ACMA
American Composites Manufacturers Association

RECOVER. TRANSFORM. INNOVATE.

Composites Recycling Conference 2020 | Online

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EXPLORING THE NEED FOR LIFE CYCLE ANALYSIS AND COST ANALYSIS

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LCA/LCI WHAT DO WE KNOW and DON'T KNOW

Global Composites Sustainability Coalition LCA/LCI Initiative

How to generate complete credible LCI input data

LCA/LCI that supports the Supply Chain Infrastructure

ISO has LCA Standards for composites focused on Environmental Impact

Need a complete set of Standards for LCA/LCI and Composites Recycling

Support from DOE, NIST, IACMI, ACMA Partners, ISRI, EPRI, EuCIA, Comp. UK

Thermolyzer Phase 1 Techno-Economic LCA/LCI Model

LCA/LCI development at ACMA/IACMI/Composites UK/EuCIA/DOE/ORNL and others have created LCAs for composites

There is no Universal Consensus LCA/LCI for composites

A General Awareness of Sustainability

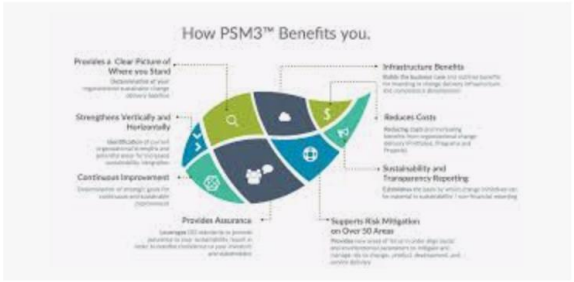
At the Consumer Level

At Universities and Research Institutes

At Government Agencies

Large and Small Companies

ALLIANCE TO END PLASTIC WASTE



The PSM3™ Sustainability Assessment
greenprojectmanagement.org

SDO Sustainable Development Organization

Sustainable Development Organization ...
wateractionhub.org

CENTER FOR SUSTAINABLE ORGANIZATIONS

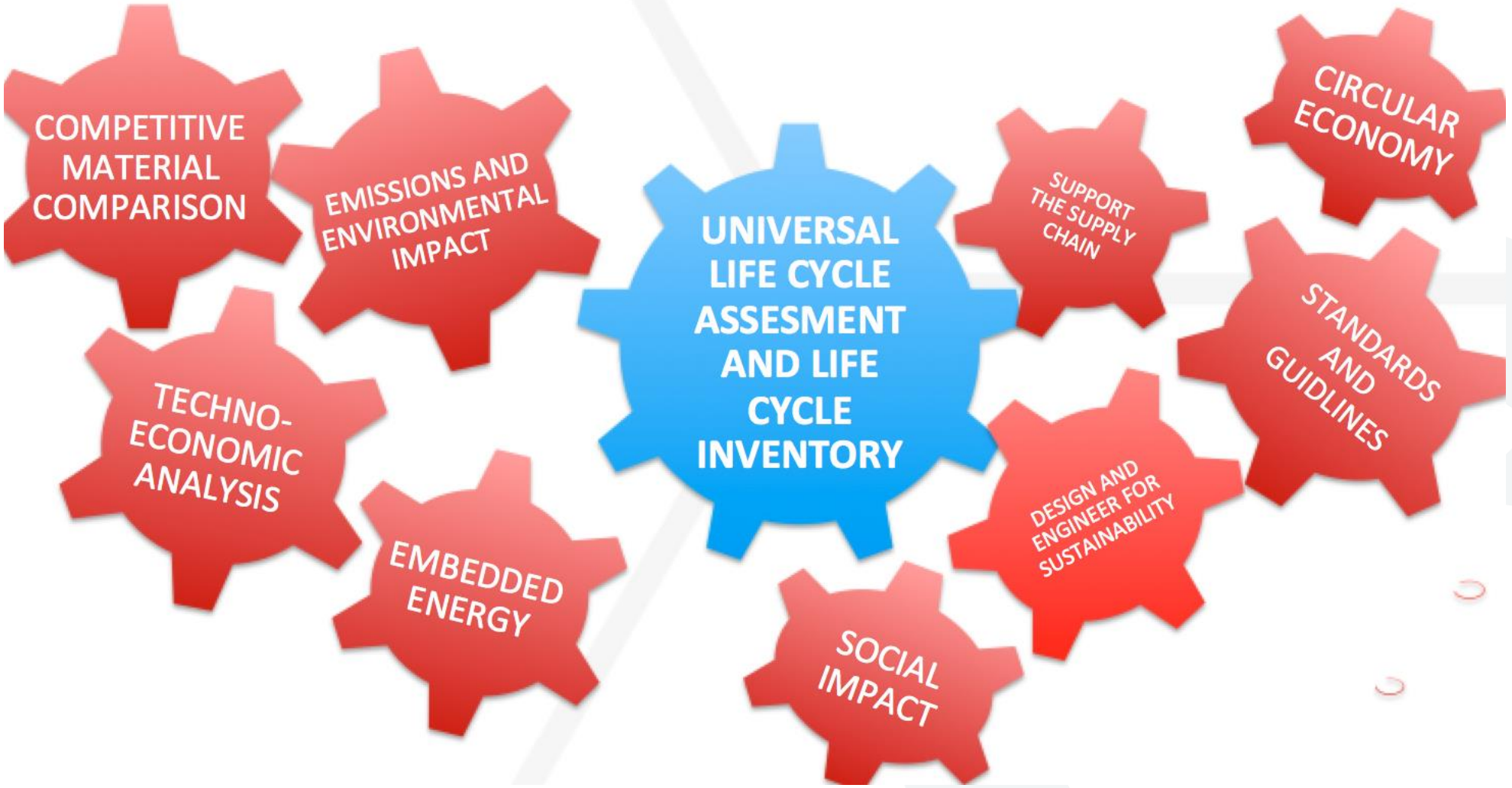
Welcome To Sustainable Organizations ...
sustainableorganizations.org

A Sampling of Sustainability and Life Assessment Organizations

Sustainability and a Universal LCA/LCI Model

- **Elements of a Universal LCA/LCI Model**
  - Design and Engineer for Sustainability/Recycling incorporating LCA analysis into the design/engineering cycle
  - Support the Supply Chain with a Universal LCA/LCI Model and Standards
  - Embedded Energy LCA/LCI and accurate LCI input data
  - Overall Emission and Environmental Impact (Carbon Footprint)
  - Techno-Economic Analysis for single and multi-life scenarios
  - Social Impact to current and future generations
  - How do we compare Composites to other materials in an LCA/LCI model

Elements of a Universal LCA/LCI Model



SUMMARY : THINGS TO THINK ABOUT

- **Sustainability/Life Cycle Assessment is a process of objectively and fairly comparing and determining the most efficient utilization of raw materials and energy with the least negative impact.**

Eco-Calculator

Jaap van der Woude

EuCIA

Defining LCI and LCA

Life Cycle Inventory (LCI)

Collection and quantification of inputs / outputs for a process or material

Life Cycle Assessment (LCA)

Scientific method for estimating the environmental footprint of a product.Includes one or more LCI/LCA's:

i.e. manufacturing, user phase, end of life information

Cradle to Gate

All inputs and outputs from extraction/harvest of raw materials & energy up to the point it leaves the manufacturing site.

Cradle to Grave

All inputs and outputs from extraction/harvest to the end of the useful life of the product, including the use and maintenance of the product, and end-of-life disposition.

ISO 14040/44 2006

Environmental management — Life cycle assessment — Principles and framework

Last reviewed and confirmed in 2016

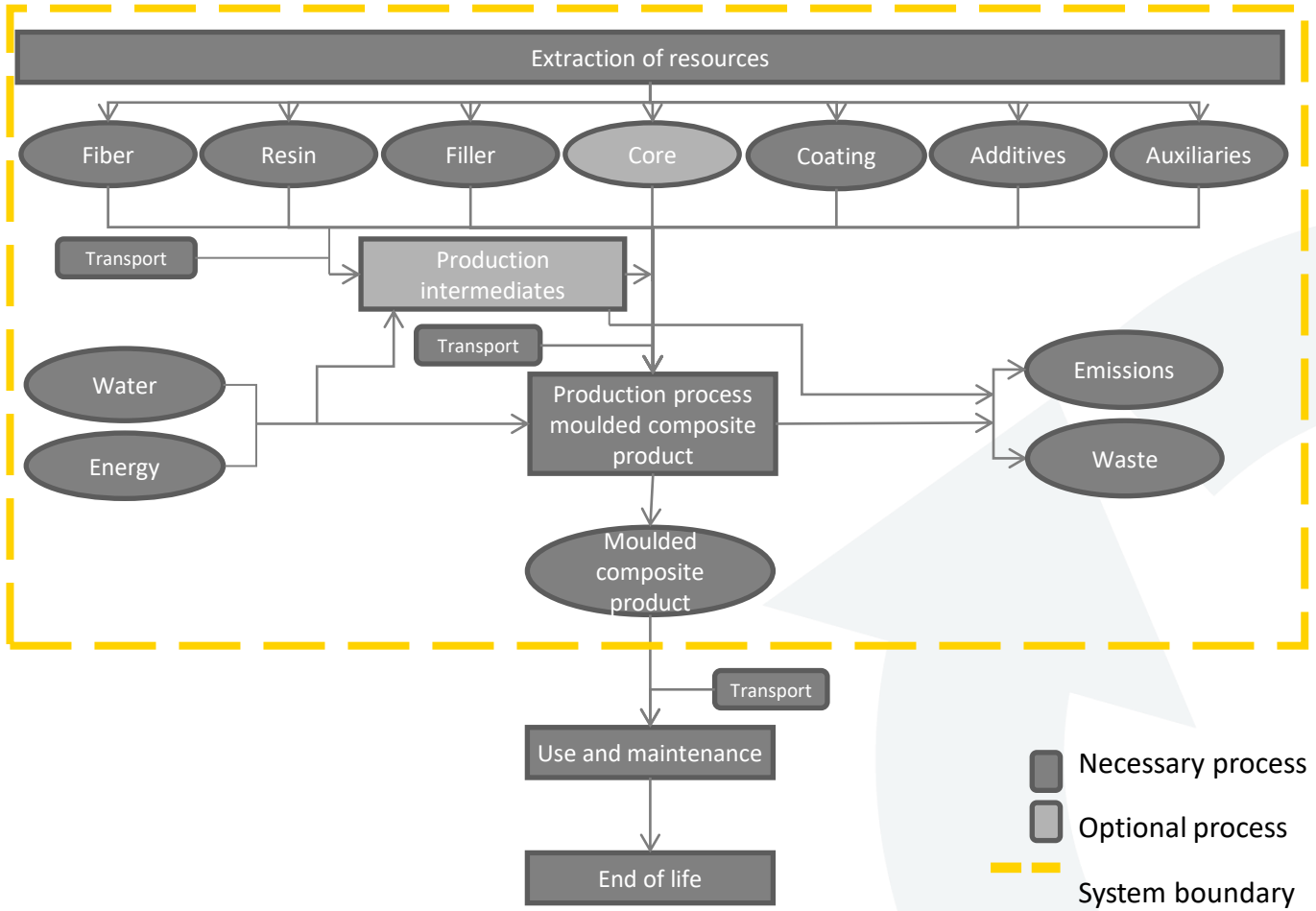
ISO 14040/44:2006

- describes the principles and framework for life cycle assessment (LCA) including:
- definition of the goal and scope of the LCA, the life cycle inventory analysis (LCI) phase, the life cycle impact assessment (LCIA) phase, the life cycle interpretation phase, reporting and critical review of the LCA, limitations of the LCA, the relationship between the LCA phases, and conditions for use of value choices and optional elements.

ISO 14040/44:2006

- covers life cycle assessment (LCA) studies and life cycle inventory (LCI) studies. It does not describe the LCA technique in detail, nor does it specify methodologies for the individual phases of the LCA.
- The intended application of LCA or LCI results is considered during definition of the goal and scope, but the application itself is outside the scope of this International Standard.

System Boundary: Cradle to Gate



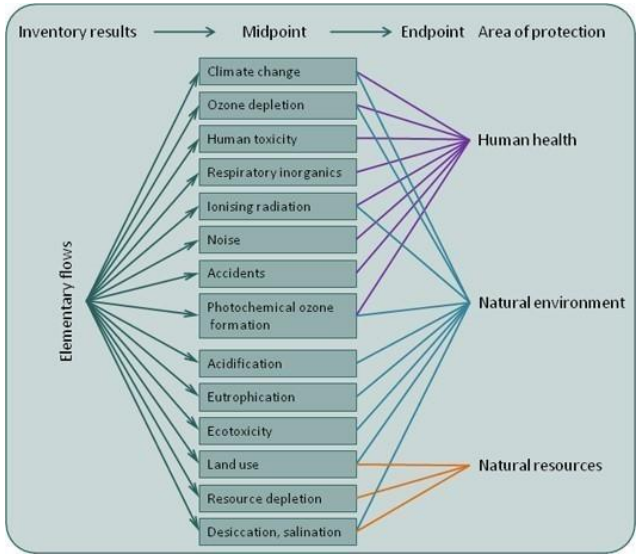
Impact assessment methods for the Eco Impact Calculator
Three environmental methods

- International Reference Life Cycle Data System (ILCD) 2011 Midpoint+ V1.06 / EU27 2010, equal weighting
- Cumulative Energy Demand V1.10 / Cumulative energy demand
- Greenhouse Gas Protocol V1.01 / C02 eq (kg)

The development of the ILCD was coordinated by the European Commission in a broad international consultation process with experts, stakeholders and the general public.

International Reference Life Cycle Data System (ILCD)

https://eplca.jrc.ec.europa.eu/?page_id=1159



Impact category	Unit
Climate change	kg CO_2 eq
Ozone depletion	kg CFC-11 eq
Human toxicity, non-cancer effects	CTUh
Human toxicity, cancer effects	CTUh
Particulate matter	kg PM2.5 eq
Ionizing radiation HH	kBq U235 eq
Ionizing radiation E (interim)	CTUe
Photochemical ozone formation	kg NMVOC eq
Acidification	molc H+ eq
Terrestrial eutrophication	molc N eq
Freshwater eutrophication	kg P eq
Marine eutrophication	kg N eq
Freshwater ecotoxicity	CTUe
Land use	kg C deficit
Water resource depletion	m^3 water eq
Mineral, fossil & renewable resource depletion	kg Sb eq

ILCD provides:

- a common basis for consistent, robust and quality-assured life cycle data, methods and assessments.
- This LCIA considers multiple impact categories that influence human health, natural environment and natural resources.
- The emissions and resources derived from the inventory are assigned to each of these impact categories, followed by
- conversion into indicators that reflect pressures per unit emission or resource consumed

Cumulative energy demand (CED)

impact categories MJ/kg

Impact category	Unit
Non-renewable (fossil)	MJ
Non-renewable (nuclear)	MJ
Non-renewable (biomass)	MJ
Renewable (biomass)	MJ
Renewable (wind, solar, geothermal)	MJ
Renewable (water)	MJ

- Total measure of energy resources necessary for the supply of a product or a service.
- CED specifies all non-renewable (i.e. fossil and nuclear energy) and renewable energy sources as primary energy values

Greenhouse Gas (GHG) Protocol

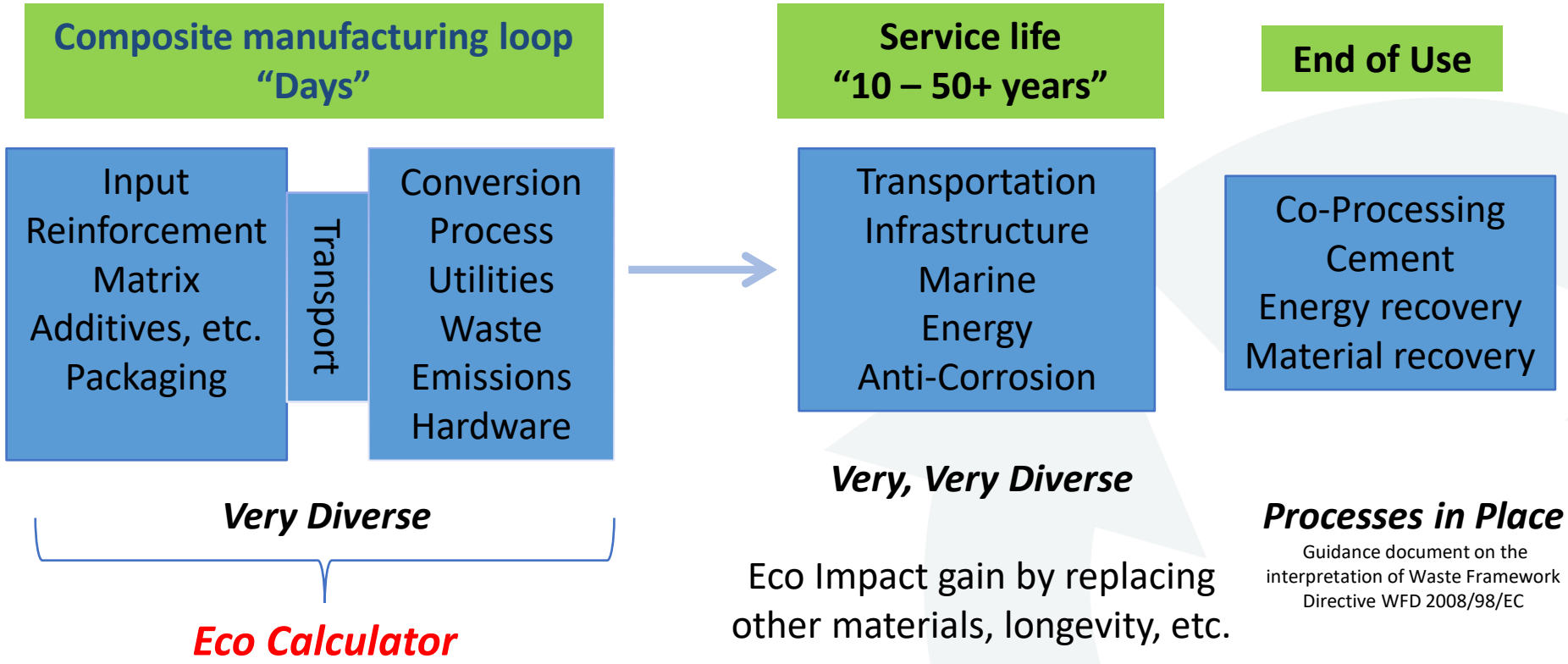
(https://ghgprotocol.org)

Impact category	Unit
Fossil CO_2 equivalent	kg
Biogenic CO_2 equivalent	kg
CO_2 equivalent from land transformation	kg
CO_2 uptake	Kg

- A multi-stakeholder global partnership of businesses, NGOs, the World Resources Institute (WRI) and the World Business Council for Sustainable Development (WBCSD), Launched in 1998
- GHG Protocol's mission: develop internationally accepted greenhouse gas (GHG) accounting and reporting standards and tools; promote adoption in order to achieve a low emissions economy worldwide.

FRP Life Cycle

"Innovative Concepts: Many Different Products in Many, Many Different Applications"



Eco Calculator only for cradle to gate manufacturing: can be used as input for full life cycle calculations

Initiative EuCIA: Eco Calculator for Composite Parts

EuCIA (www.eucia.eu) **has developed the Eco Calculator** in cooperation with **EY** Cleantech and Sustainability Services and **Biinc**.

The Eco Calculator allows composite manufacturers to calculate the **environmental impact of their products**, without the need of a deep know-how of Life Cycle Assessment processes.

The tool generates **an Eco Report, a Summary Report and SimaPro 8.2 Export**

- Using a transparent and uniform sector methodology for processes **following ISO 14.040/044**
- Follows the three environmental **Impact assessment methods**: **CED, GHG, ILCD**
- Based **on Industry generated, peer reviewed, quality data** as well as material data from **eco inventories* i.e. EU average energy mix is used**
- Conversion processes based on industrial averages as well possibility to modify/own input
- **Output can be used as input:** manufacturing of product input for full life cycle calculations
- The Eco Factsheet is based on EU industry average figures for the conversion processes. Third party verification on the processes has not been performed and this is therefore **not an Environmental Product Declaration (EPD).**

The Eco and Summary reports are to be **shared with clients and other stakeholders**, to fulfill the need for accurate and specific environmental information.

The tool is **web-based,** easy to use

The tool is free http://ecocalculator.eucia.eu/

The tool is launched http://bit.ly/29pRJDn

* GFE (http://www.glassfibreeurope.eu); Plastics Europe (www.plasticseurope.org); AVK (www.avk-tv.de); Ecoinvent 3.1

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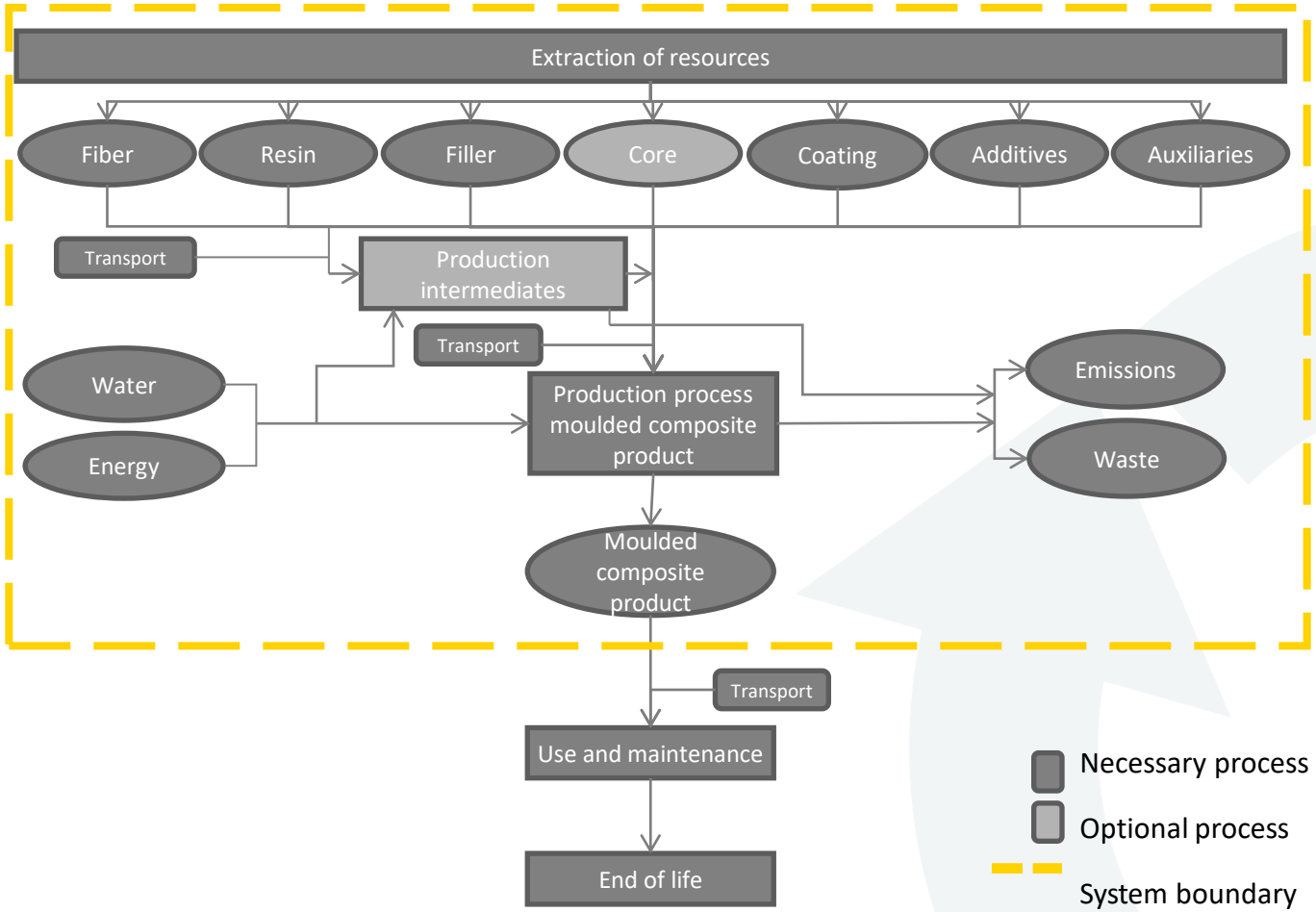


Although Main Industry Processes Covered, still missing a

(A questionnaire on NDA basis is used)

SELECTED PROCESSES

In model

- Pultrusion
- Resin infusion
- Resin transfer moulding
- SMC Pressing
- SMC Compounding
- *TP compounding
- *TP Injection molding process
- *LFT/UD tape

* modelled

Missing

- Centrifugal casting/Filament winding
- Hand lamination
- Spray-up
- Pre-forming
- Prepreg autoclaving
- BMC Compounding
- BMC Pressing

Adaptation processes for “own situation” possible

RECENTLY ADDED

Modelled TP conversion processes
- No comments received

New Core Materials

Fiber Glass Mat

Update of all fiber glass products with latest data from industry
- Major discrepancies resolved

Carbon Fiber
- Literature based study
- Enhancement with experimental data @ ITA
- Global LCA review (NCC, Deakin,..)

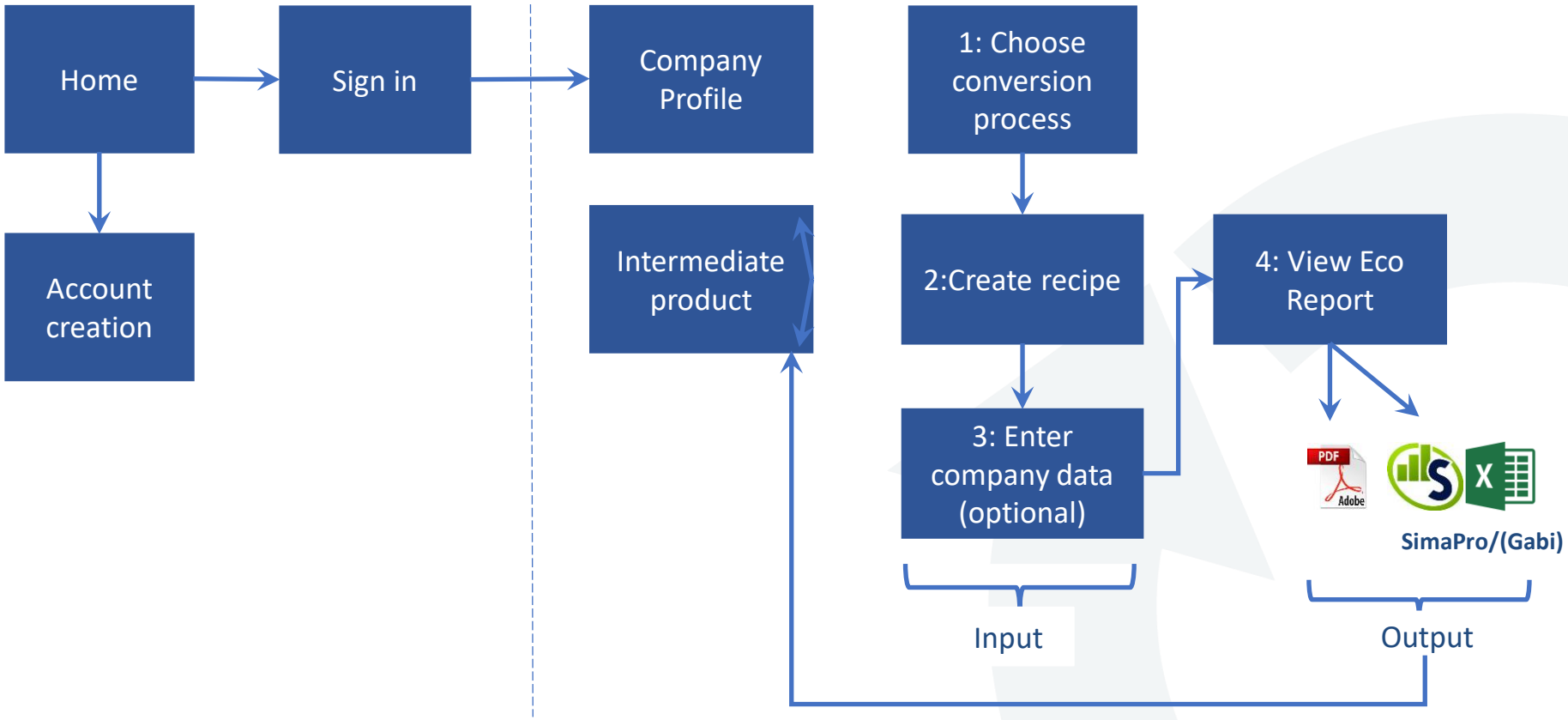
Background document updated

GAPS

- Materials
  - *Specific EP Curing agents*
    - *Amine, Anhydride*
  - *Flame retardants*
    - *BPS/Synergist, family of Polyphosphinates*
- Processes
  - Some processes
  - Some intermediate products such as *woven roving and non crimp fabric*

Collection industry data continues

Workflow of Eco Calculator



Next steps Eco Calculator and future questions

An LCA tool needs “maintenance”: data and sometimes procedures may change over time following improved understanding

For modelled data (CF LCA, TP conversion processes) input is elected

Need to complete the dataset:

- Processes (modelling or collection)
- Materials i.e. epoxy X-linkers, FR

Data for natural fibers under development (flax)

Follow EU initiative for PEFCR – what means compliance?

Inclusion of recycling in the tool?

THANK YOU

Questions