Evaluating the path to a sustainable tire industry: unlocking the potential of recovered carbon black

Driven by ambitious environmental objectives, major tire companies are increasingly adopting this sustainable substitute for carbon black to decarbonize their production chain and get the most out of end-of-life tires

How should players in the carbon black value chain integrate this substitute into their business model and jointly capture the value of this untapped resource?

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Executive summary

Carbon black and its recently developed substitute, the recovered carbon black

Carbon black (CB) is a raw material obtained from the incomplete combustion of heavy petroleum products, also referred to as virgin carbon black (vCB). It is commonly used in black-colored day-to-day use products such as car tires. Its substitute, recovered carbon black (rCB), produced via thermal pyrolysis, addresses two opportunities. First, it provides a sustainable way of recycling used tires from which rCB is derived. Second, it decarbonizes tire production, as rCB production generates five times less carbon emissions than conventional fossil-fuel based production (vCB).

Global demand for carbon black in 2023 amounts to ~18 Million tons per annum. The substitution potential of rCB is expected to grow over the next few years

The European carbon black market accounts for nearly ~15% of global demand, estimated at ~18 Mtpa in 2023. rCB is estimated to have the potential to substitute 10-20% of traditional uses, limited by its relatively inferior quality for 1-to-1 replacement in specific use cases. Given current consumption, this could represent 250-550 thousand tons per annum in Europe alone, translating in several hundred million euros in value. Ongoing R&D efforts actively aim at improving production processes and even upgrading rCB to make it suitable for a wider range of applications.

A new ecosystem driven by a commitment on sustainability is being shaped in the end-of-life tire supply chain

The initial carbon black supply chain involved three players: petroleum suppliers & oil refiners, vCB producers, and end-users which mainly include tire manufacturers. The introduction of rCB reshaped this supply chain, adding three main players: rCB producers and upgraders, end-of-life tire suppliers and regulatory authorities. Numerous investment funds and major industry players are early-movers active in the emergence of this new rCB market (e.g. Niersberger, Antin Infrastructure Partners).

Several technological and regulatory barriers still need to be tackled to reach large-scale deployment

The main challenges for rCB producers include ensuring consistent product quality, addressing the still immature state of pyrolysis technology, overcoming the industry's slow adoption of new products, and establishing standardization. The introduction of the ASTM committee D36 in 2017, with its rating system for rCB quality, marks a positive shift toward addressing these challenges and promoting coordination within the industry.

Despite the ambition of rCB producers and strategic partnerships with major industry names, announced capacities are not expected to meet medium-term demand, leaving a gap for investors

Today, a dozen rCB players produce together ~20 ktpa of rCB. The three largest producers today are Circtec (in partnership with Birla Carbon) alongside Pyrum Innovations AG and Bolder Industries. In March 2023, Swedish company Enviro, supported by Michelin and Antin Infrastructure Partners, announced an ambition to reach a processing capacity of ~38 ktpa of rCB by 2030.

However, the current installed capacity (~20 ktpa) and announced additional capacity (~232 ktpa) fall short of meeting the estimated demand for recovered carbon black in Europe (250-550 ktpa).

The current state of the industry poses numerous questions for all actors involved in order to ensure its success, in particular the ability to secure long-term offtake agreements and the successful upscaling of production capacities thus reducing both commercial and technological risks for investors.

Agenda

1. Carbon black and its recently developed substitute, recovered carbon black: key facts
2. Global demand for carbon black is expected to reach ~18 million tons per year by 2023. The substitution potential of rCB is expected to increase over the next few years
3. A new ecosystem, driven by a commitment to sustainable development, is taking shape in the end-of-life tire supply chain
4. A number of technological and regulatory hurdles still need to be overcome before rCB can be deployed on a large scale
5. Despite the ambition of rCB producers and their strategic partnerships with major industry names, announced capacities are unlikely to meet demand in the medium term, providing an opportunity for new producers to position themselves
6. Conclusion: Market potential deserving the attention of a wide range of players

1. Carbon black and its recently developed substitute, recovered carbon black: key facts

- **Carbon black (CB) is a raw material derived from heavy petroleum products, referred to as *virgin carbon black* (vCB), that can be found in most black-colored day-to-day use objects such as car tires.**
- **Recovered carbon black (rCB), a derivative of conventional fossil fuel-based carbon black (vCB), presents a dual opportunity by offering a sustainable solution for recycling the 1.5 billion discarded tires globally and by significantly reducing carbon emissions in tire production when substituting rCB to vCB by a factor of five.**
- **There are several methods of producing rCB. They are generally based on three main stages, resulting in the recovery not only of the rCB but also of the steel and oil contained in the tires.**
- **The difference in the manufacturing process and the raw materials needed to produce CB, (petroleum oils for vCB vs. End-of-Life Tires for rCB) gives rCB price stability but lower product quality and therefore fewer applications.**

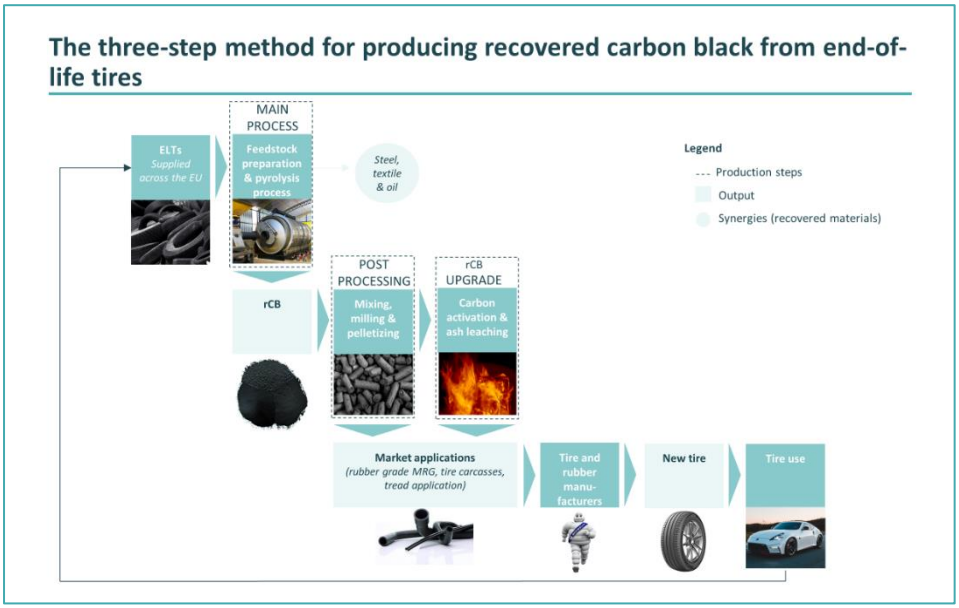
Carbon black is a raw material produced from the incomplete combustion of heavy petroleum products, commonly referred to as ***virgin carbon black***. It has widespread applications in rubber, paints, and coatings, and is a key component in various everyday items like charger cables, phone covers, and pen ink. One prominent application of carbon black is in **car tires**, where it serves both as black pigment and a filler material.
Its substitute, *recovered carbon black* (rCB), developed through a thermal pyrolysis process, addresses two opportunities.

- First, **it provides a sustainable way of recycling used tires** from which rCB is derived. Individual car tires have a lifespan of around five years (50,000 km) and contribute significantly to the global waste stream. With over 1.5 billion discarded annually, they constitute a large and available untapped potential resource. In Europe, in 2019, 95% of the 3.5 million tons of passenger ELTs (End of Life Tires) were collected. This high collection rate is attributed to the ELTs management system introduced in Europe in 2006, which places responsibility on tire manufacturers for ELTs collection and recycling. The thermal pyrolysis technology developed by several tire producers and start-ups repurposes end-of-life tires by producing rCB and thereby creating a sustainable tire recycling loop.

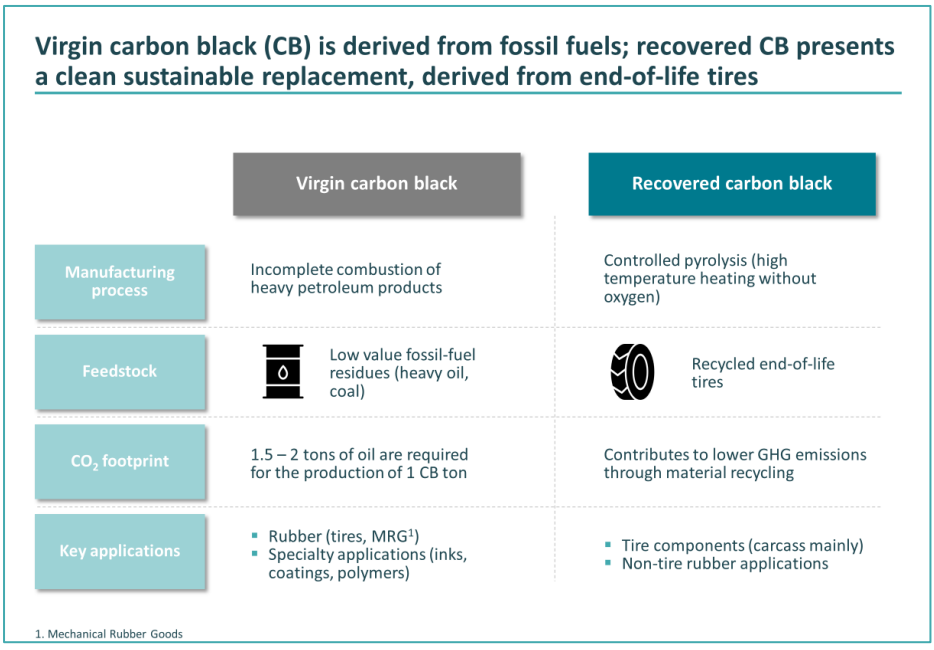
- Second, **recovered carbon black is a lever for decarbonizing the tire production chain.** A vehicle tire contains on average 30% carbon black. rCB production generates five times fewer carbon emissions than conventional fossil fuel-based production (vCB). This generates 10 kg of CO_2 when produced from virgin carbon black, compared to only 2 kg of CO_2 when produced from recovered carbon black. This move towards sustainability has been somewhat accelerated by the embargo in Russia due to the invasion of Ukraine, underscoring the strategic importance of rCB in ensuring supply chain resilience and supporting the industry's pivot towards more sustainable production practices. As of July 2024, EU will ban carbon black imports from Russia (30% of EU imports).

Recovered Carbon Black (rCB) Production and comparison with Virgin Carbon Black (vCB):

- The production of rCB from end-of-life tires is a sustainable three-step method. Initially, the pyrolysis process involves shredding tires to extract rubber, which is then heated to 400°C-800°C in an oxygen-free environment (pyrolysis), yielding steel, char, and gases. The char undergoes milling and pelletizing to create rCB, while uncondensed gas fuels the process, making it self-sustaining. An optional upgrade via carbon activation and ash leaching enhances rCB for broader applications.



- Virgin carbon black (vCB) differs from rCB in raw materials and manufacturing. Derived from fossil fuels, vCB has nearly 100% carbon content and is suitable for specialty applications like toners and polymers due to its physical properties such as stability and solvent resistance. By contrast, rCB contains 80-85% carbon and 15-20% ash, affecting its quality and limiting its use to different applications compared to vCB. However, rCB offers cost benefits, being much less impacted by oil price volatility.



- In essence, rCB provides a more sustainable and cost-effective alternative to vCB, although it cannot completely replace vCB in all applications due to differences in physical properties.

2. Global demand for carbon black represents in 2023 ~18 Mtpa. The substitution potential of rCB is expected to grow over the next few years

- **The European carbon black market accounts for nearly ~15% of global demand, estimated at ~18 Mtpa in 2023.**
- **rCB is estimated to have the potential to substitute 10-20% of traditional uses (limited by its relatively inferior quality) representing 250-550ktpa of recovered carbon black in Europe.**
- **R&D efforts aim at improving production processes and upgrading rCB to make it suitable for a wider range of applications and to overcome the current segmentation of rCB and vCB applications.**

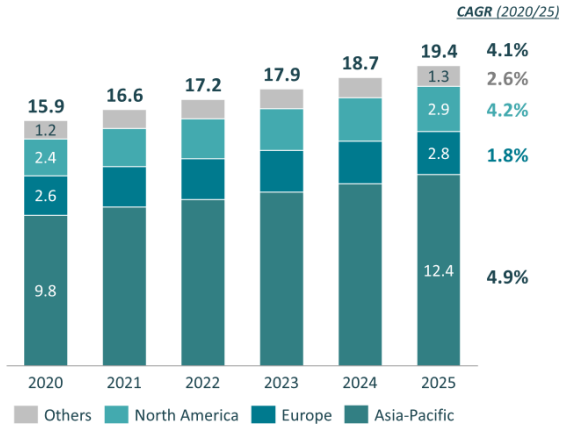
The estimated **global market size for carbon black in 2023 is ~17.9Mtpa**, with a value of around $18-20b. This size is primarily driven by industrialization in the Asia-Pacific (APAC) region and a strong automotive industry in North America. In Europe, the demand for carbon black is estimated at ~2.7M tons, representing ~$3b and 15% of the overall demand.

The global carbon black market in 2023 represented ~17.9Mtpa (~$19bn), expected to grow annually ~4% until 2025

Carbon black market macro-overview

Global Carbon Black market forecast

Million tons per annum (Mtpa), 2020 - 2025



Key takeaways

- The global Carbon Black demand in **2023 is estimated at 17.9M** tons (~$18-20bn[1]) and it is expected to increase at a rate of **4.1% CAGR worldwide**, mainly driven by **growing industrialization in APAC and strong automotive industry in in North America**
- **Asia Pacific** will experience **75% of the overall CB growth**, due to increased number of tire manufacturing plants being installed to meet **growing rubber and automotive industry** needs, mainly in India and China
- The demand in **Europe** will stay relatively flat, with a focus on **domestic rubber products** and **specialty applications** for higher value products

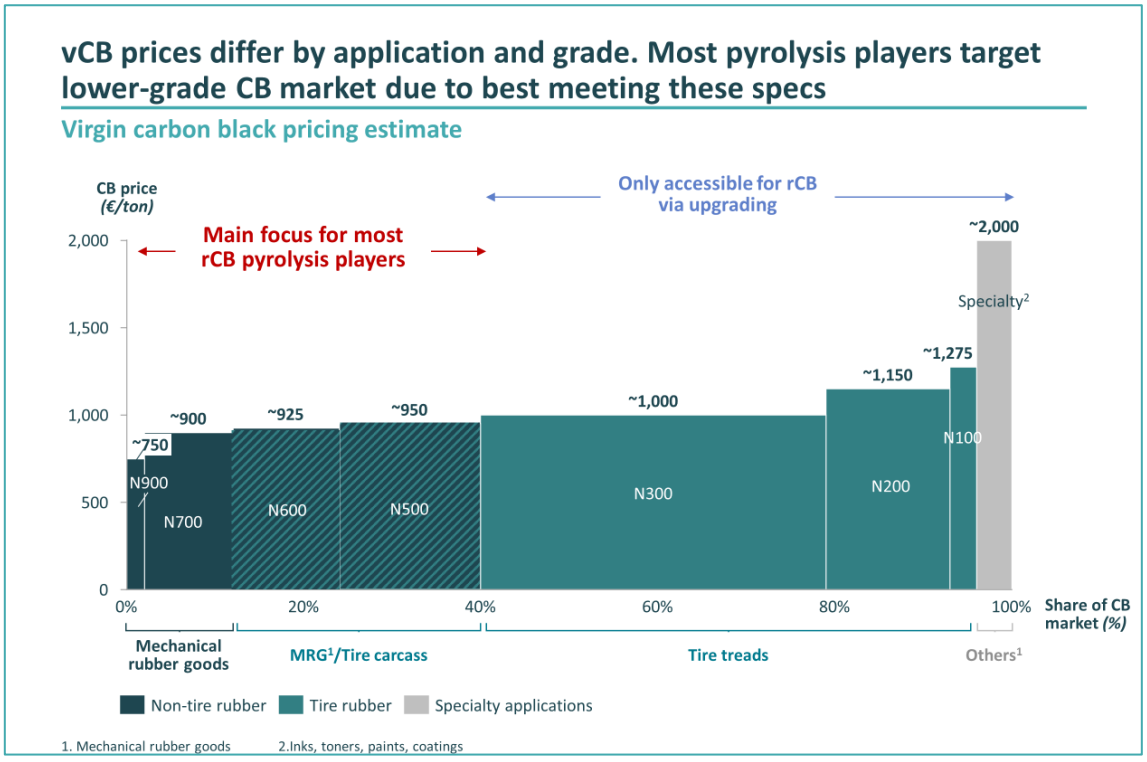
1. Based on Redeye Research 2018 estimation, adjusted for volume increase and price decrease in 2023

Recovered carbon black serves as a sustainable alternative to virgin carbon black and has the **potential to replace 10-20% of virgin carbon black** (due to its inferior quality), equivalent to 250-550ktpa of rCB in Europe(~$265-530M).

However, this substitution is constrained by the lower quality of rCB compared to vCB. Ensuring **product consistency and quality is the primary challenge** faced by rCB producers. Product consistency is the key client requirement as it enables the seamless integration of rCB into industrial processes. A lack of control over feedstock can lead to substantial variations in rCB output quality. Moreover, supplying high-quality rCB (fiber/debris-free) constitutes another challenge as it determines the suitability for specific applications, for example a too-high level of impurities (e.g. ash and silica) can prevent it from being used for tire treads applications.

To address these challenges, stringent control over raw materials, extensive laboratory testing, and new technology development are essential. **Ongoing research aims to enhance production processes and improve rCB quality** to expand its range of applications. Notably, recent developments indicate a shift towards the use of sustainable materials in tires. For instance, Michelin's MotoE 2022 tires incorporated 40% sustainable materials while meeting safety and performance criteria, including speeds of up to 250 km/h. This serves as an example of the ongoing improvement in the quality of rCB.

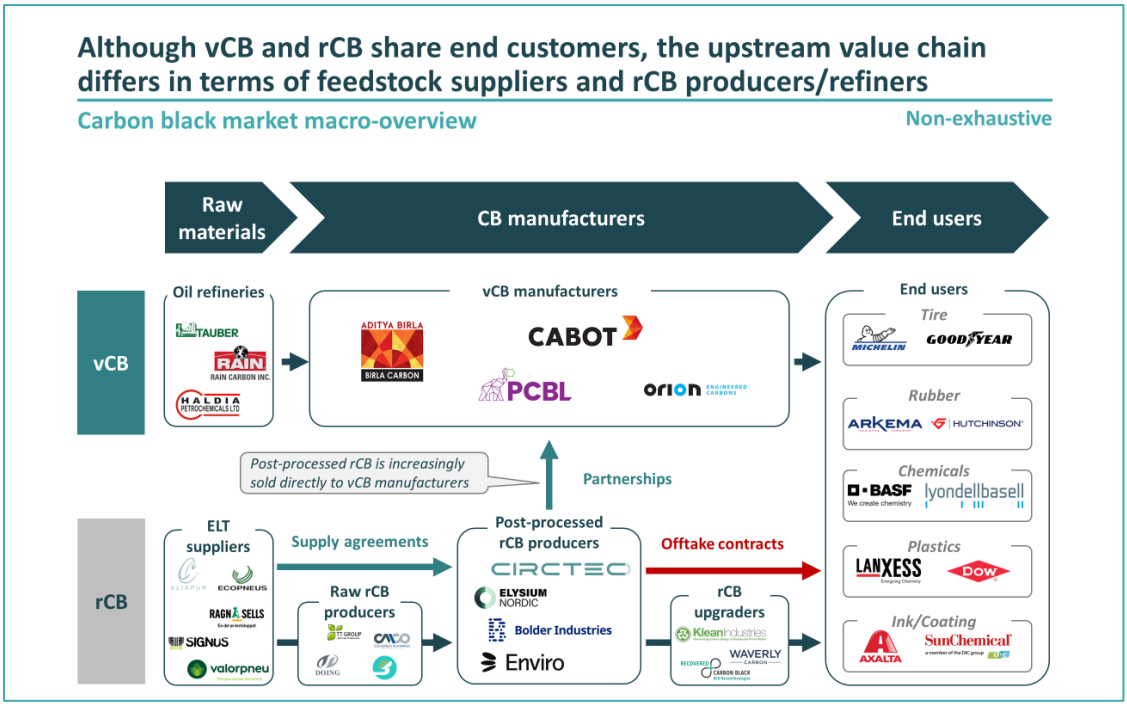
In 2017, the ASTM committee D36 established a rating system for the quality of recovered carbon black between N900 and N100 (from worst to best quality). **Both rCB and vCB can be employed in mechanical rubber goods and tire carcass applications** (N900<->N500). However, **pure rCB** can only be utilized in **tire treads** (N300<->N100) if it undergoes **upgrading processes**. Specialty applications such as toners, inks, or polymers (rated above N100) are still not accessible to rCB given the high-quality requirements.
Overall, **the application spectrum for rCB is expanding**, thanks to advancements in rCB upgrading and enhancement processes, **gradually bringing it closer to more demanding vCB applications**.



3. A new ecosystem, driven by a commitment on sustainability, is being shaped in the end-of-life tire supply chain

- **The carbon black supply chain, which initially comprised oil refiners, vCB producers and end users (tire manufacturers), has become more complex, now including tire suppliers, rCB producers and upgraders.**
- **rCB producers and upgraders comprise raw, post processed and refined rCB producers, whose mission is to create and enhance rCB from ELTs for diverse applications.**
- **In addition, non-profit end-of-life tire recyclers, funded by tire manufacturers, and waste management actors provide raw material to rCB producers.**
- **Several public bodies spearhead the enforcement of waste management practices, like the EU DG Environment, primarily responsible for policy on ELT management**
- **Major industry players and investment funds, including Niersberger and Antin Infrastructure partners, actively engage in the emerging rCB market through partnerships and joint ventures.**

The **carbon black supply chain** comprises various stakeholders, and recently, with the emergence of rCB and the interest it has generated, it has become more complex. Originally, the end-users of carbon black – tire, rubber, chemical, plastics, and ink producers - purchased vCB from manufacturers such as Cabot, Birla Carbon, and Orion, who source their raw materials from oil refineries. The introduction of recovered carbon black reshaped this value chain, adding three main players: raw material suppliers, carbon black producers and upgraders.



Recovered Carbon Black producers can be categorized into three groups:

- **Raw rCB producers** supply low value tire char, which requires post-processing and refining to address the carbon black market.
- **Post-processed rCB producers** can be further classified into two types: integrated players owning the pyrolysis technology for oil and rCB recovery; and pure operators who own the

plant they operate but obtain a license from technology providers to carry out the manufacturing process.

- **rCB upgraders** acquire post-processed and raw rCB and utilize carbon activation and ash leaching methods to enhance rCB quality, producing high-value specialty-grade rCB.

Two strategic partnerships models have emerged **to enhance access to rCB for end customers**, including Michelin, Goodyear and Pirelli, who are also consumers of vCB.

- First, **collaborations between vCB and rCB manufacturers** have allowed rCB players to leverage vCB players' market access, while vCB players can align with sustainability goals. The long-term agreement between Birla Carbon and Circtec since 2021 illustrates this type of partnership.
- Second, **commercial partnerships between rCB producers and end-users** have been established to facilitate co-development, better align with customer requirements, and importantly, secure rCB offtake at least during initial market introduction. An example of such a partnership is the collaboration between Swedish rCB manufacturer Enviro Systems backed by Antin Infrastructure Partners and Michelin. **Antin and Enviro entered into the joint venture in March of 2023 to build a series of plants in chosen European geographies**. Antin is a majority shareholder of the JV, Michelin a minority shareholder and Enviro has an option to become a significant minority shareholder. Michelin supports the JV by signing multi-year supply agreements regarding recycled materials from the first plants established. **The JV signed multi-year agreements for the supply of end-of-life tires and offtakes for the recovered carbon black and oil products (5-10 years secured offtake contracts with leading tire manufacturers such as Michelin, Nokian Tyres, Preem, etc.).** They announced in February 2024 the final investment decision for a first plant in Uddevall (Sweden).

In addition to rCB producers, the carbon black value chain now incorporates **end-of-life tires recyclers**, who supply rCB producers with the necessary raw materials. In Europe, these recycling entities are non-profit organizations funded by tire producers and importers. They collect an eco-contribution, which in 2023 amounts to €1.40 per processed car tire, deducted from the initial tire sale.

To fulfill their obligation regarding end-of-life tire management, major tire manufacturers such as **Bridgestone**, **Continental**, **Goodyear**, **Pirelli** and **Michelin** have established non-profit organizations in the countries where they operate to oversee the collection of used tires. Examples of these organizations include **Aliapur** in France (founded in 2003), or **Ecopneus Scpa** in Italy (founded in 2011). This efficient collection system, with a collection rate of nearly 95%, was established in response to European directives making public actors in charge of regulation another important player of the carbon black value chain. One of the most influential public entities overseeing this chain is the **European Union's DG Environment** which has introduced various **directives over the years**. In 1999, it prohibited the landfilling of used tires; in 2000, it implemented measures to prevent the generation of waste from vehicles and their components, and in 2006, it introduced the ***Extended Producers Responsibility scheme,*** making tire producers responsible for managing used tires.

Waste management companies such as **Veolia** and **Suez** play a crucial role in this tire collection process, collaborating with garages, dedicated recycling centers, public landfills, and gas stations to supply used tires to rCB producers.

Marubeni also entered the rCB market in February 2024 through an investment in RCB Nanotechnologies, a Munich-based company currently constructing a rCB chemical purification plant

to produce recovered Carbon Black to be used in tires. Marubeni plans to consolidate and structure a sustainable value chain from rubber raw materials to tire.

Finally, the interest from various **investment funds** in this emerging substitute, coupled with **strategic partnerships** involving prominent industry players, highlights the growing importance of this new product. For example, the post processed rCB producer **Klean Carbon** has collaborated with **Niersberger Group**, Europe's leading biogas engineering and construction company, to develop commercial scale pyrolysis technology within the European Union. Furthermore, **Antin Infrastructure Partners** investment fund has formed a joint venture with **Enviro Systems**, with support from **Michelin** to create the world's first large-scale tire recycling group. Lastly, the **BlackCycle project**, an initiative coordinated by Michelin and funded by the EU, aims to establish a circular tire economy in Europe.

The commitments of various tire manufacturers on recycled and sustainable materials will increase demand for rCB, and interest from many other new entrants:

- Michelin and Bridgestone shared in a joint whitepaper the goal of 100% sustainable materials in tires by 2050
- Fabien Gaboriaud, Senior Vice President of Sustainable Materials & Circularity at Michelin shared a goal of *"40% recycled and renewable sustainable materials by 2030"*

4. Several technological and regulatory barriers still need to be tackled to reach large scale deployment of rCB

- **One major obstacle relates to the technology readiness level of the different pyrolysis technologies which is often too immature for large-scale commercialization (TRL 7-8).**
- **The industry's slow-paced adoption of new products constitutes another obstacle to the expansion of rCB.**
- **The lack of standardization prevents much-needed coordination and common definitions for standardized grades and norms for the industry. This has been changing since 2017 with the creation of the ASTM committee D36 which established a rating system (from N900 to N100) to evaluate rCB quality and facilitate exchange between producers and buyers.**

While the recovered carbon black market appears to be a promising and dynamic market, **several challenges hinder its expansion**, primarily due to its not yet full technical maturity.
Most pyrolysis technologies are considered demonstration systems (TRL-7, on the Technological Readiness Level scale) or first-of-a-kind commercial system (TRL-8), which is still too immature for large-scale commercialization (requiring TRL-9).

The **industry's slow-paced integration of rCB in new products** constitutes another obstacle to the expansion of rCB. Indeed, the process of developing new products with recovered carbon black or integrating it into existing ones has experienced a long lead time, often taking a decade or more, as seen in the tire industry. Corporate sustainability initiatives, such as **Michelin's** commitment to incorporating 40% recycled and sustainable materials in the production of new tires by 2030, and 100% by 2050, should accelerate the adoption of recovered carbon black in the rubber industry as a viable substitute for virgin carbon black.

Numerous challenges remain for rCB primarily due to rCB technical immaturity, however the barriers are expected to soften in the near future

rCB market barriers

rCB barriers	Barrier strength	Description	Expected evolution
Quality inconsistency		▪ Lack of feedstock control can cause large variability in rCB output quality	▪ Strict feedstock control and state-of-the-art testing laboratory key to supply consistent products
Low perceived product quality		▪ Impurity levels not on-par with virgin CB (high ash and silica content)	▪ Technology development and better feedstock control
Industry slow to adapt to rCB		▪ Historically, developing new products or integrating rCB into existing ones has had long lead time (10 y for the tire industry)	▪ Acceleration of new rCB qualification process and corp. sustainability push
Technology immaturity		▪ Main pyrolysis technologies are considered TRL[1] 7-8, with process to date primarily focused on oil recovery	▪ More experience expected as new capacity is brought online post 2022
Lack of standardization		▪ No existing industry standards in terms of testing and product classification for rCB	▪ ASTM committee D36 set up to develop new industry standards for rCB

1. Technology readiness level (TRL7 – Demonstration system; TRL8 – First of a kind commercial system; TRL9 – Commercially mature)
Source: market interviews, Wolfersdorff Consulting Berlin, Emerton analysis

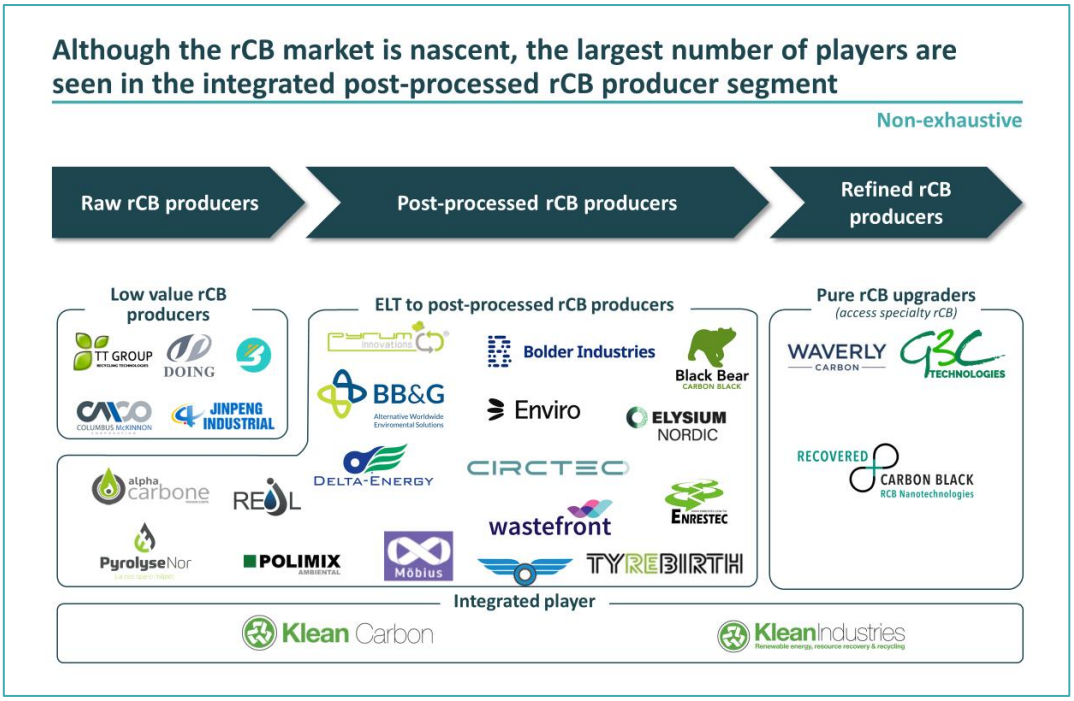
Low → High

Finally, there is a **lack of standardization** in terms of testing and product classification for rCB. In 2017, **ASTM committee D36** was established to outline differences between char, carbon black, raw recovered carbon black and recovered carbon black. Additionally, subcommittees were formed to develop **quality and safety standards** for recovered carbon black products as well as terminology, guidelines, practices, and testing methods. This led to the creation of a rating system that categorizes the quality of recovered carbon black on a scale from N900 to N100, determining its suitability for various applications. While this rating system aids in **facilitating the exchange between producers and buyers**, the numerous distinctions within the N900 and N100 range can complicate the system and could slow the development of standardized products.

5. Despite the ambition of rCB producers and their strategic partnerships with major industry names, announced capacities are not expected to meet demand in the medium term, leaving a gap for new producers to position themselves

- **Today, a dozen rCB producers, both pure players and integrated ones, produce together ~20 ktpa of rCB.**
- **The three largest producers today are Circtec in partnership with Birla Carbon, alongside Pyrum Innovations AG and Bolder Industries. Recently, in March 2023, Swedish company Enviro, aided by Michelin and Antin Infrastructure Partners, announced an ambition to reach a processing capacity of 1,000 ktpa of recycled tires in the long run, with additional capacity expected to reach ~70 ktpa rCB by 2030 in Europe**
- **However, the current installed (~20 ktpa) and announced additional capacity (~232 ktpa) fall short of meeting the estimated demand for recovered carbon black demand in Europe (250-550 ktpa).**

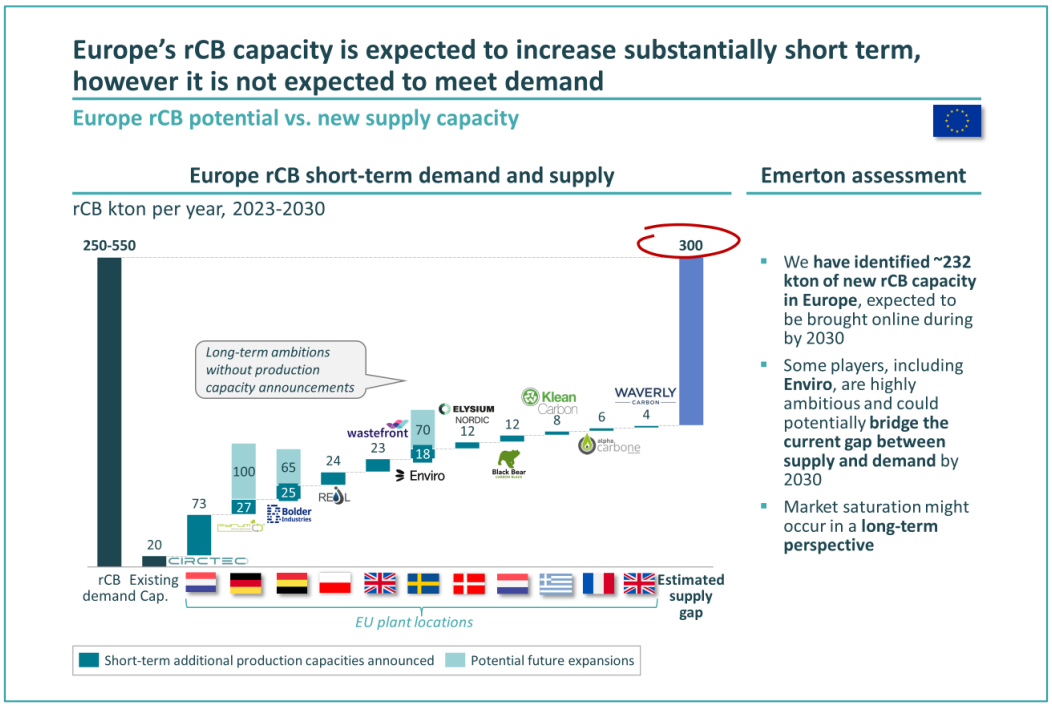
Today, in Europe, around twelve players are trying to meet the demand for rCB. Together, they have an **operating production capacity of ~20 kton per year**. The largest producer today is **Circtec,** an integrated player which has formed a strategic partnership with a major vCB producer, **Birla Carbon**. Another prominent rCB producer is the listed company **Pyrum Innovations AG**, which recently joined forces with **BASF SE** (the leading chemical group) and **Suez** (the French water and waste management specialist). **Pyrum** is positioning itself as a significant actor in the rCB market, with the goal of expanding its production capacity by four by 2030.



Another notable player in rCB production is the Swedish company **Enviro Systems**, whose technology has been acquired by Antin Infrastructure Partners, and is aiming to build **five factories in**

Europe by 2030 with the goal of managing one-third of used tires in Europe resulting in an annual production of nearly ~70 kton of rCB. Enviro has also set an **ambitious target of processing 1,000 kton of recycled tires**, around **300 kton of which would be converted into rCB** although they have yet to outline a specific industrial plan at this stage.

The pure players include the Danish company **Elysium Nordic** and the English company **Wastefront**. While their facilities are still in the development phase, they are projecting increasing production capacities. **Elysium Nordic** anticipates an annual production capacity of 12 ktpa while Wasterfront is aiming for around 23 ktpa.



Despite the presence of these promising companies and numerous partnerships, the **current supply of rCB falls significantly short** of the existing demand in Europe. The current supply stands at approximately ~20 ktpa while demand ranges from 250-550 ktpa. The **potential future expansions** of the most ambitious players such as **Enviro could potentially bridge the supply and demand gap.**

It is essential to acknowledge the two significant expectations for the future trajectory of the rCB sector. Having initially started at a gradual pace, the industry is now advancing into the stage of industrialization and commercialization, with momentum now gathering strongly. A strong interest is anticipated as the sector expands, as reflected in the emergence of long-term commitments and offtake agreements, which indicate a market ripe for the mass deployment of technology.

Given the increasing demand dynamics, the capacity of existing facilities combined with the announced short-term additional capacities and long-term ambitions fall short of meeting the demand. This discrepancy presents a compelling opportunity for new market entrants and investors. The immediate challenges that must be tackled include establishing a supportive framework for sustained engagement and achieving the technological maturity necessary for broad-scale deployment, both essential for the sector's full potential to be realized.

The outlook is promising as advancements in technology and growing market interest pave the way for a greener, more sustainable industry.

6. Take-aways: clear potential deserving attention from a wide range of players

The recovered carbon black market is still in its infancy and shows promising signs of growth in the medium-term, as it is one of **the main decarbonization levers for the tire industry**. Currently, **market players do not share a common position on rCB**: some are actively striving to deploy capacity and be early movers in the market, others have set ambitious decarbonization targets including (but not limited) to carbon black production, transport, and use. Finally, some actors are still reluctant to position themselves, given the relative uncertainty that lies ahead.

The industry is expected to take off once the main regulatory and industrial challenges are lifted, especially via **market standardization** and **clear sustainability targets and mechanisms**, where most of the efforts are being dedicated today.

In view of the rCB market's potential, players wishing to enter this market should not lose sight of a few key considerations.

For **ELT suppliers** and **waste management companies**

- Who will be the pioneers of this emerging market in which regulation plays a crucial role?
- What are the most effective means of capturing sufficient volumes of ELT's?

For **technology providers** and **rCB manufacturers**

- What are the key purchasing criteria and winning strategies to commercialize rCB effectively?
- Which emerging technologies or innovations could disrupt the rCB industry?
- How to manage the challenges of securing a consistent feedstock of ELTs, and what strategies should be put in place to mitigate supply risks?
- What are the strategic prerequisites needed to support the production scale-up much needed by the industry?

For **conventional carbon black producers**

- What impact has the rCB revolution on conventional CB producers' competitiveness and product portfolio?
- How can potential partnerships with ELT suppliers, rCB manufacturers and off-takers be structured and leveraged?
- Which rCB players are relevant and open to a partnership?

For **tire manufacturers**

- What are the main adoption trends of recovered carbon black in future products, and key factors influencing the decision-making process?
- What quality and performance standards are required from rCB manufacturers to enable effective substitution and integration into future products?

For **regulators**

- How can regulatory frameworks be optimized to facilitate the sustainable growth of the rCB market?
- What mechanisms can be implemented to ensure compliance with sustainability targets and market standardization?