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Life Cycle Assessments – A method to assess environmental impacts and to facilitate business & strategic decision making

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Curriculum

1998 – 2003 Bachelor in Physics
University of Patras, GR

2003 – 2005 MSc in Materials Sci. & Technol.
NTUA, GR

2005 – 2009 PhD in Polymer Physics
NTUA, GR

2010 – 2011 Research Fellow
Cranfield University, UK

Sustainability

2020 Business Sustainability Management
University of Cambridge

2021 Life Cycle Assessment:
Basic Principles and Uses
Maastricht University

2021 SimaPro LCA Training Software
ESU-services

Outline

- **Introduction**
  - ABB’s 2030 sustainability strategy
  - Utilization of sustainable plastics in our products and their packaging
- **Environmental performance comparisons**
  - Cradle-to-gate LCAs of different LDPE: fossil-based, mechanically recycled, biobased
  - Cradle-to-grave LCAs of packaging: paper vs plastic (fossil-based, mechanically recycled, biobased)
- **Concluding remarks**

Links (abb.com)

- Sustainability strategy 2030
- Mission to Zero
- Customer emissions
- Circularity framework
- EcoSolutions label

Introduction

ABB today

Electrification

Motion

Leading technologies

Great team

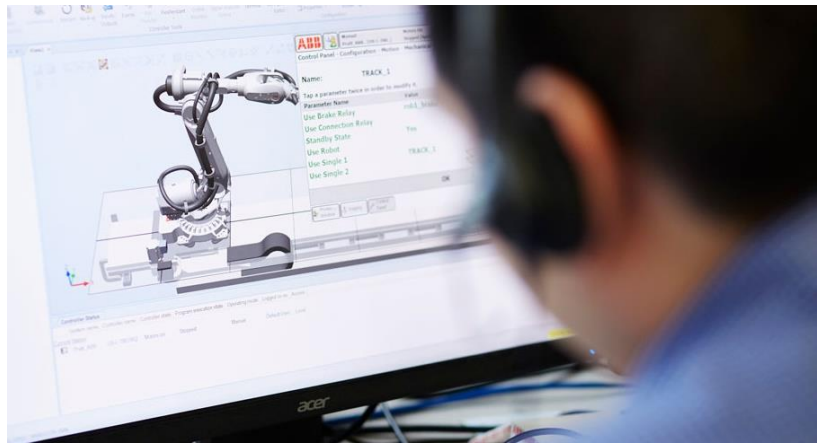
Strong brand

Market trends
and customer needs

- Electrification of transport
- Increased sustainable productivity
- Automated manufacturing
- Digital solutions and services
- Smart factories

Process Automation

Robotics & Discrete Automation



Electrification Business Area

Overview: 6 empowered Divisions generating ~$12B in 100+ countries

Distribution Solutions

Medium and low voltage control & protection products, systems & switchgear, automation & services

GLOBAL #1
in Medium Voltage

Smart Power

Low voltage breakers & switches, enclosures, motor starter application, power protection

GLOBAL #2
in Low Voltage

Smart Buildings

Miniature breakers, distribution enclosures, wiring accessories, building automation

GLOBAL #2
in electrification

Installation Products

Wire & cable management and protection, termination, medium voltage for utilities, conduits, fittings & other accessories

GLOBAL #2/NAM1 #1
in electrical products that connect & protect

Power Conversion

Power conversion products including embedded power products, DC power solutions and services

GLOBAL #3
for DC to DC power converters

E-mobility

DC fast & high-power chargers, DC & AC Wallbox, bi-directional charging, HV & bus charging, site & load mgmt, remote diagnostics service

GLOBAL #1-2
in charging infrastructure

$11.9 BILLION
in revenue (2020)

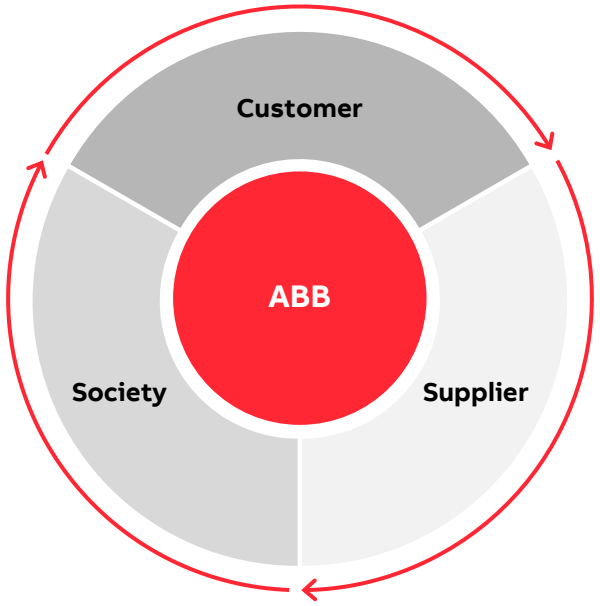
~50K
employees worldwide

100+
countries

1.7 MILLION
products shipped/day

ABB sustainability strategy

Striving to achieve all targets by 2030



We enable a **low-carbon society**

- Support our customers in reducing annual CO_2 emissions by **>100 Mt**[1]
- **Carbon neutrality** in own operations
- Supply chain emission reduction

We preserve **resources**

- **80%** of ABB products & solutions covered by circularity approach
- **Zero waste** to landfill[2]
- Supplier Sustainability Framework

We promote **social progress**

- **Zero harm** to our people and contractors
- Comprehensive D&I framework[3]; **25% women** among ABB leaders
- **Top-tier** employee engagement score in our industry
- Impactful support for community-building initiatives

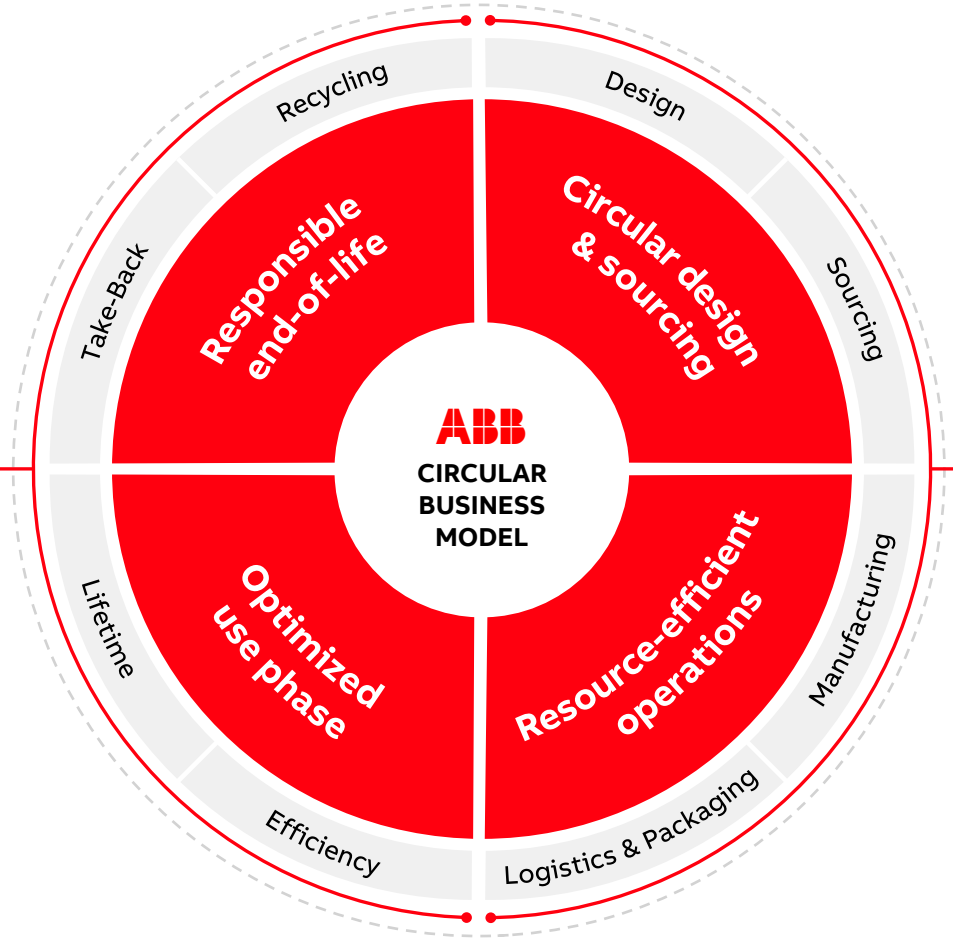
1. Savings in the year 2030 from solutions provided to customers 2021–30
2. Wherever local conditions allow
3. Diversity & Inclusion framework

Integrity and transparency across our value chain

ABB Circularity framework

80% of our products and solutions covered by the circularity approach

WHAT WE ENABLE
Circular customer solutions

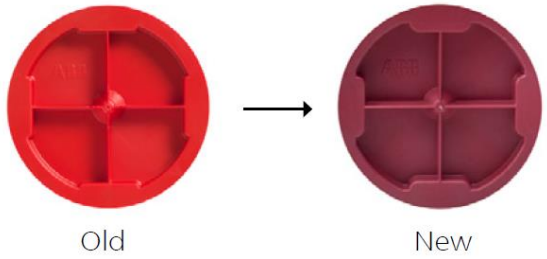


WHAT WE DO
ABB circular operations

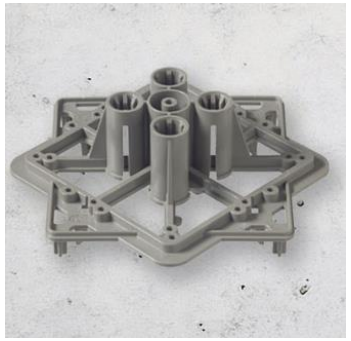
Introduction of recycled materials in ABB products

Examples on parts/products made of 100% post-consumer recycled plastics

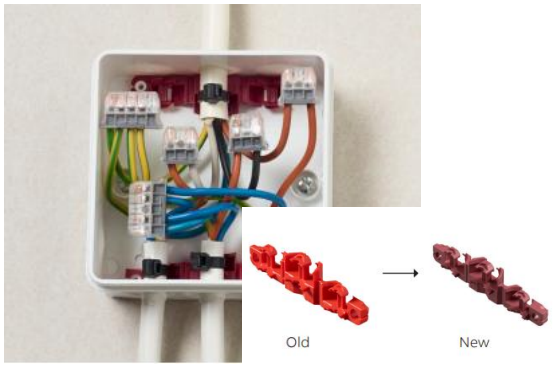
Box covers



Box supports



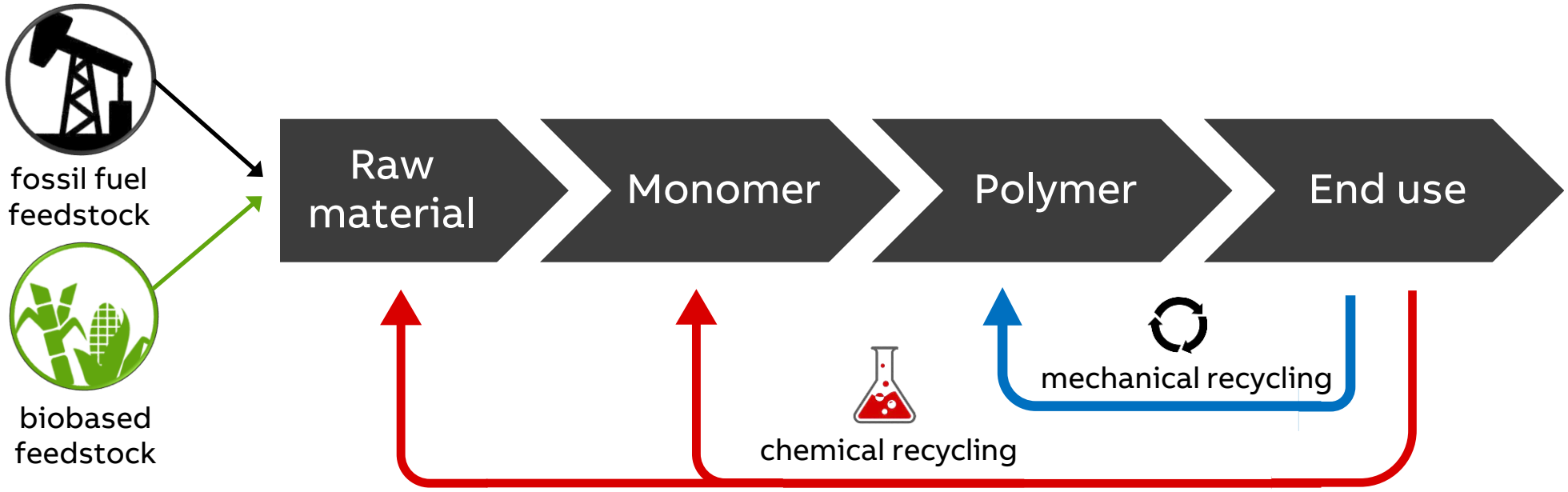
Strain reliefs



Surface mounted junction box

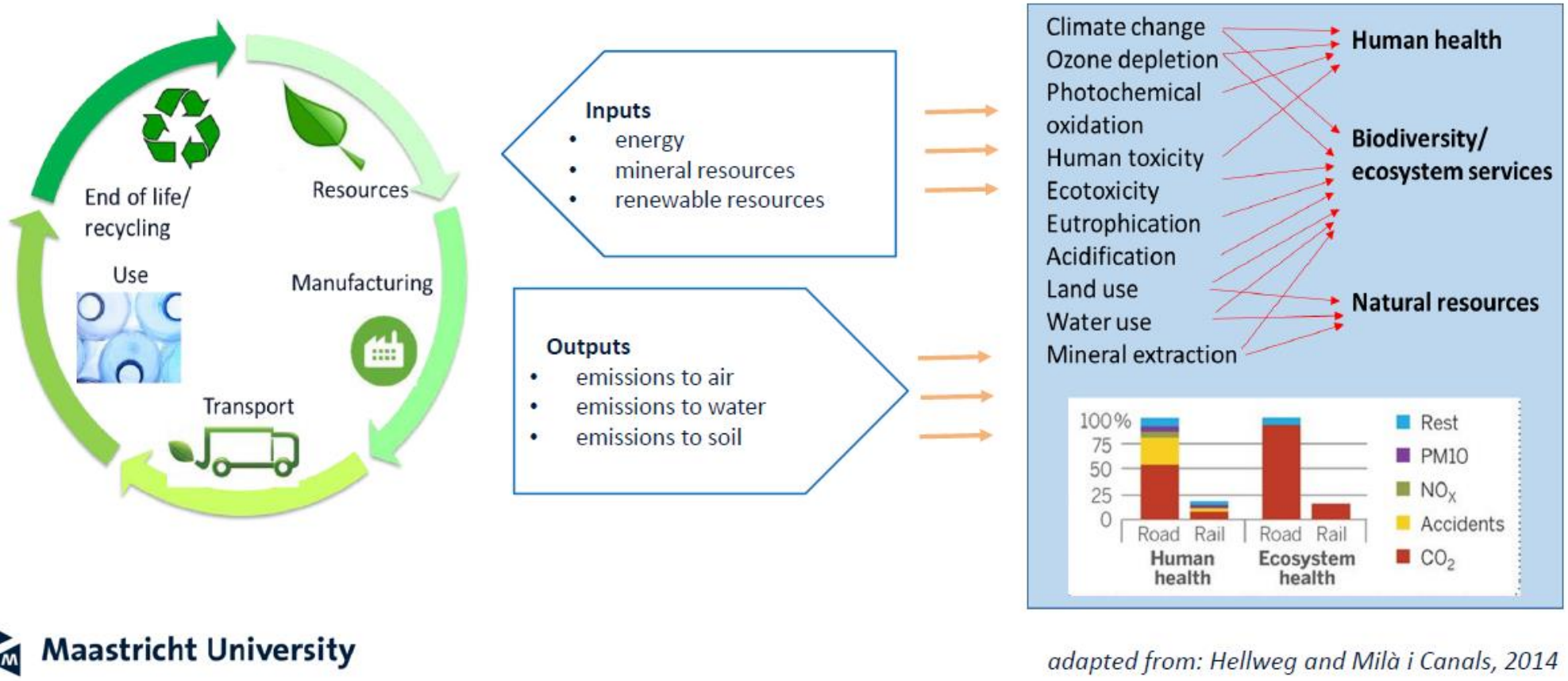
Sustainable plastics

Overview



Environmental performance comparisons

Life Cycle Assessment



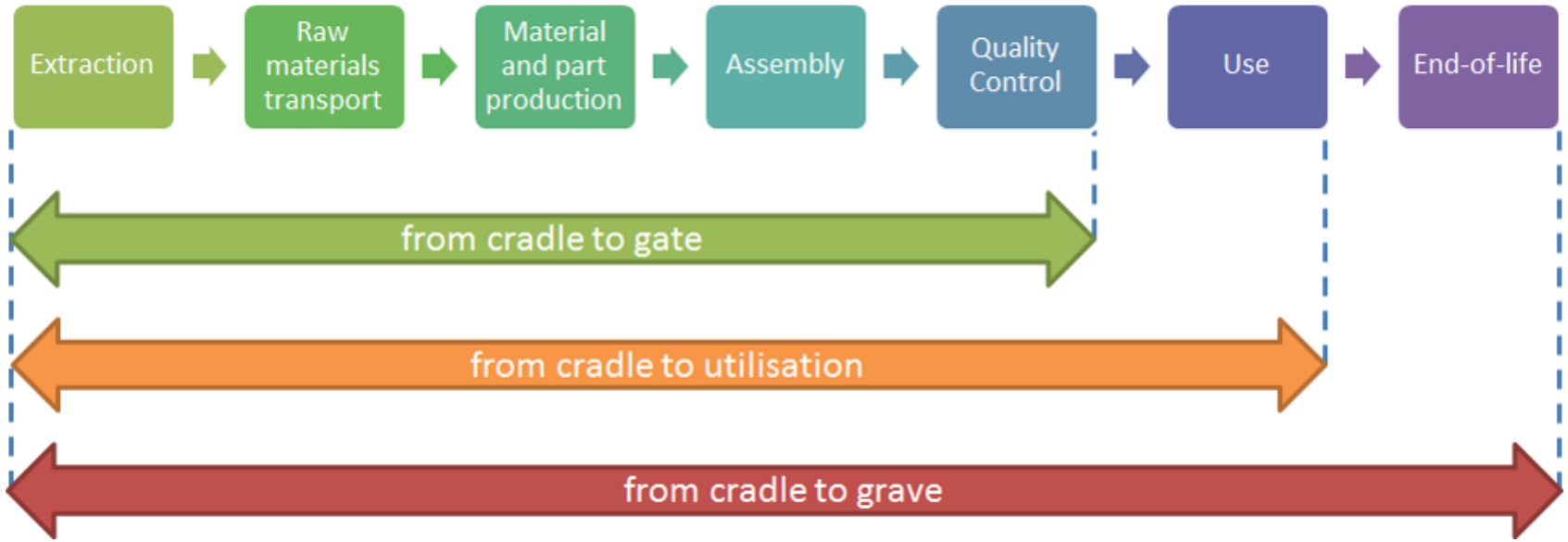
Maastricht University

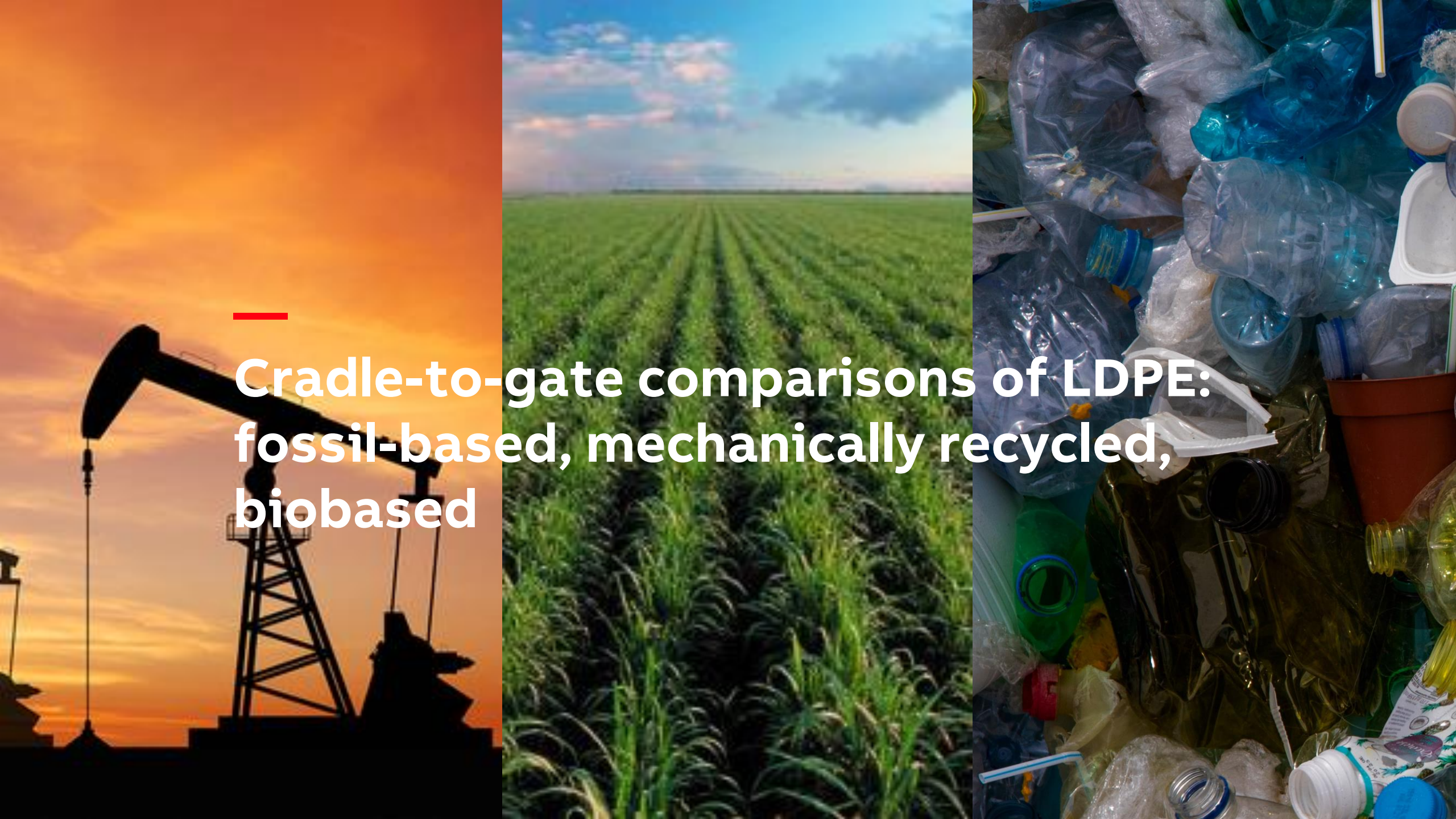
adapted from: Hellweg and Milà i Canals, 2014

Life cycle assessment

Types

LCA is a technique that tries to identify, measure and characterize different potential environmental impacts associated to each one of the stages of the life cycle of a product.





Cradle-to-gate comparisons of LDPE: fossil-based, mechanically recycled, biobased

Sustainable vs fossil plastic raw materials

Midpoint cradle-to-gate comparisons

Impact category	Unit	Fossil based LDPE	Recycled (70%) LDPE	Biobased LDPE
Climate change	kg CO2 eq	2,578352	1,303567	-0,53002
Ozone depletion	kg CFC11 eq	6,08E-08	6,45E-08	1,51E-07
Ionising radiation	kBq U-235 eq	0,120958	0,137126	0,302711
Photochemical ozone formation	kg NMVOC eq	0,010904	0,004815	0,00951
Particulate matter	disease inc.	8,99E-08	5,17E-08	1,9E-07
Human toxicity, non-cancer	CTUh	1,98E-08	1,34E-08	2,52E-08
Human toxicity, cancer	CTUh	6,6E-10	6,18E-10	1,47E-09
Acidification	mol H+ eq	0,010924	0,005353	0,009344
Eutrophication, freshwater	kg P eq	0,000595	0,000382	0,000782
Eutrophication, marine	kg N eq	0,002156	0,001265	0,002359
Eutrophication, terrestrial	mol N eq	0,02251	0,012007	0,024844
Ecotoxicity, freshwater	CTUe	30,41634	18,32578	44,20443
Land use	Pt	4,088956	5,42092	319,8388
Water use	m3 depriv.	1,477042	0,539718	4,035778
Resource use, fossils	MJ	75,95467	29,57609	20,12049
Resource use, minerals and metals	kg Sb eq	2,27E-05	1,39E-05	4,42E-05
Climate change - Fossil	kg CO2 eq	2,572	1,278814	1,254
Climate change - Biogenic	kg CO2 eq	0,004942	0,023794	0,011812
Climate change - Land use and LU change	kg CO2 eq	0,00141	0,000958	-1,79583
Human toxicity, non-cancer - organics	CTUh	1,43E-09	7,13E-10	9,2E-10
Human toxicity, non-cancer - inorganics	CTUh	3,74E-09	2,21E-09	6,35E-09
Human toxicity, non-cancer - metals	CTUh	1,53E-08	1,07E-08	1,86E-08
Human toxicity, cancer - organics	CTUh	1,94E-10	2,25E-10	8,52E-10
Human toxicity, cancer - inorganics	CTUh	0	0	0
Human toxicity, cancer - metals	CTUh	4,66E-10	3,93E-10	6,16E-10
Ecotoxicity, freshwater - organics	CTUe	0,241894	0,205295	0,687104
Ecotoxicity, freshwater - inorganics	CTUe	4,110895	2,22919	3,905677
Ecotoxicity, freshwater - metals	CTUe	26,06355	15,8913	39,61164

Cradle-to-gate comparisons by SimaPro using the ecoinvent 3.6 database and the EF 3.0 impact assessment method.
1 kg of material has been adopted as functional unit.

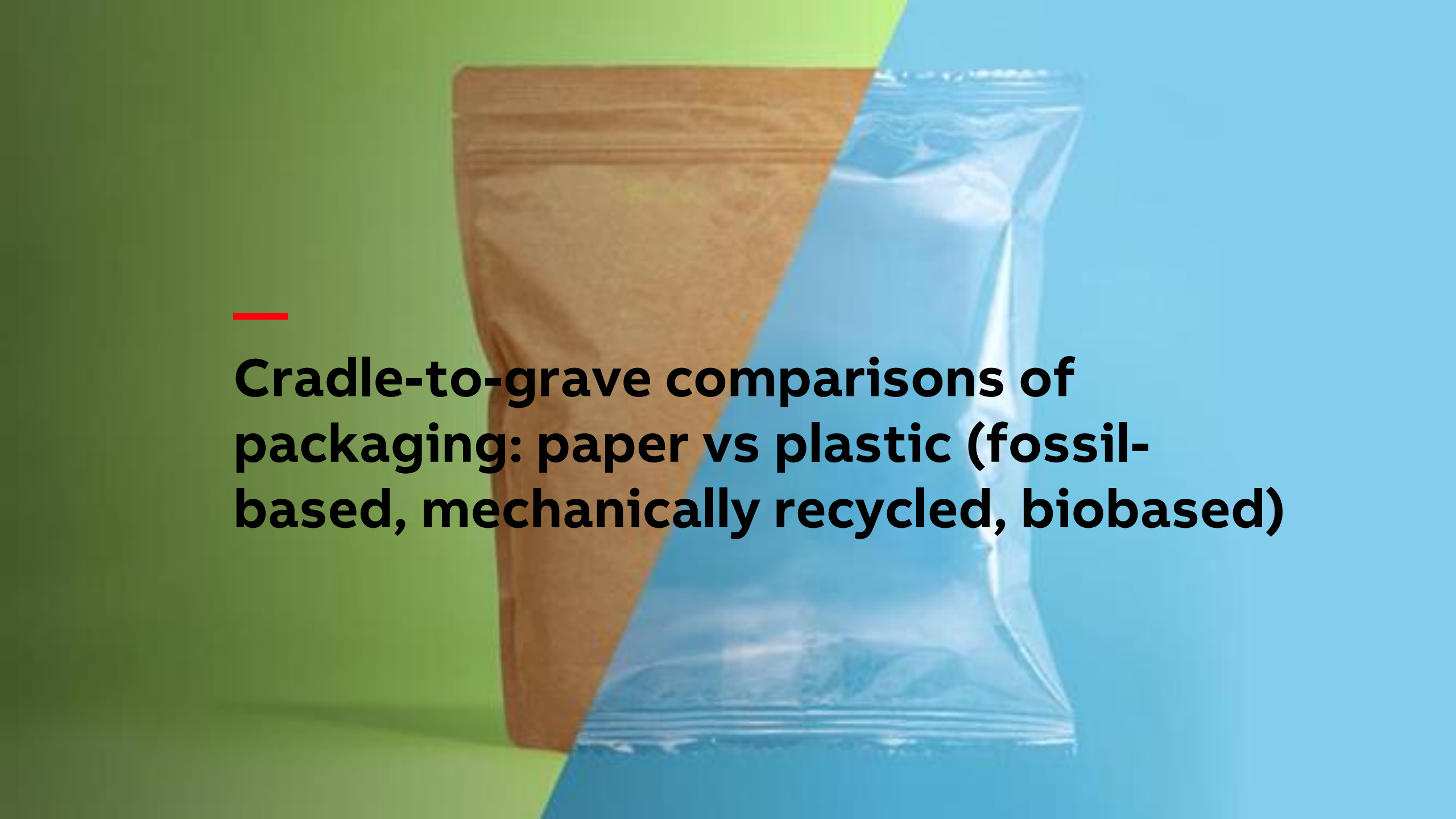
Sustainable vs fossil plastic raw materials

Single score cradle-to-gate comparisons

Category	Unit	Fossil based LDPE	Recycled (70%) LDPE	Biobased LDPE
Total	**µPt**	**277,0044**	**135,054**	**225,4607**
Climate change	µPt	67,0606	33,9046	-13,7853
Ozone depletion	µPt	0,071549	0,075922	0,177202
Ionising radiation	µPt	1,436214	1,628189	3,594305
Photochemical ozone formation	µPt	12,83725	5,669094	11,19597
Particulate matter	µPt	13,52529	7,777602	28,54233
Human toxicity, non-cancer	µPt	1,588115	1,072352	2,021403
Human toxicity, cancer	µPt	0,831296	0,779423	1,850104
Acidification	µPt	12,19112	5,97408	10,42746
Eutrophication, freshwater	µPt	10,37619	6,649886	13,62511
Eutrophication, marine	µPt	3,265011	1,9159	3,572391
Eutrophication, terrestrial	µPt	4,725095	2,52049	5,215124
Ecotoxicity, freshwater	µPt	13,68297	8,243963	19,88563
Land use	µPt	0,396089	0,525114	30,98215
Water use	µPt	10,95946	4,004637	29,94495
Resource use, fossils	µPt	97,19281	37,84603	25,7465
Resource use, minerals and metals	µPt	26,86539	16,46676	52,46538

Normalization and weighting factors according to the EF impact assessment method

Impact category	Normalizatio	Weighting
Climate change	0,0001235	0,2106
Ozone depletion	18,64	0,0631
Ionising radiation	0,0002370	0,0501
Photochemical ozone	0,02463	0,0478
Particulate matter	1680	0,0896
Human toxicity, non-	4354	0,0184
Human toxicity, canc	59173	0,0213
Acidification	0,01800	0,062
Eutrophication, fresh	0,6223	0,028
Eutrophication, marir	0,05116	0,0296
Eutrophication, terres	0,005658	0,0371
Ecotoxicity, freshwate	0,00002343	0,0192
Land use	0,000001220	0,0794
Water use	0,00008719	0,0851
Resource use, fossils	0,00001538	0,0832
Resource use, minera	15,71	0,0755



Cradle-to-grave comparisons of packaging: paper vs plastic (fossil-based, mechanically recycled, biobased)

Paper vs plastic packaging

Cradle-to-grave LCA comparisons

Packaging under comparison

- Paper board boxes
  - ≥ 90% recycled content

- LDPE plastic bags (50 µm)
  - Fossil-based LDPE
  - 70% PCR LDPE
  - 100% biobased LDPE

Methodology

- Functional unit: weight of packaging needed to pack 1000 items
  - paper board boxes: 12.38 kg
  - plastic bags: 1.38 kg
- LCA
  - Ecoinvent 3.6 database
  - EF 3.0 impact assessment method

End of Life scenarios[1]

- End of Life plastics (Finland)
  - Landfill 1%
  - Incineration 53%
  - Recycling 46%
- End of Life paper board (Finland)
  - Recycling 93 %
  - Incineration 7 %

[1] https://ec.europa.eu/eurostat/web/waste/data/database

Paper vs plastic packaging

Midpoint & single score cradle-to-grave comparisons

Evaluation per impact category

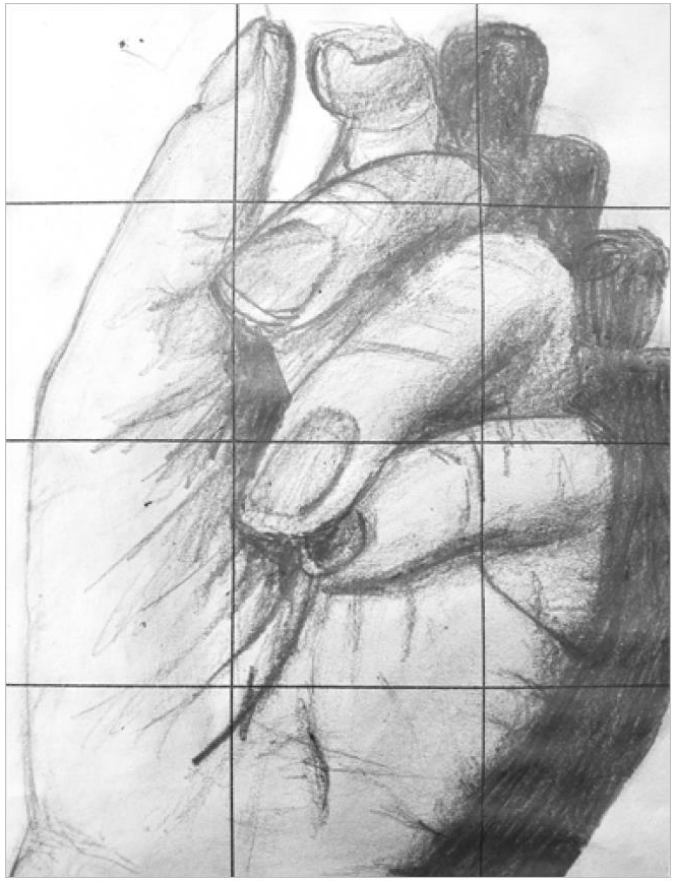
Impact category	Unit	Paper board box	Fossil based LDPE	Recycled (70%) LDPE	Biobased LDPE
Climate change	kg CO2 eq	11.23	5.88	4.12	1.59
Ozone depletion	kg CFC11 eq	1.22E-06	1.48E-07	1.53E-07	2.72E-07
Ionising radiation	kBq U-235 eq	2.48	0.39	0.41	0.64
Photochemical ozone formation	kg NMVOC eq	3.28E-02	1.70E-02	8.65E-03	1.51E-02
Acidification	mol H+ eq	5.95E-02	1.85E-02	1.08E-02	1.63E-02
Eutrophication, freshwater	kg P eq	5.14E-03	1.24E-03	9.46E-04	1.50E-03
Eutrophication, marine	kg N eq	1.38E-02	3.81E-03	2.58E-03	4.09E-03
Eutrophication, terrestrial	mol N eq	1.34E-01	3.86E-02	2.41E-02	4.18E-02
Ecotoxicity, freshwater	CTUe	177.87	53.91	37.23	72.94
Land use	Pt	183.25	18.61	20.45	454.35
Water use	m3 depriv.	4.90	3.18	1.89	6.71
Resource use, fossils	MJ	179.64	115.66	51.66	38.61
Resource use, minerals and metals	kg Sb eq	8.92E-05	4.00E-05	2.79E-05	6.98E-05
Climate change - Fossil	kg CO2 eq	11.03	5.86	4.08	4.05
Climate change - Biogenic	kg CO2 eq	0.14	0.01	0.04	0.02
Climate change - Land use and LU change	kg CO2 eq	5.70E-02	3.19E-03	2.56E-03	-2.48
Ecotoxicity, freshwater - organics	CTUe	9.41	0.56	0.51	1.17
Ecotoxicity, freshwater - inorganics	CTUe	18.36	10.38	7.79	10.10
Ecotoxicity, freshwater - metals	CTUe	150.10	42.97	28.93	61.67

Evaluation on a single score

Impact category	Unit	Paper Board Box	Fossil based LDPE	Recycled (70%) LDPE	Biobased LDPE
Total	µPt	1127	506	310	435
Climate change	µPt	292	153	107	41
Ozone depletion	µPt	1	0	0	0
Ionising radiation	µPt	29	5	5	8
Photochemical ozone formation	µPt	39	20	10	18
Particulate matter	µPt	76	22	14	43
Human toxicity, non-cancer	µPt	9	3	2	4
Human toxicity, cancer	µPt	5	2	2	3
Acidification	µPt	66	21	12	18
Eutrophication, freshwater	µPt	90	22	16	26
Eutrophication, marine	µPt	21	6	4	6
Eutrophication, terrestrial	µPt	28	8	5	9
Ecotoxicity, freshwater	µPt	80	24	17	33
Land use	µPt	18	2	2	44
Water use	µPt	36	24	14	50
Resource use, fossils	µPt	230	148	66	49
Resource use, minerals and metals	µPt	106	47	33	83

Concluding remarks

- Addressing supply-chain emissions is essential for achieving carbon neutrality related targets, enabling companies to impact a volume of emissions several times higher the ones corresponding to their own direct operations and power consumption.
- The selection of raw materials plays an important role on both Scope 3 emissions and on product, as well as its packaging, environmental performance.
- LCAs are a powerful tool allowing us to quantify the environmental impacts of a given material, product, process or service enabling informed, conscious decisions.
- LCA findings motivate us to look beyond carbon footprint and consider additional environmental impact categories (e.g. ecotoxicity, land use, water use, etc) before selecting the most environmentally sound material option.
- Besides environmental performance, other factors such as technical performance, cost as well as customer/consumer perception and acceptance should be taken into account.



Keir Hills (12 years)
Switzerland

"You got this in your own hands – take control and make a change."

Image obtained from "ABB kids for climate action" drawing book.

Driving progress for a sustainable tomorrow.