



STILFOLD®

Swedish industrial origami folding and low carbon metals creates greener transportation system

Twinshift research study demonstrates that STILFOLD's curve-folded unibody design and California Metals' responsible material sourcing compound into a 53% mass reduction and 50% carbon reduction versus an industry-leading Asian cargo-bike platforms. Neither lever alone delivers — together, they compound. Pointing to a 20× climate multiplier in heavy transport.



A new transatlantic study shows that curve-folded unibody design is the dominant lever in decarbonising structural metal. By integrating frame, body panels, and cargo bed into a single curve-folded structure, STILFOLD's chassis weighs 53% less than the equivalent assembly in an industry-leading Asian cargo-bike platform — and embodies approximately 50% less carbon, despite upgrading from carbon steel to stainless. The same playbook points to multipliers above 20× when scaled to truck and automotive structures. Geometry leads. Unibody integration compounds it. STILFOLD's flexible, tooling-free process is what makes both possible at industrial scale.

At the cargo-bike scale, the attribution is clear. STILFOLD's curve-folded unibody chassis weighs 15.5 kg and integrates three categories of components — structural frame, body panels and fairings, and cargo bed — that together total approximately 33 kg of mixed metal and plastic in an industry-leading Chinese cargo-bike platform. Cradle-to-gate, the footprint falls from approximately 83 kg CO₂ (Asian-sourced carbon steel at ~2.2 kg CO₂e/kg combined with ABS/PP plastic body components at ~3.5 kg CO₂e/kg) to approximately 42 kg CO₂ (European-sourced stainless steel 304L at 2.7 kg CO₂e/kg). A ~50% reduction — achieved by integrating multiple component categories into a single structure, while upgrading to a more durable, corrosion-resistant alloy that requires no protective coatings and is fully recyclable at end of life.

The study, conducted under the Twinshift research project with funding from Vinnova, Sweden's innovation agency, through the Future Mobility programme, is led by STILFOLD, the Swedish design-technology company pioneering software-defined manufacturing, in partnership with California Metals. It combines cradle-to-gate carbon analysis across material-and-region combinations with digital-twin simulations of the STILRIDE cargo bike chassis, drawing on independent lifecycle-assessment data. The findings reframe the decarbonisation debate for structural metal: design, not sourcing alone, is the dominant carbon lever.

Most industrial decarbonisation strategies cut carbon by switching to lower-carbon materials or greener supply chains. The Twinshift study shows what happens when the strategy inverts: integrate multiple component categories into a single unibody structure, then use less of a higher-grade material to build it. Sourcing and material choice compound the effect further.

Lever one: curve-folded geometry — the dominant carbon lever. STILFOLD's computational design and curve-folded forming integrate three component categories — structural frame, body panels, and cargo bed — into a single unibody structure, 53% lighter than the equivalent assembly in an industry-leading Chinese cargo-bike platform. This single lever does most of the work behind the ~50% headline carbon reduction: reducing mass and eliminating plastic body components is more powerful than improving the carbon intensity of any single material.

Lever two: responsible material choice — durability and sourcing. STILFOLD deliberately upgrades from carbon steel to stainless steel 304L: approximately twice the embodied carbon per kilogram, but corrosion-resistant, coating-free, longer-lived in service, and fully recyclable. Sourcing from European mills with high recycled content (2.7 kg CO₂e/kg) keeps the upgrade carbon-competitive. Across nine material-and-region combinations analysed in the study, EU-sourced Outokumpu Circle Green stainless 304L delivered the best balance of structural performance, durability, and embodied carbon for this application.

Lever three: a flexible, tooling-free process — the industrial enabler. STILFOLD's patented robotic curve-folding does not appear in the cradle-to-gate carbon figure directly — but it is what makes the geometry savings physically achievable at industrial scale. Where conventional stamping requires die sets costing up to \$5 million per geometry and multi-step forming lines, curve-folding replaces all of this with a single continuous bending operation from flat sheet, consuming approximately 12 kWh per chassis. Without this process, the unibody integration and 53% mass reduction that drive most of the carbon saving would not be manufacturable.

The math behind the multiplier is well-established in heavy-transport LCA. Industry benchmarks for passenger vehicles place lifetime operational savings at roughly 6–8% energy reduction per 10% mass reduction. For a heavy-duty truck travelling a million kilometres over its life, every kilogram removed from the chassis can save 20–30 kg of

CO₂ in operation alone — a multiplier of more than 20× on the manufacturing saving. Secondary mass effects compound this further: lighter chassis enable smaller batteries, lighter drivetrains, and lighter supporting structures.

"The cargo bike proves the principle. The real climate impact appears when the same design logic is applied to larger structures in trucks, cars, and industrial systems."

— Jonas Nyvang, CEO, STILFOLD

Underpinning the playbook is STILFOLD's digital-twin framework, which integrates California Metals' advanced lifecycle databases for high-performance metals with STILFOLD's computational design and manufacturing technology. The framework provides full lifecycle visibility — from raw-material sourcing to final product — giving manufacturers precise insight into carbon footprints, energy consumption, recyclability, and structural performance. The project achieved 90% alignment between digital-twin predictions and physical material tests, compared with typical current-industry levels of around 60–70%.

"The industry has spent years focusing on greener alloys, but the real opportunity lies in combining responsible material sourcing with smarter structural design. By integrating detailed lifecycle data into a digital-twin environment, Twinshift enables manufacturers to see exactly where carbon is created — and where it can be eliminated."

— Michael Resl, CEO, California Metals

The project is working toward full traceability of material flows and CO₂ footprint from raw-material extraction to recycling, linking key parameters including material weight, energy consumption, recyclability, and structural integrity.

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About STILFOLD

STILFOLD is a Swedish design and technology company revolutionizing manufacturing with its patented origami-inspired curve-folding technology. The company combines sustainability with innovative design to create strong, lightweight, and cost-efficient structures with minimal environmental impact. STILFOLD's unique method enables the production of complex metal components from flat materials, reducing material waste, energy consumption, and the need for heavy tooling.

The company collaborates closely with clients across various industries, including automotive, aerospace, and consumer goods, to develop tailored solutions that meet the future demands of sustainability and innovation. With a strong belief that form and function should unite without compromise, STILFOLD aims to redefine the possibilities within design and manufacturing.