



Driving Circular Transformation: NIO and TÜV Rheinland Close the Loop in Automotive Sustainability



Executive Summary

The partnership between NIO and TÜV Rheinland sets a new benchmark for circular innovation in the global automotive industry. Confronted with the challenge of reducing emissions and resource consumption, NIO — one of China's leading electric vehicle manufacturers — partnered with TÜV Rheinland to build and verify a closed-loop recycling system for vehicle components.

Through TÜV Rheinland's **Recycled Material Verification (RMV)** based on **ISO 14021**, NIO successfully proved that metals recovered from end-of-life vehicles can be reused in the production of new cars. Within just three months, the collaboration verified two metal components — the **wheel hub** and **the aluminum housing of the air-conditioning compressor** — achieving **up to 20% recycled content** while maintaining product quality, safety, and traceability.

The joint blueprint "From Zero to Infinity – 'Car-to-Car Loop' Levers Circular Economy" (August 2025) documents the project's findings and has been recognized by Chinese research and government institutions as a **model for circular economy implementation** in the automotive sector.

Looking ahead, NIO and TÜV Rheinland plan to expand their collaboration to carbon-neutral manufacturing, and

wider circular verification, proving that **sustainability and innovation accelerate each other when trust and transparency meet**.

Project at a Glance

DETAILS

Partners	NIO & TÜV Rheinland
Objective	Verification of recycled materials for circular car manufacturing
Duration	~3 months (2025)
Standard	ISO 14021
Components	Wheel hub, compressor housing
Recycled content	Up to 20% (pilot phase)
Outcome	Certified closed-loop recycling system ("Car-to-Car Loop")
Publication	Whitepaper "From Zero to Infinity", Sep 2025



1. Why Circularity Matters

The automotive sector is under increasing pressure to decarbonize and use resources more efficiently. With its national goals of carbon peaking by 2030 and neutrality by 2060, China is driving a fundamental industrial transformation: from linear production to circular value creation.

For NIO, sustainability is integral to innovation. The company's mission, Blue Sky Coming, captures its ambition

to build vehicles that combine smart technology with environmental responsibility. Yet, one critical question remained:

How can a carmaker truly close the loop – reusing materials from retired vehicles to create new ones?

2. Why NIO Chose TÜV Rheinland

To turn this ambition into measurable reality, NIO needed a partner capable of providing independent, internationally recognized verification. With more than 150 years of experience in quality assurance and sustainability certification, TÜV Rheinland offered exactly that combination of expertise, neutrality, and trust.

ITS CARBON AND ENERGY MANAGEMENT TEAM CHINA LED THE INITIATIVE, DELIVERING:

- the methods of Recycled Material Verification (RMV) based on ISO 14021
- Corporate and Product Carbon Footprint Verification
- ESG reporting and training
- Strategic advisory on circular economy development

NIO chose TÜV Rheinland because of the long-standing expertise in quality, environmental, and sustainability verification.

“Our RMV service helps avoid greenwashing and proves that recycled materials truly meet international standards.”



Penn Ding,
Sustainability Manager,
TÜV Rheinland
Greater China.

FROM CLAIM TO PROOF:

HOW RMV PREVENTS GREENWASHING

TÜV Rheinland's Recycled Material Verification (RMV) service provides independent verification that recycled materials used in products are genuine, traceable, and compliant with international sustainability standards.

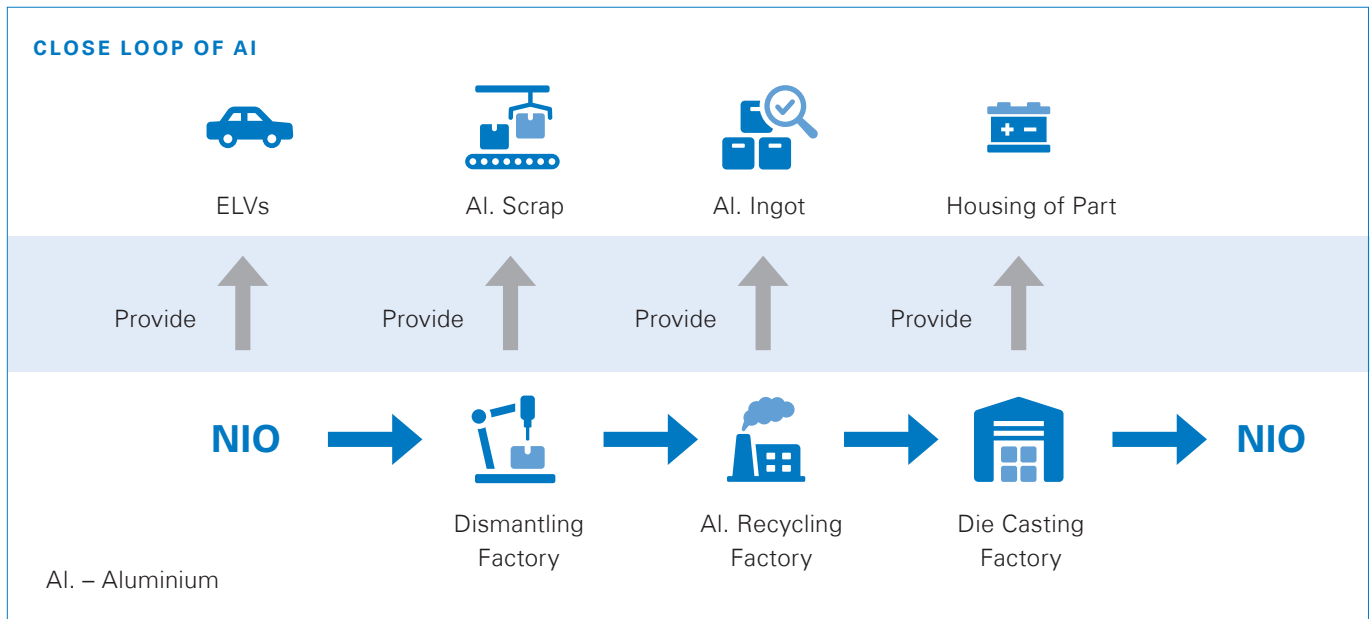
In many industries, “greenwashing” occurs when companies claim to use recycled or eco-friendly materials without objective proof. RMV closes this gap through a combination of technical audits and supply chain verification.

KEY ELEMENTS OF THE RMV APPROACH:

- **End-to-end traceability:** Every material flow is tracked – from dismantling and collection to recycling and reintegration into new components.
- **On-site audits and testing:** TÜV Rheinland experts validate material quality and processing methods on site.
- **Compliance with ISO 14021 and global standards:**
- All verified materials meet internationally recognized definitions of “recycled content.”
- **Independent certification:** Ensures transparency, credibility, and comparability across suppliers and markets.

By applying this structured verification process, TÜV Rheinland helps manufacturers demonstrate real sustainability performance – not just claims.

Building on this RMV methodology, NIO and TÜV Rheinland applied the approach to a real-world pilot – verifying recycled metal components within NIO's manufacturing ecosystem. This marked the first step in translating RMV principles into an operational “car-to-car” recycling model.



3. How the “Car-to-Car Loop” Works

The joint project is one of China’s first verified circular initiatives for metal components, a field that has traditionally focused on plastics. Together, NIO and TÜV Rheinland built a model for a closed-loop recycling system that collects metals from end-of-life vehicles and reintegrates them into new production cycles.

SCOPE AND PROCESS

- Two components were selected for verification: the wheel hub and the aluminum housing of the air-conditioning compressor.
- The verification process, based on ISO 14021, was completed within approximately three months and involved multiple supply chain partners – from dismantling and smelting to recasting and final integration into new vehicles.
- Each stage was audited to ensure that recycled materials met high standards of quality, safety, and traceability.

DIGITAL TRACEABILITY AS ENABLER

- To manage the complex flow of recycled materials, NIO implemented a digital traceability system that monitors material origin and movement in real time.
- TÜV Rheinland auditors cross-checked this data to validate consistency and accuracy, combining sustainability assurance with digital verification.
- This integration of Industry 4.0 tools and circular economy principles now serves as a best-practice reference for data-driven material reuse.

“The recycled metal comes from NIO’s end-of-life vehicles and is reused in manufacturing new ones. Each step – from dismantling to recasting – is tracked and verified to guarantee authenticity.”

Penn Ding, Sustainability Manager,
TÜV Rheinland Greater China

4. What Changed – Results and Industry Impact

The pilot demonstrated that circularity in the automotive sector is not only technically feasible but also measurable and scalable. By closing the loop for metal components, NIO and TÜV Rheinland provided tangible proof that recycled materials can meet the same performance standards as virgin metals – while delivering environmental, operational, and reputational benefits.

ENVIRONMENTAL AND OPERATIONAL RESULTS

The project delivered measurable improvements in both environmental performance and operational efficiency. Within just three months, NIO and TÜV Rheinland achieved up to 20 percent verified recycled content in two key metal components – the wheel hub and the aluminum housing of the air-conditioning compressor.

By replacing virgin aluminum with high-quality recycled material, NIO significantly reduced carbon emissions associated with raw-material extraction and processing. At the same time, the verified use of secondary metals led to greater resource efficiency and cost optimization across multiple supply-chain partners.

The verification process itself proved scalable: the established audit framework can now be applied to additional vehicle components, suppliers, and future product lines. Overall, the pilot showed that verified circularity not only strengthens environmental performance but also enhances production stability, transparency, and trust throughout the value chain.

ENVIRONMENTAL AND OPERATIONAL RESULTS (OVERVIEW)

- 20 % verified recycled content achieved in two key metal components
- Reduced carbon emissions through replacement of virgin aluminum
- Improved resource efficiency and cost savings across the verified supply chain
- Scalable audit framework applicable to future components and suppliers
- Enhanced transparency and trust in material sourcing and production

CULTURAL AND REPUTATIONAL IMPACT

The project inspired a broader shift in mindset across NIO's supplier network.

Training sessions and workshops facilitated by TÜV Rheinland helped partners implement transparent data systems and align their operations with circular-economy principles.

The initiative also strengthened NIO's position as a pioneer of verified circularity in China's automotive sector.

The jointly published blueprint "From Zero to Infinity – 'Car-to-Car Loop' Levers Circular Economy" (August 2025) was recognized by research and government institutions as an industry benchmark for closing material loops.



"Achieving sustainable development relies on the joint efforts of governments, industry organizations, academia, automakers, parts suppliers, and even every individual. The Blue Book on Vehicle Circularity not only documents NIO's long-term exploration in the ESG field, but also serves as a forward-looking roadmap."

NIO



5. Lessons Learned

After the successful pilot, NIO and TÜV Rheinland demonstrated how a circular value chain can become measurable reality. Within just three months, the partners verified two key metal components – the wheel hub and the aluminum housing of the air-conditioning compressor – based on the international ISO 14021 standard. Both components achieved up to 20 percent verified recycled content, confirming that secondary materials can meet the same quality and safety standards as virgin metals.

The project also proved that circularity can be implemented efficiently: verification was completed across several supply chain partners, from dismantling and smelting to recasting, establishing a replicable protocol for other vehicle parts and future suppliers. By substituting virgin aluminum with recycled materials, NIO achieved measurable carbon reductions and increased resource efficiency — setting a new benchmark for automotive sustainability in China.

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VERIFIED RESULTS AT A GLANCE

- **Components verified:** Wheel hub and aluminum housing of the air-conditioning compressor
- **Verification duration:** Approx. three months
- **Standard applied:** ISO 14021 (Environmental labels and declarations)
- **Recycled content achieved:** Up to 20 % verified recycled metal
- **Impact:** Lower carbon emissions, improved resource efficiency, and replicable protocol for future components and suppliers

6. Outlook – Scaling Circular Transformation

Building on the success of this pilot, NIO and TÜV Rheinland are preparing to extend their partnership to new areas of circular innovation. The next steps include carbon-neutral production, and broader circular supply-chain verification to embed circular principles across the entire manufacturing ecosystem.

Their shared goal is to turn the “Car-to-Car Loop” from a single verified project into a scalable industry standard – contributing to China’s vision of a smart, circular, and low-carbon automotive economy. By aligning technological innovation with verified sustainability, the partnership continues to demonstrate that circularity and competitiveness reinforce each other.

Looking ahead, both partners will further integrate TÜV Rheinland’s verification expertise into NIO’s long-term sustainability roadmap. Planned areas of collaboration include carbon-neutral manufacturing processes, and supply-chain circularity audits that ensure every supplier can meet consistent standards of transparency and environmental performance.

The strategic ambition is clear: to scale the “Car-to-Car Loop” from an innovation pilot into a verified industry framework applicable across the global automotive value chain. By establishing measurable criteria and independent assurance mechanisms, NIO and TÜV Rheinland aim to set a precedent for data-driven circular transformation.

“Circular economy is no longer an option — it’s the new productivity engine for the automotive industry. Together with NIO, we’re proving that sustainability and innovation go hand in hand.”

Penn Ding, Sustainability Manager,
TÜV Rheinland Greater China

DID YOU KNOW?

The **ISO 14021** standard defines internationally accepted requirements for self-declared environmental claims such as “recycled content” or “recyclable.”

By basing verification on this standard, TÜV Rheinland ensures transparency, comparability, and global recognition of NIO’s achievements in circular innovation.

LEARN MORE

Find out how TÜV Rheinland supports organizations on their journey toward verified sustainability and circular transformation: www.tuv.com/sustainability

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