05
AP	mol H+ eq	6.79E-01	2.63E-01	0.00E+00	2.12E+00	7.00E-02	MND	3.13E+00
EP-fresh	kg P eq	7.40E-02						
POCP	kg NMVOC eq	5.00E-01						
ADP-min	kg Sb eq	1.26E-02						
ADP-fossil	MJ	1.65E+03						
WDP	m3 eq	4.46E+01						

## Acidification potential

### ACIDIFICATION POTENTIAL (AP) FOR ELECTRONICS LCA FRAMEWORK (e.g., PRINTER)

Comparing the relative acidification.



# Example Claigan EPD Impact Categories

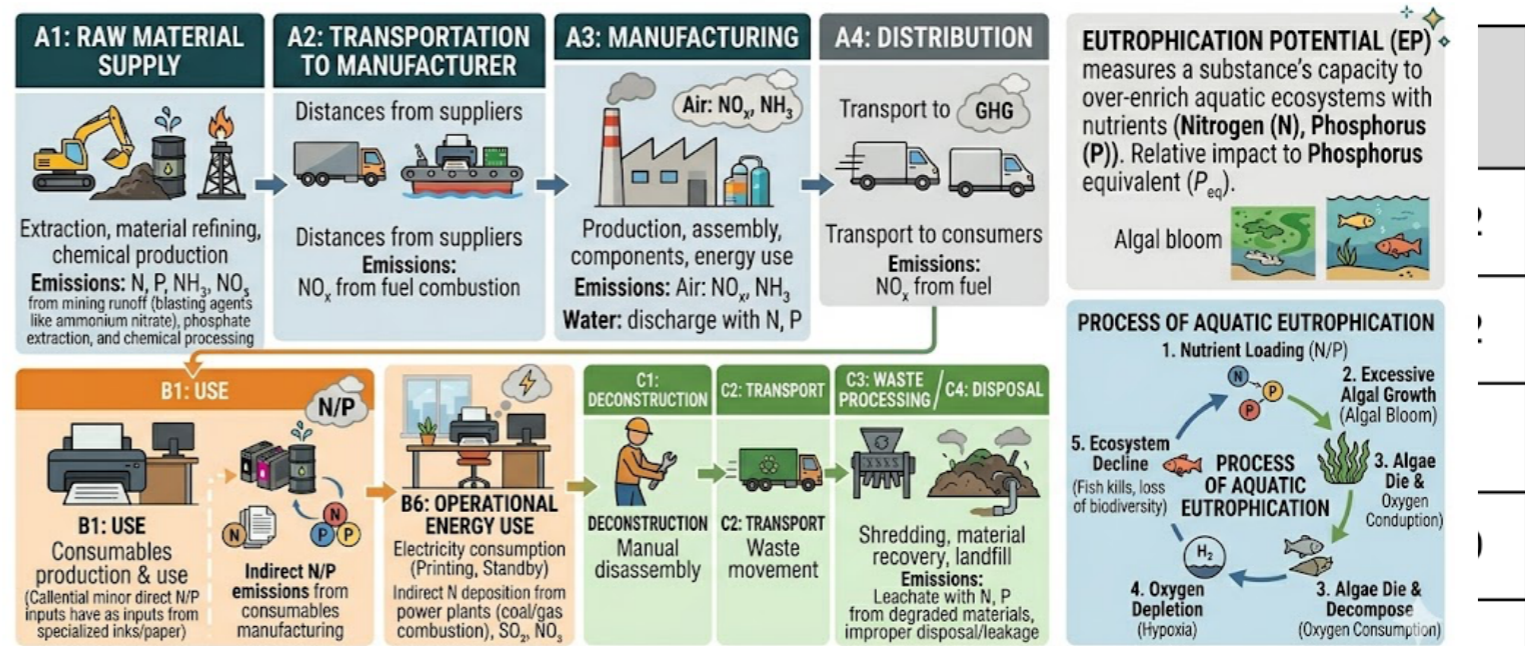
## 4.1 Impact Categories

Table 6: Impact Categories from EF v3.1 LCIA calculation

Indicator	Unit	A1-A3 (Manufacturing)	A1: RAW MATERIAL SUPPLY	A2: TRANSPORTATION TO MANUFACTURER	A3: MANUFACTURING	A4: DISTRIBUTION	Other	Other
GWP-total	kg CO2 eq	1.17E+02	Extraction, material refining, chemical production Emissions: N, P, NH <sub>3</sub> , NO <sub>x</sub> from mining runoff (blasting agents like ammonium nitrate), phosphate extraction, and chemical processing	Distances from suppliers Distances from suppliers Emissions: NO <sub>x</sub> from fuel combustion	Production, assembly, components, energy use Emissions: Air: NO <sub>x</sub> , NH <sub>3</sub> Water: discharge with N, P	Transport to consumers Emissions: NO <sub>x</sub> from fuel	EUTROPHICATION POTENTIAL (EP) measures a substance's capacity to over-enrich aquatic ecosystems with nutrients (Nitrogen (N), Phosphorus (P)). Relative impact to Phosphorus equivalent (P <sub>eq</sub> ). Algal bloom	
GWP-GHG	kg CO2 eq	1.16E+02						
ODP	kg CFC-11 eq	3.30E-05						
AP	mol H+ eq	6.79E-01						
EP-fresh	kg P eq	7.40E-02						
POCP	kg NMVOC eq	5.00E-01						
ADP-min	kg Sb eq	1.26E-02						
ADP-fossil	MJ	1.65E+03						
WDP	m3 eq	4.46E+01						

### EUTROPHICATION POTENTIAL (EP) FOR ELECTRONICS LCA FRAMEWORK (e.g., PRINTER)

Comparing the relative eutrophication

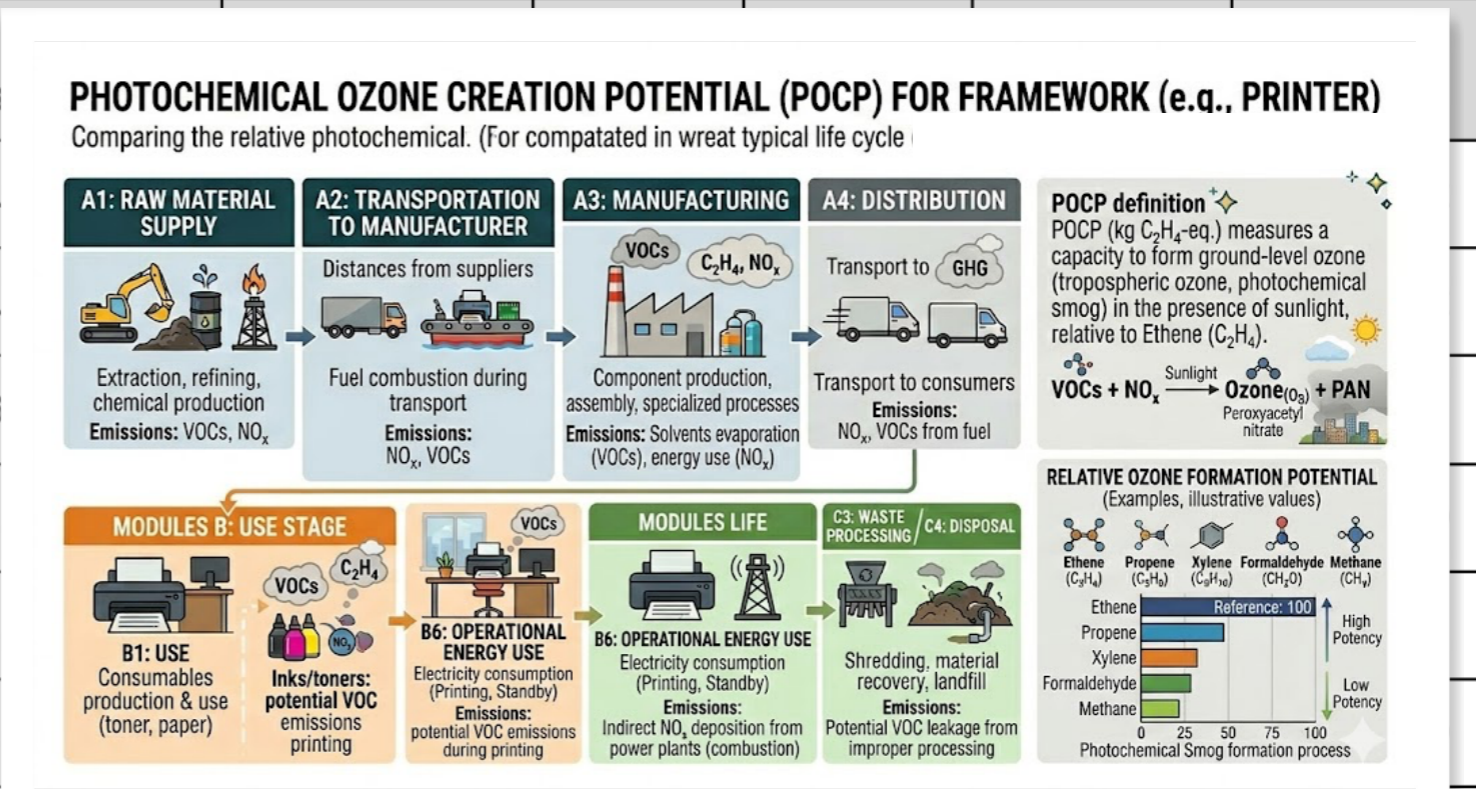


Eutrophication Potential  
Nitrogen into environment

# Example Claigan EPD Impact Categories

## 4.1 Impact Categories

Table 6: Impact Categories from EF v3.1 LCIA calculation

Indicator	Unit	A1-A3 (Manufacturing)	(Dis)	PHOTOCHEMICAL OZONE CREATION POTENTIAL (POCP) FOR FRAMEWORK (e.g., PRINTER)																		
GWP-total	kg CO2 eq	1.17E+02	4.	 <p><b>PHOTOCHEMICAL OZONE CREATION POTENTIAL (POCP) FOR FRAMEWORK (e.g., PRINTER)</b> Comparing the relative photochemical. (For computed in wreat typical life cycle)</p> <p><b>A1: RAW MATERIAL SUPPLY</b> Extraction, refining, chemical production Emissions: VOCs, NO<sub>x</sub></p> <p><b>A2: TRANSPORTATION TO MANUFACTURER</b> Distances from suppliers Fuel combustion during transport Emissions: NO<sub>x</sub>, VOCs</p> <p><b>A3: MANUFACTURING</b> Component production, assembly, specialized processes Emissions: Solvents evaporation (VOCs), energy use (NO<sub>x</sub>)</p> <p><b>A4: DISTRIBUTION</b> Transport to consumers Emissions: NO<sub>x</sub>, VOCs from fuel</p> <p><b>POCP definition</b> POCP (kg C<sub>2</sub>H<sub>4</sub>-eq.) measures a capacity to form ground-level ozone (tropospheric ozone, photochemical smog) in the presence of sunlight, relative to Ethene (C<sub>2</sub>H<sub>4</sub>). VOCs + NO<sub>x</sub> <math>\xrightarrow{\text{Sunlight}}</math> Ozone(O<sub>3</sub>) + PAN Peroxyacetyl nitrate</p> <p><b>RELATIVE OZONE FORMATION POTENTIAL</b> (Examples, illustrative values)</p> <table border="1"> <tr> <td>Ethene (C<sub>2</sub>H<sub>4</sub>)</td> <td>Propene (C<sub>3</sub>H<sub>6</sub>)</td> <td>Xylene (C<sub>8</sub>H<sub>10</sub>)</td> <td>Formaldehyde (CH<sub>2</sub>O)</td> <td>Methane (CH<sub>4</sub>)</td> </tr> <tr> <td>100</td> <td>~40</td> <td>~10</td> <td>~5</td> <td>~1</td> </tr> </table> <p>High Potency Low Potency</p> <p>Photochemical Smog formation process</p>							Ethene (C <sub>2</sub> H <sub>4</sub> )	Propene (C <sub>3</sub> H <sub>6</sub> )	Xylene (C <sub>8</sub> H <sub>10</sub> )	Formaldehyde (CH <sub>2</sub> O)	Methane (CH <sub>4</sub> )	100	~40	~10	~5	~1		
Ethene (C <sub>2</sub> H <sub>4</sub> )	Propene (C <sub>3</sub> H <sub>6</sub> )	Xylene (C <sub>8</sub> H <sub>10</sub> )	Formaldehyde (CH <sub>2</sub> O)								Methane (CH <sub>4</sub> )											
100	~40	~10	~5								~1											
GWP-GHG	kg CO2 eq	1.16E+02	4.																			
ODP	kg CFC-11 eq	3.30E-05	6.																			
AP	mol H+ eq	6.79E-01	2.																			
EP-fresh	kg P eq	7.40E-02	8.																			
<b>POCP</b>	<b>kg NMVOC eq</b>	<b>5.00E-01</b>	3.																			
ADP-min	kg Sb eq	1.26E-02	4.00E-04								0.00E+00	5.60E-03	5.77E-05	MND	1.87E-02							
ADP-fossil	MJ	1.65E+03	6.46E+02								0.00E+00	1.06E+04	1.95E+02	MND	1.31E+04							
WDP	m3 eq	4.46E+01	4.56E+00	0.00E+00	1.56E+02	5.94E+00	MND	2.11E+02														

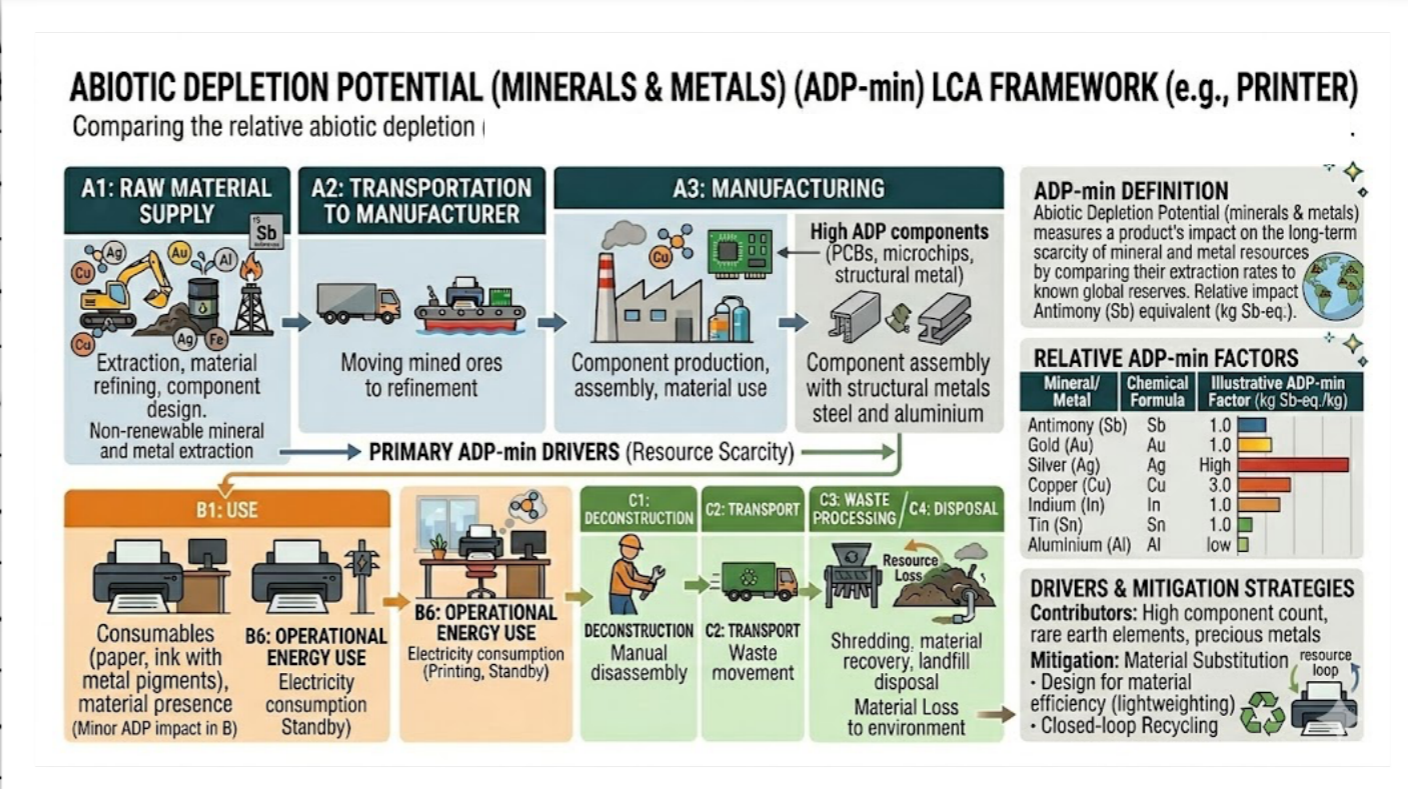
Photochemical Ozone Creation Potential  
*Creation of smog*

# Example Claigan EPD Impact Categories

## 4.1 Impact Categories

Table 6: Impact Categories from EF v3.1 LCIA calculation

Indicator	Unit	A1-A3 (Manufacturing)	B1-B6 (Use)	C1-C4 (End of Life)	MND	TOTAL (A+B+C)
GWP-total	kg CO2 eq	1.17E+02				7.98E+02
GWP-GHG	kg CO2 eq	1.16E+02				7.96E+02
ODP	kg CFC-11 eq	3.30E-05				4.43E-05
AP	mol H+ eq	6.79E-05				3.13E+00
EP-fresh	kg P eq	7.40E-05				5.97E-01
POCP	kg NMVOC eq	5.00E-05				2.13E+00
ADP-min	kg Sb eq	1.26E-02				1.87E-02
ADP-fossil	MJ	1.65E+03				1.31E+04
WDP	m3 eq	4.46E+01				2.11E+02



Abiotic depletion of minerals

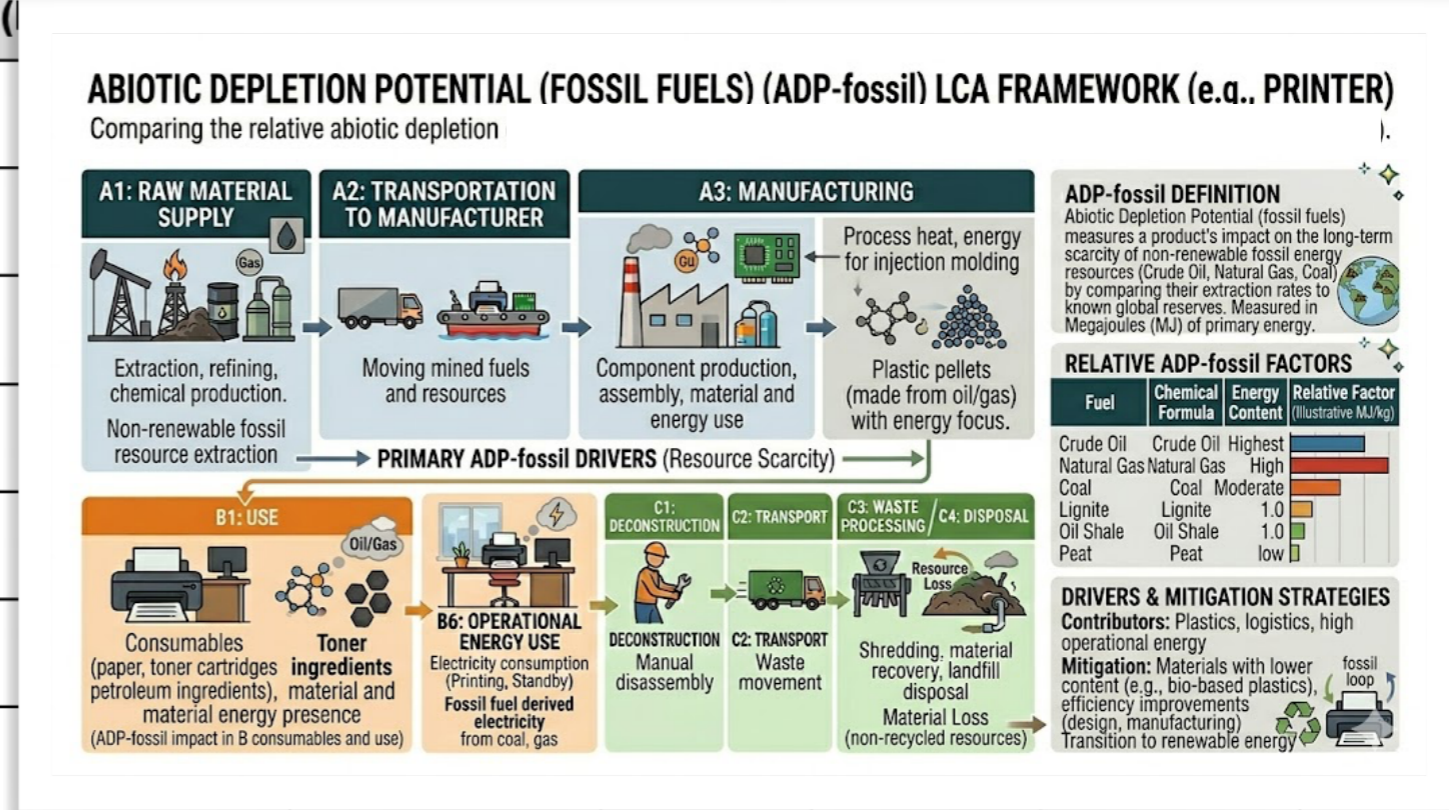
Depletion of non-fossil resources (minerals)

# Example Claigan EPD Impact Categories

## 4.1 Impact Categories

Table 6: Impact Categories from EF v3.1 LCIA calculation

Indicator	Unit	A1-A3 (Manufacturing)	A4	A5	B1-B7	C1-C4 (End of)	D	TOTAL (C)
GWP-total	kg CO2 eq	1.17E+02						1.17E+02
GWP-GHG	kg CO2 eq	1.16E+02						1.16E+02
ODP	kg CFC-11 eq	3.30E-05						3.30E-05
AP	mol H+ eq	6.79E-01						6.79E-01
EP-fresh	kg P eq	7.40E-02						7.40E-02
POCP	kg NMVOC eq	5.00E-01						5.00E-01
ADP-min	kg Sb eq	1.26E-02						1.26E-02
<b>ADP-fossil</b>	<b>MJ</b>	<b>1.65E+03</b>	<b>6.46E+02</b>	<b>0.00E+00</b>	<b>1.06E+04</b>	<b>1.95E+02</b>	<b>MND</b>	<b>1.31E+04</b>
WDP	m3 eq	4.46E-01	4.56E+00	0.00E+00	1.56E+02	5.94E+00	MND	2.11E+02



Abiotic depletion of fossil fuels

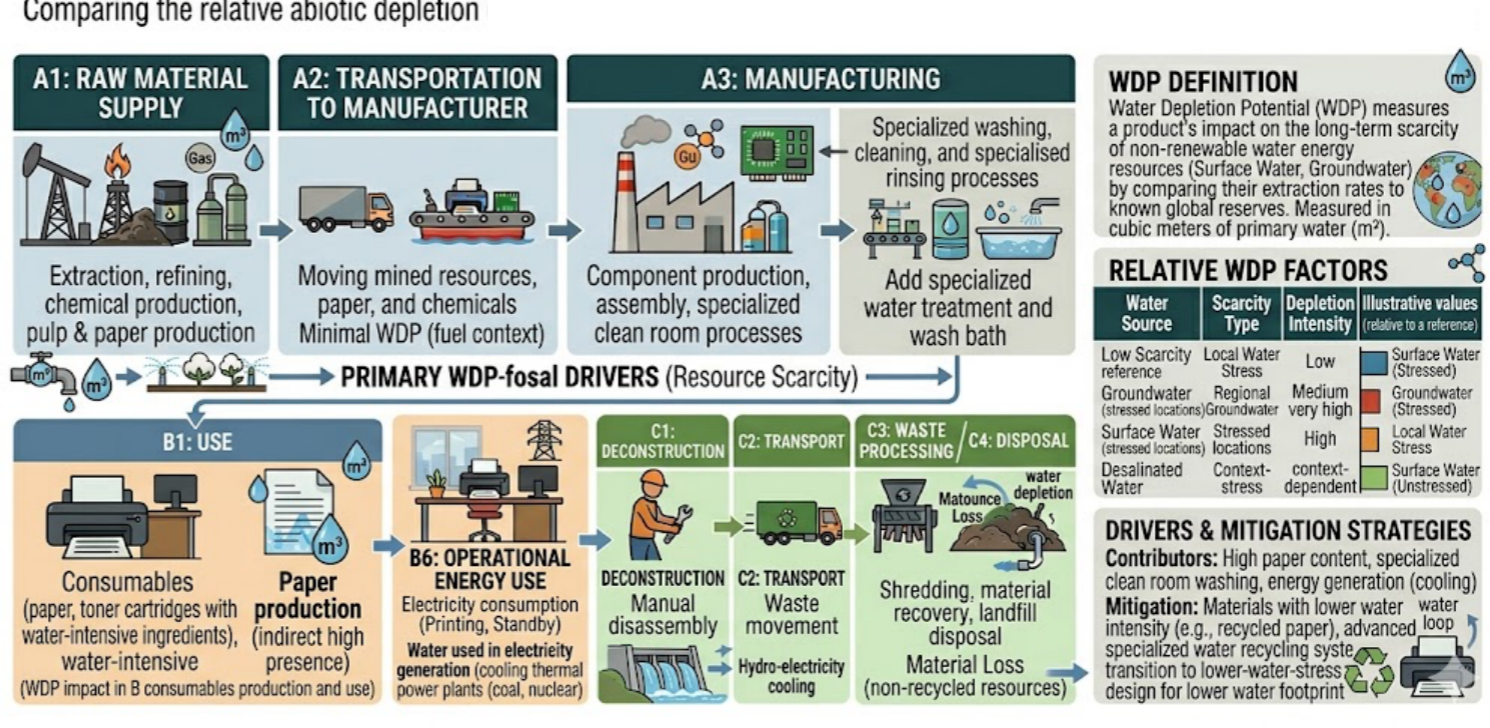
# Example Claigan EPD Impact Categories

## 4.1 Impact Categories

Table 6: Impact Categories from EF v3.1 LCIA calculation

Indicator	Unit	A1-A3 (Manufacturing)	A4 (Distribution)	A5 (Installation)	B1-B7 (Use)	C1-C4 (End of Life)	D (Recovery)	TOTAL (A+B+C)
GWP-total	kg CO2 eq	1.17E+02						E+02
GWP-GHG	kg CO2 eq	1.16E+02						E+02
ODP	kg CFC-11 eq	3.30E-05						E-05
AP	mol H+ eq	6.79E-05						E+00
EP-fresh	kg P eq	7.40E-05						E-01
POCP	kg NMVOC eq	5.00E-05						E+00
ADP-min	kg Sb eq	1.26E-05						E-02
ADP-fossil	MJ	1.65E+01						E+04
<b>WDP</b>	<b>m3 eq</b>	<b>4.46E+01</b>	<b>4.56E+00</b>	<b>0.00E+00</b>	<b>1.56E+02</b>	<b>5.94E+00</b>	<b>MND</b>	<b>2.11E+02</b>

### WATER DEPLETION POTENTIAL (WDP) LCA FRAMEWORK (e.g., PRINTER)



Water depletion potential

# Example Claigan EPD

## Appendix B - Detailed LCIA Results

### Appendix B: Detailed LCIA Results (by Module)

Table 12: Detailed EF v3.1 LCIA results by Module

Impact category	Reference unit	A1_Raw Materials and Components	A2_Transport to Manufacturing	A3_Manufacturing	A4_Transport to Customer	B1_Consumables	B6_Energy Use	C2_Waste Transport	C3 C4_Waste Processing
Ecotoxicity: freshwater	CTUe	1.03E+03	1.04E+00	2.31E+02	1.22E+02	1.08E+02	1.65E+03	6.06E-01	7.37E+01
Ecotoxicity: freshwater, organics	CTUe	9.67E+01	5.69E-02	1.17E+01	4.61E+00	4.14E+00	4.54E+01	7.00E-02	1.14E+01
Climate change: land use and land use change	kg CO2-Eq	2.02E+00	3.62E-04	7.93E-01	2.71E-02	8.90E-03	6.87E-01	1.05E-04	1.91E-01
Eutrophication: terrestrial	mol N-Eq	1.03E+00	4.49E-02	2.89E-01	8.93E-01	5.05E-02	3.07E+00	2.49E-02	1.50E-01
Climate change	kg CO2-Eq	9.03E+01	7.81E-01	2.35E+01	4.81E+01	4.16E+00	6.01E+02	1.00E+00	1.48E+01
Human toxicity: carcinogenic, inorganics	CTUh	2.48E-08	9.73E-11	7.93E-09	5.14E-09	3.99E-09	9.24E-08	2.56E-11	2.15E-09
Ecotoxicity: freshwater, inorganics	CTUe	9.30E+02	9.86E-01	2.19E+02	1.18E+02	1.04E+02	1.61E+03	5.36E-01	6.24E+01
Energy resources: non-renewable	MJ, net calorific value	1.33E+03	1.00E+01	3.20E+02	6.46E+02	5.21E+01	1.06E+04	1.29E+01	1.82E+02
Particulate matter formation	disease incidence	5.07E-06	4.22E-08	1.48E-06	4.53E-06	3.31E-07	1.16E-05	1.29E-07	1.17E-06

# Example Claigan EPD

## Appendix C - Data Sources



### Appendix C: Data Sources & Proxy List

Table 13: Data Quality Assessment

Module	Process/Material	Database Source (Version)	Ref. Year	Ref. GEO	Technology	Data category	Overall Quality	Data Contribution % Climate Change	Comment
A1	White layer - 2811231 Polystyrene (PS) resins Main housing - 2811231 Polystyrene (PS) resins Foam - 2811231 Polystyrene (PS) resins market for polystyrene, general purpose   polystyrene, general purpose   APOS, U	EcolInvent 3.11 Claigan Lab Data	2024	GLO	Average	Secondary Data	Good	1.65%	Material was identified by Claigan using FTIR to be PS  High Precision: Modelled using Primary Activity Data (measured weights) combined with secondary background data.
A1	Clear layer A - 2811299 All other thermoplastic resins, n.e.c. Clear layer B - 2811299 All other thermoplastic resins, n.e.c. Black trim - 2811299 All other thermoplastic resins, n.e.c. (2811299 = polycarbonate) market for polycarbonate   polycarbonate   APOS, U	EcolInvent 3.11 Claigan Lab Data	2024	ROW	Average	Secondary Data	Good	0.94%	Material was identified by Claigan using FTIR to be PC  High Precision: Modelled using Primary Activity Data (measured weights) combined with secondary background data.

- **Plus a whole additional data package for a 3rd party reviewer**

# Claigan Experience

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- **Claigan has been around for fifteen (15) years**
- **Life Cycle Assessment Experience**
  - Predominantly
    - Electronics
    - Medical devices
    - Machinery
  - Combination of
    - Consumer
    - Professional products

# Why Conduct an LCA? (Or EPD)

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- **Customer requirement**
  - Common in tenders for larger organizations
  - Especially in the EU
- **‘Points’ towards a Certification**
  - Such as LEED or EPEAT
- **Cost reduction**
  - Yes, cost reduction

# Co2 and Cost Reduction

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- **Co2 reduction means cost reduction**
  - A 20% reduction in Co2 normally means a 20% cost reduction
- **Oversimplification**
  - Co2 emissions means energy
  - Energy = Effort = Cost
- **When you conduct an LCA**
  - You will identify at **least two significant opportunities for cost reduction**

# Selling LCA to Management

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- **Interested in a cost reduction?**
  - And the customer will not ask for a price reduction?
- **Management will listen**

# Questions?

## 4.1 Impact Categories

Table 6: Impact Categories from EF v3.1 LCIA calculation

Indicator	Unit	A1-A3 (Manufacturing)	A4 (Distribution)	A5 (Installation)	B1-B7 (Use)	C1-C4 (End of Life)	D (Recovery)	TOTAL (A+B+C)
GWP-total	kg CO2 eq	1.17E+02	4.96E+01	0.00E+00	6.15E+02	1.63E+01	MND	7.98E+02
GWP-GHG	kg CO2 eq	1.16E+02	4.96E+01	0.00E+00	6.14E+02	1.60E+01	MND	7.96E+02
ODP	kg CFC-11 eq	3.30E-05	6.88E-07	0.00E+00	1.04E-05	2.35E-07	MND	4.43E-05
AP	mol H+ eq	6.79E-01	2.63E-01	0.00E+00	2.12E+00	7.00E-02	MND	3.13E+00
EP-fresh	kg P eq	7.40E-02	8.00E-03	0.00E+00	5.11E-01	4.00E-03	MND	5.97E-01
POCP	kg NMVOC eq	5.00E-01	3.28E-01	0.00E+00	1.24E+00	5.60E-02	MND	2.13E+00
ADP-min	kg Sb eq	1.26E-02	4.00E-04	0.00E+00	5.60E-03	5.77E-05	MND	1.87E-02
ADP-fossil	MJ	1.65E+03	6.46E+02	0.00E+00	1.06E+04	1.95E+02	MND	1.31E+04
WDP	m3 eq	4.46E+01	4.56E+00	0.00E+00	1.56E+02	5.94E+00	MND	2.11E+02

# Q&A