Working Policy Brief
BLACK CYCLE

Pathways to economically viable tyre recycling value chains in Europe.

Move to the green revolution

This project has received funding from the European Union's Horizon 2020 research and innovation program under grant agreement No. 869625

EXECUTIVE SUMMARY

This policy brief presents the challenges and recommendations identified by the European BlackCycle project consortium to create a large-scale closed-loop circular economy by transforming end-of-life tyres into high-quality secondary raw materials that are technically qualified as inputs for making new tyres. This circular materials model involves a series of technologies, processes, and outputs: tyre deconstruction, granulation, pyrolysis, oil distillation, sustainable carbon black production.
We respectfully ask the EU policy maker to consider the recommendations herein and to support the deployment of more circular material flows from end-of-life tyre recycling:

The main recommendations are to:

› Promote policies that recognise the added value of material recovery from end-of-life tyres to deploy an economically viable recycling value chain.

› Create a regulatory framework that recognises pyrolysis technology as a material recovery process.

› Incentivise investments in end-of-life tyre recycling processes to ensure their industrial scale-up.

› Promote policies that recognize the added value of material recovery

› Set EU-harmonised end-of-waste criteria for secondary raw materials derived from end-of-life tyres to ensure legal certainty and free circulation within the Single Market.

› Create a regulatory framework incentivising customers to move towards recycled materials and away from virgin fossil or other extraction-based resources.

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The context:

The growing concern for sustainability calls for a transition to a more resource-efficient economy. Urgent actions are needed to enable circular economy models that reduce the continuous flow of virgin resources into the economy and increase the flow of recycled materials into the economy. This translates to extending the useful life of resources already extracted through reuse and recycling practices, while ensuring that the environmental impacts[1] are stable or reduced compared to practices using virgin materials.

In that context, the European BlackCycle project was launched to demonstrate the feasibility of the following objectives for end-of-life tyres (ELTs):

› *Transform 50% of the ~3.5 million ELTs arising annually in Europe[2] into secondary raw materials that are technically qualified to be used in new tyres.*

› *Achieve a 50% reduction in the CO2 emissions from the production of raw materials for making new tyres.*

› *Use 10 times more recycled materials in new tyres compared to the current situation.*

The BlackCycle project developed a new value chain model for recycling ELTs with technologies[3] and processes that in the scale-up phase would create around 2,000 jobs in Europe and if deployed at scale would achieve all three objectives above. The establishment of economically viable recycling value chains is a key enabler to the achievement of these objectives.

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The challenges:

The emerging ELT secondary raw material value chains, from collection to transformation to customer, face major challenges common to other sectors:

- *Market challenge*

The reluctance of consumers and economic actors to pay more for a product with higher recycled content.

- *Financial challenge*

Investments are high and productivity is not immediately optimised.

- *Regulatory challenge*

The current lack of EU-wide criteria for determining the end-of-waste status of recycled materials poses a market barrier to developing value chains across Europe which require the flow of secondary raw materials between countries from the ELT recycling process site(s) to the final user(s).

[1] *Based on eco-design and life cycle assessment principles in ISO 14006.*

[2] *https://www.etrma.org/news/new-end-of-life-tyre-statistics-2020-2021/*

[3] *See Annex II Value Chain Created by the BlackCycle Project.*

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BlackCycle Consortium Recommendations

A key factor of success is a systemic approach gathering all the actors of the ELT value chain: industrial players, startups and SMEs, investors, logistics operators, scientific support, government agencies and customers. EU policy makers can build a circular economy framework for ELT-derived materials by setting comprehensive policy and regulatory frameworks.

The BlackCycle project and other European projects (e.g., WhiteCycle[4]) aim to boost the circularity of tyres at end of life, and in doing so have shed light on the concrete difficulties of deployment at scale. To address the missing pieces identified in the project, the BlackCycle Consortium is recommending to the EU regulator to:

1. Promote policies that recognise the added value of material recovery to deploy an economically viable value chain. Such measures would increase availability of ELT-derived materials by ensuring stability of ELT feedstocks that are currently reduced by a high level of exportation outside the EU and a strong pull from industries relying on ELTs for energy.
For more details, see Policy pathway #1 in Annex I.

2. Create a regulatory framework that recognises pyrolysis technology as a material recovery process. Pyrolysis technologies cannot be deployed on a large scale unless their regulatory status as waste incineration versus material recovery process is clarified. The current situation of regulatory uncertainty is an impediment to broad implementation of pyrolysis.
For more details, see Policy pathway #2 in Annex I.

3**. Incentivise investments in end-of-life tyre recycling processes to ensure their industrial scale-up. This can be achieved by setting policies and regulations that de-risk investments in new ELT recycling technologies and scaling up proven processes.**
For more details, see Policy pathway #3 in Annex I

4 *More information on the WhiteCycle project available here: Https://cordis.europa.eu/project/id/101059639*

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4. Set EU-harmonised end-of-waste criteria for ELT-derived secondary raw materials to ensure legal certainty and free circulation within the Single Market. To ensure the operability of the circular materials value chain, end-of-waste status should be determined as upstream as possible.

For more details, see Policy pathway #4 in Annex I.

5.Create a regulatory framework incentivising customers to move towards recycled and away from virgin fossil or other extraction-based resources. This market shift can be accelerated by setting a minimum requirement for recycled content in products. In the case of new tyres and from a holistic environmental impact perspective, bio-based materials are also a key lever. Definition of targets for new tyre content should thus include both recycled and bio-based resources.

For more details, see Policy pathway #5 in Annex I.

The following section offers one-page briefs on each policy pathway the BlackCycle consortium is advocating to achieve large-scale deployment of circular material flows from end-of-life tyre recycling. Each policy pathway provides insights on specific deployment challenges, a use case from the BlackCycle project to illustrate the potential benefits that policy change could bring and recommendations on policy objectives.

The 5 policy pathways are complementary to each other and can be pursued in parallel.

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ANNEX I

5 Pathways Recommended to EU Policymakers

Policy pathway #1. Promote policies that recognise the added value of material recovery to deploy an economically viable value chain.

What is the challenge?

Availability of ELT feedstock is greatly reduced by exportation: roughly half of all ELTs are exported out of the EU. Of the remainder staying in the EU, energy recovery is still pulling away about 50% of ELT feedstock, limiting the potential for a larger share of material recovery and thus the availability of secondary raw materials[5]. Continuing to rely heavily on energy recovery as an ELT outlet creates an unattractive market for investing in material recovery technologies and production capacity due to lack of feedstock. In a Europe seeking to achieve better utilisation of valuable resources, maximising ELT material recovery and circular material flows should be the express objective.

BlackCycle use case:

The BlackCycle technologies are key to extending the volume and types of secondary raw materials derived from ELTs. Setting up value chains under the BlackCycle model to produce advanced materials[6]– recovered carbon black (r-CB), sustainable carbon black (s-CB), micronised rubber powders (MRP), sustainable plasticisers (s-plasticiser), sustainable resins (s-resins) and tyre pyrolysis oil (TPO) – depends on the availability of ELT feedstocks and their cost. The profitability of the end-to-end value chain is very sensitive to ELT costs, which are impacted by competition with energy recovery outlets.

Policy objectives

Ensure that ELT feedstocks are available for material recovery. Setting a clear policy direction to promote material recovery as the best option within the European Waste hierarchy would go a long way to maximising the recycling of the valuable materials in ELTs. In parallel, a resource-efficient Europe would focus energy recovery operations on wastes that cannot be converted to secondary raw materials. Policies that would divert such wastes from being landfilled and channel them to energy recovery operations would also significantly contribute to more circular flows of materials, even if only a single loop. Lastly, a strategy to retain ELTs in the EU, rather than exporting, would ensure stability of ELT feedstock availability.

[5] *See ETRMA report: https://www.etrma.org/news/new-end-of-life-tyre-statistics-2020-2021/.*

[6] *For a definition of "advanced materials" see the EU Communication "Advanced Materials for Industrial Leadership" (COM 2024 98 final), published on February 2024 and which adopts the OECD definition.*

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Policy pathway #2. Create a regulatory framework that recognises pyrolysis technology as a material recovery process.

What is the challenge?

Pyrolysis plants that treat ELTs produce outputs that are preponderantly secondary raw materials that are then sold on the market, while the gases generated in the process are incinerated, typically with energy recovery used to run the pyrolysis process itself. The EU Industrial Emissions Directive (2010/75/UE), however, lists pyrolysis plants under "waste incineration plants" in which "substances resulting from the treatment are subsequently incinerated." This leads to a situation in some Member States whereby pyrolysis processes are classified as waste incineration overall based on the incineration of a minority process residue – the pyrolysis gases – and without consideration of the material outputs that are not incinerated.

Such an "umbrella" approach that classifies pyrolysis facilities producing secondary raw materials as incinerators means that the requirements for incineration facility permitting apply, hence creating additional administrative and financial burdens not otherwise required.

BlackCycle use case:

In order to intake 50% of ELTs in Europe, upwards of 1.5 million metric tons every year, the BlackCycle consortium projects that up to ~75 plants would need to be established for operating pyrolysis processes. Investing in and managing the number of industrial projects to create this recycling capacity across the EU carries a high level of uncertainty about the permitting and operating requirements as long as application of the EU Industrial Emissions Directive remains ambiguous about the status of pyrolysis plants producing secondary raw materials.

Policy objectives

Ensure regulatory certainty for pyrolysis processes that produce secondary raw materials.

Regulatory or policy instruments can be used to clarify the definition of pyrolysis under the EU Industrial Emissions Directive. This could be supported, for example, by a technical description of pyrolysis in a dedicated Best Available Techniques Reference Document (or BREF[7]).

[7] *As defined under article 3(11) of the EU Industrial Emissions Directive (2010/75/UE).*

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Policy pathway #3. Incentivise investments in end-of-life tyre recycling processes to ensure their industrial scale-up.

What is the challenge?

The uncertainties in the short to medium term surrounding the economic viability of value chains for ELT-derived secondary raw materials limit the attractiveness for investors and therefore the potential to scale up these value chains.

BlackCycle use case:

Alongside existing processes that are both mature (e.g., collection, shredding, granulation) and developing (e.g., pyrolysis), the BlackCycle consortium proposes new ELT recycling processes including:

- tyre deconstruction to retrieve specific rubber material parts like tread or inner liner rubber to increase the recovery value of the rubber;
- distillation of tyre pyrolysis oil to create specific fractions of oils necessary for the final production of secondary raw materials such as sustainable carbon black (s-CB) and s-plasticisers (including s-resin) that could be used in new tyres.

The economic success of a large-scale, closed-loop model for tyre recycling in the EU depends on two factors: sufficient investment and ramp-up time to optimise productivity in new ELT recycling processes:

- Investment: Recycling ELTs into high-quality secondary raw materials requires a series of advanced industrial processes. Given the aim of the BlackCycle model to transform ~1.5 million tons of ELT per year and given that on average a plant transforms 20 kt per year of ELT, then approximately 75 plants would need to be set up across the EU, covering the successive steps of tyre deconstruction[8], shredding, granulation[9], pyrolysis and distillation [10] and requiring an estimated EUR 1.5 billion.
- Ramp-up time to optimise productivity: While the BlackCycle model projects an economically viable value chain, this will not be the case from the onset. Rather, the consortium estimates that industrial-scale ramp-up of production would take a minimum of two years with sub-optimal productivity and deferred profitability. In parallel, as the plants start to produce MRP, r-CB, TPO, s-CB, s-plasticisers and s-resins, tyre-building customers

Policy objectives

Ensure that ELT-derived secondary raw materials are competitive against equivalent raw materials produced from virgin fossil fuels.

Industrial scale-up can be achieved by setting policies and regulations that

- boost the flow of investments into the tyre-to-tyre recycling industry
- support attainment of profitability during production ramp-up.

[8] *Purpose is to retrieve specific rubber material parts like tread or inner liner rubber to increase the recovery value of the rubber.*

[9] *Both by traditional mechanical means or by cryogenic milling.*

[10] *This refers to the distillation of tyre pyrolysis oil to create specific fractions of oils necessary for the final production of secondary raw materials such as s-CB and s-plasticisers that could be used in new tyres.*

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ANNEX I

5 Pathways Recommended to EU Policymakers

Policy pathway #4. Set EU-harmonised end-of-waste criteria for secondary raw materials derived from end-of-life tyres to ensure legal certainty and free circul

What is the challenge?

One of the main hurdles to the development of a circular material flows is the waste status of the different outputs of material recovery processes.

Under the current European regulatory framework on waste, the default status of any material recovered from waste is also waste unless it meets specific criteria., Referred to as end-of-waste criteria (EoW), they are used to assess whether certain materials can be considered as having ceased to be a waste. Where no EoW criteria exist for a given waste stream, all recycled materials from that type of waste stream are considered waste. A recycled material having waste status brings administrative and financial burdens to actors in the value chain, from transport to processing to trade and the incorporation of these secondary raw materials into new products. While many companies have set ambitious, strategic objectives in the medium and long term to achieve greater circularity of their products and have committed significant resources to the development of both technologies and required capacities, the regulatory framework has not yet evolved to support these needs by removing barriers to development of secondary raw materials value chains. While the 2018 revision of the Waste Framework Directive allows Member States to define EoW criteria, the process is uneven across the EU, leading to disparities in the regulatory process and high levels of uncertainty for actors envisioning a waste status change.

BlackCycle use case:

Large-scale closed loop tyre recycling across the EU is impeded by the lack of harmonised EoW criteria for secondary raw materials derived from ELT. The three most prominent examples of such materials facing waste regulation hurdles are ELT-derived rubber, including rubber granulates and MRP, r-CB and TPO. As mentioned above, the waste status of ELT-derived materials creates a set of administrative and financial burdens including specific requirements for shipment. To ensure the operability of the value chain, the end-of-waste status point should be as upstream as possible.

Policy objectives

Facilitate cross-border flows in the Single Market of secondary raw materials derived from ELTs by providing clarity on their EoW regulatory status. EU policymakers should focus on two aspects:

- Set EU-wide harmonised EoW criteria that define when a material output from tyre recycling ceases to be waste and becomes a product in the form of a secondary raw material. These criteria should ensure that the recycled material meets specific quality standards and is suitable for safe use in the production of new products.
- Place the end-of-waste status as upstream as possible in the value chain, to avoid downstream operators in the value chain being required to qualify their facility as a waste treatment installation.

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Policy pathway #5. Create a regulatory framework incentivising customers to move towards recycled materials and away from virgin fossil or extraction-based resources.

What is the challenge?

Establishing new value chains for secondary raw materials in the current market and regulatory context will lead to a higher price for customers compared to equivalent materials from virgin fossil fuel feedstock. While willingness to pay more for products containing recycled raw materials remains low, products containing secondary raw materials will be less attractive on the market than cheaper offers with no recycled content.

BlackCycle use case:

For instance, the project consortium has concluded that at least for some years, for s-CB, which is a drop-in substitute for virgin carbon black (v-CB) in rubber mixes for making new tyres, the total cost will be higher for two reasons. First, the feedstock in the form of pyrolysis-distilled oil has a higher cost per metric ton than the virgin fossil fuel feedstock used to produce v-CB. Second, the initial yield of s-CB per metric ton of feedstock will be lower compared to that of v-CB. Therefore, the tyres containing s-CB will have a higher cost than those containing v-CB.

Policy objectives

Ensure that new tyres made with ELT-derived recycled content are competitive against tyres with no such recycled content. Accessibility and affordability to the final customer during the transition to a large-scale circular economy of end-of-life tyres can be achieved by setting policies

Set a minimum non fossil content in final product to:

- Accelerate the circular transition to shift customers towards recycled (and bio-based) materials solutions
- Increase the market demand for the recycled materials and help the industrial scale-up of their value chain and the improvement of their economical competitivity

Reduce financial and administrative impediments not faced by business-as-usual processes relying on extraction and use of virgin resources to keep production costs down in the ELT-derived materials value chain.

Key policy consideration: Recycled and bio-based materials should be considered together when defining targets for minimum content in tyres for the following reasons:

- Reducing the life cycle environmental impact requires flexibility when introducing new recycled or bio-based materials.
- Supply chains are the most cost-efficient when the actors can make choices best suited to their specific context both in terms of technical readiness, environmental impact, and economic feasibility of recycled and bio-based materials.
- Supply chains should have the flexibility to direct ELT-derived materials to both tyre manufacturing (closed-loop) and open-loop applications, depending on the market conditions.

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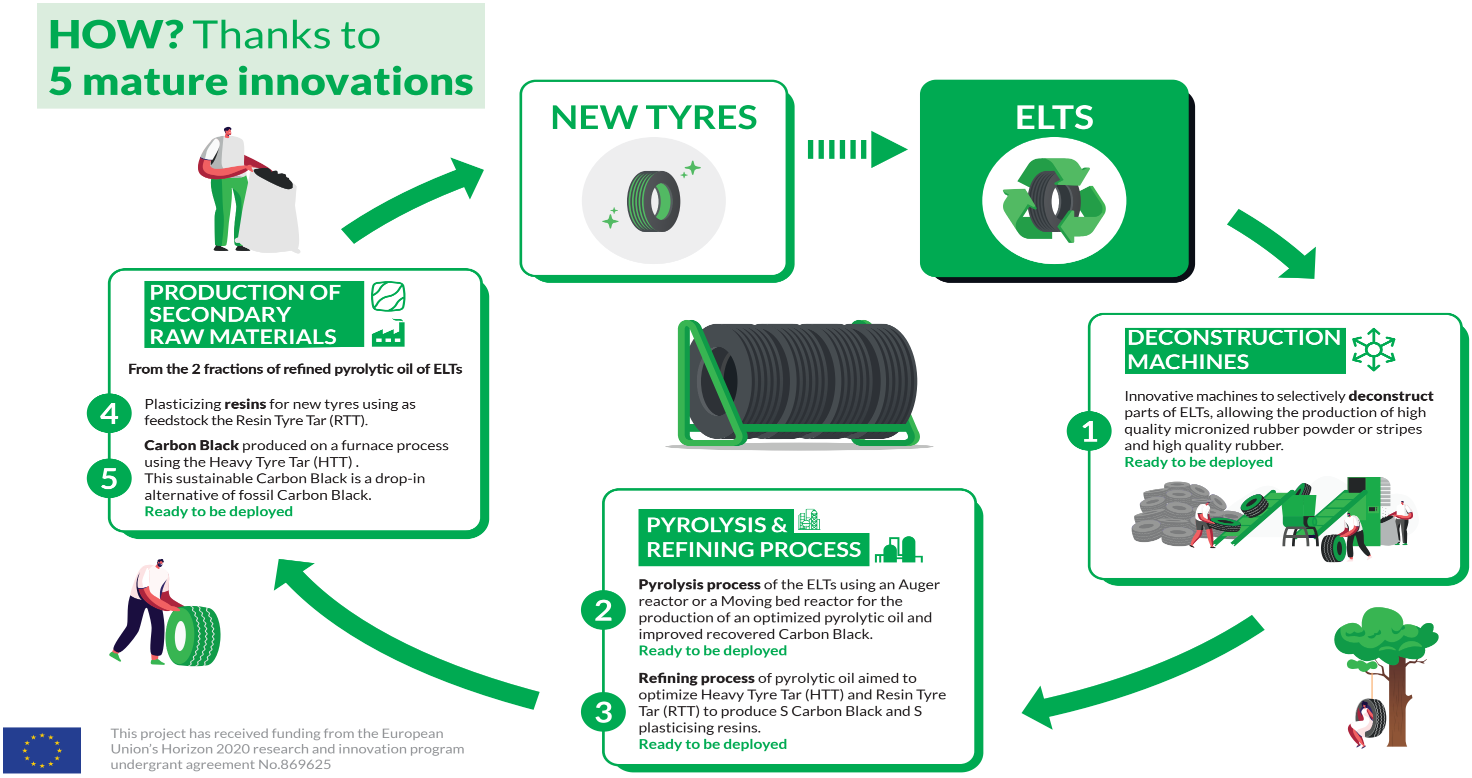
ANNEX II

Tyre Recycling Value Chain

BLACK CYCLE
Move to the green revolution

“ENABLE A MASSIVE AND VIABLE CIRCULAR ECONOMY OF TYRES”

BlackCycle has successfully transformed End of life Tyres (ELTs) into 100% valorized high quality secondary materials mainly in tyres and rubber goods



The BlackCycle value chain incorporates new know-how, namely in refining & polymerisation processes, and new technologies for tyre deconstruction and pyrolysis to create new secondary raw materials from ELTs for a use in new Tyres.

- Micronised rubber powder MRPs made from only inner liner rubber extracted from ELT feedstock with a specially designed deconstruction machine. *((unlike traditional MRPs that are a mix of rubbers with very different natures coming from all the parts of the tires (Tread+Sidewall+Carcass+innerliner+etc))*
- Higher quality recovered carbon black made from the pyrolysis of the truck tread rubber only extracted from ELT feedstock with a second specially deconstruction machine *(unlike the traditional r-CB made from pyrolysis of whole tires that contain a mix of different CBs and ash).*
- Optimised tyre pyrolysis oil and its distilled fractions that can be used to produce other secondary raw materials such as sustainable carbon black and sustainable resin.
- Sustainable carbon black produced in a furnace with a fraction of distilled tyre pyrolysis oil rather than fossil fuel feedstock.
- Sustainable resin produced from the polymerisation of monomers contained in a different fraction of distilled tyre pyrolysis oil.

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ANNEX III

Glossary

- *Closed-loop recycling:* Using secondary raw materials produced from recycling end-of-life tyres as material inputs for making new tyres.

- *Open-loop recycling:* Using secondary raw materials produced from recycling end-of-life tyres as material inputs for applications other than new tyres.

- *ELT (end-of-life tyres):* Used tyres that are no longer fitted on a vehicle and that have become a waste.

- *Granulates:* Rubber particles greater than 1 mm produced from tyre shreds

- *MRP (micronised rubber powder):* Made from mechanical or cryogenic grinding) of rubber materials and consisting of particles less than 1 mm.

- *Pyrolysis:* Thermal treatment process that transforms, in an oxygen-free environment, rubber granulates derived from ELTs into tyre pyrolysis (TPO), recovered carbon black (r-CB) and gas.

- *r-CB (recovered carbon black):* Obtained by the pyrolysis of ELT rubber, it is a mix of carbon blacks derived from the tyre and ash (Silica, ZnO,...) that is semi renforcing. It is used as a filler to reinforce the properties of rubber in tyre formulations. As a filler, the overall quality is lower than that of s-CB.

- *s-CB (sustainable carbon black):* Produced from distillated tyre pyrolysis oil, this form of carbon black is referred to as “sustainable” because it is an equivalent substitute for carbon black produced from virgin fossil fuel feedstock, having the exact same properties. It is used as a filler to reinforce the properties of rubber in tyre formulations.

- *s-resin (sustainable resin):* Produced by polymerisation of monomers contained in a distilled fraction of tyre pyrolysis oil.

- *s-plasticiser (sustainable plasticiser):* A plasticiser is an additive introduced in a rubber material to soften it. A sustainable plasticiser is made from an extraction of the distilled tyre pyrolysis oil.

- *Shredding:* Mechanical operation that breaks down whole tyres into pieces of rubber containing metal and textile components. of the tyre (e.g., tread, inner liner material).

- *SRM (secondary raw materials):* Materials produced from a waste recycling process that can be used in the manufacture of new products.

- *TPO (tyre pyrolysis oil):* Obtained by the pyrolysis of ELT rubber.

- *Tyre deconstruction:* Mechanical operation that separates the different rubber materials

- *v-CB (virgin carbon black):* Carbon black produced from virgin fossil fuel feedstock.

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