The EU End-of-Life Vehicle (ELV) Directive defines recycling as the process of recovering materials from end-of-life products and reintroducing them into the production cycle to create new materials or products. This excludes energy recovery processes like incineration but includes mechanical, chemical, and biological recycling methods.

While cured PaperShell components cannot be recycled in the traditional sense (e.g., reprocessed into new PaperShell components), they can be recovered and transformed into high-quality biochar. This aligns with the directive's recovery and reuse targets, which require up to 95% of a vehicle's weight to be reused and recovered.

a) Primary Recovery Pathway: Transformation into Biochar

PaperShell components can be processed into high-quality biochar through pyrolysis, a thermal process that heats organic materials to high temperatures (300°C–800°C) in the absence of oxygen. This prevents combustion and instead breaks down the material into biochar—a stable, carbon-rich solid.

Biochar is a soil amendment that enhances fertility, supports microbial life, and increases water retention.

The biogenic carbon initially absorbed by trees and stored in PaperShell components is not released back into the atmosphere but locked securely in the ground via biochar, contributing to long-term carbon sequestration for centuries to millennia.

If PaperShell components are transformed into biochar at their end-of-life, the material becomes carbon-negative, storing more carbon than it emits throughout its lifecycle.

This process qualifies as material recovery under the ELV Directive and supports its 95% reuse and recovery target.

b) Secondary Recovery Pathway: Wood Fraction Recycling Streams

Unlike conventional composite materials, PaperShell's biobased composition ensures compatibility with existing wood recycling infrastructure. If PaperShell components are disposed of at a recognized recycling facility, they can be sorted under the wood fraction and incorporated into established recycled wood streams.

Those wood-based material streams are processed into particleboard, chipboard, and engineered wood products, ensuring that PaperShell follows a secondary material recovery route instead of becoming waste.

This pathway aligns with the ELV Directive's 95% reuse and recovery target, as PaperShell's composition enables material recovery rather than incineration or landfill.

c) Biological Recovery Pathway: Mycelium Composting

Mycelium composting leverages the enzymatic capabilities of fungal species to break down PaperShell components into compost. Locally adapted fungal species colonize shredded PaperShell components, secreting enzymes that break down cellulose and hemicellulose into simpler nutrients. The mycelium digests the material, effectively converting it into compost.

While not yet industrially scaled, initial lab tests have shown promising results, with specific mushroom cultures identified for this purpose.

Additional End-of-Life Options

Extended Lifecycle: PaperShell components are highly durable and may be suitable for reuse in secondary applications after their initial use in a vehicle, extending their lifecycle and delaying EOL treatment.

Energy Recovery *(Worst Case)*: If no other options are feasible, PaperShell components can be incinerated for energy recovery. Although not classified as recycling, this process is permitted under the directive as part of the recovery quota.

Environmental Impact Estimates
(in the form of 1 kg chair)

Cradle-to-Cradle with Biochar Transformation:

-0.71 kg CO_2e/kg

Cradle-to-Grave with Incineration (Energy Recovery):

0.185 kg CO_2e/kg

Regulation on Deforestation-free products – Environment

PaperShell is **FSC® certified** since 2024. This includes that the paper used in PaperShell material is sourced from suppliers committed to sustainable forest management.

FSC® License code: FSC-C208852

The kraft paper we use is derived from residues of the forest industry, materials that would otherwise be used for single-use items like toilet paper. We transform this kraft paper into a long-lasting, high-performance product. This adds value to forestry operations without contributing to unnecessary harvesting or deforestation.

To further reduce environmental impact, we are working toward sourcing paper from a Swedish producer, relying on forests that are as local as possible to our production facilities and of course responsibly managed. This transition is already under evaluation and is planned to be implemented in the near future.

In the long term, PaperShell aims to incorporate recycled paper materials as the primary raw material. This includes plans to establish an on-site paper production and impregnation line, further reducing the supply chain's environmental footprint and increasing control over sourcing practices.