LCA Summary Report 2024

UBQ Tablets (Bergen op Zoom)

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SIGNATURE PAGE

LCA summary report
UBQ™ tablets (Bergen op Zoom)

Katie Livesey
Partner in Product Sustainability and Circularity, Product Sustainability and Supply Chain Group, ERM Ltd

Environmental Resources Management Ltd.
2nd Floor, Exchequer court, 33 St Mary Axe, London EC3A 8AA
T: 020 3206 5200

INTRODUCTION

UBQ Materials has developed a groundbreaking method to convert household waste, including all organics as well as hard-to-recycle materials and plastics, into a homogeneous, bio-based thermoplastic material that can displace plastics.

UBQ inaugurated an industrial-scale factory in Bergen op Zoom Netherlands in early 2024 and has commissioned a life cycle assessment (LCA) for the UBQ™ tablets produced in this new facility. The LCA was conducted by ERM, a leading sustainability advisory firm, and underwent third-party verification by Dr. Matt Fishwick, an independent expert. A copy of Dr. Fishwick's verification statement is attached in Appendix 1.

The aims of the study were as follows:

1. Allow UBQ Materials to demonstrate the environmental impact of its innovative product.
2. Benchmark the carbon footprint of UBQ's production process to waste management methods.
3. Provide UBQ's customers with independently verified information on how the use of UBQ™ material can contribute to their sustainability goals.
4. Serve as an initial step toward the development of an environmental product declaration (EPD).

This summary of the results of ERM's LCA report is suitable for internal and external communication.

The LCA was performed using forecast design data. Once one full year of production data is available, any required changes to the LCA will be made and the corresponding EPD will be created and verified with subsequent registration and publishing on the International EPD System. Through this process, the EPD will be made publicly available and accessible to UBQ Materials' customers, end-consumers, and other stakeholders.

The current report summary includes the following life cycle impact assessment categories:

Indicator	**Unit (GWP_{100})**
Global warming potential (GWP) – total	kg CO_2eq
Global warming potential (GWP) – fossil	kg CO_2eq
Global warming potential (GWP) – biogenic	kg CO_2eq
Global warming potential (GWP) – luluc*	kg CO_2eq

*luluc = land use and land-use change

METHODOLOGY

As this LCA is a precursor (pre-design) consistent with an EPD study (and appropriate PCR), the methods and indicators followed are the ones required by the International EPD System. The LCA was conducted according to the following standards:

- ISO 14044:2006+A1+A2:2020, ISO 14040:2006 (ISO 14040, 2006a:2020; ISO 14044, 2006b:2020)
- ISO 14025 – Environmental labels and declarations — Type III environmental declarations: Principles and procedures (ISO 14025, 2006)
- International EPD® System General Program Instructions v4.0 (Environdec GPI, 2021)
- Product Category Rule (PCR 2010:16, VERSION 4.0.0): Plastic in primary forms, by the International EPD® System (published 2024-07-01)

DECLARED UNIT

The declared unit is 1 kg UBQ tablets, including associated packaging (the weight of the packaging is not included in the 1 kg).

LCA CARBON FOOTPRINT RESULTS (GWP INDICATORS)

This report assesses the climate change impacts of the production of 1 kg of UBQ™ tablets, from cradle to gate, including the associated packaging. The indicators are assessed based on global warming potential over a 100-year time horizon (GWP_{100}), including upstream and core production (positive emissions) and temporary biogenic carbon removals (negative emissions).

The results using the -1/+1 approach (explained below) are shown in Figure 1**.** and Table 1.

CRADLE-TO-GATE FOOTPRINT ASSESSMENT (FOSSIL CARBON)

Fossil GWP focuses on the greenhouse gases (GHGs) emitted from fossil-associated activities in production: extraction of raw materials, transportation, processing, and packaging. Each type of fossil energy/fuel used has specific emission factors that quantify the amount of GHGs released per unit of energy produced.

BIOGENIC CARBON

Biogenic carbon refers to carbon in organic materials (such as food, wood, paper, and grass trimmings), that was originally removed from the atmosphere by photosynthesis and accumulated in living plants.

Biogenic carbon is part of the natural carbon cycle, where it moves between the air, plants, and animals, and eventually cycles back to the atmosphere due to degradation processes at end of life (EOL) of the organism or product.

Because the organic waste used as feedstock for UBQ™ contains biogenic carbon, converting it into durable products can be considered a form of temporary carbon storage for the lifespan of the product, therefore biogenic carbon is reported as a negative emission in the cradle-to-gate analysis.

When a bio-based material reaches its EOL (in landfill or incineration), the biogenic carbon is released and reported as a positive emission.

This approach of tracing biogenic carbon flows through a material's life cycle stages is referred to as the "-1/+1 approach".

LAND USE AND LAND-USE CHANGE (LULUC)

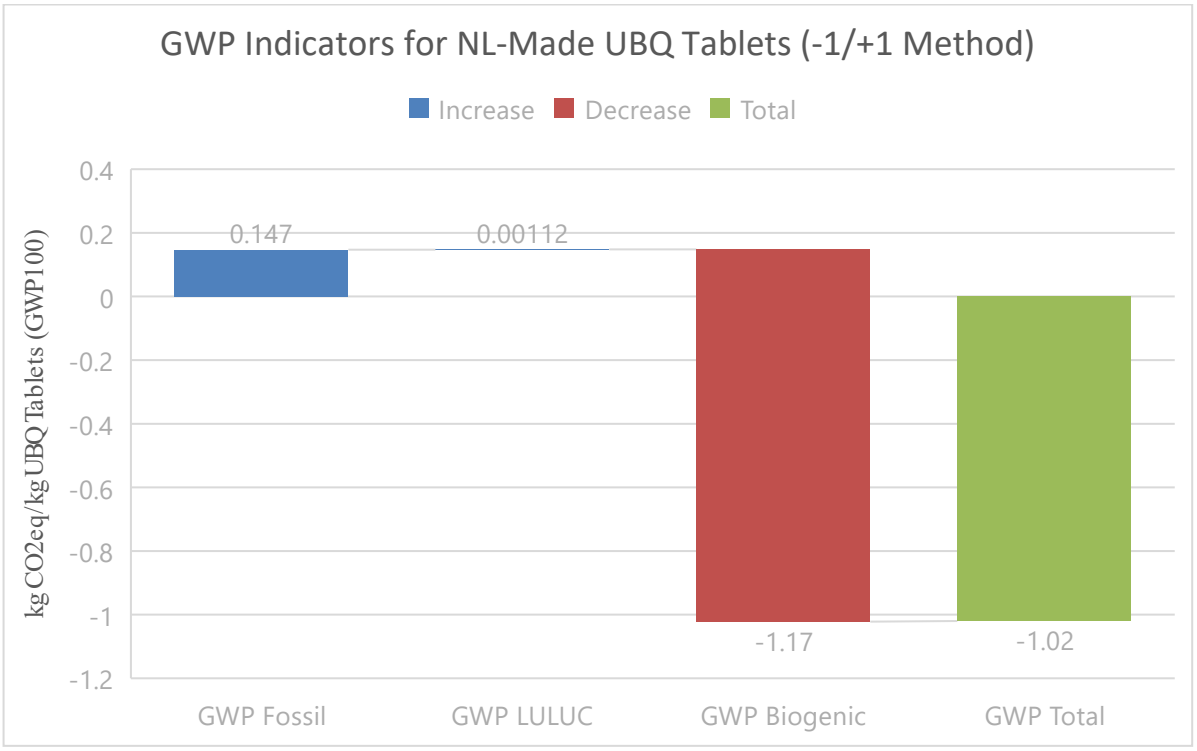
Land use and land-use change (LULUC) refers to the transformation of land from one use to another, such as converting forests to agricultural fields or urban areas. This change can significantly affect GHG emissions and carbon sequestration, which impacts the global warming potential of products.

The results of all GWP indicators (GWP_{100}) are shown in Table 1 and in Figure 1:

Table 1. GWP impact indicators using the -1/+1 approach.

Indicator (Unit)	**Total cradle-to-gate**
Total GWP (kg CO_2eq)	-1.02
Fossil fuel only GWP (kg CO_2eq)	0.147
Biogenic GWP (kg CO_2eq)	-1.17
Land Use Change only GWP- LULUC (kg CO_2eq)	1.12E-03

Figure1. GWP indicators for UBQ tablets made in Bergen op Zoom (-1/+1 approach).



ADDITIONAL CORE ENVIRONMENTAL IMPACTS

UBQ™'s environmental benefits go far beyond carbon. ERM also evaluated many additional indicators, in accordance with EPD International's General Program Instructions.

The non-carbon LCA impact indicators reported by ERM are shown in Table 2.

Table 2. Core environmental impact indicators (non-carbon).

Indicator name	Indicator Unit	Total cradle-to-gate
Ozone depletion	ODP [kg CFC-11 eq.]	2.81E-10
Acidification of terrestrial and freshwater	AP [Mole of H+ eq.]	7.92E-04
Eutrophication potential (freshwater)	EP - freshwater [kg P eq.]	4.77E-05
Eutrophication potential (marine)	EP - marine [kg N eq.	3.98E-04
Eutrophication potential (terrestrial)	EP - terrestrial [Mole of N eq.]	2.96E-03
Photochemical ozone formation	POCP [kg NMVOC eq.]	6.36E-04
Abiotic depletion potential (element)	ADPe [kg Sb eq.]	8.51E-07
Abiotic depletion potential (fossil)	ADPf [MJ]	2.25
Water deprivation potential	WDP [m³ world equiv.]	6.17E-01

More details on these indicators are described at the end of the document and here: https://www.environdec.com/indicators.

BERGEN OP ZOOM

The environmental impact of UBQ™ is dependent on many factors and will be different for each production site. All LCA information summarized here applies only to UBQ™ tablets produced in Bergen op Zoom, Netherlands.

UBQ's factory in Bergen op Zoom was designed with sustainability and resource efficiency in mind, with heat recovery systems and 100% renewable electricity, as demonstrated by guarantees of origin.

Sustainability was also considered in the supply chain, transportation of waste feedstock, and use of 30% recycled packaging. This conservationist approach is evident in the low impact values reported in the core process results of the LCA.

SENSITIVITY ANALYSES

The following sensitivity analyses were performed:

- The influence of waste composition and how it may affect the carbon feedstock and therefore the amount of biogenic carbon sequestered.
- The influence of the waste transport distance.

ASSUMPTIONS AND LIMITATIONS

The following assumptions have been made:

- Engineering design data have been used—once production data are available a more detailed LCA study will be performed and an EPD will be verified;
- An average waste composition is considered, and where details were missing in terms of specific organic components (i.e. food waste or paper and cardboard percentage in the waste) statistical country data or default values from IPCC were used;
- Where distance to waste treatment plants was not available, 100 km by truck has been considered as the conservative option;

GLOSSARY

Life cycle assessment: Compilation and evaluation of the inputs, outputs, and potential environmental impacts of a product system throughout its life cycle.

Biogenic carbon: Carbon absorbed by living organisms, such as trees and plants, during their growth cycle. Biogenic carbon may be stored in products made from bio-based materials until it is released at the end of life.

Carbon footprint: The total amount of emissions released into the atmosphere by the raw materials and manufacturing of a product. The scope may also include distribution, usage, and disposal.

Global warming potential, GWP [kg CO_2 eq]: The contribution of a product, process, or entity to climate change. It may be evaluated on different time horizons; 100 years is most frequently used, but assessment over 20 years is also commonly reported where GHGs with short atmospheric lifetimes, such as methane, are concerned.

Ozone depletion, ODP [kg CFC-11 eq]: The reduction in the concentration of ozone (O_3) in the Earth's stratosphere. The stratospheric ozone layer is crucial because it absorbs most of the sun's harmful ultraviolet (UV) radiation. When this layer is depleted, more UV radiation reaches the Earth's surface. The primary cause of ozone depletion is the release of certain man-made chemicals, particularly chlorofluorocarbons (CFCs), halons, and other ozone-depleting substances (ODS).

Acidification of terrestrial and freshwater, AP [Mole of H+ eq.]: Acidification happens when environments become more acidic, mostly because of pollutants like sulfur dioxide (SO_2) and nitrogen oxides (NO_x) from human activities. These pollutants lead to acid rain or acidic particles falling onto the ground. In land environments, acidification can harm the soil, making it harder for plants to grow and reducing the variety of plants and animals. In freshwater environments, acidic conditions can harm fish and other aquatic creatures and disrupt the balance of nutrients in the water.

Eutrophication potential (freshwater), EP - freshwater [kg P eq.]: How likely a body of water is
to become overly rich in nutrients, mainly nitrogen and phosphorus. When these nutrients are too high, they cause excessive growth of algae and aquatic plants.

Eutrophication potential (marine), EP - marine [kg N eq: High eutrophication potential means there's a greater risk of nutrient-related problems in the ocean, mainly nitrogen and phosphorus. Excess nutrients make algae grow quickly, which can cause large, harmful algae blooms, When the algae die and decompose, they use up the oxygen in the water, creating low-oxygen areas where fish and other sea life can't survive.

Eutrophication potential (terrestrial), EP - terrestrial [Mole of N eq.]: how likely land is to cause nutrient pollution in nearby water bodies. When too many nutrients like nitrogen and phosphorus come from sources such as fertilizers or wastewater and wash into lakes or rivers it can lead to excessive algae and plant growth in the water, it can reduce oxygen levels in the water, harming fish and other aquatic life, and it can also affect plant growth and soil quality on land.

Photochemical ozone creation potential, POCP [kg NMVOC eq.]: Photochemical ozone formation is the process of making ozone near the ground due to sunlight interacting with chemicals like nitrogen oxides (NO_x) and volatile organic compounds (VOCs) which are broken down by sunlight and react with oxygen (O_2) to form ozone. This ground-level ozone contributes to smog, which can cause health problems and damage plants.

Abiotic depletion potential (element), ADPe [kg Sb eq.]: Measures how much we're using non-renewable resources like minerals, metals, and fossil fuels. This concept assesses how much these resources are being consumed or diminished over time, considering their availability and the impact of extraction and use.

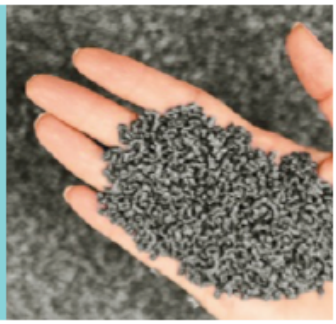
Abiotic depletion potential (fossil), ADPf [MJ]: measures how much using fossil fuels reduces their availability. It looks at how our consumption of these non-renewable resources impacts their future supply.

Water deprivation potential, WDP [m³ world equiv.]: shows how much a product or process impacts the global water scarcity problem by estimating how much water use or pollution contributes to water scarcity around the world.

ANNEX 1: CRITICAL REVIEW STATEMENT

LCA of UBQ tablets – critical review statement and report

UBQ Materials



Prepared by Fishwick Environmental Ltd (Co. number: 12863179)
Mobile: 07909 573711
Email: matt@fishwickenvironmental.com
Address: 85 Great Portland Street, London, W1W 7LT
Website: fishwickenvironmental.com

Fishwick Environmental

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Private and Confidential

This critical review assessed an environmental life cycle assessment (LCA) of UBQ tablets. The study was prepared by Environmental Resources Management (ERM) for UBQ in accordance with the international standards on LCA: ISO 14040:2006 and ISO 14044:2006. Details of this LCA study are provided below:

- **Title of study**: "LCA background report UBQ tablets".
- **Commissioner of the study**: UBQ Materials.
- **Practitioner of the study**: Marcella Volta, James Tipper, Peter Shonfield, and Katie Livesey (ERM).
- **Version of the report which the review statement belongs**: "0638899 ERM UBQ LCA background_26-07-v5.pdf".
- **Assurance type**: third party assurance via critical review.

As the commissioner of this LCA may provide headline results to customers, it is recommended that a critical peer review is carried out by an LCA expert. A review was therefore undertaken by the following reviewer based on ISO 14044:2020 Section 6.3. The reviewer was external and independent of the LCA project.

- **Matthew Fishwick** – *Environmental Consultant at Fishwick Environmental Ltd* – Matt has 17+ years of experience in life cycle assessment. Past clients in include 3M, Lonza, BP, ABF, PepsiCo, Honeywell, Jotun, GSK, and Johnson & Johnson. He has PhD, MRes, MSc and BSc degrees in environmental chemistry and is a member of the Royal Society of Chemistry (MRSC).

Details of the review are provided in this critical review statement, which has been prepared in accordance with ISO-TS 14071:2016 and ISO 14044:2006.

The critical review process ensured that:

- The methods used to carry out the LCA are consistent with ISO 14040/44;
- The methods used to carry out the LCA are scientifically and technically valid;
- The data used are appropriate and reasonable in relation to the goal of the study;
- The interpretations reflect the limitations identified and the goal of the study; and
- The study report is transparent and consistent.

The critical review process involved a detailed review of the LCA report for conformance with ISO 14040/44. The review was undertaken at the end of the study. The reviewer used a peer review template to log their comments, based

on the example given in ISO-TS 14071. These comments were discussed with ERM. Responses to these comments were sent back to the reviewer along with an updated version of the LCA report to check. The reviewer proceeded to check that they were satisfied with the responses or requested final changes.

The reviewer was provided with a detailed LCA report. Having re-read the final report and responses to final comments, the reviewer is confident that this study is in conformance with ISO 14040:2006 and ISO 14044:2006.

Table 1 (ISO conformance comments) and Table 2 (general comments) comprise the critical review report, with comments from the reviewer and responses from ERM.

In addition, the review checked the LCA against the requirements of PCR 2010:16 and found most to be met. However, full conformance with this standard is not possible as an EPD has not been generated or published yet.

Yours sincerely,

Matthew Fishwick