ubq

Product Carbon Footprint (PCF)

The product carbon footprint (PCF) is a key indicator of a product's impact on the climate. Breaking these insights to a product level can be hugely beneficial. With this knowledge, an organization can identify and address specific hotspots in its supply chain or production process to improve the sustainability of its operations.

The PCF is the total amount of greenhouse gases (GHGs) emitted into the atmosphere over the different stages of a product's life cycle. These emissions can come from many sources, such as the extraction of raw materials, fuel consumed by machinery or transportation, and electricity needed to power the factory. [Read about emission sources at the company level in Scopes 1, 2, and 3, found at https://www.ubqmaterials.com/sustainability-library/.]

The PCF calculation outcome depends on the scope and system boundaries:

- Cradle-to-gate PCF: Includes all the processes from the extraction of resources through the manufacturing of precursors and the making of the product itself, up to the point where it leaves the company gate.
- Cradle-to-grave PCF: Extends beyond cradle-to-gate to include the emissions from the product's downstream transportation, any additional processing, use phase, and end of life (EOL) treatment.

In total, the full UBQ™ thermoplastic climate impact is composed of 3 building blocks, summing up to the net PCF:

1. Upstream and core UBQ™ production footprint (Fossil): Included in cradle-to-gate.
2. Upstream land use and land use change (LULUC): Included in cradle-to-gate.
3. Biogenic carbon removals: The carbon trapped in UBQ™ is included in the cradle-to-gate PCF. It is not included in the cradle-to-grave PCF, as the biogenic carbon may be released by EOL treatment. Long-lasting product applications and circular business models can delay or prevent the potential EOL release of biogenic carbon.

Upstream & Core Production Footprint (Fossil)

As a climate-tech innovator, UBQ Materials has developed a revolutionary, patent-backed process technology to convert municipal solid waste (MSW) into a homogeneous thermoplastic material that can displace common plastics. Thanks to both the process design and strategic decisions, the production process is energy efficient and releases lower amounts of carbon emissions compared to conventional oil-based plastics or post-consumer recycled (PCR) plastic. Depending on the plastic type being replaced, the carbon footprint of UBQ™ is estimated to be several times lower than the alternative.

1. **Feedstock**: UBQ's feedstock is residual MSW. Under the cut-off approach in life cycle assessments (LCAs), waste is considered "burden free". This means it carries no environmental burden when it enters UBQ's system—these are assigned to its prior life cycle, where it was already processed, used, and discarded.
2. **Low energy demand**: The temperatures used in UBQ's conversion process are below 200°C—these lower temperatures require less energy than many industrial processes, including petrochemicals.
3. **Facility design**: UBQ's full-scale facility in Bergen op Zoom, The Netherlands, is built to maximize energy and resource efficiency. This includes using residual heat from mechanical processing systems, adding no water to the process, sustainable considerations in the supply chain, as well as recycled packaging material. In addition, all production electricity is 100% renewable energy such as solar and wind, certified through Guarantees of Origin.

Biogenic Carbon Removals

Biogenic carbon is different than fossil carbon and refers to carbon stored in food waste, wood, paper, grass trimmings, and other biomaterials through the natural carbon cycle. This carbon originates from atmospheric CO_2 captured via photosynthesis during plant growth and would typically be released back into the atmosphere through natural decomposition. Because UBQ™ uses organic waste as feedstock, this biogenic carbon is captured in the material. Converting it into durable products delays the return of this carbon to the atmosphere and therefore can be considered a form of temporary carbon capture and utilization. In cradle-to-gate LCAs, this captured biogenic carbon is counted as a **negative emission**.

Upstream Land Use Change

LULUC refers to GHG emissions resulting from alterations in land use, such as deforestation, afforestation, or the conversion of natural ecosystems for agriculture. Since UBQ™ uses residual household waste as feedstock—an input with negligible land use impact—LULUC contributions are generally minimal. However, when relevant LULUC emissions are associated with upstream inputs (such as additives or packaging), they are included in the cradle-to-gate footprint under the **"Upstream and Core Production"** category.

Carbon Footprint of UBQ Tablets (ClimaPos™) – LCA

For UBQ's factory in the Netherlands, leading consulting firm ERM has conducted a third-party-verified LCA using design data. The carbon footprint of UBQ™ tablets made in the Netherlands, according to ERM's findings, is shown in Figure 1.

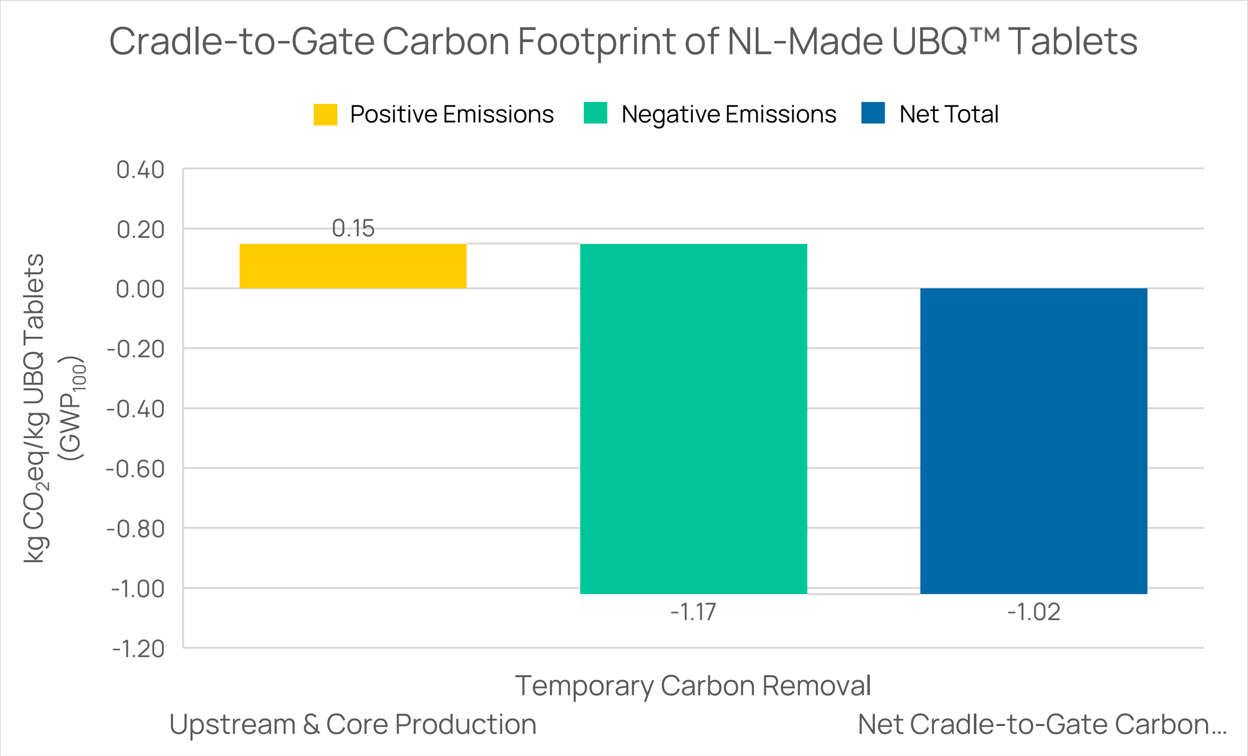

Figure 1. Upstream and core production footprint, biogenic carbon removal, and cradle-to-gate PCF of UBQ™ tablets made in Bergen op Zoom, NL, as calculated by ERM using design data (cradle-to-gate LCA according to ISO 14040:2006).

These LCA results demonstrate that UBQ™ delivers carbon benefits **on two fronts**:

1. First, the carbon footprint of UBQ™ tablet production in the Netherlands is exceptionally low—at just **0.15 kg CO_2eq** per kg of material (GWP_{100}), it's several times lower than oil-based polymers. By substituting UBQ™ for most conventional virgin or recycled oil-based polymers, manufacturers can significantly reduce the carbon footprint of their products. Representative comparisons are shown in Table 1.
2. Secondly, each kilogram of UBQ™ tablets temporarily stores 1.17 kg CO_2eq of biogenic carbon in the material, removing it from the atmosphere in a cradle-to-gate analysis.

This unique combination of a low production footprint and the ability to remove biogenic carbon sets UBQ™ apart from most materials available today.

Table 1. PCF comparison between UBQ™ tablets made in the Netherlands and conventional plastics

Material	Upstream & Core Production (GWP_{100}) (1)	Temporary Biogenic Removal (GWP_{100}) (2)	Net Cradle-to-Gate Carbon Footprint (GWP_{100}) (1+2)
Netherlands-Made UBQ™ Tablets	**+0.15**	**-1.17**	**-1.02**
Polypropylene (PP)*	+2.37 (15.9x)	No removal	+2.37
High-Impact Polystyrene (HIPS)*	+3.76 (24.5x)	No removal	+3.65
High-Density Polyethylene (HDPE)*	+2.43 (16.3x)	No removal	+2.43
Recycled Polypropylene rPP)*	+1.57 (10.5x)	No removal	+1.57

*Data shown for European materials, per ecoinvent 3

In addition to reducing emissions by replacing oil-based plastics, UBQ™ also prevents emissions that would have occurred if the waste used as feedstock had followed a conventional EOL route, such as landfilling or incineration—these are referred to as "avoided emissions". While these avoided emissions are accounted for separately from the PCF, they further amplify UBQ's overall climate benefit. [You can read more about avoided emissions in an upcoming paper from UBQ.]