We make the world a safer place.

Today for tomorrow.

TÜVRheinland®

Precisely Right.

Sustainability of Products
Life Cycle Assessment in Practice

Susanne Jorre
TÜV Rheinland

Agenda

Chapter	Subject	Page
1	Introduction of ESPR	3
2	Methodolgy Background for Life Cycle Assessment and Product Carbon Footprint	5
3	Examples	9
4	Summary	17

TÜVRheinland®
Precisely Right.

Agenda

Chapter	Subject	Page
1	Introduction of ESPR	3
2	Methodolgy Background for Life Cycle Assessment and Product Carbon Footprint	5
3	Examples	9
4	Summary	17

TÜVRheinland®
Precisely Right.

The new Ecodesign Regulation – under legislation

Ecodesign for Sustainable Products Regulations (ESPR)

will introduce more extensive ecodesign requirements for many more product groups

- Durability, reusability, retrofittability and repairability of products
- Substances that inhibit the ability of circulation
- the presence of substances of concern in products; tracking of all substances of concern throughout the life cycle of products,
- Energy and resource efficiency (→ Reduction of primary energy demand 1027 TWh/p.a. to ~ 1500 TWh/p.a.)
- Recycled content
- Reprocessing and recycling
- **CO_2 - and environmental footprint**
- and Information requirements, including a digital product passport

Agenda

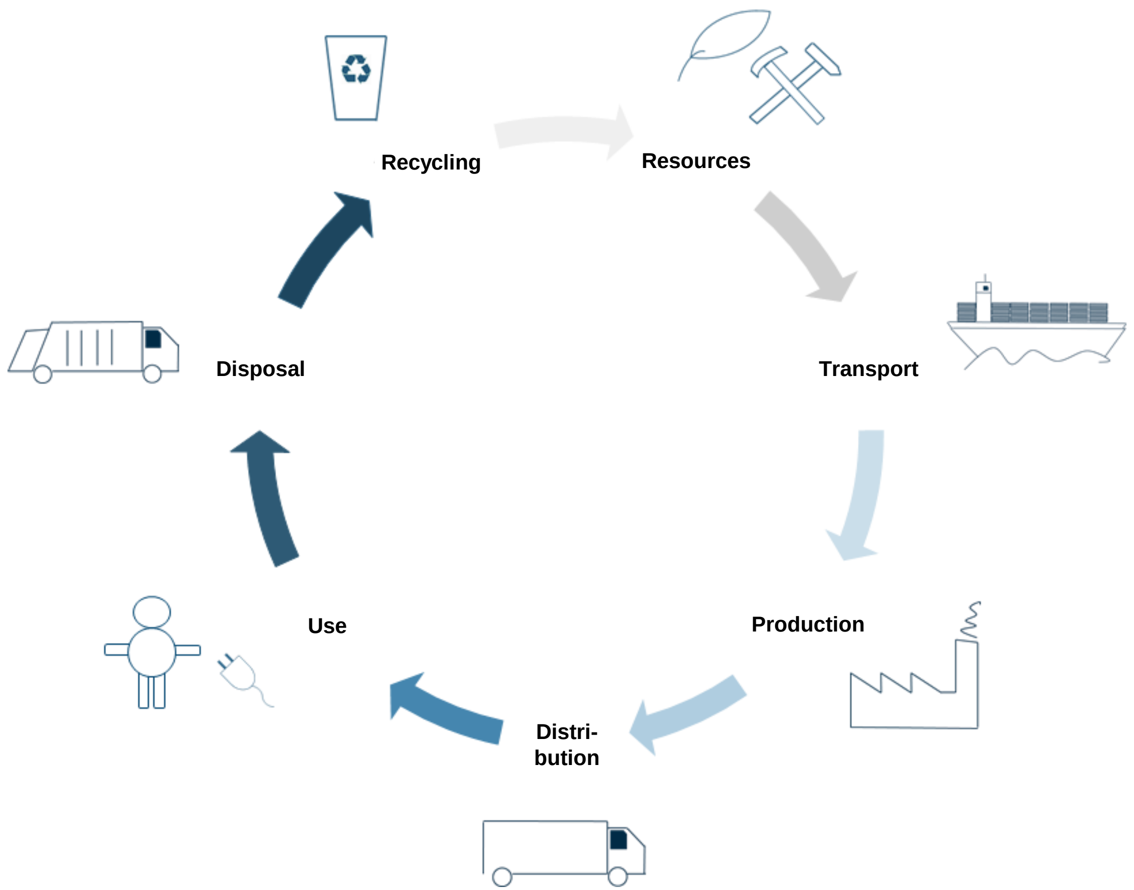
Chapter	Subject	Page
1	Introduction of ESPR	3
2	Methodolgy Background for Life Cycle Assessment and Product Carbon Footprint	5
3	Examples	9
4	Summary	17

TÜVRheinland®
Precisely Right.

Life Cycle Assessment (LCA) and Product Carbon Footprint (PCF)

LCAs/ PCFs serve the purpose of innovation, sustainable transformation of products and processes as well as differentiation from competitors and a science-based marketing.

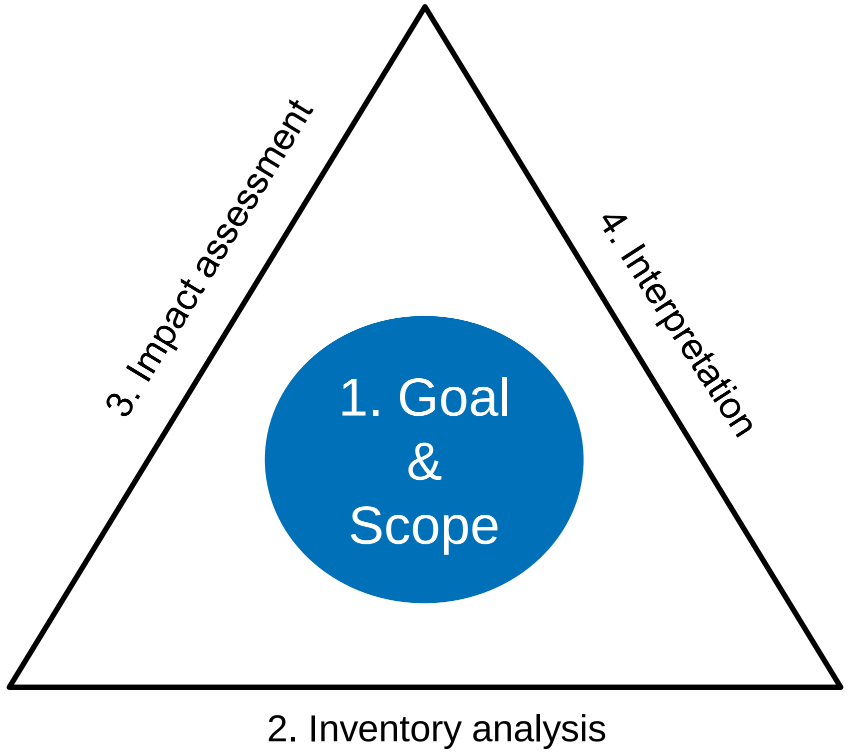
- A life cycle assessment is used to determine environmental impacts over the entire life cycle of a product.
- Environmental impacts are, for example, the influence on climate change, fossil resource consumption or acidification.
- With the help of LCAs and PCFs, companies can identify product and process optimization potential as well as climate related production hot spots.



TÜVRheinland®
Precisely Right.

Life Cycle Assessments according to ISO 14040 and 14044 or Product Carbon Footprint according ISO 14067

Overview



Application into market

- Documentation of ecological aspects of the products
- Proof of sustainability commitment for consumer
- Innovative product and eco design
- Reduction of environmental impact

TÜVRheinland®
Precisely Right.

Life Cycle Assessment – Environmental Impacts

Relation between LCA and PCF

Product Carbon Footprint:
involves determining the total amount of CO_2 and other greenhouse gases generated along the entire value chain of a product.

Climate change	Global warming because of greenhouse gases in the atmosphere
Eutrophication	Increased human-induced nutrient inputs to environmental systems
Acidification	Reduction of the pH value of soil and water bodies due to acid input
Resource use	Consumption of fossil and elemental resources
Summer smog	Air pollution due to high concentration of ozone and photo-oxidants

TÜVRheinland®
Precisely Right.

Agenda

Chapter	Subject	Page
1	Introduction of ESPR	3
2	Methodolgy Background for Life Cycle Assessment and Product Carbon Footprint	5
3	Examples	9
4	Summary	17

Example: Office Chair 1/3

Source: Data (environdec.com)

- **Functional Unit:** One chair in use for 8 hours a day, 5 days a week, for 15 years. (Production location Spain)

Upstream

- Components/ Raw Materials extraction
- Manufacturing Process

Core

- Raw materials/ components transportation
- Product manufacturing processes
- Waste treatment
- Electricity, Natural Gas, Water
- Maintenance

Downstream

- Distribution
- Maintenance
- Product use
- Product and packaging end of life

TÜVRheinland®
Precisely Right.

Example: Office Chair 2/3

Source: Data (environdec.com)

Product

Materials	Weight (kg)	% of total weight	Recycled content
Steel	4,4636	27,57%	42,85%
Aluminium	0,1683	1,04%	62,50%
PA6	3,1188	19,26%	46,36%
Polyurethane	1,1239	6,94%	8,40%
Polyester	0,0300	0,19%	21,00%
POM	0,0730	0,45%	5,00%
PP	4,3656	26,97%	29,12%
Polyester Cloth	0,1140	0,70%	0,00%
TOTAL	**13,4572**	**83,12%**	**35,96%**

Packaging

Materials	Weight (kg)	% of total weight	Recycled content
Cardboard	2,6000	16,06%	100,00%
LDPE	0,1260	0,78%	0,00%
Paper	0,0060	0,04%	60,00%
TOTAL	**2,7320**	**16,88%**	**95,30%**

Recycled material

Item	Recycled content	Pre-consumer	Post-consumer
Packaging	95,30%	95,30%	0,00%
Product	35,96%	35,96%	0,00%
TOTAL (Packaged product)	**45,97%**	**45,97%**	**0,00%**

TÜVRheinland®
Precisely Right.

Example: Office Chair 3/3

Source: Data (environdec.com)

Environmental performance

Potential environmental impact

PARAMETER		UNIT	UPSTREAM	CORE	DOWNSTREAM	TOTAL
Global warming potencial (GWP)	Fosil	KgCO2 eq.	7,17E+01	5,93E+00	4,05E+00	8,17E+01
	Biogenic	KgCO2 eq.	4,20E-01	9,27E-04	3,57E-04	4,21E-01
	Land use and land transformation	KgCO2 eq.	5,89E-02	1,06E-03	8,25E-05	6,01E-02
	TOTAL	KgCO2 eq.	7,22E+01	5,93E+00	4,05E+00	8,22E+01
Acidification potential (AP)		KgSO2 eq.	2,78E-01	1,76E-02	1,69E-02	3,13E-01
Eutrophication potencial (EP)		KgPO43- eq.	1,16E-01	3,13E-03	2,77E-03	1,22E-01
Formation potencial of tropospheric ozone (POCP)		kg NMVOC eq.	2,30E-01	1,62E-02	2,34E-02	2,69E-01
Abiotic depletion potential - elements		KgSb eq.	3,89E-04	5,62E-07	3,51E-07	3,90E-04
Abiotic depletion potential - fosil fuels		MJ, net calorific value	1,13E+03	8,74E+01	5,74E+01	1,28E+03
Water scarcity potential		m3 eq.	4,16E+01	8,38E-01	2,04E+00	4,44E+01

82 kg CO_2eq. ~ 480 km car travel / per person

82 kg CO_2eq. ~ 315 km air travel / per person

TÜVRheinland®
Precisely Right.

Source for comparison data: ghg-conversion-factors-2023-condensed-set-update.xlsx (live.com)

Example: Coffee Machine 1/2

Source: [coffee-machine-slca.pdf (wordpress.com)]

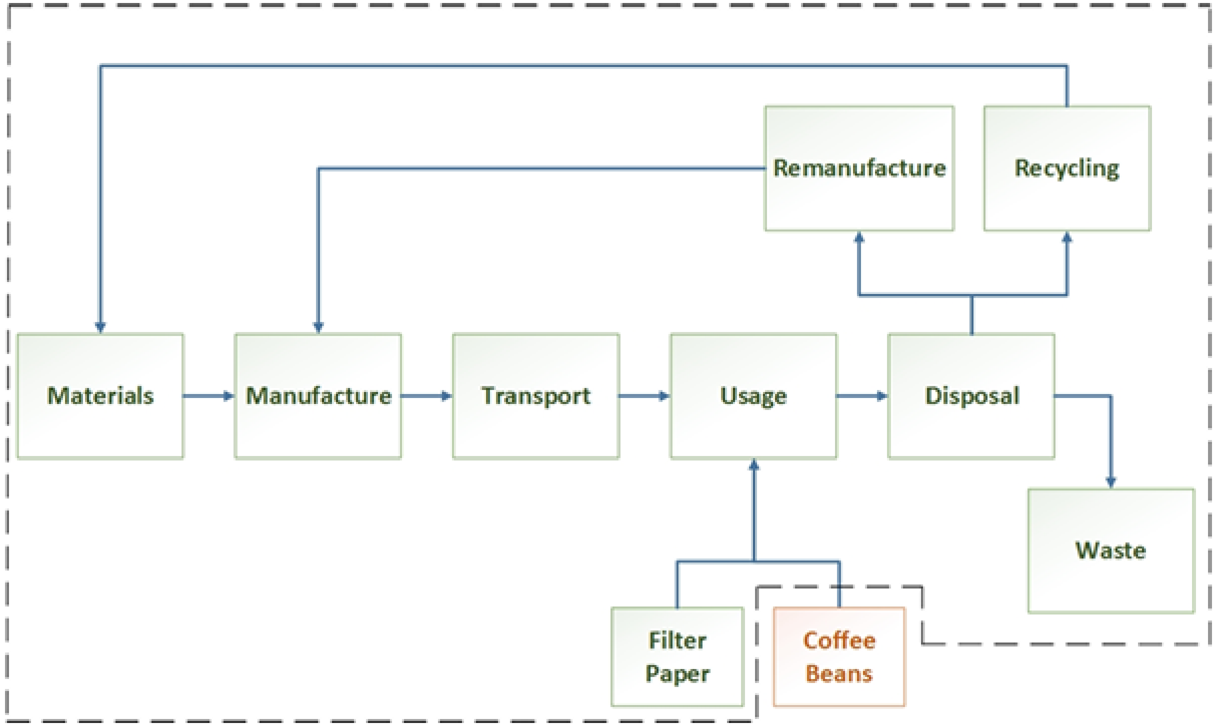


Table 1 Material and Process Energy Demand

Component	Material	Process	Mass kg	Material Energy MJ	Process Energy MJ	Total Production Energy MJ
Housing	Polypropylene	Polymer moulding	0.91	85.54	7.826	93.36
Small steel parts	Steel	Def. Processing	0.12	9.72	0.408	10.13
Small Aluminium parts	Aluminium	Def. Processing	0.08	16.8	0.208	17
Glass Jug	Glass (Pyrex)	Moulded	0.33	8.25	2.706	10.96
Heating element	Ni-Cr alloy	Def. Processing	0.026	3.38	0.0676	3.45
Electronics & LED	Electronics	Assembled	0.007	21	0.91	21.91
Cable sheath, 1m	PVC	Polymer extrusion	0.12	7.92	0.912	8.83
Cable core, 1m	Copper	Def. Processing	0.035	2.485	0.07	2.55
Plug body	Phenolic	Polymer moulding	0.037	3.33	0.481	3.81
Plug Pins	Brass	Def. processing	0.03	2.16	0.069	2.23
Packaging, Padding	Polymer foam	Polymer moulding	0.015	1.65	0.165	1.82
Packaging, box	Cardboard	Construction	0.125	3.5	0.0625	3.56
Other materials	Proxy material: Polycarbonate	Polymer moulding	0.04	4.4	0.44	4.84
TOTAL			1.875	170.135	14.33	184.45

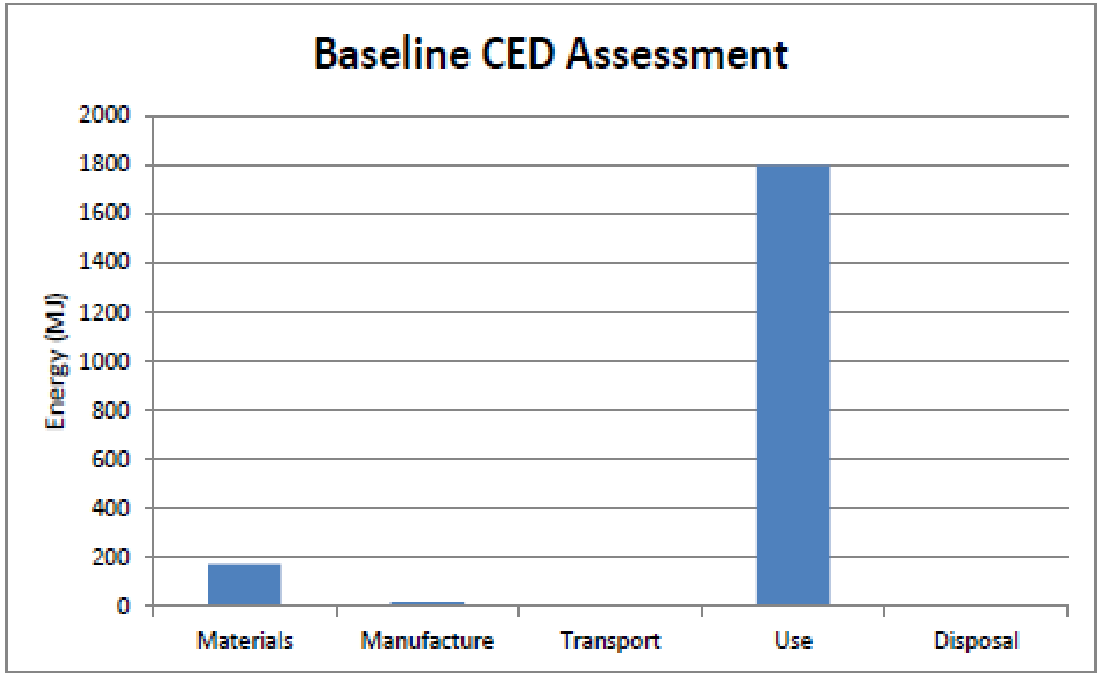
Each use cycle also consumes a filter paper, weighing approximately 2 grams. Over 5 years 1,825 of them (3.65kg of paper) are used.

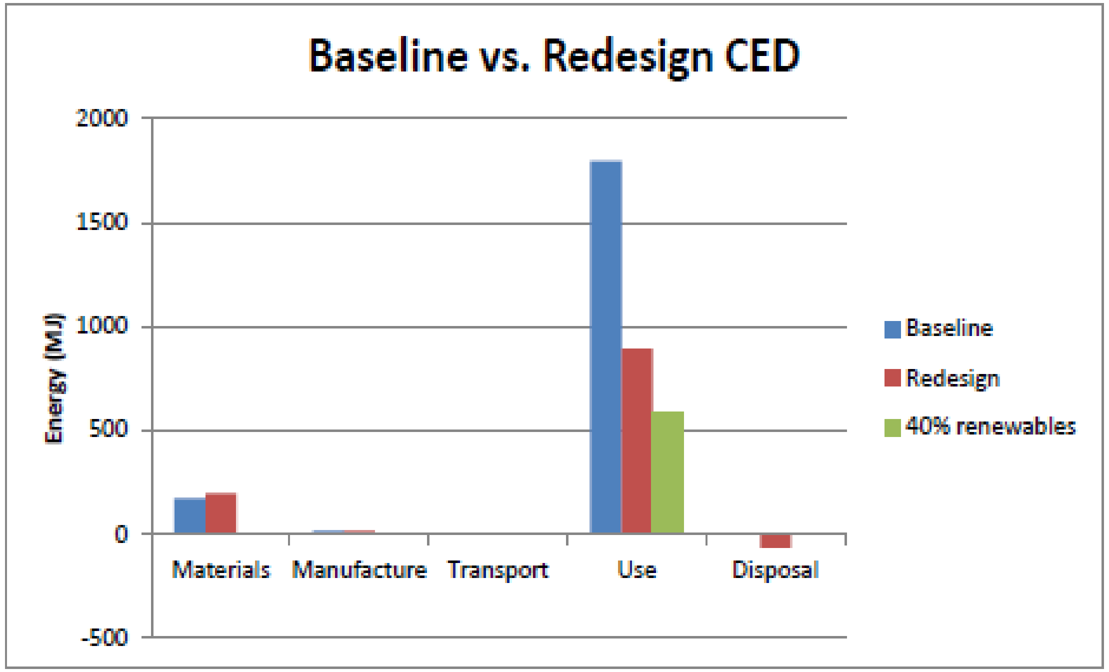
Example: Coffee Machine 2/2

Source: [coffee-machine-slca.pdf (wordpress.com)]

- **Functional Unit:** This coffee machine (640-watt) used once a day over a lifespan of 5 years, the total electrical power consumed is 194kWh (location: Ireland).

CED of a product refers to the total energy usage of a product throughout its life cycle.





The two redesign changes which impact the production stage are the replacement of the glass carafe with a vacuum flask carafe and the inclusion of the reusable stainless-steel filter.

Example: Stuffed toy 1/2

Source: A Playful Life Cycle Assessment of the Environmental Impact of Children's Toys (depaul.edu)

- **Functional unit:** one toy (quantity) providing a minimum of two hours of entertainment (service, quality, and duration) for a child aged 4-10.

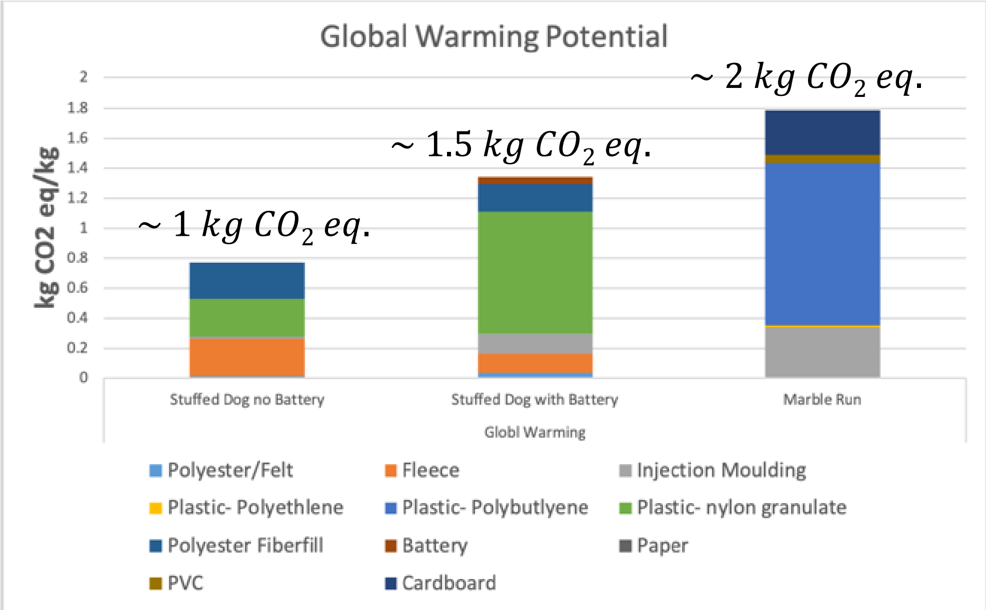
- **Scope:** a small plush dog (4 inches by 4 inches by 12 inches), a plush dog with battery pack for tail wagging (4 inches by 4 inches by 12 inches), and the children’s game Marble Frenzy™

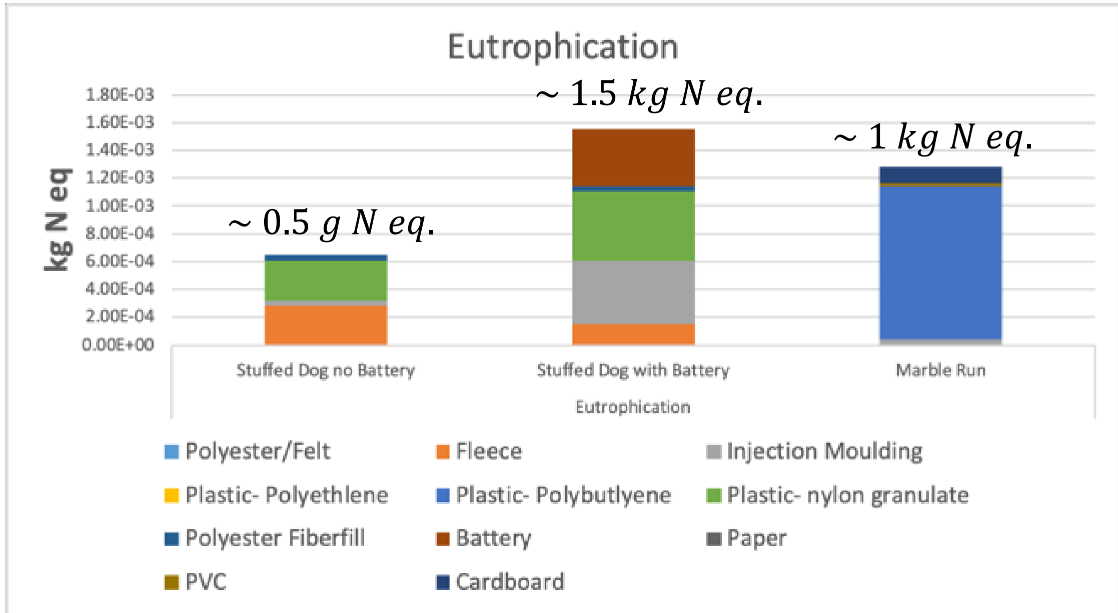
TÜVRheinland®
Precisely Right.

Example: Stuffed toy 1/2

Source: A Playful Life Cycle Assessment of the Environmental Impact of Children's Toys (depaul.edu)

Eutrophication: human-induced nutrient inputs to environmental systems





1 kg CO_2eq. ~ 1 kg of milk

Source for comparison data: buel.bmel.de/index.php/buel/article/download/43/Brade-92-1-html?inline=1

TÜVRheinland®
Precisely Right.

Agenda

Chapter	Subject	Page
1	Introduction of ESPR	3
2	Methodolgy Background for Life Cycle Assessment and Product Carbon Footprint	5
3	Examples	9
4	Summary	17

TÜVRheinland®
Precisely Right.

Summary – LCA and PCF in ESPR

	Lifecycle Assessment (LCA)	**Product Carbon Footprint (PCF)**
Data background	Raw materials, processing, transport data, use, end of life	Raw materials, processing, transport data, use, end of life
Advantages	- **Different** environmental impacts are considered - Scientifically accepted methodology - Standard based - Holistic approach that identifies hotspots for optimization	- Compared to LCA, it is limited to a **single environmental category** (climate change) - Regarding communication possibilities, currently the most **"popular"** and often the most relevant in LCAs.
ISO Standards	ISO 14040 ISO 14044	ISO 14040 ISO 14044 ISO 14067
Complexity	high	medium

- Life cycle assessment is an **ecodesign requirement** and addresses:
  - Transparent presentation of the environmental characteristics at the product level, and derivable **product / process optimizations**
  - Realization of optimization potentials e.g. **Saving resources, reducing energy consumption, which helps to reduce greenhouse gases**
  - **Competitive advantages** through differentiation in the competitive environment and therefore **intended to be published by manufacturers in the Digital Product Passport under the ESPR**

- There are always greenhouse gas emissions that can be avoided, e.g. through product and process optimization, but there is also **always a part that is unavoidable**, which can then be offset accordingly with high-quality recognized climate protection projects to achieve a product without greenhouse emissions.

TÜVRheinland®
Precisely Right.

Thank you for your attention

www.tuv.com

Susanne Jorre

Susanne.Jorre@de.tuv.com; +49 221 806 4501

Sustainability Expert, TÜV Rheinland Energy GmbH

TÜVRheinland®
Precisely Right.