Life cycle assessment of Generation 4.0 Lime e-bikes and e-scooters

Final

Harris Feldman and Brian Bunte

19th September 2022

Anthesis

Life cycle assessment

What is LCA?

Life cycle assessment is a decision support tool that allows quantitative environmental profiles to be generated for different products systems.

This study is consistent with the international standards for LCA: ISO 14040:2006 and ISO 14044:2006 and follows the required four-stage iterative process. The study is also aligned with the guidance within WRI's New Urban Mobility Alliance's *Assessing the environmental impact of micromobility: a guide for cities*

1 Goal and scope

The first stage of LCA is to define the goal and scope of study to understand the objectives and indented applications, the boundaries of what is being assessed and the performance requirement that the product fulfils.

2 Inventory analysis

The second stage is inventory analysis, where an inventory of flows to and from nature is created, usually using a combination of primary and secondary data collected for each unit processes of the product system.

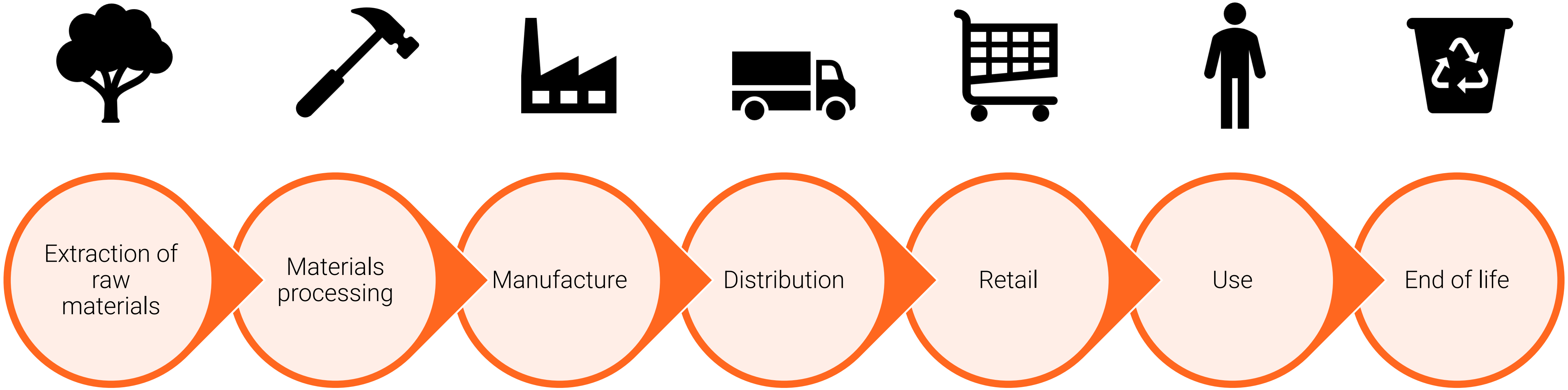
3 Impact assessment

The third stage is impact assessment, which is where inventory data are applied to characterization factors to generate the main results and determine the environmental impacts.

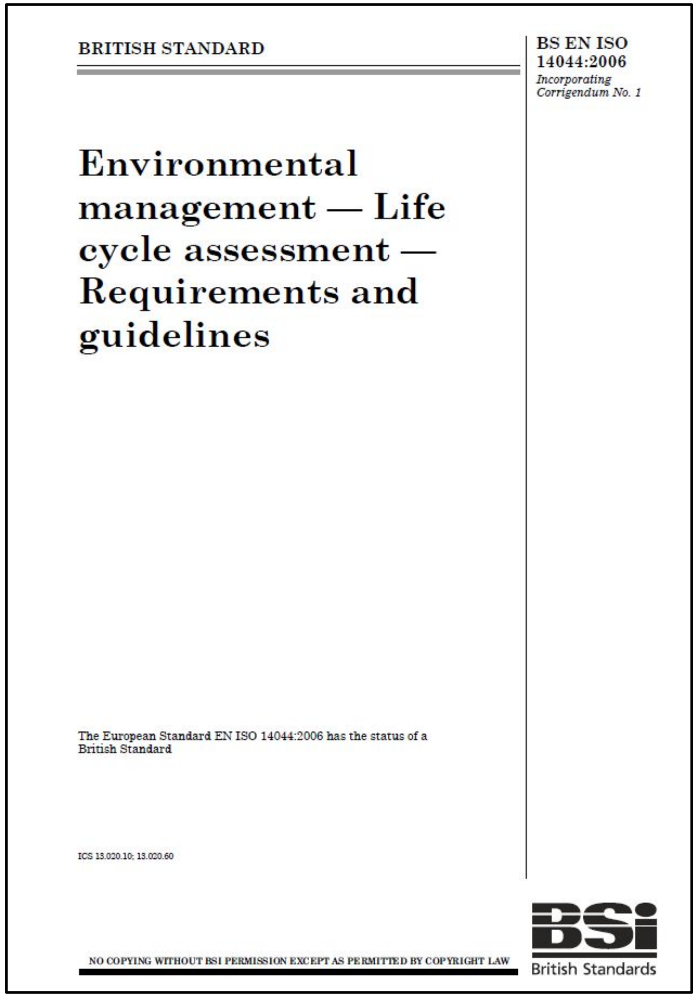
4 Interpretation

The final stage is interpretation, which is where conclusions are drawn, sensitivity and uncertainty analyses are performed, and recommendations made.

A holistic approach captures impacts across the entire product lifecycle



Standards followed



BRITISH STANDARD

BS EN ISO 14044:2006
Incorporating Corrigendum No. 1

Environmental management — Life cycle assessment — Requirements and guidelines

The European Standard EN ISO 14044:2006 has the status of a British Standard

ICS 13.020.10; 13.020.60

NO COPYING WITHOUT BSI PERMISSION EXCEPT AS PERMITTED BY COPYRIGHT LAW

BSi British Standards

Guidance was taken from the following standards:

- ISO 14040:2006
- ISO 14044:2006
- PAS 2050:2011
- Greenhouse Gas Protocol Product Life Cycle Accounting and Reporting Standard
- WRI's New Urban Mobility Alliance: Assessing the environmental impact of micromobility: a guide for cities
- World Steel Association: Life Cycle Inventory Methodology Report

Characterized mid-point results (per passenger km)

Impact category	Impacts per passenger km (p-km)	Gen 4 eScooter Paris	Gen 4 eScooter DACH	Gen 4 eScooter Stockholm	Gen 4 eBike Paris	Gen 4 eBike DACH
Ozone depletion	g CFC-11 eq/p-km	1.89E-06	1.94E-06	2.012E-06	5.84E-06	6.37E-06
Global warming	g CO2 eq/p-km	19.7	25.5	22.6	49.4	64.9
Smog	g 03 eq/p-km	1.6	1.7	1.8	3.6	4.3
Acidification	g S02 eq/p-km	0.14	0.15	0.16	0.27	0.34
Eutrophication	g N eq/p-km	0.01	0.01	0.02	0.03	0.04
Fossil fuel depletion	MJ surplus/p-km	0.03	0.03	0.03	0.10	0.11

Comparison: Carbon Intensity per passenger-km of common transport modes in Paris

Traveling by e-scooter or e-bike can significantly reduce the carbon impact of a trip when displacing other common transport modes

Mode of Transport	Unit	Subway/Metro	Bus (ICE)	Personal Car (ICE)	Taxi/Ridehail (ICE)
Carbon Emissions[1]	g CO2e per p-km	66	91	162	276
Lime Gen 4 e-scooter (19.7g CO2e per p-km)	Percent lower carbon intensity if using e-scooter (%)	-70%	-78%	-88%	-93%
	Times more carbon intense than e-scooter (x)	3.4x	4.6x	8.2x	14.0x
Lime Gen 4 e-bike (49.4g CO2e per p-km)	Percent lower carbon intensity if using e-bike (%)	-25%	-46%	-70%	-82%
	Times more carbon intense than e-bike (x)	1.3x	1.8x	3.3x	5.6x

Anthesis

[1] Cradle-to-grave carbon emissions per passenger-km for common transport modes from International Transport Forum report *Good to Go? Assessing the Environmental Performance of New Mobility*

Life cycle impact assessment (LCIA) method

All TRACI v2.1 mid-point environmental impact categories were used in this study.

Impact category	Description
Ozone depletion	Removal of stratospheric ozone (“good ozone”) through chemical reactions between ozone and ozone-depleting substances (e.g. CFCs) released into the atmosphere, which allows a greater amount of harmful ultraviolet radiation from the sun to reach Earth’s surface.
Global warming	A long-term rise in average temperatures on Earth caused by the radiative forcing of greenhouse gases such as CO_2, methane, nitrous oxide released into the atmosphere.
Smog	Generation of ground-level ozone (“bad ozone”) through chemical reactions between nitrogen oxides, nitric oxide and volatile organic compounds in the presence of sunlight to form secondary pollutants such as ozone, which can cause/intensify respiratory diseases.
Acidification	An increase in the acidity of freshwater and soil systems caused by chemical reactions between CO_2, sulfur dioxide and nitrogen oxides (for example) and water, which can have detrimental effects on plant and aquatic life and buildings.
Eutrophication	An increase in the nutrient load of water bodies to a point where excessive growth of algae occurs, which may result in dissolved oxygen depletion.
Fossil fuel depletion	Consumption of non-renewable natural fossil resources, which cannot be replenished on human timescales.

Anthesis

Anthesis is the Sustainability Activator.

We are the largest group of dedicated sustainability experts in the world: a team of 1000+ people, operating in 40 countries, to serve more than 2,000 clients.

Launched in March 2013 to meet market demand for an international firm whose core business is providing commercially relevant sustainability services.

We exist to shape a more productive and resilient world by helping organisations transition to new models of sustainable performance.

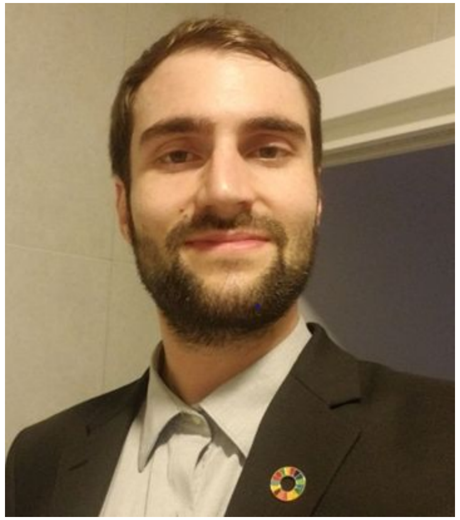
Our team combines broad and deep sustainability expertise with the commercial and operational capabilities it takes to conceive and deliver real change.

Anthesis project team

Harris Feldman

Harris is an LCA and material sustainability specialist with a Master's degree in Industrial Ecology and over five years experience advising clients in a management consulting setting. Harris has conducted LCAs for products ranging from outdoor sporting equipment to compostable packaging solutions. Other clients include DellEMC, Cascade Designs, Boston Consulting Group, U.S. Army, and Target.

Harris lead on the analysis.



Brian Bunte

Brian is a greenhouse gas and LCA professional with a Master's degree in Greenhouse Gas Management and Accounting and several years experience teaching LCA and sustainability-focused courses at Colorado State University. Brian has contributed to a variety of LCAs and provided guidance and support to students learning the art of LCA. Past clients include Johnson & Johnson, Seagate, and Norton.

Brian supported the analysis.