UBQ MATERIALS: ADVANCED WASTE CONVERSION TECHNOLOGY & EMISSIONS REDUCTIONS

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PROJECT INFORMATION	
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Content

1. Converting waste to a resource through a new breakthrough technology

Global municipal solid waste (MSW) generation exceeds 2 Billion tons per year and is expected to double by 2050.[1] Similarly, global annual production and consumption of plastics is expected to quadruple from the current 350 million tons to over 1 billion tons by 2050.[2] Properly managing waste and leveraging it as a resource is critical to reduce global warming and address the Sustainable Development Goals (SDGs).[3]

UBQ Materials (UBQ) has developed a robust closed-loop system that valorizes waste by converting it into safe, durable and recyclable plastic composites. This solution diverts MSW from landfills, thus creating significant and important benefits for the climate in the form of avoided emissions and pollution. Thanks to both the climate benefits and valorizing waste into a renewable resource, UBQ plays an important role in the transition toward a low-impact circular economy.

Supplementary reports providing evidentiary substance are available from UBQ.

2. Environmental benefits of UBQ

2.1. Significant greenhouse gas emission reductions

The production of UBQ material uses substantially unsorted residual MSW as its primary feedstock. Currently, UBQ is based in Israel and diverts this waste from its usual fate: landfilling.

In a landfill, waste decomposes in anaerobic conditions (in the absence of oxygen), a biological process that produces methane. Methane, a potent greenhouse gas, is typically measured in "CO_2 equivalent" to understand its climate impact compared to carbon dioxide emitted into the atmosphere. To understand the impact of carbon equivalence on our climate over time, or Global Warming Potential (GWP), measurements are typically made using either a short- or long-term scale (20 or 100 years). Both scales allow scientists to calculate the carbon footprint of greenhouse gases.

Impact of Methane compared to Carbon Dioxide:

Long-Term Impact Scale: 100 years	Short-Term Impact Scale: 20 years
Conventional approach; used by most standards and published studies. Called GWP_{100} in IPCC reports[4]. Methane is 34 times more harmful than CO_2.	Alternative approach; addressing the urgency we face to fight climate change. Called GWP_{20} in IPCC reports. Methane is 86 times more harmful than CO_2.

Both approaches are equally valid from a scientific perspective.
The difference comes from the time scale at which decisions must be made.

[1] What A Waste 2.0: A Global Snapshot of Solid Waste Management to 2050, World Bank 2018
[2] The New Plastics Economy: Rethinking the future of plastics, Ellen MacArthur Foundation, 2016
[3] Waste Aid International, [https://wasteaid.org.uk/waste-sustainable-development-goals]
[4] Global Warming Potential, as published by the Intergovernmental Panel on Climate Change, IPCC 2013, AR5.

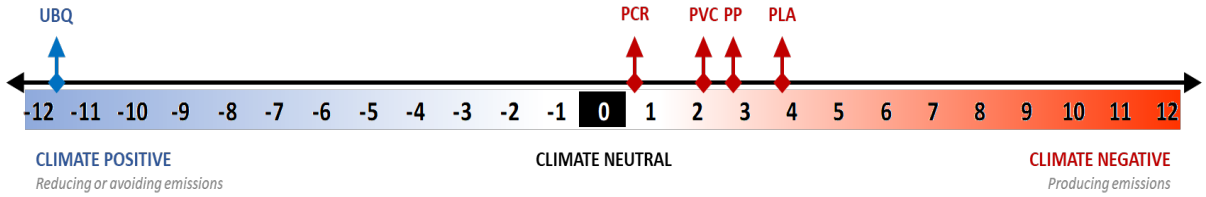
UBQ has used the widely recognized UNFCCC methodology[5] along with supporting IPCC data[6] to calculate the amount of methane that is avoided by diverting waste from landfill. UBQ has also calculated the emissions related to their processing (mostly energy use), following a standard life cycle assessment procedure (ISO 14040).

Given the production process is not energy intensive and there is a large amount of avoided emissions due to diverting waste from landfill, the net total greenhouse gas emissions of UBQ provides a significant benefit for the climate. The following results, using conservative assumptions, have been validated by Quantis.

The average net carbon footprint of 1 kg of UBQ material is:

Long-Term Impact Scale (GWP_{100}):	Short-Term Impact Scale (GWP_{20}):
Net benefit of 4.38 kg CO_2eq	Net benefit of 11.7 kg CO_2eq

The climate impact per kg (GWP_{20}) of UBQ Material compared to a selection of conventional plastics:



The benefit shown here is highly significant in comparison to the impact of other conventional market plastic materials available today.[7] When compared to polypropylene (PP), one of the most widely used plastics, the above impact scaling shows an environmental improvement of over 14.5 kg/CO_2eq. **To the best of our knowledge, this positions the UBQ Material as the most climate positive plastic available today.** When using GWP_{100}, the benefit is less significant but still places the UBQ Material in the same position.

2.2. Accelerate circular economy transition through waste diversion, conversion and resource efficiency

Given the MSW feedstock, the UBQ conversion process upcycles waste into a valuable resource, reducing the extraction new fossil resources and creating a closed material-loop where there was previously a linear cradle-to-grave system. Moreover, UBQ plastic composites are fully recyclable, further contributing to a circular economy. This is underscored in one of the UBQ material formulations where *Cradle to Cradle Certification* by MBDC[8] is expected[9].

Additionally, with a lower melting point than conventional plastics, overall efficiency of end-product manufacturing could be improved through reduced energy and production cycle-times.

Lastly, to maximize overall societal benefits, UBQ ensures that materials such as residual PET bottles, metals and glass are removed and sent back to recyclers. This lateral benefit of recycling other discarded materials was not considered in the calculations of the environmental benefits of UBQ.

2.3. Neutralize the carbon footprint of conventional polymers

With a significant carbon footprint benefit, when UBQ material is compounded with conventional (fossil derived) polymers, the UBQ fraction can offset the carbon footprint of the conventional fraction.[10] This results in a carbon neutral plastic.

[5] CDM Methodological Tool 4 : Emissions from Solid Waste Disposal sites, Version 08.0, UNFCCC, EB 94, May 2017
[6] IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories, 2009, Volume 5: Waste, Chapter 2: Waste Generation, Composition, and Management Data; Chapter 3: Solid Waste Disposal, Chapter 5: Waste, and Background Paper: CH4 Emissions from Solid Waste Disposal
[7] The comparative scaling uses the short-term (GWP_{20}) for both UBQ and the generalized material data per the ecoinvent 3.3 database with the following values: PCR(g) of 0.4 t/CO_2eq.; PVC(sp) of 2.2 t/CO_2eq.; PP(g) of 2.8 t/CO_2eq.; and PLA(g) of 3.8 t/CO_2eq.
[8] McDonough Braungart Design Chemistry, mbdc.com/how-to-get-your-product-cradle-to-cradle-certified/
[9] Official opinion of Annette Hastrup, Vugge-til-Vugge, the certified third party C2C assessor and member of the C2C Standards Board.
[10] See UBQ supplementary report

The fraction, or loading level, of the UBQ material required to obtain carbon neutrality depends on the base polymer and on the adopted approach for calculating the methane climate effect, as shown below. The following results are calculated using the same conservative assumptions as in section 2.1.

Reaching a carbon neutral PP compound with UBQ:

Long-Term Impact Scale:	Short-Term Impact Scale:
UBQ loading level of **34%** or above can achieve carbon neutrality when compounded with PP.	UBQ loading level of **20%** or above can achieve carbon neutrality when compounded with PP.

3. Unique properties of UBQ Material

3.1. 3rd generation bio-based plastic composite

The UBQ material is a composite material made from residual waste input[11], which is a 3rd generation feedstock[12]. This includes organic waste (food, garden, paper and cardboard waste) as well as mixed non-recycled plastics destined for landfill. Since the organic waste fraction of the UBQ material feedstock is typically 70% of the total weight[13], UBQ can be considered bio-based[14], even though the level can vary slightly depending on the region providing the feedstock.

3.2. Health, safety and compliance

The UBQ conversion process is both a complete mechanical and chemical transformation. It does not allow the survival of any microorganisms and completely neutralizes molecules that are related to waste degradation. Operating under relatively low temperatures, the process has no combustion and produces no hazardous fumes.

All external third-party laboratory testing results demonstrate the UBQ Material is safe for people and for the environment according to the most stringent US & European hazardous waste rules, compliant under REACH[15], as well as Cradle-to-Cradle standards.

Based on this, the UBQ material is completely safe to use and does not present any health or safety concerns.[16]

3.3. Mechanical properties

The UBQ Material can be utilized both on its own or as an additive to be used in conventional product manufacturing to be compounded with both fossil-derived or bio-based polymers regardless if they are virgin, recycled, or waste discards.

Given its compatibility, it can be compounded with most of the main market polymers and additives while maintaining the desired mechanical properties (e.g.: tensile strength, stiffness, melting point) required for any specific application. Other properties such as pigmentation, UV or impact resistance can also be adapted. As such, the UBQ material can both preserve the original qualities of the conventional plastics with which it is combined and adapt to other additives that may be chosen for specific applications.

[11] The production of 1 kg of UBQ material requires 1.34 kg of residual waste input where the 'delta' represents the moisture content which is removed in the conversion process. Waste composition and moisture levels within the waste stream can vary slightly from region to region.
[12] [Terminology EN 16575] Third Generation Feedstocks: Relying on direct waste streams that typically have no other intended use and are either buried (landfilled) or burned (incinerated). Algae are also considered as 3rd generation. Agricultural waste is 2nd generation feedstock.
[13] This percentage is based on dry weight input for UBQ's Israeli facility.
[14] [Terminology EN 16575] Bio-Based Products: A product wholly or partly derived from biomass. Products can be an intermediate, material, semi-finished or final product.
[15] REACH Analysis Report: Impact on UBQ Products, ETHOS Architecture, Planning, & Environment Ltd, Dov Basel, Senior HSE Partner, 2014
[16] Official opinion of Jo-Anne Shatkin, CEO of Vireo Advisors, LLC, based on more than 30 years of experience in environmental chemistry and expertise in quantitative human and environmental health risk analysis.

3.4. Broad applicability

The UBQ material is compatible with the main market polymers, additives, manufacturing techniques and applicable to most durable product applications segments. This enables applicability in thousands of different products across a diverse range of industries and segments while being safe to use without limitation.[17]

3.5. Recyclable and safe for end-of-life disposal

When properly collected for recycling, products made with the UBQ material can be recycled with excellent results.[18] In fact, the UBQ material acts as a bonding agent between other polymers within the compound and helps preserve the qualities of the polymers during the recycling process.

Though the UBQ material is largely bio-based, given its composite nature, it should not be assumed as biodegradable.[19] If not recycled, it can be landfilled or incinerated as any other plastic, without any problems.

4. Proof of concept

UBQ's semi-commercial facility in Israel is fully operational, with annual production capacity of 5 000 metric ton, and able to be scaled further in order respond to demand growth. The facility has received all necessary permits, certifications and licenses required.[20] Given the facility is closed-loop and produces no water waste, production waste, affluence or exhaust, location is permitted to be in close proximity to residential areas, as currently the case being situated within a 'Kibbutz'.

Even considering current scale of operations, the full UBQ solution, from waste input through to material output, is economically viable as a self-sustaining system.[21] The material is competitively priced compared to conventional plastics without considering the environmental value propositions. With this, UBQ's technology has the potential to bring system change to waste management.

5. Clear environmental added value

The value proposition brought by the environmental benefits of using UBQ material is a strong advantage:

- Avoids significant CO_2 equivalent emissions
- Diverts waste from landfills
- Valorizes 3rd generation feedstocks as a renewable resource
- Commercially viable bio-based composite material
- Compatible to be compounded with other market polymers
- Enables carbon neutral and climate positive applications
- Actively contributes to a circular economy
- UBQ process and materials provide no human or environmental health risk

These data points have been clearly documented by UBQ and reviewed by Quantis, which means they **may be publicly communicated** in a credible manner.

[17] Certification for food and beverage applications is still to come
[18] UBQ Material Loopability Testing Report, UBQ Materials & SYSTEMIQ, 2018
[19] Further testing is required to assess the biodegradability of the material.
[20] All permits, certifications and licenses required have been granted by the relevant local, regional, and national agencies including the Israeli Ministry of Environment.
[21] UBQ Material's Business Model & Go-To-Market Strategy Development, SYSTEMIQ, 2018