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Pyrum Innovations AG

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General Presentation 2024

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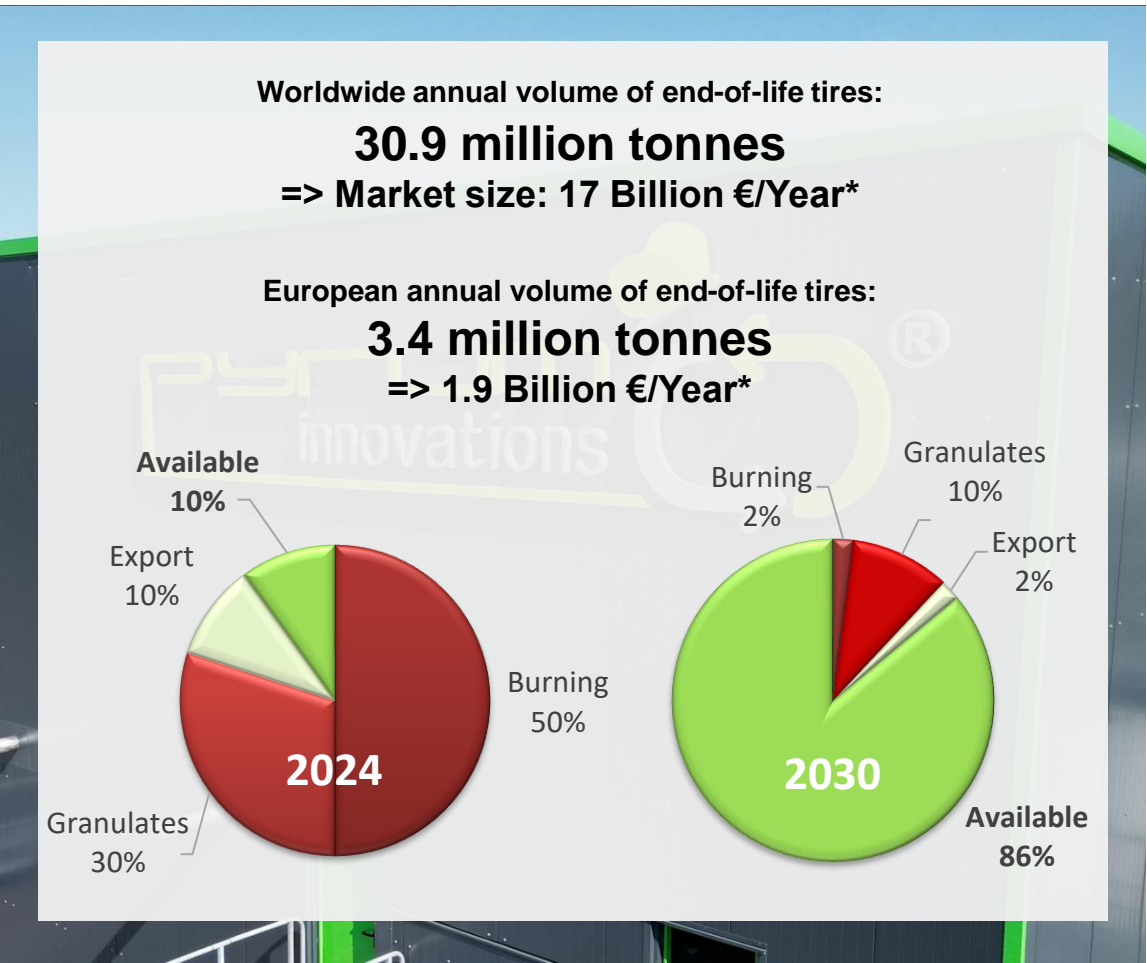
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Global End-of-Life-Tire (ELT) market accounts for approx. 30.9 mt p.a.

... as tightening regulatory environment forces countries and corporates to take action

Global ELTs in 2019



* Base on 100 €/ton Gatefee, 250 €/ton Steel, 4 €/ton textile, 450 €/ton Pyrum Oil and 850€/ton rCB

Tightening regulatory environment

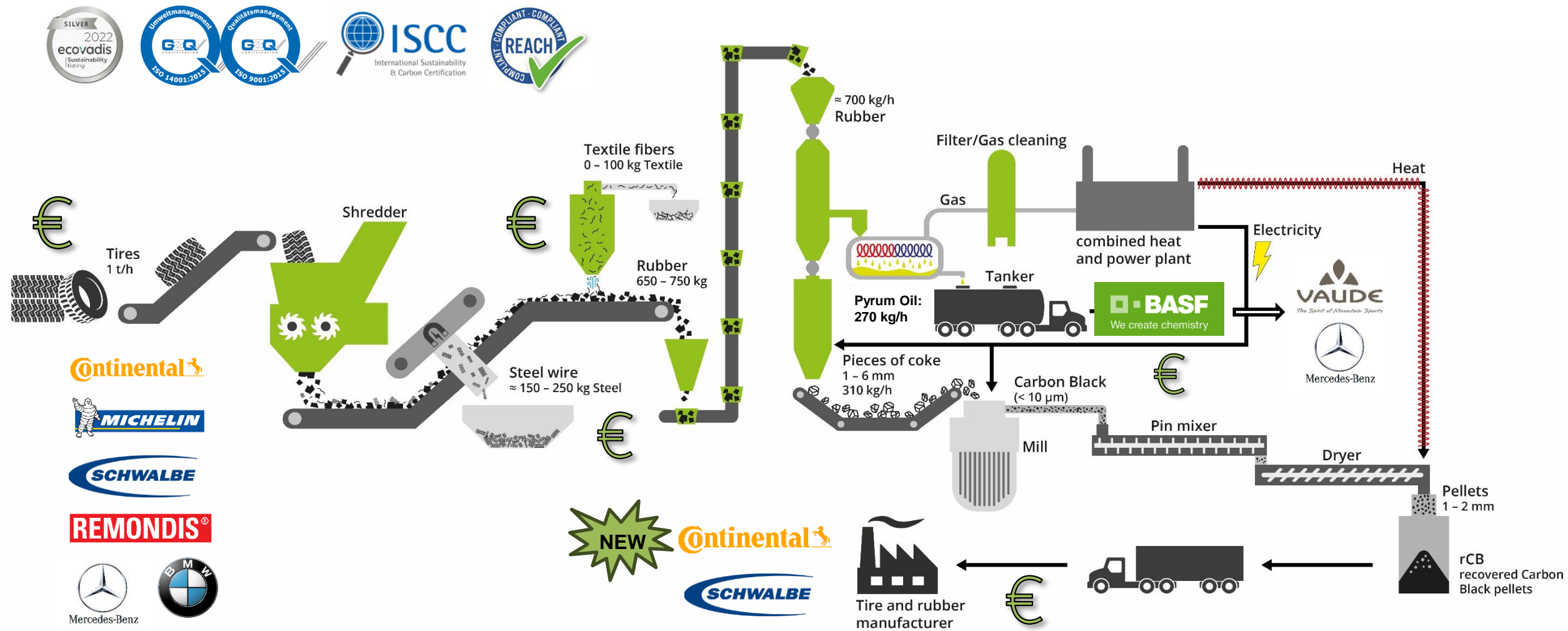
- Landfill Ban**
 The landfill of End-of-Life-Tires and shredded tires is prohibited
- Ban on incineration**
 Prohibition of burning rubber products
 Prohibited the use of shredded tire granulate outdoors
- Ban of Rubber granulates**
Summer 2023: EU has decided to forbid the use of rubber granulates for certain uses (microplastics) => 30 % of used tires are used for this purpose
- OEM Audits are requiring circularity grades**
 The market is pushing for new raw materials
- Increasing cost of CO₂**
 Burning tires becomes more and more expensive



Pyrum offers patented technology with strong value proposition...

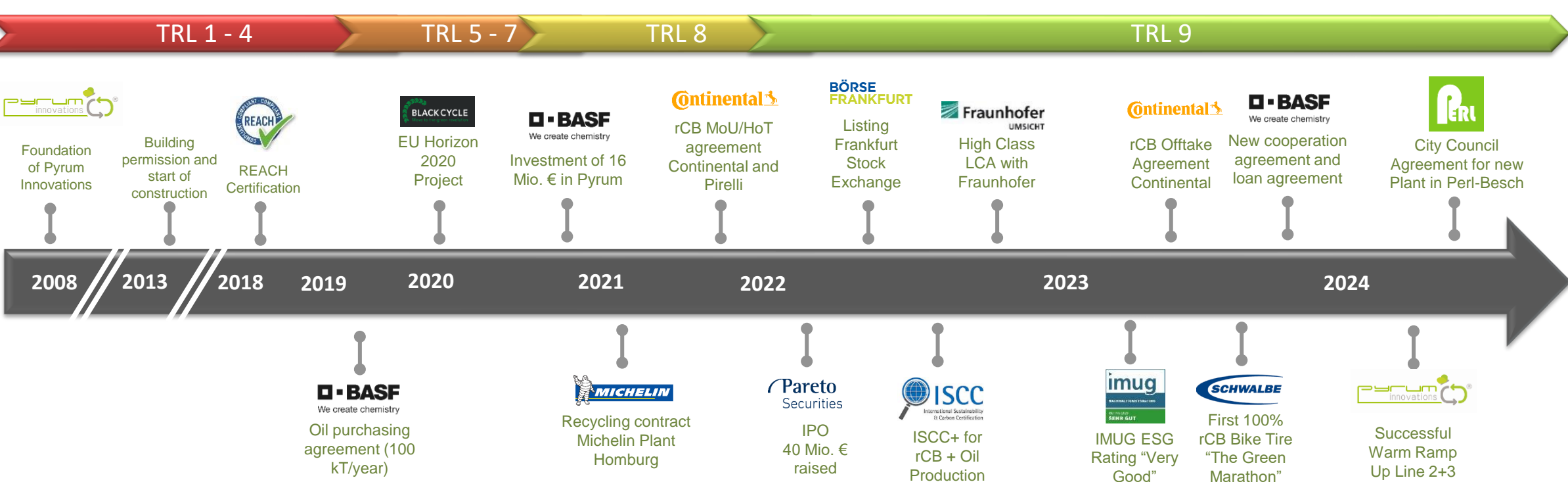
... converting rubber into several high value chemical products – thermolysis oil, carbon and gas

How Pyrum creates value



Our history in short with TRL (Technical Readiness Level)

Key milestones



Latest success

JDA and rCB Offtake signed with Continental

50 Mio. € new Loan Agreement for Roll Out financing

Schwalbe "The Green Marathon" first 100% rCB Tire

Imug ESG Rating finalized: "Very Good"



LCA: Life Cycle Assessment

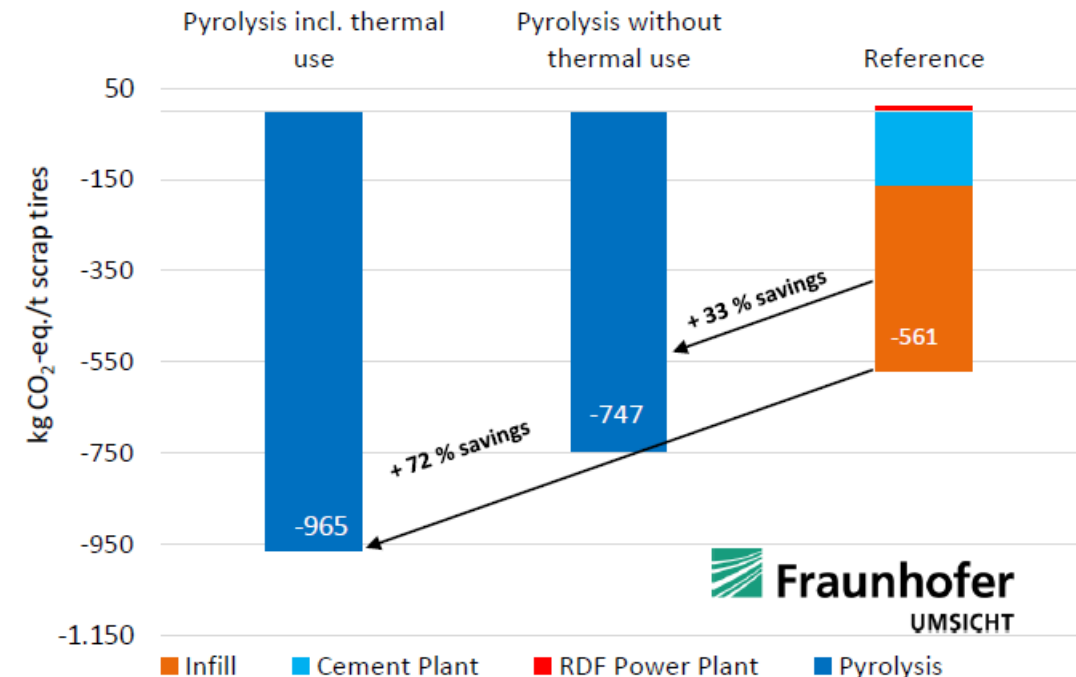
Results better than expected

Explanation

- The LCA has been made by Fraunhofer Institute between **May and September 2022**
- The results come from the Pyrum pyrolysis process only and cannot be compared to other pyrolysis processes
- Comparison of the CO₂ Eq. savings depending on different recycling processes. This means: „**How much CO₂ is saved by the recycling process instead of using fossil fuels or raw materials?**“ :
 - **EBSPower Plant:** + 164 kg / to used tires
 - **Cement plant:** - 395 kg / to used tires
 - **Material recovery:** - 778 kg / to used tires
 - **Pyrum:** - 965 kg / to used tires
- From a CO₂ saving perspective, only material recovery is approaching the results of the Pyrum process and represents a good combination.
- Combination of material recovery and Pyrum pyrolysis technology is the best solution.

244% CO₂ savings

LCA graph Fraunhofer



Source: Maga, D.; Aryan, V.; Blömer, J. (2022): Comparative Life Cycle Assessment of End-of-Life Options for Used Tires; Fraunhofer Institute for Environmental, Safety, and Energy Technology UMSICHT

The last important Milestone to close the loop: rCB

No rCB can be sold to the market without those certificates

Usually it takes years to get all these certificates



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• Received certificates in the last 12 months:

- Ecovadis: Silver Status
- VDA 6.3: Continental, Pirelli, Hankook, Mercedes, BMW
- ISCC+ for Oil and rCB
- ISO 9001
- ISO 14001
- IMUG ESG Certificate



• Milestone:

- First official rCB delivery in April 2023
- 100% „in Spec“ production since July 2023
- Stable „in Spec“ production since August 2023



Real applications of circularity

... areas of use that are already in operation

VAUDE Outdoor Equipment and Clothing



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Altreifen-Recycling
Robuste Produkte - klimafreundlich durch Recycling von Altreifen

Massenbilanz Altreifen-Recycling – was ist das?

Reife(n) Leistung für dich und das Klima! Unsere Textilien unter Verwendung eines Massenbilanzverfahrens sind klimafreundlich, hoch funktionell und tragen gleichzeitig zur Lösung eines großen Abfallproblems bei, das von Altreifen verursacht wird: VAUDE setzt hier eine Technologie ein, die aus schwer recycelbaren Kunststoffen Öl gewinnt und dieses wiederum in einem zertifizierten Massenbilanzierungsverfahren dem System der Polyamid-Herstellung zuführt. Das daraus gewonnene, nachhaltige Polyamid ist genauso funktionell wie ein herkömmliches Polyamid, spart aber bei der Herstellung ca. 60 % an CO₂-Emissionen ein!*

* Chemycling, Environmental Evaluation by Life Cycle Assessment, BASF, November 2020
GaBi version 9.2 (2020), Sphera AG, Polyamide 6 Granulate

[Erfahre hier mehr zu Massenbilanz Altreifen-Recycling](#)

Source: <https://www.vaude.com/de-DE/Herren/Beliebt-Neu/Altreifen-Recycling/>

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Real applications of circularity

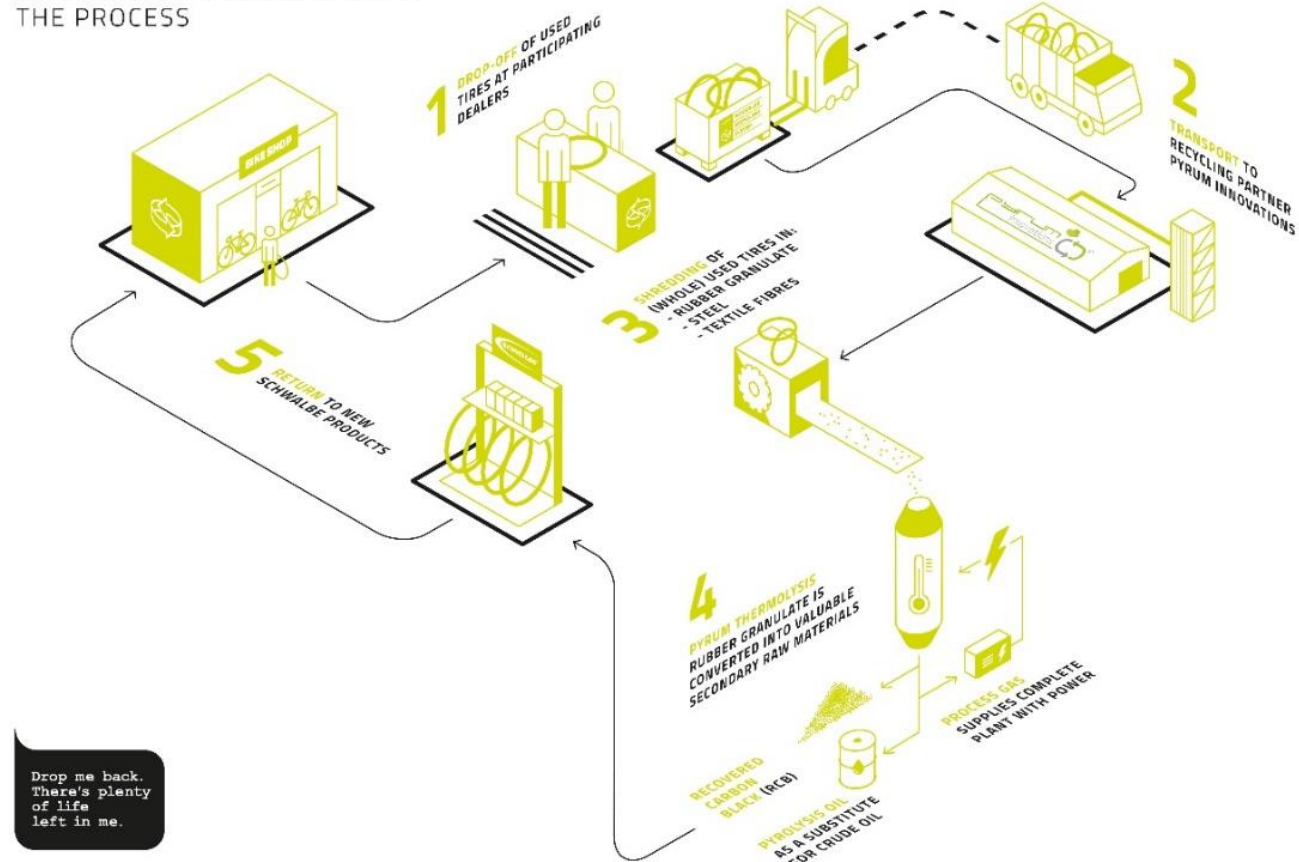
... areas of use that are already in operation

Schwalbe Recycling System and „THE GREEN MARATHON“



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SCHWALBE RECYCLING SYSTEM THE PROCESS



- Already 2.100 bike stores in Germany are participating = almost 1/3 of German market.
- The first 100% Pyrum rCB tire was released at the EUROBIKE in June 2023



Real applications of circularity

... areas of use that are already in operation

Mercedes-Benz door handles



Source: Mercedes Benz Group AG



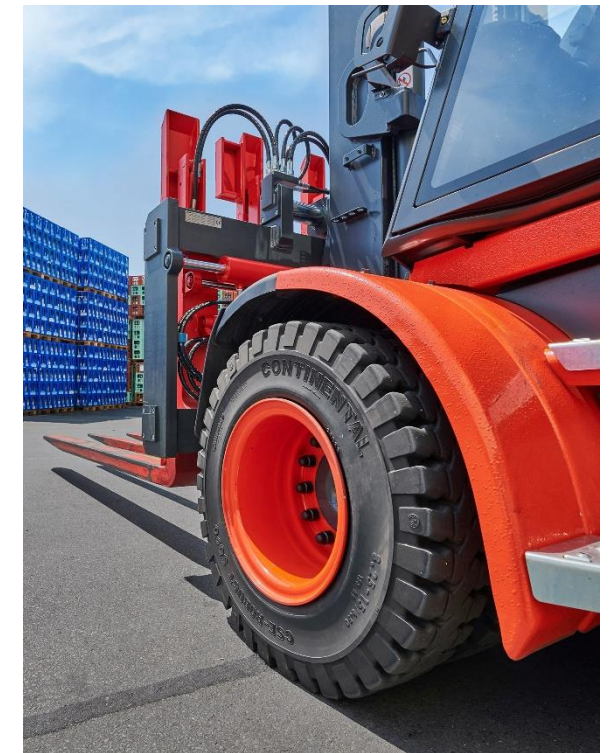
Real applications of circularity

... areas of use that are already in operation

Continental Tires since September 2023



- Solid tires from Continental's tire plant in Korbach now contain recovered carbon black from end-of-life-tires
- By 2050 at the latest, Continental aims to use 100 percent sustainable materials in its tire products
- Solid Tires produced since Calendar week 23 2023 contain Pyrum rCB



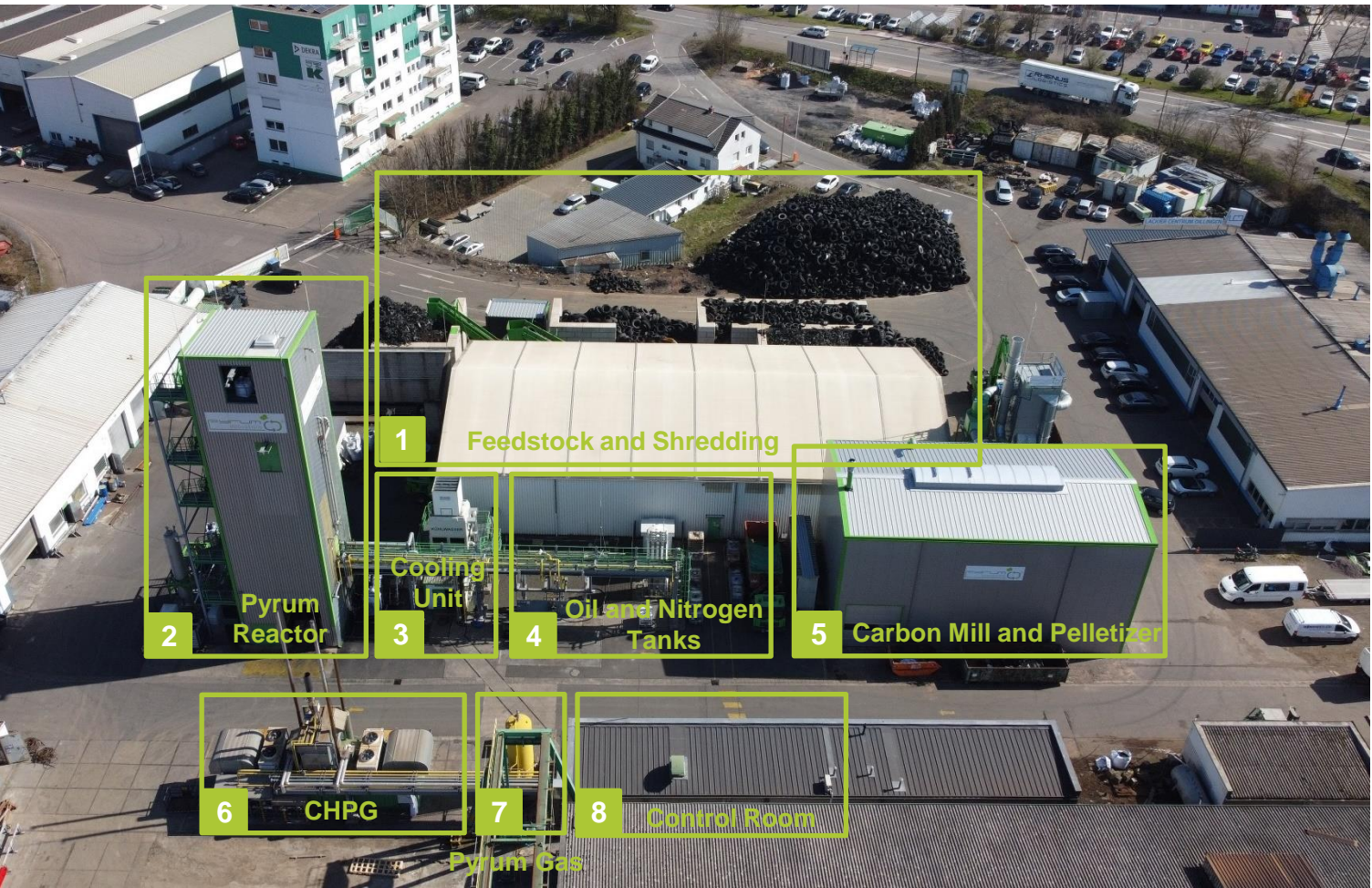
Source: Continental Press Release 12.09.2023



Dillingen plant was one industrial production line for end-of-life-tires...

... and has been running on industrial scale since May 2020 with commercial sales

Overview of the operational unit¹



Notes: (1) Current capacity of 5,600 tons p.a.; (2) Patents are owned by Pyrum Innovations International S.A.; (3) In Full operation since April 2023

Comments

- 1 ▶ **Feedstock (end-of-life-tires) and shredding unit:** granulating whole tires and separating rubber from steel and textile fibers
- 2 ▶ **Pyrum reactor:** patented² main part of the Pyrum process. 25-meter-high tower transforming rubber granulates into pyrolysis oil, carbon and gas
- 3 ▶ **Standardized cooling unit** to cool the whole process and all end-products
- 4 ▶ **Oil tanks (40,000 liters underground) and pumping station:** to fill trucks with Pyrum oil + nitrogen
- 5 ▶ **Carbon mill and pelletizer:** to transform raw carbon to commercially recovered Carbon Black (rCB)³
- 6 ▶ **Gas generator:** generation of power for the Pyrum plant thanks to the produced gas from the process
- 7 ▶ **Storage and cleaning of pyrolysis gas:** before it enters the gas generator
- 8 ▶ **Control room:** controlling the entire plant with 2-3 persons only



Dillingen plant consists today of 3 industrial production lines for end-of-life-tires...

... and here we have the two new lines at the Headquarter in Dillingen/Saar called TAD 2+3

Overview of the new operational unit¹



Comments

- 1 ▶ **Feedstock (end-of-life-tires) and shredding unit:** granulating whole tires and separating rubber from steel and textile fibers
- 2 ▶ **Pyrum reactor 2+3:** patented² main part of the Pyrum process. 25-meter-high tower transforming rubber granulates into pyrolysis oil, carbon and gas
- 3 ▶ **Standardized cooling unit** to cool the whole process and all end products
- 4 ▶ **Oil tanks (160,000 liters underground) and pumping station:** to fill trucks with Pyrum oil + nitrogen
- 5 ▶ **Carbon mill and pelletizer:** to transform raw carbon to commercial recovered Carbon Black (rCB)
- 6 ▶ **Gas generator:** creation the power for the Pyrum plant thanks to the produced gas from the process
- 7 ▶ **Storage of rCB in all forms:** 4 Silos of 100 m³ each for crude, milled and pelletized rCB
- 8 ▶ **Control room:** controlling the entire plant with 2-3 persons only

Notes: (1) Future additional capacity of 13,200 tons p.a.; (2) Patents are owned by Pyrum Innovations International S.A.



Building Site of Pyrum Unit 2 and 3 in Dillingen

Impressions

Status quo lines 2 + 3 (22.11.2023)



1 year ago



Building Site of Pyrum Unit 2 and 3

Impressions

New Power Plant and Pyrolysis Unit



Details about Pyrum Unit 2 and 3

- **Start of Building** : November 2021
- **Size of Building site:** 8.000 m²
- **Production Capacity:** up to 6 Tons of used tires per hour (10.000 tires per day)
- **Finished Parts of the Consturction:**

– Buildings:	Finished since 11.2022	✓
– Power, Water and Energy Supply:	Finished since 01.2023	✓
– Control Room and Social Building:	Finished since 04.2023	✓
– Shredding Plant for 6 to/hour:	Finished since 04.2023	✓
– Construction of Pyrolysis Unit 2+3:	Finished since 04.2023	✓
– End product Storage:	Finished since 04.2023	✓
– Cabling and controls Unit 2+3	Finished since 05.2023	✓
– Power Plant (Gas to Energy):	Finished since 09.2023	✓
– Cold ramp up:	Finished since 10.2023	✓
– Start of warm ramp up:	Started in Nov. 2023	
– New Mill and Pelletizer	2024	
- **Building time:** 22 months (Planned 18 months)
- **Delay:** 4 months (under the current supply chain conditions)

Research & Development

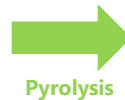
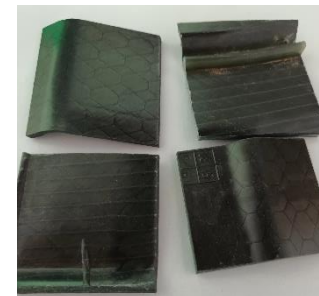
Result overview from completed projects



Project duration: Jan '21 – Jun '23

- Basic & detail engineering of a continuous and automated demonstration plant for recycling of carbon-fiber-reinforced plastic (CFRP)
- Installation of an operating container incl. machine, lock and control room
- Successful commissioning and operation of the demonstration plant

➡ First time holistic recycling of CFRP



- ✓ Perfect separation of the fiber matrix
 - ✓ High proportion of recycling
 - ✓ Sustainable supply of rCF due to substantially lower CO₂ emissions compared to new production
- ➡ Already in this plant size

Funded by Bundesministerium für Wirtschaft und Klimaschutz



Technology Arts Sciences TH Köln

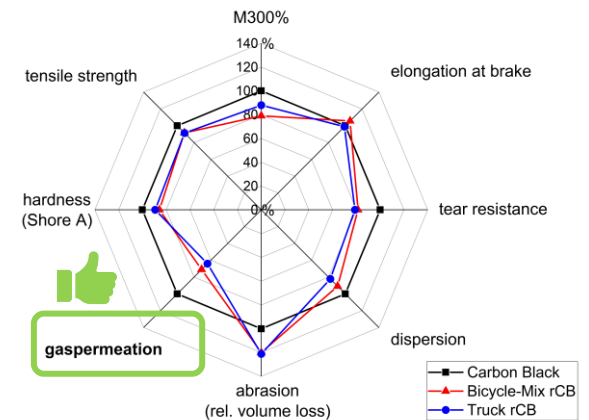
Funded by AIF Projekt GmbH

The project aims at creating, developing, and optimizing a full value chain:

Setup of the **first collection system** for bicycle tires
Optimization of **bicycle tire pyrolysis**
Implementation of bicycle-rCB into **inner tubes**

Major milestones since July 2022:

Optimization of the **pyrolysis** process conditions
Optimization of the **rCB refining process**
Introduction of **new rCB type** in rubber compounds
Performance test of **inner tube** demonstrator



- ✓ Lower gaspermeation
- ✓ Less use of fossile resources
- ✓ More sustainable



Extensive project pipeline due to attractive framework conditions

Demand is higher than capacity; projects are partly far advanced or have been started procedurally

Project status

	Project Nr.	Country	Partner/Site	General Terms agreed	Contract / Pre-Contract signed	Building site secured	20% Capital secured	Authorisation in process	Operative Company created	
100 %	1	 Germany	Saarland	✓	✓	✓	✓	✓	✓	
SPV	2	 Greece	Athen „Thermo Lysi SA “	✓	✓	✓	✓	✓	✓	
SPV	3	 Cech Republic	Prag	✓	✓	✓	✓	✓	✓	
SPV	4	 Germany	Bremen	✓	✓	✓	✓	✓		
EXT	5	 UK	SUEZ UK	✓	✓		✓	✓		
SPV	6	 Germany	Revalit GmbH, Bayern	✓	✓		✓	✓	✓	
SPV	7	 Germany	Thüringen	✓		✓	✓	✓		
100 %	8	 Germany	Hessen oder NRW	✓						
SPV	9	...								
SPV	10	DE & Europe	Unitank 2-10	✓						
SPV	11	 Germany	Baden-Württemberg	✓		✓	✓			

Remarks:

(1) The list of projects represents a selection, not the complete project pipeline.

(2) The order of the projects represents the currently planned realisation sequence. Changes over time are possible within the framework of the individual approval procedures.



Investment highlights

Pyrum addresses global environmental problems with revolutionary scalable technology

