Redefining sustainability in materials

Twaron Next® shows a path to lower fossil reliance without compromising durability

TEIJIN ARAMID

Twaron Next®

Executive summary

For high-performance industries, performance itself is a sustainability driver

In critical applications, performance itself is a sustainability driver. Durability, lightweighting, and efficiency reduce lifecycle impact by extending service life, lowering replacements, and cutting operational energy use.

Reducing reliance on virgin fossil inputs while maintaining the performance that industries depend on is complex. It requires innovation in sourcing, production, and end-of-life, supported by certification and real-world validation. There is no single solution. Progress comes through steady advances that combine high durability with certified lower-impact feedstocks and greater recyclability.

Key Insights

- Lifecycle matters. Most emissions in many industries occur during use, not production. Performance that extends service life and lowers energy use directly reduces emissions.
- Regulation is tightening. The EU CSRD will require companies to disclose Scope 1, 2, and 3 emissions, making lifecycle impact and material sourcing strategic priorities.
- Innovation is ready. Circular and bio-based (ISCC PLUS mass-balance) feedstocks are now part of aramid production, enabling lower-impact sourcing while maintaining mechanical performance.
- Validation matters. Independent ISCC PLUS certification and real-world testing (in Bridgestone solar car tires with its ENLITEN™ technology in the 2025 World Solar Challenge) confirm durability and efficiency under extreme conditions.

What This Means for You

- Procurement leaders: Verified, lower-impact materials reduce disclosure risk and simplify compliance with new sustainability reporting frameworks.
- R&D and engineering teams: Twaron Next® delivers identical performance with certified lower-impact feedstocks, allowing drop-in adoption without redesign.
- Sustainability and corporate affairs: Certified data supports CSRD-aligned reporting and tangible emissions-reduction targets.
- Business leaders: Early collaboration positions your organization as an industry frontrunner in verifiable, performance-based sustainability.
- The benchmark is set. Twaron Next® shows that performance and lower-impact sourcing can be achieved together. The first step has been taken. The next will be built on innovation, partnership, and shared commitment to operating within planetary boundaries.

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Foreword

Building a sustainable future cannot be achieved by any single company. It requires industries, supply chains, and technologies to work together to create solutions that align performance with environmental responsibility. At Teijin Aramid, our role is to deliver high-performance materials that enable companies to meet both functional and sustainability goals.

Twaron Next® is our first concrete step in that direction. As the world's first para-aramid produced with circular and bio-based feedstock and independently certified under ISCC PLUS, it demonstrates that lower-impact sourcing is possible in critical applications. Its successful use in real-world conditions shows that the transition is already underway. This paper sets out our perspective on what comes next: performance and emissions reduction advancing together, verified by data and certification, and scaled through partnership. Sustainability in high-performance materials is a complex challenge. Feedstocks must evolve, production processes must adapt, supply chains must be transparent, and products must continue to deliver under the most demanding conditions.

The transition will not happen overnight, but every step matters. Twaron Next® is one such step, reflecting our belief that lasting progress comes from collective effort. We invite you to join us in shaping the next generation of high-performance materials, ensuring they are ready for the challenges of tomorrow.

Philip Altena
Director Sustainability, Teijin Aramid

Beyond black and white

The debate on sustainable materials is often reduced to absolutes. Fossil-based inputs are "bad." Bio-based inputs are "good." In reality, the picture is more complex.

Consider a subsea power cable designed to last 25 years under extreme pressure. If its reinforcement fails early, the cable must be replaced. That creates waste, adds new manufacturing emissions, and disrupts a critical system. Offshore wind turbine blades endure millions of stress cycles in harsh marine environments. If they fracture, the efficiency of the entire installation is compromised. Tires for electric vehicles must carry heavier loads and higher torque. If they wear too quickly, the intended energy savings are lost through shorter replacement cycles.

In each case, the defining factor in sustainability is not the input alone but whether the material can endure in use. A recent meta-analysis of 98 bio-based products found average emissions 45 percent lower than fossil counterparts but also revealed wide variation and significant trade-offs; none achieved net-zero.[1] The study shows that input choice alone cannot guarantee sustainability.

The path forward is a transition built step by step. Inputs must evolve, but not at the expense of the durability and efficiency that reduce emissions during use. What matters is not only what a material is made from, but also how it performs and how that performance reduces environmental impact over the full lifecycle.

Performance as a sustainability factor

When the footprint of materials is assessed, attention often falls on how they are produced. Yet in many critical applications, most environmental impact occurs during the use phase.[2] A component that fails early, requires frequent replacement, or consumes more energy in operation can add more emissions over time than one that begins with a higher-input footprint but endures longer in use.

This is why performance is a sustainability factor. High-performance materials such as aramids reduce lifecycle impact because their strength, durability, and low weight extend service life and improve efficiency. They reduce the need for replacements, lower operational energy, and enable lighter designs that perform reliably over time.

Take tires as an example. Reinforcement layers made with Twaron® increase dimensional stability, reducing rolling resistance and cutting energy use. In electric vehicles, this directly supports extended driving range. Stronger carcass layers also extend tire life, reducing the number of replacements needed. Independent studies and industry testing indicate that aramid reinforcement can reduce rolling resistance by up to around 5 percent, improving energy efficiency in electric vehicles by approximately 2–3 percent.

Longer tire life further reduces the total number of replacements and associated manufacturing emissions. These figures are indicative and based on literature averages; actual values depend on tire design, operating conditions, and vehicle configuration. The same principle applies across industries. Longer service lives, lower energy consumption, and fewer replacements all contribute to lower cumulative emissions.

These advantages, however, are not sufficient on their own. Durability cannot compensate indefinitely for the continued use of virgin fossil feedstocks. To remain within planetary boundaries, performance efficiency must be paired with certified lower-impact feedstocks and credible end-of-life routes.

This is the direction materials must take.

Balancing performance and planetary boundaries

Planetary boundaries define the safe operating space for humanity. They include the carbon budget that underpins climate stability, the limits on water use that protect ecosystems, and the thresholds for land use, biodiversity, and novel substances. Materials intersect with each of these through both their performance and their sourcing.

- **Carbon**

  Durable fibers that extend service life reduce the number of replacements required, cutting manufacturing emissions over time. But if those fibers depend entirely on virgin fossil inputs, they still drive cumulative carbon overshoot.

  The same principle applies across industries: extending product or component lifetime lowers the relative impact of production. In the transport sector, for example, EEA analysis shows that increasing vehicle lifetime mileage from roughly 150,000 km to 250,000 km can change per-kilometer production-phase emissions by up to 70 percent, illustrating how longer service life reduces embodied emissions per unit of use.[3]

- **Water**

  Materials that allow lighter, more efficient systems lower operational energy, which can reduce water demand in power generation. Conversely, if bio-based feedstocks are produced with intensive irrigation, the burden shifts to water scarcity.

  For bio-based feedstocks, sustainability depends not only on carbon balance but also on the water footprint of the raw-material supply chain. If renewable precursors are derived from irrigated biomass, total water use can increase significantly compared to fossil-based inputs. As Gerbens-Leenes et al. (2009) report, the water footprint of biomass for energy can be 70 to 400 times larger than that of fossil energy carriers, depending on crop, location, and irrigation regime.[4] In material supply chains, this underscores why water efficiency — both in sourcing and production — must evolve alongside carbon reduction when evaluating material impact.

- **Land use and biodiversity**

  High-strength, lightweight reinforcement enables renewable infrastructure such as wind and solar to scale more efficiently. Yet bio-based sourcing that relies on large-scale agriculture can increase pressure on land and ecosystems.

  JRC bioeconomy modeling indicates that shifting toward biomass-based materials elevates cropland demands and ecosystem stress.[5,6]

  These findings highlight why sustainability metrics for advanced fibers must extend beyond CO_2 accounting to include water and land efficiency.

- **Novel substances**
  Fibers that resist degradation may perform in use but can become persistent waste streams at end-of-life if recovery is not addressed. Circular approaches, such as respinning aramid, help prevent the accumulation of unrecoverable material.

  Pilot-scale respinning of aramid has demonstrated approximately 6 percent lower production-phase CO_2 emissions compared to conventional manufacture, supporting closed-loop potential.

This framework is no longer academic. Regulation is making lifecycle impact a strategic concern. In Europe, the Corporate Sustainability Reporting Directive (CSRD) will require nearly 50,000 companies, plus thousands of non-EU subsidiaries, to disclose Scope 1, 2, and 3 emissions.[7] Materials that optimize one dimension while neglecting others risk higher lifecycle costs, stranded assets, and reputational exposure.

The implication is clear. Performance and sustainability cannot be treated as parallel goals. They must be reconciled within the same system. That means designing materials that maintain the durability and efficiency industries rely on while decoupling from fossil feedstocks and embedding credible pathways for recovery and reuse.

Twaron Next®: Proof in practice

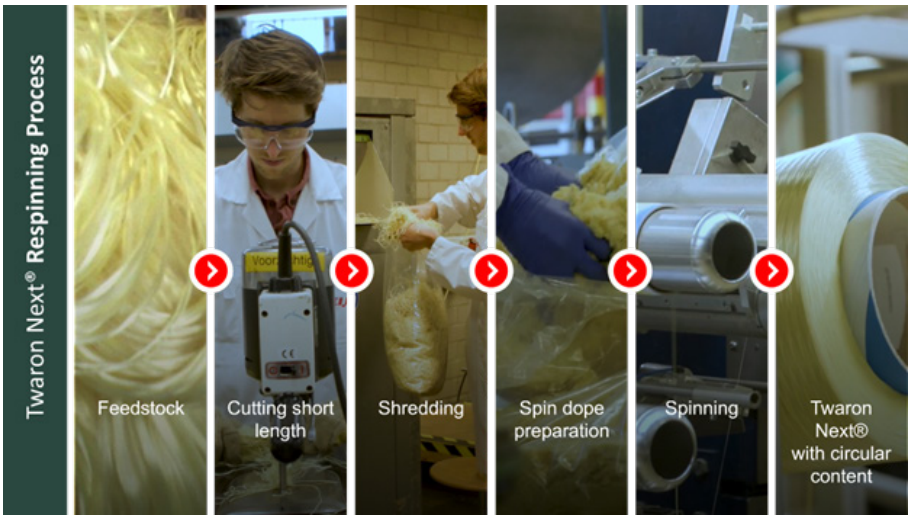
Twaron Next® proves that performance and sustainability can evolve together. For decades, aramids have reduced lifecycle impact through durability and lightweighting. The challenge was to keep these qualities while cutting reliance on virgin fossil inputs.

That challenge has now been met. Twaron Next® is the first para-aramid produced with certified bio-based feedstocks.

It shows that sustainability and performance are not separate goals but can be achieved in the same material. Its development reflects both innovation and belief: progress is possible when complexity is embraced, from material science to supply-chain partnerships and verification.

Two complementary innovation pathways are already in use:

- **Circular content (respinning)**
  End-of-life aramid is mechanically recovered, processed, and respun into new fiber. This physical recycling route cuts CO_2 emissions by around 6 percent compared with standard production. It proves that closed-loop aramid recovery is technically feasible at scale.



Both circular and bio-based routes aim to reduce reliance on virgin fossil inputs while maintaining identical performance. It's important to note that ISCC PLUS certification applies specifically to the bio-based feedstock. Circular (respinning) content is validated through internal testing and lifecycle assessment rather than third-party certification.

- **Bio-based content (mass balance)**
  A portion of the fossil input is replaced with biomass-derived feedstock, transparently tracked under ISCC PLUS certification. Because the resulting fiber is chemically identical to conventional aramid, it delivers the same performance profile while reducing fossil reliance.

Supply chain:

Physical mixing of certified and non-certified raw material

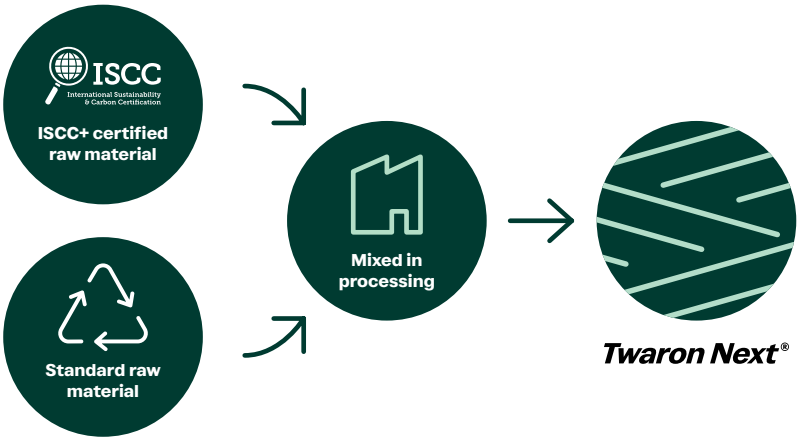
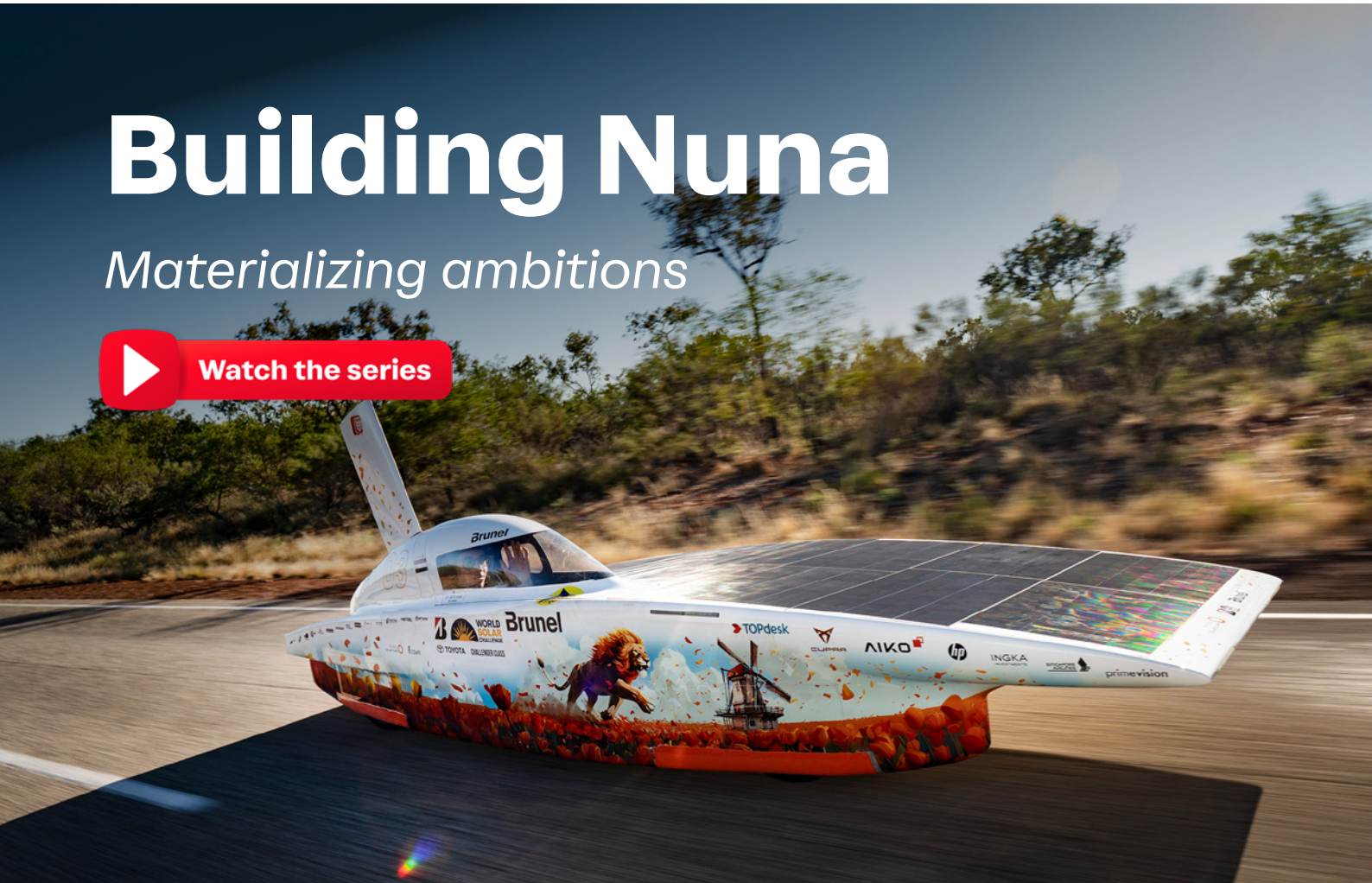


Fig 2. ISCC PLUS mass balance ensures transparent tracking of bio-based feedstock through certified aramid production.

Twaron Next® is not the final answer. Fossil feedstocks remain part of the process, and the share of circular and bio-based content must continue to grow. But it's a world-first proof point: a high-performance fiber that combines durability with lower-impact sourcing in a way that is certified, verifiable, and ready to scale.

The proof is in performance. Twaron Next® with circular content was used in Bridgestone solar car tires with its ENLITEN™ technology for the 2025 Bridgestone World Solar Challenge. Over 3,000 kilometers across the Australian outback, the tires endured extreme heat and delivered efficiency without failure.



Twaron Next®: Proof in practice

The comparison below summarizes how Twaron Next® advances sustainability while maintaining the performance expected from conventional aramids.

Parameter	Standard Twaron®	Twaron Next®	Impact
Feedstock origin	100% virgin fossil	Includes bio-based (ISCC PLUS-certified) and circular (respinning) content	Reduced fossil reliance
CO_2 footprint (cradle-to-gate)	Baseline	≈ 6% reduction (via respinning)	3.1 – 3.6
Lower embodied emissions	N/tex	1.7 – 2.6	2.2 – 2.6
Tensile strength (cN/dtex)	200 - 215	200 - 215	Identical
Modulus (GPa)	65 - 70	65 - 70	Identical
Density (g/cm3)	1.44	1.44	Identical
Thermal stability (°C, 2% mass loss)	~ 500	~500	Identical
Certification	n/a	ISCC PLUS (bio-based feedstock)	Third-party verified
Circular recovery	n/a	Pilot-scale respinning validated	Demonstrated feasibility

All values reflect established Twaron® material data or verified internal assessments. Figures are indicative for Twaron Next® pilot production and may vary as industrial scaling progresses.

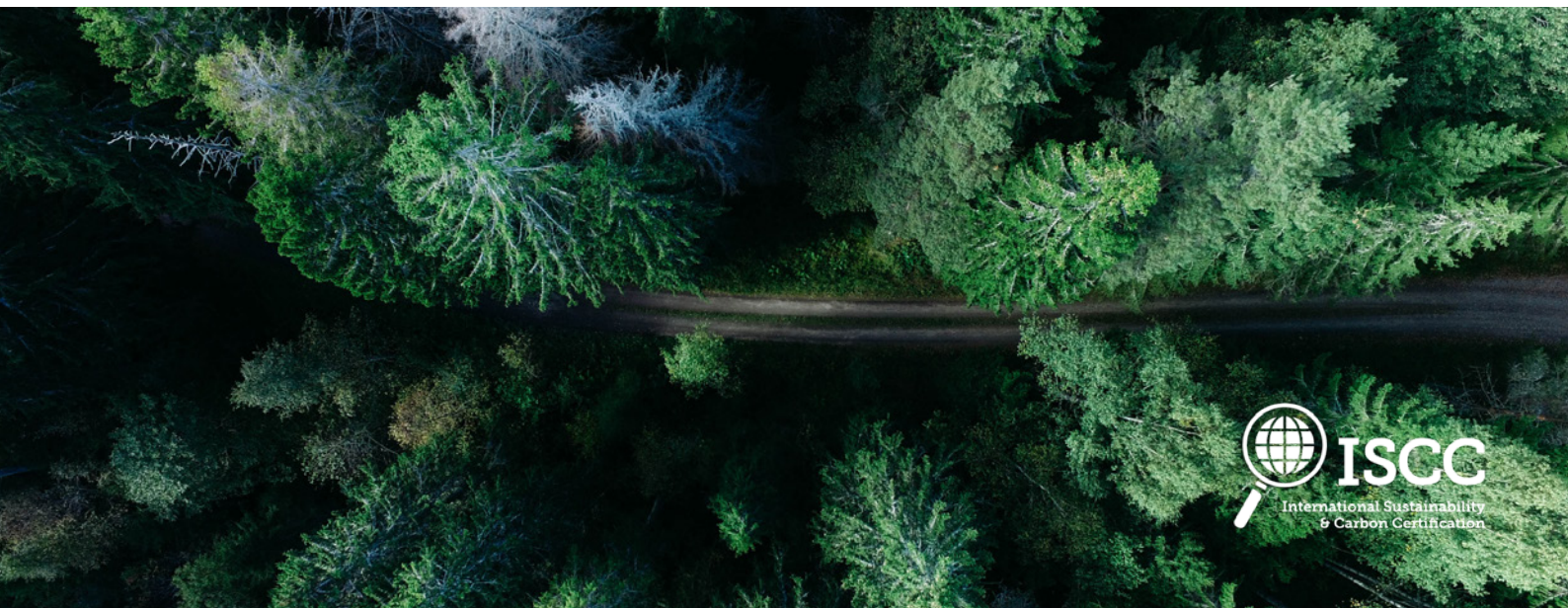
Responsible transitions

The transition to lower-impact materials will not be achieved in a single breakthrough. It requires continuous innovation, transparent reporting, and collaboration across industries.

Research and development at Teijin Aramid is expanding both existing pathways — physical recycling and bio-based feedstocks — while also exploring new routes to reduce reliance on virgin fossil resources. These include scaling circular processes, identifying renewable alternatives, and developing end-of-life solutions that increase recyclability. In every case, performance remains non-negotiable. High-performance fibers must continue to deliver durability, strength, and lightweighting while production evolves toward lower impact.

Progress must also be verifiable. Independent certifications such as ISCC PLUS ensure that claims are transparent, measurable, and resistant to greenwashing.

The shift cannot be achieved in isolation. Customers, partners, and policymakers all play a role in scaling new solutions. Twaron Next® creates an opportunity to collaborate on defining the next generation of high-performance fibers — materials that deliver essential performance within the limits of the planet's resources.



Performance within boundaries

The sustainability transition won't be achieved through a single choice or a quick win. It'll be achieved through steady progress that aligns material performance with planetary limits.

Twaron Next® provides the first proof that this alignment is possible. It combines the durability and lightweighting that industries depend on with lower-impact feedstocks that reduce fossil reliance. Its attributes are verified through independent certification and proven under demanding real-world conditions.

The path ahead remains challenging, but the direction is clear. High-performance materials must be designed to deliver both durability and responsibility. With Twaron Next®, the first step has been taken, and the benchmark for the future is now set.

To explore how Twaron Next® can help align material performance with your sustainability goals, contact our technical team for insights or sample evaluation.

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Twaron Next®