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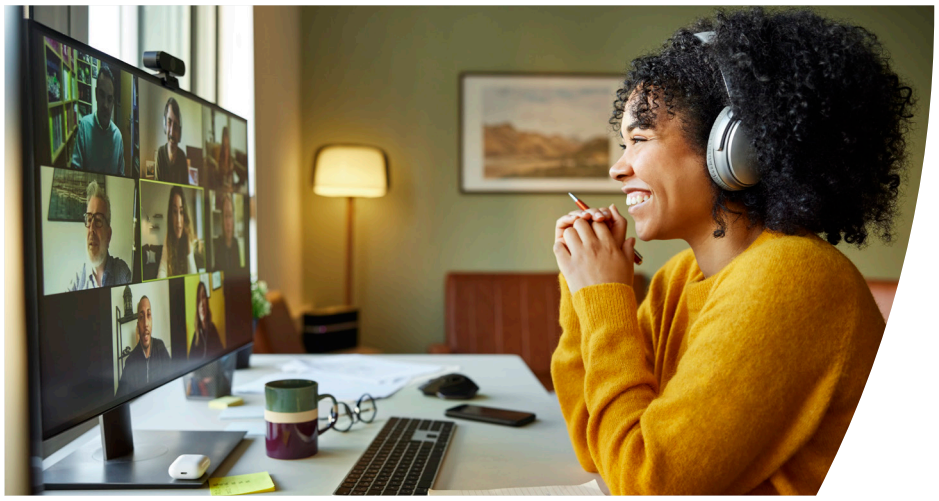
Perspectives on End-of-Life Tire (ELT) Management

Challenges and potential solutions in the US, Europe and China



Tire Industry Project

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Executive summary

Executive summary

Globally, more than one billion tires reach the end of their useful lives (as tires) every year. End-of-life tires (ELTs) and their materials are an inexpensive, yet valuable, resource for the circular economy that can be used in a variety of applications. Successful ELT management systems foster the circular-use of ELTs and help reduce the unregulated dumping of tires.

Various regional efforts by government authorities, the tire industry and individual manufacturers are currently underway to improve ELT management and efforts to increase recovery rates and move ELT management to more optimal positions in the waste hierarchy, toward circularity, have made good progress.

The World Business Council for Sustainable Development (WBCSD) Tire Industry Project (TIP) is the primary global forum for the tire industry on sustainability and has supported research into the global state of ELT management for more than a decade. Based on previous reports, data collected and the experience of regional tire trade associations (TTAs), TIP has recognized the value of organizing regional workshops to share know-how and encourage value-adding cooperation among stakeholders including tire manufacturers, trade associations, waste management and recycling organizations, research institutions and academia, and NGOs.

TIP, in collaboration with the US Tire Manufacturers Association (USTMA), the European Tyre and Rubber Manufacturers Association (ETRMA) and the China Tyre Recycling Association (CTRA), organized workshops in the US, Europe and China for ELT value chain stakeholders. Developed with experts, the stakeholder workshops sought to create a shared understanding of the challenges and potential solutions for improved ELT management.

The workshops confirmed that all three regions have improved ELT recycling rates over the last 20 years, yet important opportunities for improvement remain.

The challenges identified include inconsistencies between regional policies, a lack of suitable market reporting, high upfront investment costs for developing new ELT applications, and the absence of effective means to share information and collaborate among the numerous and diverse value chain stakeholders.

Encouragingly, the workshops revealed that enablers of better ELT management are present in the regions, including the desire to promote growth in the adoption of supportive policies and the willingness of stakeholders to drive change based on improved awareness of the benefits of sustainable practices and the circular economy.

This report finds that the increased *will* to develop better ELT management systems is frustrated by a *way* often characterized by the absence of effective means for information sharing and collaboration, incomplete and inconsistent market data, and the all-too-limited communication of ELT management successes that can guide and inspire continued improvement.

Seeking to leverage ELT stakeholder motivation, this report recommends measures aimed at providing organizations and individuals with the tools and frameworks for knowledge exchange and collaboration that they require to effectively lead the development of better – more circular – ELT management systems.

The report specifically recommends harnessing the potential of the ELT market by:

- Mobilizing stakeholders toward new, more effective and scaled management systems.
- Leveraging existing circularity metrics to guide improvements in ELT management.
- Making use of opportunities for knowledge exchange and networking such as that provided by TIP. The report concludes with a summary of actions to be undertaken by TIP, USTMA and ETRMA in support of these recommendations.

The workshops were held between February 2021 and October 2021 to gain feedback from stakeholders in Europe, the US, and China. This report summarizes discussions from the workshops and does not necessarily reflect the most up-to-date information on ELT management from the three regions.

1 Introduction

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Formed in 2005, the Tire Industry Project (TIP) is a global, voluntary, CEO-led initiative that aims to proactively identify and address the potential human health and environmental impacts associated with the life-cycle impacts of tires to contribute to a more sustainable future. Comprising 10 leading tire companies – representing more than 60% of global tire manufacturing capacity – TIP operates under the umbrella of the WBCSD. Our work to address sustainability challenges includes contributing to the global state of knowledge on ELT management and efforts to drive improvements in ELT management through information sharing and stakeholder engagement.

A circular economy is fundamental to achieving WBCSD's vision of more than nine billion people living well within the boundaries of the planet by 2050. The estimated one billion tires that reach the end of their useful lives every year represent a valuable – and yet underexploited – resource for the circular economy.

TIP research supports the observation that ELT management has benefited from good communication and cooperation between stakeholders. The various efforts of governments, the tire industry and individual manufacturers have resulted in examples of improved ELT management, evident through increased ELT recovery rates and improved scope and uptake for the use of ELTs in improved positions in the waste hierarchy.

We recognize that moving ELT management further toward a circular economy will require enhanced information sharing, new business models, supportive policies and greater collaboration among value chain stakeholders.

To address these themes, we partnered with Accenture, the US Tire Manufacturers Association (USTMA), the European Tyre and Rubber Manufacturers Association (ETRMA) and the China Tyre Recycling Association (CTRA) to organize the series of workshops described in this report.

USTMA is the national trade association for tire manufacturers that manufacture tires in the U.S. USTMA works to achieve our long-term sustainability goal of 100% of annually generated scrap tires entering end use markets. It publishes biennially the Scrap Tire Management Summary Report to measure progress towards meeting it's long-term sustainability goal for scrap tires.

ETRMA is composed of tire and rubber manufacturing companies with operations in Europe and other national and affiliated members associated with tires and rubber. It works to exchange best practices for a sustainable regulatory environment for consumers, drivers and industry and it researches and published data on ELT management.

CTRA is a national industry association engaged in the recycling of ELTs in China. It is affiliated with the State-owned Assets Supervision and Administration Commission of the State Council, which is responsible for implementing national guidelines and policies to safeguard resources, the environment and the overall interests of industry.

2 Approach

② Approach

We convened stakeholder workshops in the US, Europe and China, with the objectives of:

1. Improving the shared understanding of regional ELT management needs and opportunities;
2. Engaging ELT value chain stakeholders in the co-creation of solutions for improved ELT management;
3. Furthering the global state of knowledge on ELT management and identifying key knowledge gaps.

We tailored workshops at the regional level (Table 1) to ensure subject matter relevance. All workshops employed a combination of breakout sessions and brainstorming for the effective exchange of knowledge and creative thinking about ELT management solutions. We interviewed ELT experts before the workshops to identify key challenges and inform the selection of topics for each region.

Table 1: Overview of the subject matter focus of workshops by region

TOPICS SELECTED FOR IN-DEPTH COVERAGE	US	EUROPE	CHINA
Application of ELT material **Scaling the use of ELT-derived material in rubber modified asphalt**	✓	✓	
Application of ELT material **Potential civil engineering applications of ELT-derived materials**	✓		
Application of ELT material **Use of ELT-derived materials in molded and extruded products**	✓		
General topic **Traceability of car tires**		✓	✓
General topic **Circularity metrics**		✓	
General topic **Rubber powder market**			✓

For an explanation of the in-depth topics at the regional workshops, see Appendix 1

3 Perspectives on ELT management

3 Perspectives on ELT management

This section provides an overview of each of the three regional workshops. For a more detailed account of the ELT management challenges and potential solutions raised during each of the workshops, see Appendix 1.

UNITED STATES

Background

The USTMA's 2019 U.S. Scrap Tire Management Summary reveals that although tires remain one of the most recycled products in the US, ELT markets have not kept pace with the annual generation of ELTs. The free market system dominates in the US, where companies recovered almost 76% of ELTs for use in products including rubber modified asphalt, automotive parts, mulch for landscaping, and tire-derived fuel. This was down from a 2013 recycling peak rate of 96%. There were approximately 1 billion ELTs in stockpiles in the US in 1990; by 2019, companies had recycled over 94% of those tires. Around 56 million tires remained stockpiled.

Workshop format and focus

Over three days, more than 80 value chain stakeholders – including, representatives from tire manufacturers, recycling associations, non-governmental organizations (NGOs) and academia – convened for a virtual workshop.

Focusing on rubber modified asphalt (RMA), civil engineering, and molded and extruded products, the workshop sought to obtain feedback and ideas to further grow market development and the greater use of ELTs in these applications and what could be done to achieve them.

Key take-aways from the US workshop

The use of ELTs in Rubber Modified Asphalt (RMA) has excellent potential for growth. RMA success stories, positive field data and pressure on authorities to manage noise pollution and promote circular solutions for end-of-life products and materials are important enablers of this growth. To help scale the adoption of RMA, suggestions include the creation of a body of experts and testing facilities for research, demonstration and dissemination of data and positive examples to grow interest in the solutions that RMA can provide.

The workshop identified barriers to greater **use of ELTs in civil engineering**, including a lack of scalable solutions, concerns about potential environmental impacts, a lack of champions to demonstrate benefits, and regulatory requirements that can discourage engineers from adopting the use of new materials. To mitigate these barriers, participants suggested an open-data platform for the sharing of insights on use cases and detailing environmental benefits and potential impacts. Participants also saw value in the adoption of a federal campaign that would help communicate the need to use ELTs as a preferred material for civil engineering projects.

Participants identified opportunities to spur market growth **use of ELT-derived material in molded and extruded products**, including a lack of homogeneity in ELT-derived materials, misalignment between supply and demand, competition from other materials, costly testing processes and poor appreciation of the benefits of ELT-derived materials within the key target groups of supply chain actors and customers. They suggested the establishment of material grading standards (such as those adopted for recycled plastics) and a consortium for engagement and information exchange between key actors as means to improve the use of ELT-derived material in molded and extruded products.

Other notable observations and recommendations:

- The patchwork of state laws presents a barrier to the scaling of ELT markets by inhibiting the inter-state replication of processes, specifications and formulations.
- A centralized and trustworthy source of information on ELT management is lacking and any such source should accommodate the different interests and levels of expertise that comprise the ELT stakeholder ecosystem.
- Action is needed across the value chain to advance ELT management by, for example, incentivizing recyclability in tire design, coordinating research agendas and resources, and enabling entrepreneurship and innovation through the provision of capital and the sharing of information.
- Stakeholders are clearly motivated to continue dialogue on new ELT management solutions.

EUROPE

Background

According to the ETRMA, every year in Europe, businesses collect and treat more than 3 million tons of ELTs through recycling and recovery processes. And according to its End-of-Life Tyre Report 2015, over the last 20 years, tire collection and ELT management trends have been positive. Moving from 8% recycling, 14% energy recovery and 78% unknown/stocks in 1994 to 52% recycling, 40% energy recovery, 3% civil engineering and 5% unknown/stocks in 2019 – with an overall collection of 95% of ELTs in Europe.

Europe has three different systems for managing ELTs:

- **Extended producer responsibility (EPR)**, where producers maintain full or partial responsibility for their products, which extends to the end-of-life stage. Most European countries apply this model.
- **Free market**, where legislation describes objectives but does not designate responsibility. For example, Germany and Austria apply this model.
- **Tax based**, which is applied in Denmark and Croatia and uses a tax levied on tire producers that is subsequently passed on to the consumer.

Workshop format and focus

More than 70 ELT value chain stakeholders met online over three days to explore ways in which to enable large-scale transformation for more sustainable ELT management.

The workshop placed a special focus on the challenges and solutions associated with scaling the use of RMA, improving the value chain traceability of tires to improve recycling rates and developing circularity metrics to guide the transition to a circular economy.

Key take-aways from the workshop

Mirroring observations from the US workshop, participants saw the use of ELTs in RMA as having excellent potential for growth, with important enablers of this growth evident in the region. Participants confirmed that RMA has seen limited application in Europe to date. Suggestions for scaling the use of RMA include the development of a consistent product strategy, the establishment of a body to promote the solution to lawmakers, the use of testing facilities and the coordination of experts to validate RMA benefits, and the creation of a platform for knowledge exchange and sharing of RMA case studies.

Workshop participants noted that a tire tracing system could bring important benefits to ELT management and help tackle issues such as illegal trade, the sorting process and bringing transparency to recycling routes. The workshop confirmed that no common tire-specific methodology or measurements exist to develop or implement circularity metrics to guide the transition to a circular economy. Specific limitations include a lack of tire-specific concepts and metrics for circularity, limited information on the benefits of circularity in ELT management, and the uncoordinated efforts of stakeholders and adjacent industries. To remedy this situation, participants agreed on the need to drive greater alignment in the ecosystem and that a central aspect of this would be to develop and implement a widely adopted circularity framework for tires. Participants noted the WBCSD Circular Transition Indicators (CTI) tool – among others – for its potential as a starting point for this work, with the collection and dissemination of good practice case studies recognized as being important to raise awareness and interest in the added value of circularity metrics.

Workshop participants also made the following observations and recommendations:

- Europe-wide solutions are required to advance ELT management. National-level policies still manage and regulate some topics, whereas a Europe-wide approach could see benefits from economies of scale. Specifically, participants recommended the implementation of a European regulation or policy aimed at supporting the transition to a circular economy.
- Echoing the US workshop, participants aligned on the need for a centralized and trustworthy source of information on ELT management, tailored for the different interests and levels of expertise that comprise the ELT stakeholder ecosystem.
- On the development of tire traceability tools, the reference value of relevant frameworks and methods from other industries and products are of note. Examples included the use of radio-frequency identification (RFID) in fleet tire management and how companies could expand this concept to trace ELTs.
- In terms of trading, there is a need for Harmonized System (HS) codes that reflect circular markets and the application of ELTs.

CHINA

Background

According to CTRA, in 2019 China generated more than 12.8 million tons of ELT. The overall recycling rate has not yet reached 70% and ELT generation is still growing at an annual rate of 8% to 10%. Between 2016 and 2020, companies processed a total of 34 million tons of ELT, while they retreaded around 32 million tires. The most common ELT recovery routes in China are reclaimed rubber, rubber powder and pyrolysis.

While ELT management is growing in China, development challenges remain. In July 2021, the National Development and Reform Commission (NDRC) (国家发展和改革委员会) published a plan to increase the circular economy, in which it recognized the value of ELTs and highlighted key focus areas, including their classification, use and disposal. The plan also underlined the importance of upgrading processing facilities and improving the market for ELT use.

China's implementation of a circular economy plan has had a positive impact. In August 2021, the Ministry of Commerce of the People's Republic of China released the China Renewable Resources Recycling Industry Development Report (2020). While the impacts of COVID-19 have included a reduction in the rate of increase in ELTs, the report notes that the continued growth in numbers of ELTs in China represents important potential for the recycling market.

Several governmental organizations are involved in the promotion of ELT management in China, including:

National Development and Reform Commission (国家发展和改革委员会): The Department of Resource Conservation and Environmental Protection is responsible for the implementation of macro-policies for the development of a circular economy.

Ministry of Industry and Information Technology (中华人民共和国工业和信息化部): This ministry's Department of Energy Conservation and Comprehensive Utilization (节能与综合利用司) and Department of Raw Material Industry (原材料工业司) are responsible for formulating and implementing industrial plans, policies and standards, and monitoring the daily operation of industry.

Ministry of Ecology and Environment (中华人民共和国生态环境部): This ministry is responsible for introducing environmental protection policies and monitoring industrial pollution.

Workshop focus and format

This virtual gathering of Chinese stakeholders focused on the topic of data collection and did not examine potential solutions to current challenges. In parallel to the workshop, a TIP representative attended the CTRA annual conference to learn more about ELT management in China.

In addition to general challenges for ELT management and tire traceability, this workshop also considered the topic of ELT-derived rubber powder.

Key take-aways from the workshop

The discussions, interview sessions with experts and a conference visit revealed additional insights:

- Retreading, reclaimed rubber, rubber powder and pyrolysis are the four primary reuse and recovery paths for ELTs in China. The large size of the Chinese ELT market offers enormous potential for the growth of a circular economy but the scale also presents a challenge for the implementation of market-wide policies and considerable opportunities for innovation in new applications for ELT recovery.
- The state of ELT management in China has evolved rapidly. The market is dynamic, with frequent implementation of new regulations; but it is a diverse ecosystem of stakeholders of different sizes with inconsistent adherence to policy.
- Challenges to further developing ELT management in China include the volatility of ELT prices, the diversity of players in the market and their different approaches to ELT policy, and the high upfront investment costs required to develop new recycling methods and infrastructure.
- There is no market-wide ELT traceability system in place in China but workshop participants agreed that a system would bring important benefits. They noted that numerous players collect and distribute ELTs, some of which are not certified recyclers, which in turn negatively impacts product price on the market.
- The Chinese rubber powder market mainly supplies materials for use in road construction, sports tracks, runways and soundproofing materials for construction.
- There is evidence that it is difficult for foreign customers to buy ELTs for the production of rubber powder.

4 Overarching summary of the lessons learned at the three workshops

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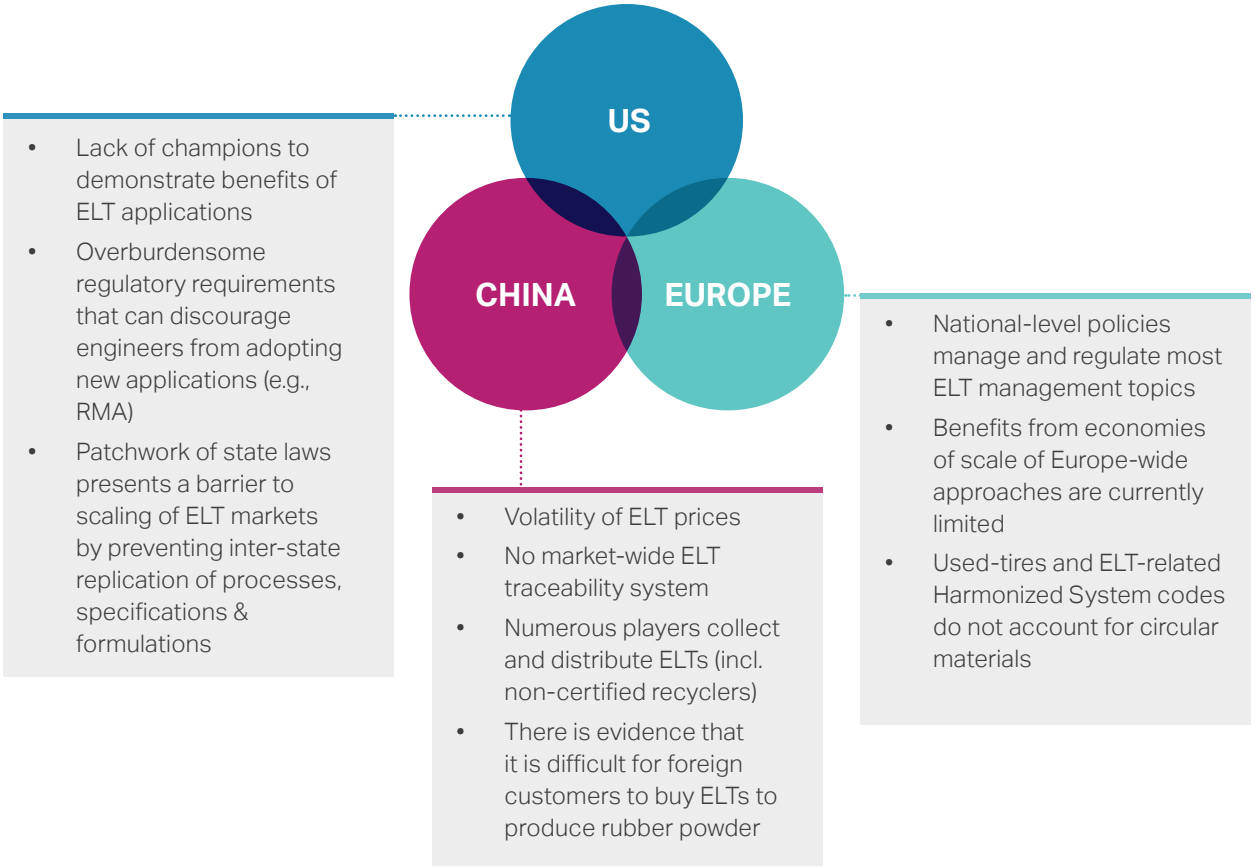
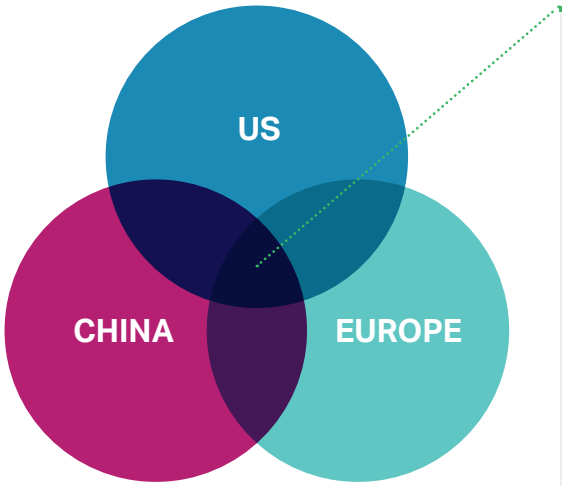
As a first step, the participants in each workshop identified the key challenges in their region. They are summarized below.

Figure 1: Summary of challenges highlighted per region



Even if each region has a different context and a different ELT management system in place, there are some common challenges across the regions.

Figure 2: Summary of challenges common to all three regions



- Inconsistencies between regional policies and their implementation (US states/Chinese provinces/European countries)
- High upfront investment to develop new ELT applications
- Absence of effective means for information sharing and collaboration among numerous and diverse value chain stakeholders
- Remaining data gaps and lack of consistent market reporting
- Limited communication of ELT management successes that can guide and inspire continued improvement

KEY LESSONS LEARNED AND PRIORITIZED SOLUTIONS PER IN-DEPTH TOPIC ACROSS REGIONS

Rubber modified asphalt (RMA): This promising application could boost the use of ELTs as a valuable material since there are strong enablers, such as existing success stories, good field data, the need for governments to reduce noise emissions in cities and promote sustainable recycling practices. To help scale RMA, discussions in Europe and the USA showed that creating a consistent product strategy, a lobby to represent the topic in political circles, a body of experts with the right testing facilities and expertise to run test projects, and a central sharing platform would be major milestones on the path to the successful use of ELTs in RMA.

Rubber powder market in China: Currently, most ELT rubber is used for road construction, sport tracks in stadiums, asphalt in airports, soundproofing material in construction, and reclaimed rubber. Various collectors, small and large, characterize the ELT collection system in China. There is also a general lack of transparency on how the system works and strong volatility in ELT prices. It is difficult for foreign players to come into the Chinese market and buy ELTs as a resource to produce rubber powder for the market.

ELT civil engineering applications: Civil engineering projects can use ELT material in the form of whole or shredded tires. These projects encompass embankments, backfill for walls, road insulation, field drains, erosion control and rainwater runoff barriers, materials to establish wetlands and marshes, crash barriers and jetty bumpers. The dialogue workshop revealed that common challenges include a lack of scalable solutions, concerns about environmental impact, lack of champions to demonstrate benefits, and the high regulatory requirements that can make engineers reluctant to trust new materials.

To help scale civil engineering applications, an open (global) platform to share and access data and insights on use cases, environmental benefits and critical issues across various types of stakeholders would be valuable, as well as defining a federal regulatory approach that helps to communicate the use of ELTs in civil engineering projects, as done for plastic recycling schemes.

ELT applications for molded and extruded products: Companies can use ground rubber (also called crumb rubber) in the form of power or granulate to produce molded and extruded rubber products. The difference between molded and extruded products is how they're made. Processes for molded rubber goods include injection molding or compression molding. The process for extruded rubber goods comprises pressing

through a die with the desired cross-section using the pressure of an extruder. The dialogue showed common challenges, such as the lack of homogeneity of ELT material, misalignment between supply and demand, competition from other materials, costly testing processes, and the need for education on the benefits of using ELT rubber instead of raw rubber for supply chain actors and customers.
The discussions showed that establishing measurement standards, like recycled plastics models, and improving the collaboration between actors through a consortium could help to promote the applications and help scale new ones.

Circularity metrics: In recent years, the circular economy has come to the fore as a new model to pursue sustainable economic growth. However, for companies and governments to be able to assess their circular performance, they need consistent measurement processes and metrics.
There is no consensus on how companies can measure their effectiveness in moving towards more circular business models. The dialogue showed common challenges including a lack of standard approaches to tracking metrics, a lack of tire-specific circularity concepts and metrics, the fact that savings for the environment are not tangible, the efforts of stakeholders are scattered and uncoordinated, there is limited alignment with adjacent industries such as automotive, stakeholders along the value chain misunderstand the need to collect data, common end-of-waste legislation and absence of public sector mandate to report circularity metrics.

To bring circularity metrics to life, participants agreed that it is key to create a circularity framework for tires and enforce greater alignment in the ecosystem. Businesses could use WBCSD circularity indicators as a starting point; making case studies more broadly available would be another step.

Traceability of car tires: Currently, shops and retail locations track tires via their tire identification number (TIN) numbers. They need to manually record this number each time and then enter it into a computer system, which holds all the database information related to that tire. To date, the tire industry, with its original equipment manufacturer customers and tire assembly providers, has not created an industry standard that would connect an intelligent tire to the factory or vehicle via, for instance, RFID.

Participants agreed that there are many benefits related to creating a proper tire tracing system that would help to overcome challenges such as lack of transparency on where tires go, illegal trade, lax regulations, safety issues, and lack of clarity about the responsibility for making recycling route decisions. All actors along the value chain, including tire manufacturers, ELT collection points, recyclers and companies using ELT material, need to collect and identify insights, share data, assess selection processes, develop new processes for recycling, and investigate new markets, labels and products.

5 Recommendations and next steps

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GENERAL RECOMMENDATIONS

The workshops revealed that an important challenge to improved ELT management is the diversity and number of players that make up the value chain. The value chain needs leaders to harness the considerable potential of the ELT market through the organized mobilization of stakeholders for new, effective and scaled ELT management systems.

Tire traceability and ELT circularity metrics are key enablers of improved – more circular – ELT management. Stakeholders should consider existing tools available within and outside of the tire industry (such as the WBCSD's Circular Transition Indicators (CTI)) for their potential to provide the market with the transparent monitoring of performance necessary to guide improvements in ELT management. And they should share successful local and regional initiatives more broadly. The workshops confirmed that stakeholders are motivated to continue to work together to better the ELT market and that this engagement will be critical to effectively addressing challenges and developing and scaling solutions. ELT stakeholders should continue to make use of opportunities for knowledge exchange and networking provided by initiatives such as the WBCSD Tire Industry Project.

The circular economy has its foundations in the principles of sustainable development; as such, stakeholders should make all improvements to ELT management systems with due consideration of potential human health or environmental impacts.

To keep progressing, there is a need for governments and private organizations to raise awareness and take actions on sustainability and the circular economy in order to foster momentum in the value chain for collaboration and the adoption of better practices.

NEXT STEPS

TIP, USTMA and ETRMA have updated their ELT management workplans, informed by the challenges and solutions raised during the workshops.

Following the first workshops, TIP published two sustainability frameworks that integrate relevant lessons learned and insights from the discussions:

- **The End-of-life tire (ELT) management Toolkit (2021)** identifies key steps to establish and enhance ELT management, with examples from various regions and countries.
- **Sustainability Driven: Accelerating Impact with the Tire Sector SDG Roadmap (2021)** describes how the tire value chain interacts with the Sustainable Development Goals (SDGs), the areas where the tire sector can have the most significant impact, and key actions to scale and accelerate contributions to the SDGs. Seven impact pathways comprise the roadmap, one of which focuses on circularity and ELT management and details a series of actions aimed at solving challenges, including those raised during the workshops.

TIP will continue to raise awareness of the importance of good ELT management practices and their contribution to the SDGs as described in the roadmap and the ELT Management Toolkit.

Further, the following provides an overview of some of the actions and initiatives that **TIP** will implement or support:

- TIP will initiate the development of a digital platform for ELT stakeholders to contribute to advancing global ELT management through networking and the gathering and sharing of best practices and knowledge.
- TIP, USTMA and ETRMA will update the ELT waste-hierarchy and recovery-route matrix to accommodate global sustainable and circular markets. TIP will define what sustainable and circular ELT markets mean at a global level and describe their characteristics.
- TIP will evaluate standardized methodologies and metrics for improved measurement and monitoring of the circularity of the tire value chain.
- TIP will work with customs experts and tire trade associations (TTAs) to identify potential updates to Harmonized System codes, for the benefit of improved ELT management.

- Building on the successes of the workshops organized in the US, EU and China, TIP will continue engaging with stakeholders from the ELT value chain and TTAs in other regions to exchange on the needs and solutions for ELT management.

In response to stakeholder requests made during the US workshop, **USTMA** is working on the following actions and projects:

- USTMA will continue to collect data on scrap tire markets and produce it's biennial Scrap Tire Management Summary Report to assess scrap tire markets in the U.S.
- USTMA will develop a report on the tire-derived aggregate (TDA) state of knowledge to look at TDA performance and its environmental and economic benefits in order to identify data gaps and where additional research might be needed.
- Following the release of the State of Knowledge Report on Rubber Modified Asphalt in June 2021, USTMA will continue to communicate its results through workshops planned for late 2022 in the North-East and South-East of the US. These workshops aim to address the patchwork of state specifications and regulations related to asphalt and they will be a forum for success stories and information sharing among the key collaborators in this field.
- USTMA will work to advance RMA and TDA as infrastructure solutions.
- USTMA will ensure that state end-of-life tire policies are reasonable and support market growth and will provide regular and consistent advocacy and education at the state level.

ETRMA took into consideration the challenges identified and solutions proposed by the participants of the EU workshop and will work on the following:

- ETRMA will continue updating its end-of-life tire management report yearly.
- Following the reopening of the European Commission's end of waste work, ETRMA will further develop the end of waste status for the ELT waste stream.
- ETRMA will continue collaboration with the European Recycling Industries' Confederation (EuRic) on a joint action plan to improve the recycling of ELTs in Europe.
- Regarding traceability, ETRMA recognizes the benefits and follows with interest the CERUB certification system (a label for sustainable recycled tire materials) to ensure traceability and transparency in the European ELT recycling chain. CERUB certification system has been developed by ELT Cos.
- ETRMA will cooperate in the debate on chemical recycling in Europe and support initiatives to further develop pyrolysis and devulcanization

TIP encourages all ELT value-chain actors to consider how they can contribute to the opportunities identified in this report, and we look forward to working with you toward a circular economy for end-of-life tires.

Appendix

1. An explanation of the focal topics of the regional workshops

SCALING THE USE OF ELT-DERIVED MATERIAL IN RUBBER MODIFIED ASPHALT

Rubber modified asphalt (RMA) is a bituminous mix of blended aggregates, recycled rubber and bitumen. Compared to conventional asphalt, RMA has demonstrated improved performance at low and high temperatures and a longer lifespan. RMA can also contribute to lower traffic noise levels and reduced vibrations from heavy loads.

POTENTIAL CIVIL ENGINEERING APPLICATIONS OF ELT-DERIVED MATERIALS

ELTs and their materials have properties that make them valuable for civil engineering. They are lightweight and durable and their use in different forms can provide insulation, shock and noise absorbance, and permeability. ELTs find use in the form of whole and shredded tires; conventional uses include construction of embankments, backfill for walls, road insulation, field drains, erosion control and rainwater runoff barriers, and crash barriers and jetty bumpers.

USE OF ELT-DERIVED MATERIALS IN MOLDED AND EXTRUDED PRODUCTS

Crumb rubber in the form of powder or granulate can be used to produce molded and extruded rubber products. The difference between molded and extruded products is how they're made. Processes for molded rubber goods include injection molding or compression molding. The process for extruded rubber goods comprises pressing through a die with the desired cross-section using the pressure of an extruder.

TRACEABILITY OF CAR TIRES

Car tires have tire identification numbers (TIN). Companies can use them to track key phases in the tire's life, from creation through to retail and servicing, to recovery at the end of its useful life as a tire. To date, the tire value chain does not have an industry standard for tracking individual tires or a central database that provides tracking information for all tires. The DOT week code used since 1971 – which is embossed on the tire sidewall – remains the only globally standardized method of tracking tires. New technologies, such as radio-frequency identification (RFID), present new opportunities to improve global knowledge and coordination of ELT management

CIRCULARITY METRICS

There is currently no consensus on how to effectively benchmark and measure improvement in the circularity of the tire life cycle. To address this gap, WBCSD has developed the Circular Transition Indicators (CTI), a framework to measure circularity that all industries can apply, regardless of their size, value chain position or geography.

RUBBER POWDER MARKET

Rubber powder is an important product of tire recycling. It has a growing number of applications with the emergence of high-performance powders (e.g., production of tires, footwear, hoses, and RMA).

2. Glossary of terms

Circular economy (CE): An economic model that is regenerative by design. Its goal is to retain the value of the circulating resources, products, parts and materials by creating a system with innovative business models that allow for long life, optimal (re)use, renewability, refurbishment, remanufacturing and recycling. (Source: WBCSD (2020). Circular Transition Indicators V3.0: Metrics for business, by business.)

Circularity metrics: A metric is a method to understand change over time across several dimensions. Circularity metrics focus on assessing the physical processes underlying circular performance. Indicators include all stages of the value chain, such as share of secondary materials used and recycling rates. (Source: Circle Economy and PACE (2020). Circular Metrics for Business: Finding Opportunities in the Circular Economy.)

Civil engineering and backfilling: A recovery route where civil engineering applications (water retention and infiltration basins, supporting walls, etc.) and landfilling or mining activities (tires that are shredded and mixed in with other geological materials to reclaim sites that have been mined out for example) make use of recovered ELTs.

Devulcanization: A chemical process that breaks the bonds of vulcanized rubber without shortening the carbon chains. Devulcanization is a recovery method for material recovery.

Devulcanized rubber: Rubber produced from the devulcanization process.

End-of-life tire (ELT): A tire that can no longer serve its original purpose on a vehicle. This excludes tires that are retreaded, reused or exported in used cars.

Extended producer responsibility (EPR): In the case of ELTs, when EPR applies, EPR holds the producer of tires (manufacturer or importer) responsible for the organization of ELT management, with targeted volumes generally defined based on the quantities of tires put onto the market.

Ground rubber: Ground rubber is produced by grinding ELTs into different sized pieces. Metal and fabric can be removed and the granules are sized for specific applications.

Material recovery: A recovery route category where ELTs are recovered for the production of new material. For example, ELT can be used to produce tire-derived material (TDM)

Pyrolysis: The decomposition of ELT material into oil, gas, steel and char in different proportions. The process includes the application of pressure, high temperatures and usually the absence of oxygen. Carbonization, gasification and thermolysis are related recovery methods.

Reclamation/reclaimed rubber: The conversion of vulcanized rubber waste into a state in which it can be mixed, processed and vulcanized again. Reclamation usually involves a chemical process. It is considered a method of material recovery.

Recovery application: The use of a recovery product, such as the use of tire granulate in rubber modified asphalt.

Recovery method: The process used to extract useable materials from ELT.

Recovery product: The the product of processing through a recovery method, for example tire granulate.

Recovery route (RR): The value chain from the point of collection, through processing and treatment methods to products and applications in end-markets.

Recycling: Involves the reprocessing of articles such as ELT to produce products, materials or substances. This excludes the production of tire-derived fuel.

Retreading: Also known as recapping or remolding. The process of tire renewal for reuse by replacing worn-out rubber belts and treads with new ones.

Rubber modified asphalt (RMA): A pavement material that consists of regular asphalt concrete mixed with crumb rubber made from recycled tires. The main benefits of RMA includes noise reduction and road durability increase.

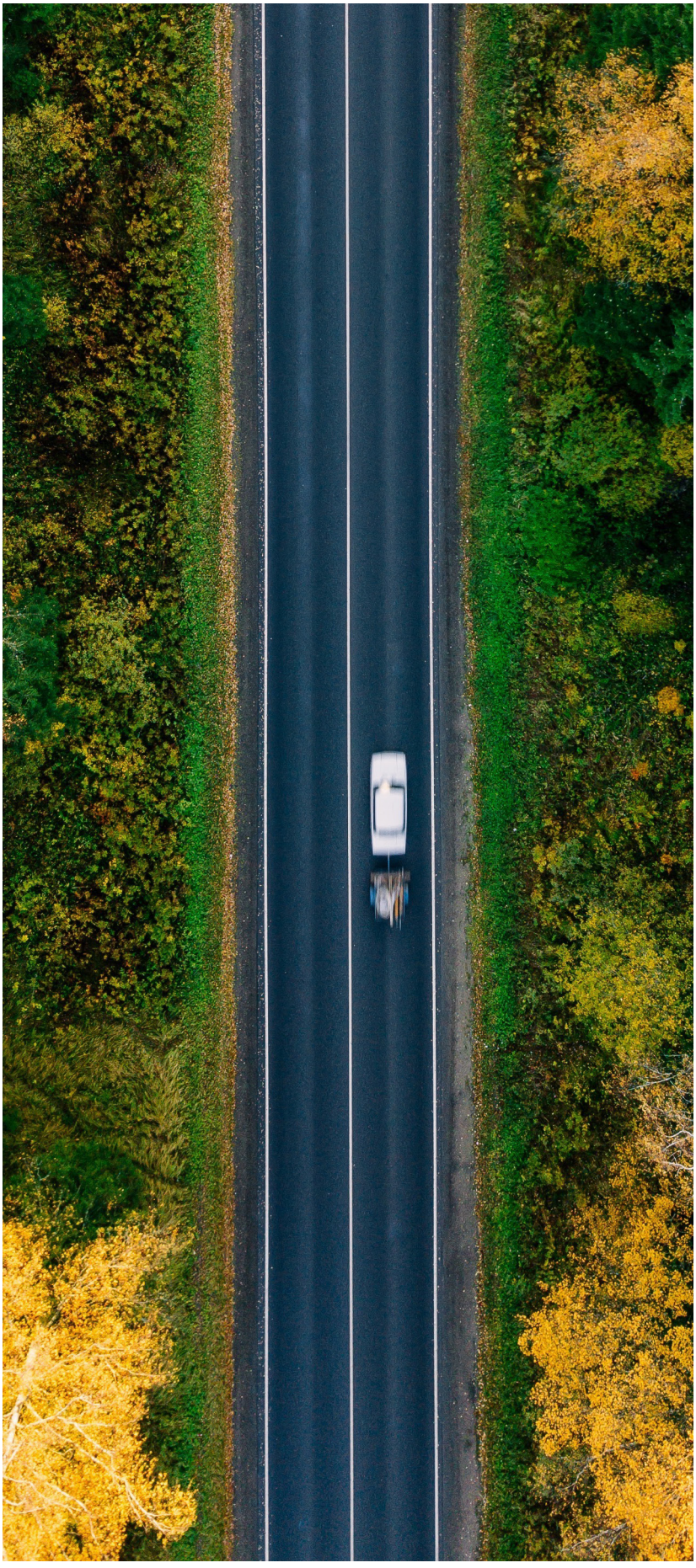
Rubber powder: Micronized rubber powder (MRP) is categorized as a dry powdered elastomeric crumb rubber in which the majority of the particles are <1000 µm.

State of knowledge (SOK): A review and analysis of the available information on a topic.

Tire-derived aggregate (TDA): A building material made of recycled tires that are shredded into pieces of varying sizes. It is commonly used in construction projects because it is readily available, lightweight, and less costly than many other materials.

Tire-derived material (TDM): An example of recycling, TDM is a product made from the recycled material of ELT.

Tire-derived fuel (TDF): A recovery sub-category, TDF is ELT used as an alternative fuel to produce energy through combustion (energy recovery). TDF also refers to the fuels produced by a specific treatment of ELT (such as pyrolysis, which can produce oil and gas output products along with a TDM portion).



3. ELT management challenges and potential solutions tables

The following tables capture the ELT management challenges and potential solutions that participants shared during the three regional workshops. They do not necessarily reflect the views or opinions of TIP or its members. Some of the entries have been edited for clarity and length.

1. STAKEHOLDER DIALOGUE USA – DETAILED SUMMARY

How might we scale the use of rubber modified asphalt (RMA)?

The content below has its origin in the stakeholder dialogue and consists of the anecdotal evidence and personal opinions of the different participants. Workshop participants discussed challenges and how to overcome them and prioritized the solutions highlighted in **orange**.

CHALLENGES IN SCALING THE USE OF RMA?	HOW MIGHT WE OVERCOME THESE CHALLENGES? *Prioritized solutions in orange
MARKET & ECONOMICS	
Lack of funding for RMA market development There is a high capital cost to develop a market for RMA. Currently, money and resources are being spent on established processing and recycling models instead of new market development. Also, recyclers are not strong at developing new markets since they are focused on their core business. With the focus on climate change mitigation in the next years it will be essential for ground tire rubber manufacturers to begin assessing their contribution and maybe even looking at environmental product declarations (EPDs).	Increase awareness for the lifecycle cost benefits of RMA vs other asphalt types. Improve and innovate the process of producing RMA at lower costs, promote process and its benefits. Collaborate with policy makers including state Departments of Transportation to spur RMA market development.
High upfront cost for shifting to RMA production There is a lack of knowledge of contractors about what will change when using RMA and a reluctance to adopt new and costly processes and equipment. As a result, the bidding process in many states tends to be based on the lowest bid rather than performance. Contractors need to see a process that makes sense from an economic and engineering point of view. In the past, the price for RMA has been too expensive because the use of crumb rubber in asphalt production is relatively expensive compared to normal hot mix asphalt as well as virgin devulcanized rubber. Nevertheless, new processes (e.g., dry process) can reduce the price and contractors are starting to see the benefits.	
Competition from plastics industry and sustainability rush Plastic waste can be an alternative to rubber in RMA. The plastics industry has more capital than tire processors to grow new markets for their waste and is becoming a competitor for the RMA market. Also, there is a strong polymer-modified asphalt lobby at the Department of Transportation (DOT) and state level.	
Limited tire manufacturer involvement The highest priority of tire manufacturers is the safety of the tire. Currently, some participants consider the manufacturer's involvement in ELT management to be limited.	
Partial lack of extensive local supply of crumb rubber due to high costs of using crumb rubber for RMA The use of crumb rubber in asphalt production is relatively expensive compared to normal hot mix asphalt and virgin unvulcanized rubber.	

RESEARCH

Lack of centralized body of expertise to answer key questions

There are conflicting opinions on the function of rubber powder in asphalt and no centralized body of expertise that can answer key questions in a consistent way with the right knowledge, experts and equipment to decide on and run what are considered the right test projects for data collection to make the case for RMA.

Inconclusive evidence bases on health and environmental impact of RMA and lack of long-term field data

Lack of scientific consensus on the potential health and environmental impacts of rubber modified asphalt (also relative to alternative materials) has resulted in some hesitancy among companies and public actors.

Create a centralized body of expertise on RMA that has the right experts and testing facilities to give advice and educate stakeholders and run adequate/relevant test projects/studies.

Actions to take going forward

Short term (6 months)

- Define goals and objectives of center.
- Identify potential sites for center (e.g., universities and large research labs).
- Review staff/equipment capabilities.
- Negotiate a task order budget
- Develop specific project, testing and training agendas.
- Recruit standing body of experts (producers, contractors, academics, experts).

Mid-term (2 years)

- Found permanent international organization to act as a centralized body of expertise with national chapters.
- Find a way to get international support.
- Collect key available studies, information, data, etc.
- Identify gaps and define a roadmap to fill them.
- Create links between this body and interested parties (DOT, engineers, contractors).

Long term (more than 2 years)

- Support publications/partners in developing research, e.g., journal on asphalt technology.
- Regular education programs and conferences could be organized to update on knowledge.

RESEARCH

Run test projects to collect missing field data on RMA and on contribution to microplastics, etc.

Actions to take going forward

Short term (6 months)

- Set out goals and objectives.
- Define range of environments, mix designs, traffic levels and determine scale and financial commitment. This is what is really needed to grow this market in the US.
- Integrate DOTs in project design.
- Select demo sites, possibly test tracks or full use roads.
- Select tech to demonstrate.
- Establish long-term monitoring and reporting.
- Feed results through tech center to DOTs.

Mid-term (2 years)

- Include producer community in project design and discussion, use the trial as an industry teaching tool.
- Transfer funds to run the tests.
- Research to demonstrate performance, life-cycle analysis (LCA) and other benefits.
- Research to answer new threshold questions relating to zinc (Zn), organic compounds 6PPD and 6PPD quinone, microplastics and tire and road wear particles (TRWP).
- Compare RMA manufacturing processes: wet, dry, wright process.
- Encourage state market development funding for research to answer the threshold question.
- Determine actors to run the tests.

Create a platform/database to facilitate information sharing.

REGULATIONS	
Current testing practice for asphalt is not suitable for RMA Current mandatory testing practices are outdated and are not even followed for traditional asphalt. Due to the nature of the test, it is clear that RMA would not pass the test and therefore the product is not considered. Tests only focus on demonstrating the strength of one component of the asphalt and do not look at the holistic final product or application. **Missing statewide specifications on RMA** Currently, there are no statewide specifications and a lack of federal actors to oversee and make specifications consistent.	Adapt test standards and regulations to RMA.
EDUCATION	
Lack of multi-level education Many times, stakeholders like scrap tire processors and regulatory staff do not speak the same language as DOT/road engineers. Scaling RMA requires collaboration and education between various stakeholders along the value chain to speak the same language and base discussions on identical facts and figures. **Lack of acceptance by DOT engineers and contractors due to negative reputation from failed past projects** To get specifications from the material engineers at each state DOT, RMA as a material must be accepted. Since safety is the highest priority for engineers, bringing in new methods and applications implies a certain perceived new risk. Also, there is limited staffing and little experience in the states on the use of RMA and past failures make DOTs hesitant to try again. Indeed, the mixed success of early rubber modified asphalt projects initiated in the 1980s and 1990s continues to influence opinion, despite more recent success stories.	Actively promote success stories, such as how California is successfully scaling RMA to overcome negative reputation from past failures. Deploy coordinated effort to facilitate technical dialogue with DOTs and FHWAs for specifications for RMA Actions to take going forward Short term (6 months) • Identify coalition members that have relationships with key states (expected to be Arizona, California and Massachusetts. • Gather data on existing successful projects around the country to share with DOT leadership. • Identify contractors that are willing to promote RMA and associated benefits. • Develop coordinated messaging to request federal DOT promotion of RMA in infrastructure plans.

EDUCATION	
	Mid-term (2 years) • Leverage national trade associations for state DOTS (like the American Association of State Highway and Transportation Officials – AASHTO) to deploy DOT education and best practices. • Develop education tools from success stories and a state of knowledge (SOK) that can be used at federal and state levels. • Improve coordination between USTMA and rubber processors on this effort. • Develop multi-stakeholder group to coordinate efforts from the value chain for RMA. Taking a full life-cycle approach to market development. • Work with ASTM to amend standards to make RMA more accessible for DOT agencies. • Use workshops as a venue through which state DOTs can share best practices with each other.

A general solution to respond to the challenge above is to create a platform or database to facilitate information sharing in a single place of trust:

- Contacts and experts
- Champions and successful projects, success stories
- Studies, test projects
- Technical data

Run dedicated workshops and training for a variety of stakeholders from the ELT value chain to demonstrate benefits, explain processes, share success stories and increase awareness of benefits of RMA

How might we increase the use of ELT materials in civil engineering?

The content below has its origin in the stakeholder dialogue and consists of the anecdotal evidence and personal opinions of the different participants.

Workshop participants discussed challenges and how to overcome them and prioritized the solutions highlighted in **orange**.

CHALLENGES	HOW MIGHT WE OVERCOME THESE CHALLENGES? *Prioritized solutions in orange
PRODUCT	
Lack of ready, consistent and scalable solutions There is a lack of specific ready-to-use material solutions for the different civil engineering applications to make engineers comfortable with using ELT material for their projects and engineers are reluctant to experiment with new materials.	Demonstrate and communicate the benefits of developing ready-to-use material solutions tailored to most widely used civil engineering applications and advocate material solutions among engineers.
MARKET & ECONOMICS	
Competitive market dynamics There are strong competitive market dynamics between manufacturers of TDA material, which is why companies treat material compositions and means of processing as a trade secret, hindering knowledge sharing. **Lack of large-scale customers to create limited demand** There is a lack of large-scale customers to create the necessary demand for production to achieve scale. **Local availability of tire-derived aggregate (TDA)** Since some civil engineering projects can use very large quantities of TDA it is sometimes difficult to ensure quick availability of required quantities in the right place and time. As customers do not yet use the material widely and consistently, it is difficult to predict future demand for TDA.	Develop market brokers and have supply chain ready. • Package it as a readily available "bundled/wrapped" commodity to have attractive supply offerings. • Create a place to store material for bigger supplies. • Create a "broker" to have supply chain ready to get material to customers. Incentivize market creation by manufacturers. Give tire manufacturers economic incentives to facilitate markets for ELT (in other words, "skin in the game"). Create steady demand to stimulate investments. • Use public procurement as a reliable kick-starter and foreseeable quantities over coming years. • Find anchor clients with larger projects for predictable demand, like landfill extraction systems.

RESEARCH

Lack of availability and accessibility to data on environmental and health impacts

Even though there already has been a considerable amount of research into using TDA in civil engineering applications, these insights are not easily and quickly accessible to key decision-makers.

There are data gaps that exist regrading the use of ELT material in certain civil engineering applications related to tire materials.

Unclear advantages and disadvantages of TDA

For many civil engineering applications the advantages and disadvantages of using TDA compared to natural aggregates, such as sand or gravel, are not entirely clear. This ambiguity hinders the scaled use of the material.

No collaboration between engineers and researchers

The lack of connection between engineers and researchers makes it difficult to understand and identify relevant issues.

Create an open data platform to quickly share and access data and insights on potential use cases, environmental benefits, and critical issues across various types of stakeholders. The information and research available on the platform would be continuously updated. Third parties, which are independent and transparent, could serve as a host or gatekeeper.

Actions to take going forward

Short term (6 months)

- Connect to existing data sets, summarize current databases, leverage existing research.
- Adopt an existing assessment
- framework, like GreenScreen.
- Engage with likely opponents.
- Identify financing mechanisms.

Mid-term (2 years)

- Engage stakeholders.
- Perform a state of knowledge and collect all research papers.
- Create comparative overview of TDA and alternatives.
- Understand data gaps.

Long term (more than 2 years)

- Reach out to stakeholders – existing and potential.
- Collect best management practices for TDA.
- Create certifiable material guide for TDA.
- Develop archive for new users and use guidelines.

RESEARCH	
	Develop a research agenda for: • Comparative analysis to apply same standards to all materials (e.g., for infill material) and extend research on leaking from iron materials; • Missing environmental studies by analyzing existing research on all major civil engineering applications, defining remaining gaps and set up respective pilot projects together with researchers.
EDUCATION	
Lack of champions demonstrating the use of TDA in civil engineering There is a lack of champions in the private and public sectors that demonstrate new solutions in civil engineering for which TDA can be used effectively and communicate best practices publicly and with enthusiasm. **Lack of knowledge about various applications of TDA** There is a lack of knowledge and understanding of the various applications of TDA as well as their properties, benefits and environmental impacts at potential customers, regulators, etc.	Incentivize actors that have successfully worked with TDA in civil engineering projects to share their success stories through media or via conferences. Create a learning and communication platform. • Facilitate better/more communication across regions (countries, states, etc.) to share success stories and challenges. • Provide education tools highlighting the value of TDA to regulators and civil engineers, outlining historic solutions to problems that were conquered with TDA. • Provide a collection of white papers that address TDA's properties and availability when designed properly to improve environmental impacts of existing civil engineering projects. Run demonstrations/pilots. • Test pre-treating material so that it may lose chemicals. • Design demonstration projects to collect 6PPD in infiltration galleries with TDA as high void space storage material, perhaps lined with organic soils.

EDUCATION

Communicate benefits clearly to customers.

- Communicate economic benefits from LCA to customers/ governments to make the business case for using TDA over other materials.
- Identify opportunities to communicate TDA benefits to interested parties, e.g., define the use of TDA in stormwater infiltration as best practice if possible.

Develop product categorization/ classification.

- Develop a product category rule for infill material to compare TDA and other infill materials in a common way.

REGULATION

Requirements of civil engineering projects

For many civil engineering projects there is high regulatory pressure and a tight timeline requiring rapid action, which results in trusting familiar material and processes rather than having the openness to experiment with TDA. They often do not evaluate positive environmental benefits vs other materials.

Non-uniform laws in various states

There are different regulations, specifications and approaches in the different regions and even states, which represents a challenge for scaling TDA as it needs to be adjusted based on the local requirements.

Public administration could incentivize the use of TDA in public civil engineering projects by introducing a minimum ratio of recycled materials that needs to be used.

Find a federal regulatory approach like tire-derived fuel (TDF) for which the Environmental Protection Agency (EPA) has a non-hazardous secondary materials category that defines what is waste and what is a legitimate fuel, for states to define TDA.

Actions to take going forward

Short term (6 months)

- Review existing federal regulations to identify opportunities for rulemaking to define TDA.
- Promote the use of TDA in federal procurement policies.

Mid-term (2 years)

- Petition EPA for rulemaking to define what infill material is a waste and what is a legitimate product.

A general solution to respond to the challenge above is to create a platform or database to facilitate information sharing in a single place of trust:

- Create an open data platform to share data and information holistically on use cases and LCA, benefits, critical issues, etc. – across research institutions, across administrations, etc.;
- Develop a list of relevant data for each major TDA application and do a gap analysis;
- Perform a state of knowledge on TDA to pull all of the information we have about performance and environmental impacts and benefits into one place, update as new studies become available and identify data gaps;
- "Reframe the conversation of "no waste" - base material for new uses - while considering potential environmental and and human health impacts and benefits.
- Aim to speed up the process of information sharing;
- Build on precompetitive collaboration among tire manufacturers to evaluate and make publicly available chemical hazard assessments of chemicals used in tires;
- Use trusted third parties that are independent and transparent as host and gatekeeper.

Share TDA use success stories in civil engineering projects via media and conferences.

How might we foster the use of ELT material to produce molded and extruded products?

The content below has its origin in the stakeholder dialogue and consists of the anecdotal evidence and personal opinions of the different participants.

Workshop participants discussed challenges and how to overcome them and prioritized the solutions highlighted in **orange**.

CHALLENGES	HOW MIGHT WE OVERCOME THESE CHALLENGES? *Prioritized solutions in orange
PRODUCT	
Lack of homogeneity of ELT material ELTs vary greatly in terms of their material composition, quality and age. The absence of proper sorting of ELTs along these characteristics leads to large inconsistencies in quality of the secondary material, **complicating subsequent production processes** (e.g., sulfur vulcanization) **of recycled material** and potentially leading to lower ELT material use and lower product performance.	Ensure better sorting of tires by leveraging new tracing technology to ensure consistency over ELT material properties. This could ensure greater homogeneity of ELT material.
MARKET & ECONOMICS	
Misalignment between supply and demand As the market for molded and extruded products from ELTs is rather new and supply and demand can hardly be foreseen, suppliers often cannot guarantee that the material has the right mesh size and quality, and quantity is readily available at the right place. This causes reluctance on the part of manufacturers to use ELT material for their products. **Testing process is too extensive and costly** Molded and extruded products using ELT material require extensive testing (e.g., for toxic substances), which often ruins the economics, especially for entrepreneurs who cannot afford the up-front investments for the testing process.	**Set-up regular conferences and meetings to foster the collaboration between manufacturers and suppliers.** Joint mapping of application-specific demands could provide guidance for suppliers.

MARKET & ECONOMICS

Competition from other materials

For many molded and extruded products, there are other materials that can be used that may have advantages in certain contexts. For example, as plastic is not as dense as rubber, it is the preferred material in all applications for which lightweighting is important (e.g., automotive industry). Similarly, for molded and extruded products that are used indoors, rubber is rarely used due to its strong odor.

Low return on investment for some products from recycled materials

The production of molded and extruded products from crumb rubber is in some cases economically unattractive because of high cost of operations in combination with low return for products from recycled materials.

Actions to take going forward

Short term (6 months)

- Map existing consortia that could foster collaboration between manufacturers and suppliers.
- Assess whether EPA's Buy Recycled program could be used to foster collaboration.
- Engage tire suppliers during annual sustainability symposium.

Mid-term (2 years)

- Share regional efforts and success stories among manufacturers and suppliers.
- Map application-specific demands that help guide suppliers.
- The Administration and Cabinet are foster enabling new initiatives through legislation and policies.

Long term (more than 2 years)

- Build a platform to operate on and develop collaboration programs.

Consider to what extent it might be possible to standardize products and consolidate product portfolios so that matching supply and demand of the material is easier and more efficient.

Develop a shared platform to allow for sharing of test data and methods that are not subject to confidentiality and represent a central point through which useful information can be accessed, e.g., list of labs capable of testing rubber products.

MARKET & ECONOMICS

Set-up consortium for testing which could prioritize, specify and allow tests for consortium members, enabling economies of scale and thereby cost benefits compared to conducting tests individually.

Address common issues related to testing (e.g., odor) jointly.

Develop performance predictors for products, which could reduce the need for testing.

Identify the use cases for which rubber due to its properties is the superior material and try to better showcase the preferability of rubber in these situations.

Aim for new regulation stimulating supply and demand and for governmental subsidies until the market is mature in order to build up supply and demand side.

EDUCATION

Shifting towards recycled materials is a complex change process
In some industries, switching from raw materials to recycled materials is a long and complex process involving many different players. For example, if the automotive industry wants to use more molded and extruded products made from recycled materials, this means that material labs, engineers and tier 1 and tier 2 suppliers must all step up. As there is no real catalyst for change (e.g., regulatory pressure), the actors involved do not see a reason to jointly initiate this change process.

More data-based education of relevant stakeholders needed
There is a need for more education of both supply chain actors and customers about the benefits of using ELT material in molded and extruded products. Among material suppliers and manufacturers there needs to be a greater awareness that ELT materials can be used in molded and extruded products in the same way as virgin materials, and more knowledge about technical details (e.g., formulations) must be shared. Customers need to be educated about the environmental benefits of using recycled materials in products (e.g., by using LCA data) and about the fact that products from recycled materials are not necessarily of lesser quality than products from virgin materials.

Set-up consortium for communication that could include stakeholders from the whole value chain, as well as from the public sector and academia, thereby ensuring the strong voice of the tire ecosystem.

Create a holistic communication strategy to ensure ongoing, deliberate and sustained outreach and to tailor communication to the various stakeholder groups, highlighting the different benefits of ELT material. Start communicating to high-volume/high-value markets.

EDUCATION	
Potential misconceptions about products from recycled materials People may develop unfounded generalizations that products made from recycled materials are of lesser quality than other products, which might apply to a few products but is not a generally valid statement. **Biased view of environmental trade-offs** Some stakeholders have questioned the potential environmental impacts of different uses of ELT material (e.g., playground tiles). Often forgotten is that the appropriate use of ELTs offers important benefits for the circular economy and other efforts to minimize the potential impacts of products at end-of-life.	**Establish standards and measurements for reliable and understandable communication (e.g., create a recycled rubber content label for products), similar to other industries** (e.g., recycled plastics model). Communicate success stories to show the variety of products for which ELT material can be used.

A general solution to respond to the challenge above is to create a platform or database to facilitate information sharing in a single place of trust:

- Test data and methods
- Success stories
- Technical data

2. STAKEHOLDER DIALOGUE EUROPE – DETAILED SUMMARY

How might we scale the use of rubber modified asphalt (RMA)?

The content below has its origin in the stakeholder dialogue and consists of the anecdotal evidence and personal opinions of the different participants. Workshop participants discussed challenges and how to overcome them and prioritized the solutions highlighted in **orange**.

CHALLENGES IN SCALING THE USE OF RMA?	HOW MIGHT WE OVERCOME THESE CHALLENGES? *Prioritized solutions in orange
MARKET & ECONOMICS	
The commercial strategy for RMA's product positioning and pricing as well as regulations are different in each country The high upfront capital spending is necessary to develop a market for RMA and essential to doing so is a consistent commercial strategy. Currently, each country positions and prices RMA differently and has its own history and experience in using RMA to build road infrastructure. Moreover, each country has different regulations related to RMA (if any at all). **High upfront cost for shifting to RMA production** The construction costs of using crumb rubber in asphalt production is relatively expensive compared to normal hot mix asphalt and to using virgin unvulcanized rubber.	Similar to the US stakeholder dialogues, EU dialogue stakeholders suggested the joint development of a market positioning strategy for RMA.

MARKET & ECONOMICS

Unbalanced risk distribution of using a new application
Even if there is no risk in using RMA when produced according to the right standards, road owners feel that they are taking the risk of a potential failure since the other stakeholders involved, such as the paving company, asphalt contractor, rubber powder producer, etc., are not willing to provide a warranty.

Incomplete communication of requirements of RMA, which might lead to further unsuccessful projects.

Negative reputation due to failed projects in the past
The tire recycling industry in the past has not addressed this market professionally. For example, specifically in the Netherlands, the impression was given that the particle size of the rubber powder (<1 mm) was the criterium for a successful application in asphalt. The parties involved realized that the success rate is in the binder. The application for rubber powder in asphalt in the Netherlands without binder was a disaster and since then no asphalt company wants to discuss it anymore.

Competition and strong lobbying by polymer manufacturers
EU stakeholders made similar comments to those of US stakeholders: that plastic waste can be an alternative to rubber in RMA. The plastics industry has more capital than tire processors and is quickly growing new markets for their waste and is a competitor for the RMA market.

Actors from the RMA supply chain are far away from each other, which makes communication harder and indirect (paving company, asphalt contractor, rubber powder producer, politicians, regulators, recyclers, etc.)

Build an RMA advisory board of experts from across the supply chain that can share and discuss key topics on a centralized platform to facilitate information sharing in a single place of trust to:

- Establish a common language – by making sure technical terms are easy to understand by all stakeholders involved (state engineers, politicians, administrators, etc.), using, for instance, clear definitions of terms, glossaries, etc.;
- Offer translation of top studies;
- Also address any other technological solution that is challenging crumb rubber to have a transparent scientific debate and perhaps identify possible synergies (in terms of both technology and dissemination);
- Show that laboratory testing allows for the predicting of asphalt durability (fatigue tests, rutting test, crack test, etc.); asphalt design is not a trial-and-error practice but is science-based. Use the number of articles/papers that are available already.

Action to take going forward

Short term (6 months)

- Platform design principle = simple user interface, practical and pragmatic for a variety of users.
- Create a first platform prototype.
- Collect and share a variety of studies and be sure to compare like examples when it comes to technical aspects and performance improvements.
- Designate part of the recycling fee for RMA research/practice and the advisory platform.

MARKET & ECONOMICS	
	• Create a working group in ETRMA or European Tyre and Rim Technical Organisation (ETRTO) incl. major player of Asphalt Industry and Academy (create ecosystem). • Identify universities and companies that have experience in working and designing RMA and invite them to collect and share the information to get good advice and consultancy. • Locally, each country prepares a database with experts and consultants in RMA from the specific country, inviting them to this European board; once collected, join all of them, organize and share with all stakeholders. • Define the audience to use the platform, tailor user centrality, use modern formats. • Find champions to "market" or tell stories about successful RMA applications (companies, media, youtuber, etc.). Mid-term (2 years) • Organize a specific RMA congress to collect further experiences. Long term (more than 2 years) • Create best practices awards. • ssess value of platform for users and improve iteratively. Establish an insurance fund to remove risk of trying new applications. Finance 3 construction companies to try and champion RMA to speed up demonstration of successful RMA projects (vs financing more theoretical studies).

PRODUCT

Lack of "design to recycle for RMA" by manufacturers
Tire manufacturers currently do not promote or raise awareness about ELTs as a resource. Also, the chemicals already used in tires may prevent them from being reused into asphalt.

Only a few European countries have technical specifications for RMA
Discussions oftentimes revolve around perceived technical challenges with RMA, not on clear and proven facts. There is no standard body that writes technical specifications for RMA since it still is not an established material to use for asphalt production in Europe.

Lack of acceptance of RMA as a material by engineers of public agencies and reluctance to try new technology and change the usual way of working
Engineers tend to be risk averse to new methods and applications since safety is their highest priority. Changing the usual way of working takes time.

Discussions oftentimes revolve around perceived technical issues
As many stakeholders are involved in conversations on new ELT applications, the discussions can end up focusing on technical issues "heard of" and not actual technical challenges confirmed by specialists.

Missing central body of experts to communicate to a variety of stakeholders
Different stakeholders from across the value chain approach public agencies that decide on road construction, which makes the effort look uncoordinated and sometimes ambiguous.

Create a "blue book" to clearly define which technology and mixtures to promote.

Develop strategy to work with other players (e.g., from oil industry).

As the market is changing and big corporations are increasingly involved with sustainable sourcing of raw materials, aim to involve Total or Shell or others for high-tech solutions and create a win-win situation.

REGULATION

Perception of ELTs as waste and missing regulatory support to promote ELTs as a resource
In the political arena ELTs are still regarded as waste and not as a resource. Also, there is no regulatory support to, for instance, set a mandatory minimum quantity of ELTs to be recycled into asphalt, which could boost R&D.

Short-term agenda of politicians and tight budgets in many parts of Europe
RMA shows various long-term benefits that might not pay off within the timeframe of an election period.

Tight budgets in many parts of Europe
If circular economy is linked to cost increase it becomes less interesting.

Lack of acceptance of RMA as a material by technicians of public agencies
As public officials have to follow standard requirements when approving the construction of new roads and new applications imply new ways of looking at construction approvals, the acceptance tends to be lower as there is less experience with the materials/applications.

Create a strategy for a stronger RMA lobby at European and local levels.

- Establish common standards for RMA specifications (e.g., have minimum quantity ELT recycled into asphalt).
- Not only bet on circular economy by public administrators but also monitor their actions to check compliance with sustainability parameters in road management, design and construction.
- Invest in academia-driven projects that demonstrate how RMA supports green public procurement (GPP) policies in circular procurement and life-cycle costing.
- Educate regulators and industry.
- Create a common agreed strength, weakness, opportunity, and threat (SWOT) analysis for RMA based on current experience to be published and presented to legislators.

REGULATION

Actions to take going forward

Short term (6 months)

- Define lobby working group and work with professional lobbying organizations to obtain end-of-waste (EoW) status for ELT rubber and work out regulatory framework for: EU Norms – technical standards and obligation of rubber use. E.g., make sure that RMA is part of the "alternatives" as a material for asphalt and other applications such as artificial turf (potentially via ETRMA).
- Create a strategic stakeholder map to define organizations and stakeholders to work with and understand why certain stakeholders are not in favor of RMA and find a way to change minds.
- Use the momentum of topics such as sustainability, noise mitigation** and circular economy to enter conversations and ensure RMA is included in political and regulatory definitions of "sustainability" and "recycling". Surveil politician's actions to hold them more accountable. (**Note: Noise mitigation is important right now. Road administrators must have an action plan to reduce the noise in urbanized areas.)
- Get ETRMA to agree that RMA is an approved joint target.
- Implement Green Public Procurement (GPP) policies in cooperation with the authorities to set minimum goals for use of ELTs. The GPP is a useful tool for public administration but currently with low usage.

REGULATION	
	• Present successful RMA use projects and other scientific case studies to increase awareness of benefits. • Secure funding for sustainability and noise topics for ELT applications, as well as general infrastructure/highway funds. Mid-term (2 years) • Create a joint paper to support the tire industry call for promotion of RMA. • Pick a first champion (player/ country) to be followed by others. Include locally based authority for roads, tunnels, etc. • Involve municipalities in trial and demonstration projects and co-fund several local road trial resurfacing projects. • Ask for a mandatory lifecycle costing (LLC) /LCA-based approach to public procurement. • Develop national technical specifications. Long term (more than 2 years) • If an EU EoW regulation is going to be adopted, ask for recognition of RMA as a destination that is to be preferred, e.g., local governments, Deges (German Autobahn), state authorities. Develop an "incentive system" for recyclers to develop new markets and present new ideas (that could be co-financed through tire manufacturers to boost the development of, for instance, new applications for ELTs).

EDUCATION & STUDIES ON RMA

Inconclusive evidence base for health and environmental impact of RMA
Lack of scientific consensus on the potential health and environmental impacts of rubber modified asphalt (also relative to alternative materials) has resulted in some hesitance among companies and public actors.

Multitude of studies (scattered across institutions and countries), variety of languages and limited long-term studies on RMA is creating distance between the various actors in the RMA supply chain and there is no central repository with studies and best practices
Indeed, a variety of studies exists from corporate and academic players; however, they are in different languages. This implies lowered awareness of the existence of those studies and cumbersome search and translation.

Additionally, actors along the RMA supply chain such as public ministries for transportation, asphalt producers, recycling companies, construction companies, etc. have different priorities, key performance indicators (KPIs), core business focus, different language, etc.

Many times, stakeholders like scrap tire processors and regulatory staff do not speak the same language as DOT/road engineers. Scaling RMA requires collaboration and education between various stakeholders along the value chain to speak the same language and base discussions on identical facts and figures.

Lack of long-term studies and systematic measures to investigate technical performance, impact in vehicle/road performance and health risk
Currently, different measurements (e.g., fuel consumption, vehicle emissions, TRWP vs other asphalt technologies) and testing techniques are applied and only limited long-term studies are available.

Co-finance long-term monitoring study with same testing and measurement techniques and review and document existing applications with companies who built RMA roads and understand what led to the successful implementation.

- Review and define actions based on new reports: USTMA conducted a state of knowledge (SOK) on rubber modified asphalt. This was performed in partnership with The Ray and the University of Missouri. It identifies existing research on performance and assesses research on environmental impacts and benefits. It also identifies key data gaps and existing inputs to perform an LCA for rubber modified asphalt. The SOK was made public and available in May 2021.
- Finance more LCA studies, commissioned by independent third parties: different scenarios to be covered, multiple trial roads with associated studies on different types of surfaces with variation in the mixes.
- Cross-border research collaborations: As more field data on rubber modified asphalt is needed, cross-border and inter-regional communication could be encouraged to improve the collection and exchange of data.
- Assess pros and cons: Even if the pure cost of RMA might be higher than it currently is, it is necessary to show the benefit for the environment due to the recyclability of ELT and of RMA itself.

EDUCATION & STUDIES ON RMA

- Collect more field data by running test projects: As lab tests do not forecast long-term performance of rubber modified asphalt properly more field data is needed.

Develop design tools (software) for RMA to facilitate the inclusion of RMA mixes.

A general solution to respond to the challenge above is to create a platform or database to facilitate information sharing in a single place of trust:

- Champions and success stories
- Technical data, studies and translation
- Contacts and experts
- Best practices

How might we create traceability of tires along its value chain that enables more efficient and effective recycling?

The output of the in-depth discussion on traceability differs from other breakouts since it was discussed at a higher level as the topic is still in its infancy.

The content below has its origin in the stakeholder dialogue and consists of the anecdotal evidence and personal opinions of the different participants.

CHALLENGES

Challenges related to the high-level transparency of ELT management, which could be overcome with better tracing

- Even though there is rough transparency on recycling/ recovery routes of ELTs, the data is not complete and limited statistics are available.
- Data on life-cycle assessments of tires are not comprehensive for recycling and recovery routes.
- Lack of transparency about illegal trade and percentage of tires for which eco-contributions were paid according to the respective EPR scheme.
- Regulations by the European Commission are not strict enough.

Challenges related to the sorting process of ELTs, which could be overcome with better tracing

- Unsophisticated sorting processes in which tires from different brands and age are recycled together. The resulting feedstock is not homogenous, which limits its usage for high-value applications.
- Safety and security issues: If specific tires (e.g., self-sealing, inbuilt technology) are not sorted out before the shredding process the recycling plant can be damaged or could present a fire risk.
- It is challenging to ensure that ELTs do not contain any hazardous material. All tires produced in Europe are done so according to the REACH regulation. Tires from outside the EU might not have been produced accordingly due to illegal imports.
- As any raw material is identified by composition or its mechanical features, ELTs must be "properly" segregated to get the end-of-waste (EoW) status.
- It is unclear who takes responsibility along the value chain for making a recycling route decision. This constitutes a big problem as reuse is a central element in the context of the EU rules on EPR.

TIRE MANUFACTURER	
Information of interest	**Benefits**
• Comprehensive LCA data for tires • Company-specific data about recovery and recycling routes • Age of tires by category being discarded within certain period • Degradation through use and storage relative to age	• Better report on ELT generation and circularity. • Better understand design for retreading. • Enable feedstock for same loop recycling. • Obtain better LCA data for product test reports

Actions to take going forward

- Be ready to identify insights from inconsistent and complex data and design relevant questions that the data would provide an answer to.
- Define for which purpose and to whose benefit traceability will be implemented.
- Start with implementing traceability technology in tires that need special treatment (e.g., self-sealing tires).
- Communicate clear messages on the safety levels of tires with recycled content vs new tires.

ELT COLLECTION POINTS	
• Tire condition of ELTs • Ability of ELTs to be retreaded instead of recycled • Recycled content rates of new tires	• Select processor based on type/ condition of tire. • Better assess if ELT can be safely re-introduced into retreading process. • Set fees according to tire categories, if possible.

Actions to take going forward

- Communicate data on tires with recycled content to convince end-customers.
- Assess and decide where the ELT selection decision should take place along the value chain (e.g., at the collection points/dealers or later when arriving at the recycling station). Currently, there is no standard moment/point in the life cycle of tire where it is decided if and how an ELT will be further processed.

ELT RECYCLER

- Information about specificities (e.g., self-sealing), winter/summer tire, age, degradation and whether it has already been retreated
- Information on tire composition (e.g., share of silica, substances of very high concern (SVHC))
- Compliance with regulations (e.g., taxes/eco contribution paid)
- Information about final use of ELT material after recycling

- Claim compensation for illegally sold tires.
- Reduce costs and time for sorting as tracing technology enables automation.
- Benefit from higher quality in the recycled materials.
- Achieve greater security and safety.
- Possibly get European EoW status.

Actions to take going forward

- Development of novel and optimized recycling processes.
- Develop new markets that would be interested in receiving recycled material of high quality.
- Create a solid barrier against illegal trade, particularly on used tires imported from North EU into Mediterranean countries.
- Identify ways to profit financially from optimized sorting and recycling.

COMPANIES USING ELT MATERIAL

- Transparency about material composition of feedstock (especially with regards to potential SVHC)
- Data to assist with "end of waste criteria" in the EU
- Information about the applied recycling process

- Ensure that own products comply with REACH.
- Obtain more homogenous secondary material feedstock.
- Develop higher-value products.
- Gain confidence to fulfill safety and quality expectations.

Actions to take going forward

- Identify potential new products that could be produced if better feedstock existed.
- Set up label to indicate the amount of recycled content in products.

How might we apply circularity concepts and metrics to the tire value chain to guide its transformation towards a circular economy?

The content below has its origin in the stakeholder dialogue and consists of the anecdotal evidence and personal opinions of the different participants.

Workshop participants discussed challenges and how to overcome them and prioritized the solutions highlighted in **orange**.

CHALLENGES	HOW MIGHT WE OVERCOME THESE CHALLENGES? *Prioritized solutions in orange

METRICS DESIGN, EDUCATION AND AWARENESS

An LCA assesses environmental impacts associated with all the stages of a product's life, moving from raw material extraction through material processing, manufacturing, distribution and use. Currently, LCAs are not applied consistently and the industry has not yet aligned on a common methodology and standard approach, leading to a lack of tire-specific circularity concepts and metrics

While there is much thought leadership around circular economy (CE) and circularity metrics, there currently is no common vision from the industry and ecosystem on key parameters of what circularity means when applied to the tire life cycle, value chain and how to measure it, e.g., using LCAs or developing tailored metrics for the sector to better address the aspects of circularity.

It is difficult to compare measures across the whole value chain due to different standards, metrics and system-border definitions

It is unclear where and with what to begin with as there is a broad range of options on tools and metrics with many variations.

The need to collect data is not understood along the whole value chain, which leads to a lack of metrics on the technical value of secondary material

Awareness of the need to collect data is non-existent along the entire value chain, which makes it complicated to develop and calculate metrics. Moreover, the benefit to the environment of the use of secondary materials instead of virgin materials are not tangible or visible.

Granularity of activities and methodologies varies widely

There are many stakeholders involved in a variety of action areas, which makes efforts scattered and uncoordinated. Moreover, the granularity of activities and methodologies vary widely.

Misunderstanding that "circularity" means only closed-loop recycling and no clarity on how circularity concepts can be applied to tire value chain

A circular economy is a multi-dimensional way of working towards better, more long-term success creating value through efficient and restorative resources that can be made and remade into products that have a continual use or recycled into future life cycles. The term of circular economy is often misunderstood. How to translate this new way of working into the traditional business is still a challenge for many stakeholders.

Limited alignment with adjacent industries, such as automotive

If industry-specific metrics are created, it needs to be clear how they will interact at the end-of-life when tire materials would be used for other purposes, for example in construction products.

Create circularity frameworks for tires and more alignment in the ecosystem

- Consider the WBCSD Circular Transition Indicators (CTI) as a potential starting point – applying them concretely for tires.
- Make case studies available from and for small and medium-sized enterprises (SMEs), innovators and municipalities.
- Differentiate more clearly between recovery and recycling.
- When using ELTs in different applications, KPIs should describe CO2 and natural resource savings for the different options.
- Beyond CO2 emissions, other indicators that help to enhance material reusability and social benefits should also be considered (e.g., savings in materials, energy, costs, waste production).
- Perform social LCA to identify social benefits.

Actions going forward

Short term (6 months)

- Reach alignment between tire manufacturers and car producers on common goals regarding circularity.
- Align on common goals and benefits of CE metrics for all stakeholders from manufacturing to new products.
- Agree with all stakeholders on a common (probably already existing) basis to start with. Further complexity and details can be added step by step.

METRICS DESIGN, EDUCATION AND AWARENESS	
	Mid-term (2 years) • Quantify R&D yearly budget dedicated to the development of recycling solutions for tire materials. • Consider operational indicators such as "time to reuse" and logistic mileage indicators. • Recyclers + experts from CTI/ WBCSD could figure out the specifics of tire-recycling, including different outputs like scrap metal, rubber powder, pyrolysis oil, carbon black, etc. • WBCSD/TIP could test CTI with the tire value chain to understand challenges and what additional metrics or sector guidance is needed to support more circularity in the sector. • ELT companies, legislators, the European Commission and others could develop and harmonize new circular concepts. • Create indicators to rank alternatives (% of tire material that can be used in that process and "purity level" of the output relative to virgin material).
	Circularity by design • Consider safety and low rolling resistance as metrics and central aspect of education, as it is a key element of tire performance and contributing to sustainability. • Design for recycling by having product classification for certain new-use applications based on the main characteristics of upcoming ELT. • Incorporate into new tire development the thought of the whole value chain, incl. end-of-life and aim for closed-loop recycling, reusing, etc.). • Deal with circularity needs at the producer level. If there is agreement that the ultimate circular concept is using ELTs in new tires, it is crucial to consider that in the design of the tires.

ECONOMICS

Meaningful LCAs need a tailored approached, which is costly to set up; reporting circularity metrics causes costs, whereas its benefits (also financially) are not entirely clear

A more developed end market (more innovative uses for ELTs) would imply the need to revise LCA for tires to accommodate/describe main possible uses of materials at ELT stage.

Since reporting of circularity metrics is not yet regulated and mandated by the public sector, many stakeholders do not see the benefits of tracking and communicating specific circularity metrics, especially as reporting circularity metrics is costly.

Scale existing concrete solutions

- ELT management companies could shift budget allocation from collection to end market development.
- Build upon existing metrics and concepts to limit costs.
- Focus on scaling the available technologies. The best possible recycling technology must be widely adopted, not just at a few recycling plants (NL: EcoTest as an example, further examples in Scandinavia, CERUB, etc.).

Actions going forward

Short term (6 months)

- Use CERUB, a chain of custody system for ELT material from collection to new products, to incorporate recycled content metrics into the system. This creates data for CTI and others. A potential collaboration with TIP/ETRMA could be of value.
- TIP could aggregate all available resources in one place.
- TIP/ETRMA could follow up with CERUB and Ecotest to understand what can be scaled up + landscape assessment with other available tools and initiatives.
- Create a repository of available metrics, data, methods and concepts.

POLITICS AND REGULATION

No common end-of-waste legislation
There is no harmonization on the end-of-waste criteria on an application basis.

Lack of standardization in legislation
Actors from across the value chain have not come together to jointly define necessary changes in the legislation and to highlight the benefits for the environment to legislators.

Harmonized System (HS) code for circular material does not yet exist
The World Customs Organization (WCO) developed the Harmonized System code as a multipurpose international product nomenclature that describes the type of good that is shipped. Today, customs officers must use HS code to clear every commodity that enters or crosses any international borders.

The public sector has not yet mandated reporting of circularity metrics
The private sector is not the only actor interested in measuring its progress against the circular economy. Governments are adopting circular economy roadmaps and action plans with metrics and indicators in them. Non-governmental organizations have established their own metrics and certification schemes related to circularity. Lastly, there are numerous academic studies on how to measure circularity and its associated impacts. The metrics and methodologies for each of these approaches rarely overlaps or complements one another.

Need to differentiate between plastic waste and ELTs
Currently, there is no clear overview of the similarities and differences of both materials as a resource for the circular economy.

Actions going forward

Short term (6 months):

- TIP could define specific HS codes for circular materials and investigate how the industry can engage with WCO on ELT-related HS codes.
- Harmonize end-of-waste criteria on an application basis.
- Players from the complete tire value chain could agree upon necessary changes in the legislation and highlight the benefits for the environment to the EU legislation to push for change.
- Reach EU-wide agreement on the position of chemical recycling in the waste hierarchy. (Is it recycling? Under which conditions?)

Mid-term (2 years)

- Add representatives of tire recycling companies to advance progress on recycling technologies in the future.
- Achieve mandatory use of the existing CERUB tool in the EU.
- Define a clear roadmap to help ELT management companies shift budget allocation from collection to end-market development.

3. STAKEHOLDER DIALOGUE CHINA – DETAILED SUMMARY

What are today's general challenges to ELT management in China?

(Source: CTRA report, interviews and conference visit)

CHALLENGES IN POLICY MAKING	HOW MIGHT WE OVERCOME THESE CHALLENGES?
ELT management legislation is evolving in China The legal and regulatory system related to ELT management is evolving and yet incomplete. The development of ELT management lacks strong institutional and policy support, resulting in inconsistent ELT management systems across the country. Extended producer and consumer responsibility has not been implemented yet. The country is planning to carry out special legislation for ELT management and to use legal, market and technical means to regulate environmental pollution and waste of social resources.	It is possible that the government will establish a recycling compensation system of "imposing taxes on polluters and compensating the recyclers".
Counterproductive effects of environmental policies and execution of ELT management In some regions and cases, governmental supervision of environmental protection and air quality implies very strong law enforcement, which restricts production and can imply the shutting down of entire factories. For instance, due to rigid environmental regulations, some companies must stay in batch production mode (with high cost and low output) year-round. Once the air quality in the production site fails to meet certain standards, the factories are required to shut down, allowing for no flexibility. Such one-size-fits-all policies can therefore cause companies (such as potential ELT recyclers) to encounter a limited production period, which makes them unable to meet their full production capacity; some companies must suspend operations and even declare bankruptcy.	
Inconsistent levels of policy implementation of VAT incentives The "VAT Incentives Catalog for Resource Utilization Products and Labor Services" (Fiscal taxation document [2015], clause no. 78) includes tax relief on the recycling and use of "End-of-Life Tires and Rubber Products". However, when implementing the policy, tax authorities in different regions have different scales and understanding of the listed technical standards and conditions, which in turn makes some companies lose opportunities to benefit from the VAT incentives.	

BUSINESS CHALLENGES	HOW MIGHT WE OVERCOME THESE CHALLENGES?
Financial pressure due to large upfront investment **The upfront investment to build and run ELT rubber pyrolysis factories is high. As a result, ELT pyrolysis companies require more support, such as tax reductions or business financing support, to be able to make the business case and upgrade facilities accordingly.**	
Low production volume of fine and ultra-fine rubber powder Due to the large production of reclaimed rubber in China, most of the crude rubber powder has been used as raw materials to produce reclaimed rubber. Accordingly, the production of fine rubber powder and ultra-fine rubber powder is relatively low and their applications are rather limited.	
Environmental policy constraints on general operation of recycling companies As mentioned in the challenges in policy-making, local environmental protection laws can imply restrictions on companies, limiting their production or even shutting them down from time to time. This directly affects the sales volume of rubber powder, which is used as a raw material to produce rubber products and building materials.	
Overdue payments from downstream markets of rubber powder leads to low liquidity Some companies stated that they have low liquidity due to the default payments from the downstream markets of rubber powder. Companies have financing needs and require financial support and investment guidance from banks and other financial institutions.	
Volatile ELT prices due to supply shortage The ELT market witnesses frequent supply shortages and a strong increase in the price of ELTs. As a result, company profits keep dropping, bringing challenges to business operation and future investment planning.	Improve policy implementation and market regulation
Serious pollution due to the use of dynamic desulfurization technology Many companies in the recycling industry adopt dynamic desulfurization technologies. Given the heavy pollutants released during the production process, companies encounter great challenges in terms of environmental protection. Some companies have difficulties in achieving green production due to their small production and operational scale, insufficient investments in environmental protection facilities, and the limited application of advanced production technology and equipment.	

Competition of small and scattered companies influences product prices Currently, there are many small and scattered companies without proper licenses operating in the market. They provide cheap and subpar products with low production costs, which influences the market price negatively. Financially competing against such products and production standards becomes difficult.	
Low market demand for retreaded tires Firstly, the overall retreading industry competes with the new-tire industry. Due to increasing production of new tires, prices keep declining. Thus, some consumers of retreaded tires (such as bus companies) choose to purchase new tires, resulting in decreasing market demand for retreaded tires. Secondly, some existing policies restrict the use of retreaded tires, such as the introduction of the GB 7258 policy in 2012 which states that "all road buses', travel buses' and school buses' wheels and other motor vehicle steering wheels shall not be equipped with retreaded tires." Thirdly, consumers and governmental institutions have not yet fully recognized the importance of retreading as an accelerator in the development of China's circular economy. Therefore, demand for retreaded tires remains low.	Increase consumer confidence of buying and using retreaded tires
Lack of ELTs that are retreadable When designing and manufacturing new tires, mandatory technical quality standards for tire retreading are missing, causing some products to become non-retreadable. Also, vehicle inspection departments do not require mandatory wearing limit tests for the use of tires. In addition, a lack of clear understanding and appropriate awareness in terms of tire use among consumers result in accelerated tire wear. Therefore, there is a shortage of tires that are suitable for retreading.	

How does today's ELT collection system work and how might tire traceability look like in the future?

(Source: stakeholder dialogue discussion)

CHALLENGES	HOW MIGHT WE OVERCOME THESE CHALLENGES?
The government has formulated and enacted recycling standards and regulations and has designated qualified organizations to collect and process ELTs. So far 80 organizations are officially recognized recycling companies. Nevertheless, there are unregulated collection and recycling practices in the market. Often, small collectors without proper qualifications collect ELTs and sell them to the highest bidders, ignoring the recycling qualifications and capabilities of collectors.	Currently, there is no tire traceability system in place. If one were to be designed in the future, the following data points would be interesting for tracing since they would help understand accurate recycling rates, apply the most suitable recycling methods, verify adherence to the corporate social responsibility of companies, etc. • Sources of production • Tire specifications • Sales channels • Tire replacement details • Recycling factories • Recycling methods.

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Which applications of rubber powder from ELTs is currently used in China and what are challenges in scaling these applications?

(Source: stakeholder dialogue discussion)

CHALLENGES	HOW MIGHT WE OVERCOME THESE CHALLENGES?
At present, the main applications include making waterproof and soundproofing materials in construction and road construction materials. **Challenges and ideas to help scale new applications** • The corporate social responsibility of environmental protection puts financial pressure on the enterprises as they have to invest in the research and development of new refining technologies. • The volatile and increasing prices of ELTs and the existence of small collectors without proper qualification disrupt normal supply and demand in the market and result in disorderly intra-industry competition. • Some enterprises claim that governments have already enacted many policies to support ELT recycling enterprises, while others think that there is insufficient legal support for their businesses. Such a paradox may be due to the inappropriate implementation of relevant policies.	**Ideas to help scale new applications** • Upgrade the technology and improve the adhesion and abrasion resistance levels in road construction, for instance, to increase the appeal of this solution, thereby contributing to scaling its application. • Provide tax incentives to lower the financial burden linked to the social responsibility of environmental protection, which in turn would help

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(Recycling Research Institute/ Scrap tire news)

TIP remains committed to sustainable ELT management and looks forward to continuing to engage with stakeholders whose collective actions can drive circularity in the global management of end-of-life tires.

ABOUT WBCSD

WBCSD is the premier global, CEO-led community of over 200 of the world's leading sustainable businesses working collectively to accelerate the system transformations needed for a netzero, nature-positive, and more equitable future.

We do this by engaging executives and sustainability leaders from business and elsewhere to share practical insights on the obstacles and opportunities we currently face in tackling the integrated climate, nature and inequality sustainability challenge; by co-developing "how to" CEO-guides from these insights; by providing science-based target guidance including standards and protocols; and by developing tools and platforms to help leading businesses in sustainability drive integrated actions to tackle climate, nature and inequality challenges across sectors and geographical regions.

Our member companies come from all business sectors and all major economies, representing a combined revenue of more than USD $8.5 trillion and 19 million employees. Our global network of almost 70 national business councils gives our members unparalleled reach across the globe. Since 1995, WBCSD has been uniquely positioned to work with member companies along and across value chains to deliver impactful business solutions to the most challenging sustainability issues.

Together, we are the leading voice of business for sustainability, united by our vision of creating a world in which 9+ billion people are living well, within planetary boundaries, by mid-century.

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