

Life Cycle Assessment study demonstrates the potential of Avantium's FDCA and PEF technology to curb global warming

AMSTERDAM, 21 February 2022, 18:00 hrs CEST – Avantium N.V., a leading technology company in renewable chemistry, has published Life Cycle Assessment (LCA) data for its bottles made from PEF (polyethylene furanoate): a plant-based, fully recyclable plastic material with superior performance. nova-Institut GmbH recently completed the ISO-certified LCA to assess the potential environmental impact of monolayer PEF and multilayer PET/PEF bottles. Compared to the incumbent fossil-based PET bottle designs, significant improvements in carbon footprint of around 35% in greenhouse gas (GHG) emissions can be achieved depending on the chosen application. This is also combined with the biogenic nature of the emissions (from renewable carbon) that a PEF bottle would release at end-of-life, which do not contribute additionally to global warming. Once PEF is commercially available, substantial economic, technological, and environmental optimisations are expected within the value chain, leading to further reduction of its environmental impact.

Compared to fossil-based PET bottle solutions, the use of renewable feedstock (high-fructose syrup from wheat) in PEF results in clear reductions in GHG emissions throughout the entire life cycle. A second driver for the lower carbon footprint of PEF bottles is the improved barrier and mechanical properties of PEF, enabling a substantial reduction in material usage compared to PET bottles. For monolayer PEF bottles, this results in 33% lower GHG emissions, and 37% reduction for multilayer PEF/PET bottles.

In addition, as all plants absorb carbon during growth, an inherent advantage of PEF-based products is the temporary storage of carbon dioxide. At the end-of-life of a PEF-based product (i.e. when PEF can no longer be recycled and is incinerated), this biogenic carbon re-enters the natural carbon cycle, whereas fossil-based plastics release carbon at the end-of-life that has been locked up in the ground for millions of years, increasing that total carbon amount of carbon in the atmosphere. Some non-EU companies report carbon-negative climate change results for their bio-based materials, taking this short-term carbon storage into account. European LCA standards and methods do not allow carbon discounting based on temporary storage and therefore this is not included in this LCA¹.

Further improvements foreseen

This LCA study is the basis for assessing the sustainability benefits of Avantium's current PEF applications. It enables identification and quantification of further technology development, as well as opportunities for improvement in the value chain. Further improvements may consist of the use of renewable energy, different feedstock sources, process optimisation and recycling of PEF. For instance, in this LCA, the current energy mix of the Netherlands, which still contains a low percentage of renewable energy, was assessed. It is foreseen that the use of both renewable heat and electricity will become the norm in the near future. Recent energy optimisation work for an FDCA plant at industrial scale has already shown that energy consumption can significantly be reduced, resulting in a further improved LCA. Furthermore, this LCA study still assumes that PEF will initially end up in an open-loop recycling stream with relatively low recycling rates. Sufficient market growth will enable an individual closed-loop material recycling stream with high efficiencies. The PEF process is expected to become much more efficient, in both energy integration and achieved yields. Substantial further GHG emission and other environmental benefits will be achieved when these factors have been realised. Avantium will conduct another LCA study once those improvements are materialised.

Ed de Jong, Vice President Development at Avantium and responsible for the PEF applications LCA: "This LCA study provides clear confirmation of the reduced carbon footprint of PEF bottles compared to the fossil-based incumbents. We strongly believe that the development of PEF to full industrial scale from 2024 will lead to a further substantial reduction in the carbon footprint of PEF applications, also in other fields such as flexible packaging and apparel."

ISO certification

Avantium partnered with nova-Institut GmbH under the framework of the PEference projectⁱⁱ to perform this full cradle-to-grave LCA study for PEF bottles. The entire life cycle of PEF-based bottles is assessed, from the extraction or cultivation of raw materials through production, use, and disposal of the product. All relevant environmental aspects of FDCA and PEF production are analysed. PET bottles were modelled using Ecoinvent data for bottle grade PET production available from most recent Eco-profiles of the European plastics industry. The LCA is performed according to the ISO 14040/44 standard methodology and is based on the engineering data for the first commercialisation phase of Avantium's technology to produce PEF. A critical peer review of the study, by experts on LCA methodology and incumbent technologies, was conducted in order to verify whether the LCA met the requirements for methodology, data, interpretation, and reporting.

A summary of the LCA is available on the Avantium website: <https://www.avantium.com/lca/>

About Avantium

Avantium is a leading technology development company and a forerunner in renewable chemistry. Avantium develops novel technologies based on renewable carbon sources as an alternative to fossil-based chemicals and plastics. The company currently has three technologies at pilot and demonstration phases. The most advanced technology is the YXY[®] plant-to-plastics-technology that catalytically converts plant-based sugars into a wide range of chemicals and plastics, such as PEF (polyethylene furanoate). Avantium has successfully demonstrated the YXY[®] Technology at its pilot plant in Geleen, the Netherlands, and will start construction of the world's first commercial plant for large-scale production of PEF in 2022. The second technology is Ray Technology[™] and catalytically converts industrial sugars to plant-based MEG (mono-ethylene glycol): plantMEG[™]. Avantium is scaling up its Ray Technology[™] and the demonstration plant in Delfzijl, the Netherlands opened in November 2019. The third technology is called the Dawn Technology[™] that converts non-food biomass into industrial sugars and lignin in order to transition the chemicals and materials industries to non-fossil resources. In 2018, Avantium opened the Dawn Technology[™] pilot biorefinery in Delfzijl, the Netherlands. Next to developing and commercialising renewable chemistry technologies, the company also provides advanced catalysis R&D services and systems to customers in the refinery and chemical industries. Avantium works in partnership with like-minded companies around the globe to create revolutionary renewable chemistry solutions from invention to commercial scale.

Avantium's shares are listed on Euronext Amsterdam and Euronext Brussels (symbol: AVTX). Avantium is included in the Euronext Amsterdam SmallCap Index (AScX). Its offices and headquarters are in Amsterdam, the Netherlands.

Forward-looking information / disclaimer

This press release may include forward-looking statements. Other than reported financial results and historical information, all statements included in this press release, including, without limitation, those regarding our financial position, business strategy and management plans and objectives for future operations, are forward-looking statements. These forward-looking statements are based on our current expectations and projections about future events and are subject to risks and uncertainties that could cause actual results to differ materially from those expressed in the forward-looking statements. Many of these risks and uncertainties relate to factors that are beyond Avantium's ability to control or estimate precisely, such as future market conditions, the behavior of other market participants and the actions of governmental regulators. Readers are cautioned not to place undue reliance on these forward-looking statements, which speak only as of the date of this press release and are subject to change without notice. Other than as required by applicable law or the applicable rules of any exchange on which our securities may be traded, we have no intention or obligation to update forward-looking statements.

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ⁱ European Commission – Joint Research Centre – Institute for Environment and Sustainability. (2010). International Reference Life Cycle Data System (ILCD) Handbook - General guide for Life Cycle Assessment - Detailed Guidance. Luxembourg: Publications Office of the European Union.

ⁱⁱ PEference has received funding from the Bio-based Industries Joint Undertaking (JU) under the European Union's Horizon 2020 research and innovation program under grant agreement No744409. The JU receives support from the European Union's Horizon 2020 research and innovation program and the Bio-based Industries Consortium.