Application of LCA in the automotive industry

UNECE GRPE

Workshop on Life Cycle Assessment

2022-05-31

Complexity I

- Vehicles are complex products
  - ca. 5 000 parts
  - ca. 10 000 part/material infos
  - ca. 40 000 processes in LCA
- High effort for calculation of sophisticated vehicle LCA
- Poor availability of LCI background data with higher spatial & temporal resolution

Complexity II

- Vehicles have complex supply chains
  - International/global structure
  - Many tiers involved (3-7 levels)
  - Dynamic/changing over time
  - Improvements/reduction measures
- Responsibility for Scope 3 emissions shared among many
- Poor availability, traceability & validation of supplier specific primary data

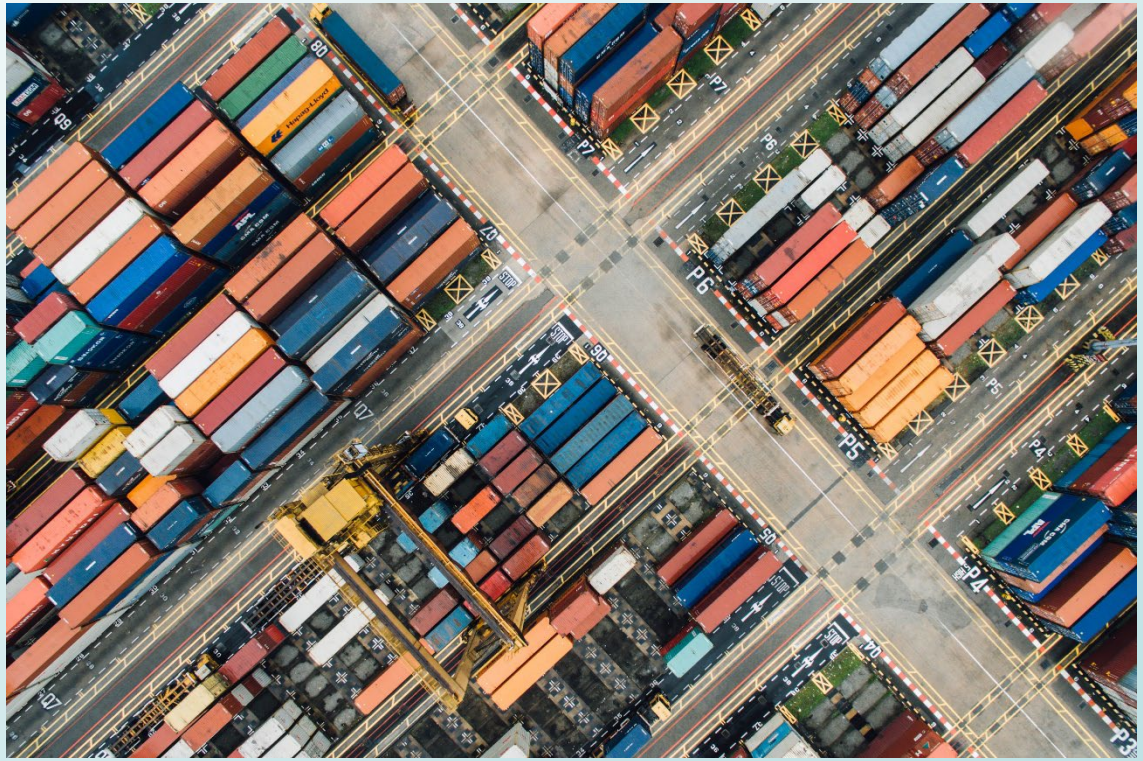
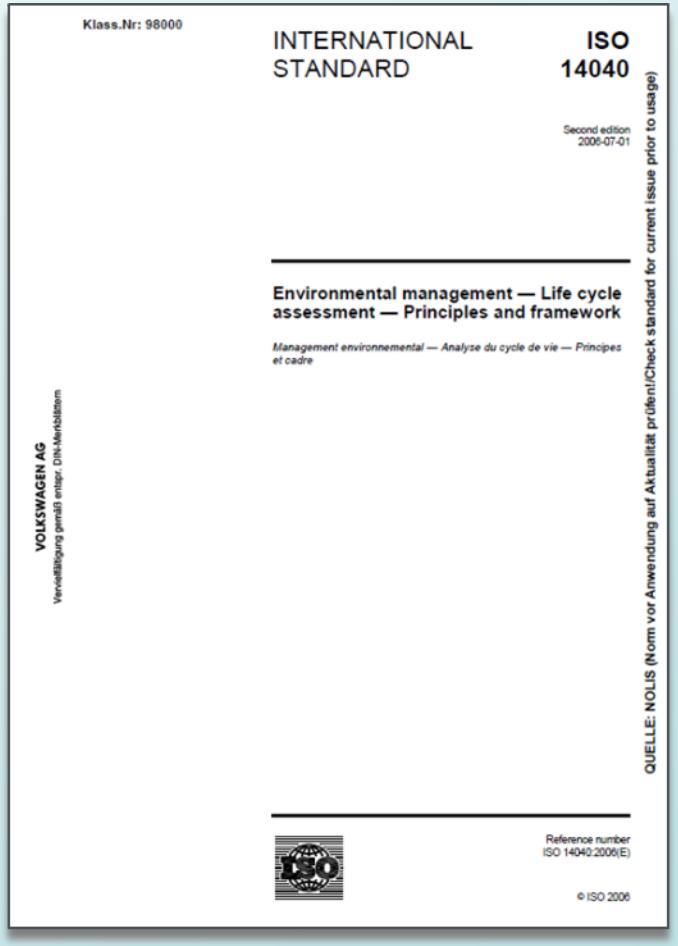


Photo by CHUTTERSNAP on Unsplash

Flexibility

- ISO 14040 & ISO 14044 allow a wide flexibility for methodological choices, e.g.
  - System boundaries
  - Detail/quality of input data
  - Allocation methods
  - Modelling of End-of-life flows
- Choice of LCI database and datasets may also influence LCA results



Klass.Nr: 98000

INTERNATIONAL STANDARD

ISO 14040

Second edition
2006-07-01

Environmental management — Life cycle assessment — Principles and framework

Management environnemental — Analyse du cycle de vie — Principes et cadre

Reference number
ISO 14040:2006(E)

© ISO 2006

VOLKSWAGEN AG
Vervielfältigung gemäß entspr. DIN-Merkblättern

QUELLE: NOLIS (Norm vor Anwendung auf Aktualität prüfen!/Check standard for current issue prior to usage)

Granularity and Comparability

Calculation effort

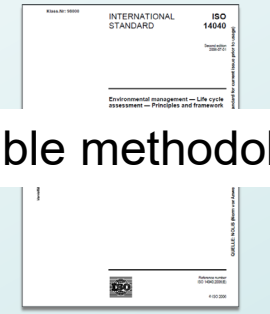
Comparability

	Level of Detail Product and Material Data	Level of Detail for Part and Material Production	
Simplified Analysis	❖ Material categories ❖ Vehicle level/module *1000 kg steel*	❖ Limited CO2 information of part production process included ❖ CO2 emission factor per material category, generic worldwide mix *2,4 kg CO2/kg steel mix = 2,7 t CO2/car*	**State-of-the-Art in automotive industry**
Scientific LCA Approach	❖ Material sub-categories ❖ Vehicle part level *High/low strength steel, alloys, cast iron, recyclates,…*	❖ Part production process (only generic) ❖ Various emission factors per material type, but still generic world wide mix *E.g. stamping incl. energy consumption, scrap share; forging/forming process,…* *e.g. per material group (HSS/LSS) and material production (BoF, EoF,..)*	
Product Specific environmental footprint	❖ Element level ❖ Vehicle part or subpart level ❖ specific vehicle type *High/low strength steel, alloys, cast iron, recyclates, including elementary level*	❖ Part production process for tier 1-n with specific regional process information ❖ CO2 emission factor per element on a regional level per production route from mining to final material *Full primary data for all production & process steps, incl. stamping at supplier X in country Y, forging at supplier X at country Y with technology A/B/C and marked or location based energy mix*	**Not possible with current method, tools & data**

Comparability as the main challenge

Complex product

Complex supply chains

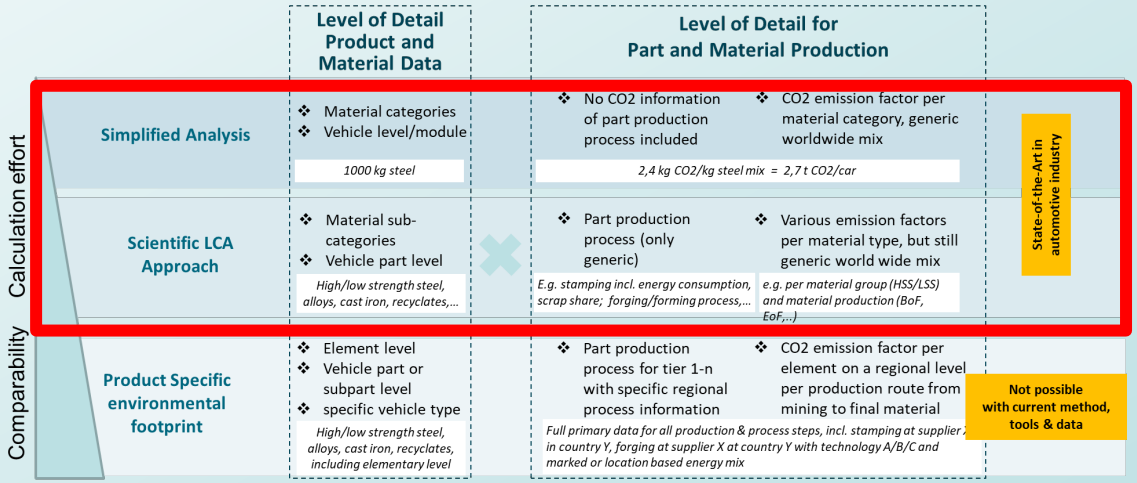


Flexible methodology

- Documentation of methodological choices and chosen datasets is essential for **transparency**
- **Comparability** of vehicle LCAs remains unsolved with current method, tools & data

LCA application in automotive industry

- Among OEMs, LCAs are applied for different applications. Main fields are:
  - Hot spot analysis / improvements
  - Research to inform technical developments
  - Calculation of scope 3 emissions
  - Internal steering of decarbonisation activities



LCA expertise within automotive industry

- Scientific publications

Environmental Science & Technology

pubs.acs.org/est https://pubs.acs.org/est?ref=pdf Article

Life Cycle Greenhouse Gas Emissions for Last-Mile Parcel Delivery by Automated Vehicles and Robots

Luyao Li, Xiaoyi He, Gregory A. Keoleian,* Hyung Chul Kim, Robert De Kleine, Timothy J. Wallington, and Nicholas J. Kemp

Renewable and Sustainable Energy Reviews 137 (2021) 110477

Contents lists available at ScienceDirect

Renewable and Sustainable Energy Reviews

journal homepage: http://www.elsevier.com/locate/rser

Well-to-wheels emissions, costs, and feedstock potentials for light-duty hydrogen fuel cell vehicles in China in 2017 and 2030

X. He [a,b], F. Wang [b], T.J. Wallington [c], W. Shen [d], M.W. Melaina [b,e], H.C. Kim [c], R. De Kleine [c], T. Lin [b], S. Zhang [b], G.A. Keoleian [a], X. Lu [b,f], Y. Wu [b,f,*]

Resources, Conservation & Recycling 158 (2020) 104794

Contents lists available at ScienceDirect

Resources, Conservation & Recycling

journal homepage: www.elsevier.com/locate/resconrec

Full length article

Comparative life cycle energy analysis of carbon fibre pre-processing, processing and post-processing recycling methods

Di He[a,*], Vi Kie Soo[a], Hyung Chul Kim[b], Paul Compston[a], Matthew Doolan[a]

Journal of Cleaner Production 336 (2022) 130474

Contents lists available at ScienceDirect

Journal of Cleaner Production

journal homepage: www.elsevier.com/locate/jclepro

Life cycle assessment of natural graphite production for lithium-ion battery anodes based on industrial primary data

Philipp Engels [a,b,*], Felipe Cerdas [a,b], Tina Dettmer [c], Christoph Frey [d], Jan Hentschel [c], Christoph Herrmann [a,b], Tina Mirfabrikikar [a,c], Maximilian Schueler [c,e]

ACS Sustainable Chemistry & Engineering

pubs.acs.org/journal/ascecg Research Article

Life-Cycle Greenhouse Gas Emission Benefits of Natural Gas Vehicles

Xiaoyi He,* Timothy J. Wallington, James E. Anderson, Gregory A. Keoleian, Wei Shen, Robert De Kleine, Hyung Chul Kim, and Sandy Winkler

Cite This: https://doi.org/10.1021/acssuschemeng.1c01324 Read Online

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ABSTRACT: Abundant supply, low prices, and low carbon content may result in an increased use of natural gas (NG) as an alternative transportation fuel. Assessments of the associated climate benefits are sensitive to the climate metric and time horizon selected to equate methane to equivalent CO_2 emissions and to the assumptions of methane emissions during NG production, distribution, and use. We report life-cycle greenhouse gas (GHG) emissions from cars, light-duty trucks (LDTs), and heavy-duty trucks (HDTs) that are powered directly or indirectly

Methane Leakage/Emissions (% of NG Consumed)

0.1-9.1 0.3-0.5 0.5-3.2

NG Production & Gathering NG Transportation & Distribution Refueling & Vehicle Use

Sustainable Materials and Technologies 28 (2021) e00263

Contents lists available at ScienceDirect

Sustainable Materials and Technologies

journal homepage: www.elsevier.com/locate/susmat

Life cycle energy and greenhouse gas emissions implications of using carbon fiber reinforced polymers in automotive components: Front subframe case study

Tapajyoti Ghosh [a], Hyung Chul Kim [b], Robert De Kleine [b], Timothy J. Wallington [b], Bhavik R. Bakshi [a,*]

Progress in Life Cycle Assessment 2018 pp 47–60 | Cite as

Comparing Carbon Performances of Mobility Services and Private Vehicles from a Life Cycle Perspective

Mara Neef, Tina Dettmer & Liselotte Schebek

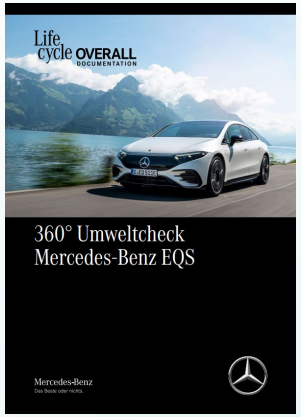
Chapter | First Online: 15 February 2019

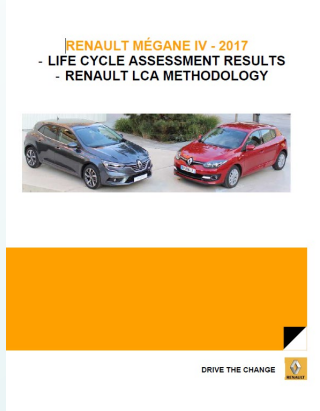
665 Accesses

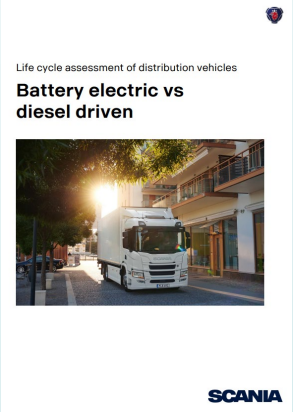
Part of the Sustainable Production, Life Cycle Engineering and Management book series (SPLCEM)

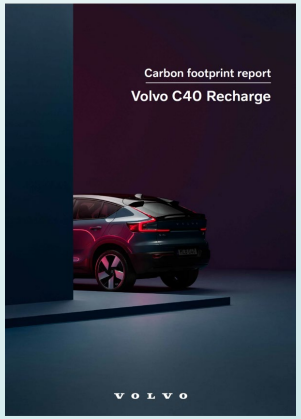
LCA expertise within automotive industry

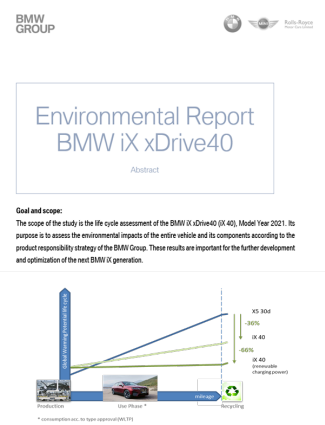
- Exemplary LCA study results

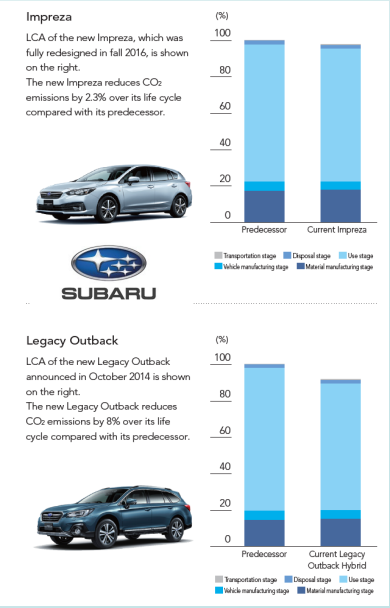


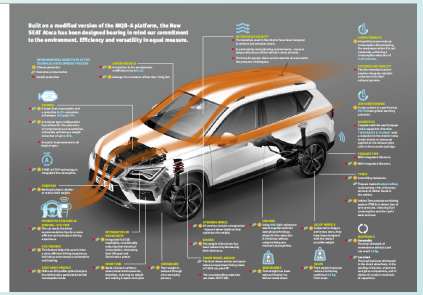


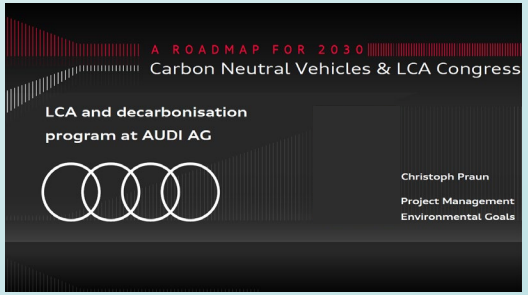


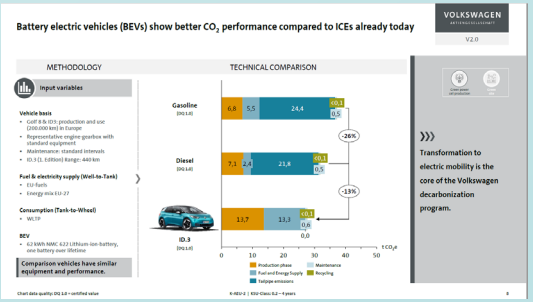












Conclusion / OICA position

- International guidelines should be formulated to pursue a globally harmonized, fair, practical and transparent LCA methodology.
- Many OICA members however believe that it is premature to cast LCA into legislation.
- OICA therefore requests that this reservation is recorded in any Terms of Reference and no commitment is made at this time for transposition into legislation.
- The example of IWG VIAQ can be taken as a successful development of mutual guidelines without the need for immediate legislation.