Environmental Impact Analysis: End-of-Life Tyres (ELT) Recovery Strategies

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Life cycle analysis (LCA) of ELT treatment scenarios

- OpenLCA was used to calculate the impact on the environment with different types of scenarios for ELTs.
- Recycling and recovering ELTs provides a valuable source of crumb rubber for further application with reduced environmental impact.
- Incineration is an irreversible loss of high-resource and energy-consuming rubber, while 122.9 kg $CO_{2\text{-Eq.}}$ per ton of ELT gives savings of 2766 kg $CO_{2\text{-Eq.}}$ compared to new tyre production.
- Recycled ELT produces valuable crumb rubber aggregates for cement composites.

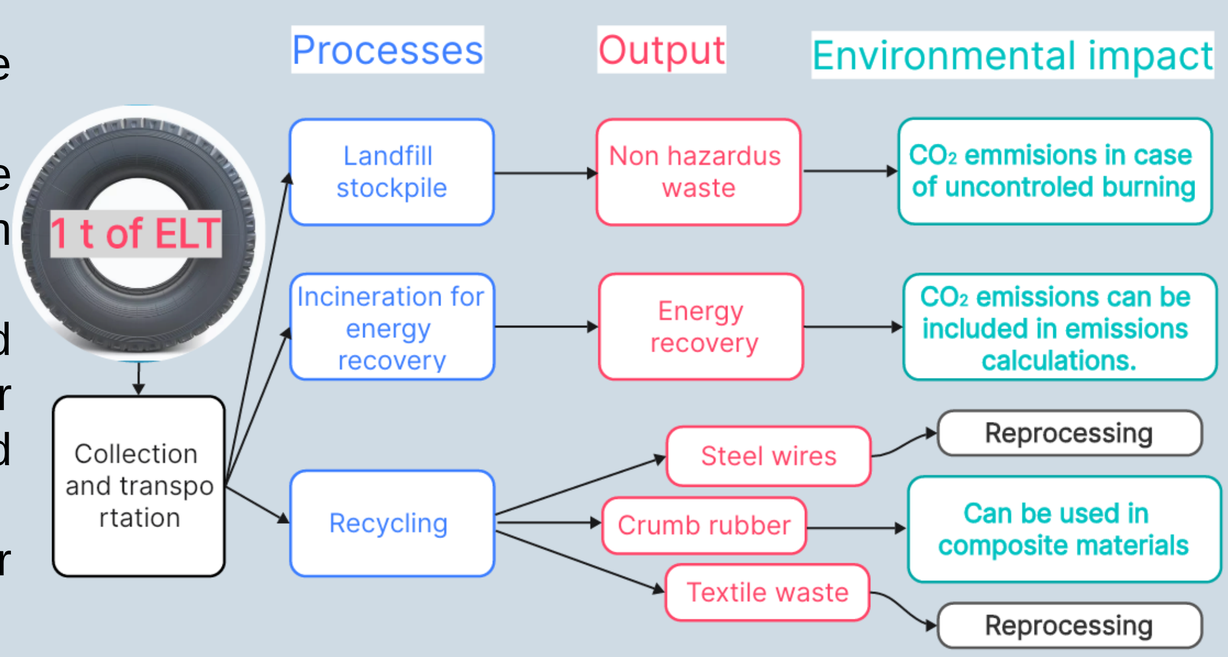

Fig. 1. Processes of ELT treatment and recycling.

Introduction

Continue to raise the amount of ELT treatment options that need to be most environmentally friendly. Disposing of ELTs in landfills poses environmental risks, and recycling emerges as a solution, including energy recovery through incineration and material recycling for various applications.

Incorporating ELTs into composite materials, particularly in cement composite, offers eco-friendly alternatives, contributing to sustainable construction practices.

Managing ELTs is pivotal for sustainable supply chains, requiring financially viable recycling systems and markets for ELT-derived products.

Experimental setup

The OpenLCA software adopts an attributional approach, assessing environmental impacts of 1 ton of ELT across treatment stages in Table 1.

TABLE 1. Description of calculation scenarios, processes and outcomes.

Scenarios	Processes	Output from ELT treatment	Risk assessment
1.	Landfill	No outcome from operation	Used territory, insect breeding, risk of uncontrolled burning which can lead to air, ground and water pollution. CO_2 emissions
2.	Energy Generation from Incineration	Heat energy, can be converted into electricity	CO_2 emissions are not included in the burning process
3.	Energy Generation from Incineration	Heat energy, can be converted into electricity	CO_2 emissions included in calculations
4.	Car tyre recycling	Crumb rubber, steel wires and textile waste	CO_2 emissions, textile waste can be incinerated, steel wires may be remelted or used in cement composites
5.	Truck tyre recycling	Crumb rubber, steel wires and textile waste	CO_2 emissions, textile waste can be incinerated, steel wires may be remelted or used in cement composites
6.	New tyre production	1 ton of tyres	CO_2 emissions

Results

OpenLCA software compares ELT options, favouring recycled crumb rubber, steel fibers, and textiles for sustainable cement composites.
Data shows car tyre recycling emits 122.9 kg and truck tyre recycling emits 36.1 kg $CO_{2\text{-Eq.}}$ incineration from 69.3 to 1693.6 kg $CO_{2\text{-Eq.}}$ Manufacturing 1 ton of new tires emits 2766.6 kg CO_2. Combined maximum emissions from production and incineration reach 4460.2 kg $CO_{2\text{-Eq.}}$ per ton.

Calculations prioritize renewable energy (RE).

Sustainable tyre practices are crucial to mitigate environmental impact (see Fig. 2.).

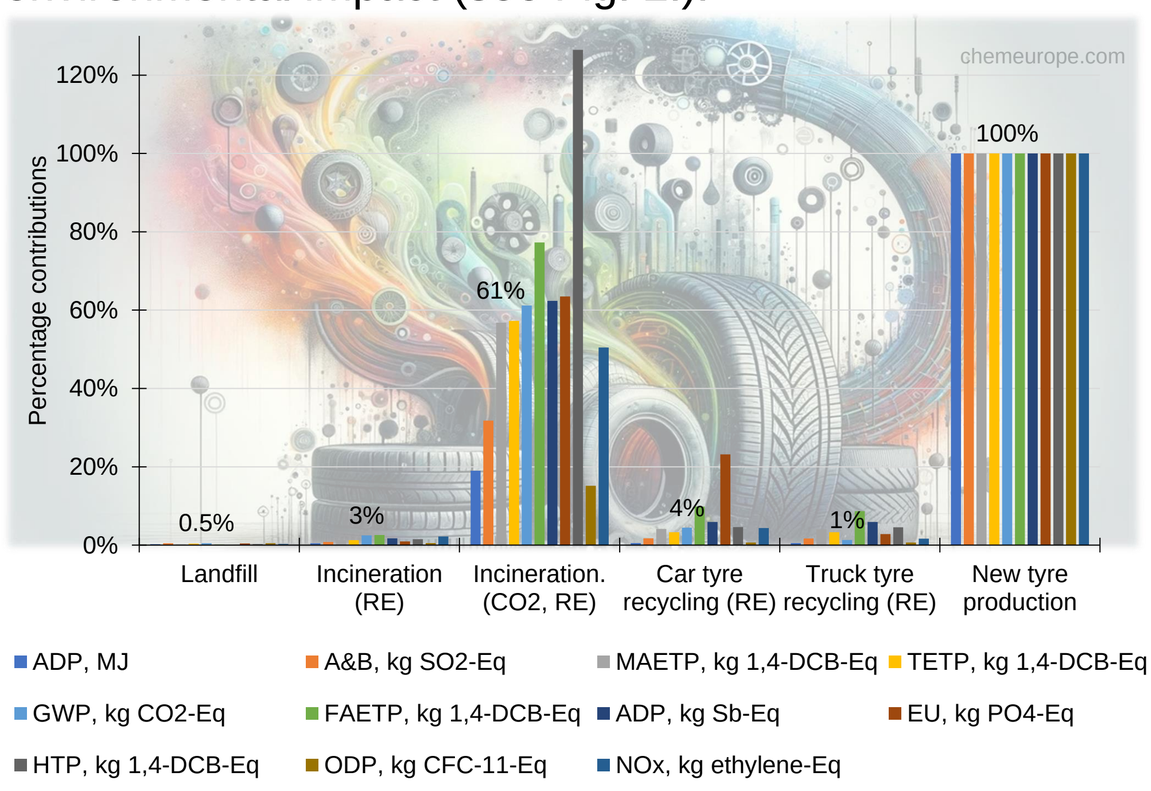

Fig. 2. Outcome illustrates the distribution of resources in the context of new tyre production.

Conclusion

ELT recycling gives a significant advantage over incineration as valuable resource is produced as secondary raw materials. Crumb rubber can be utilised as an aggregate in high-valued construction materials.