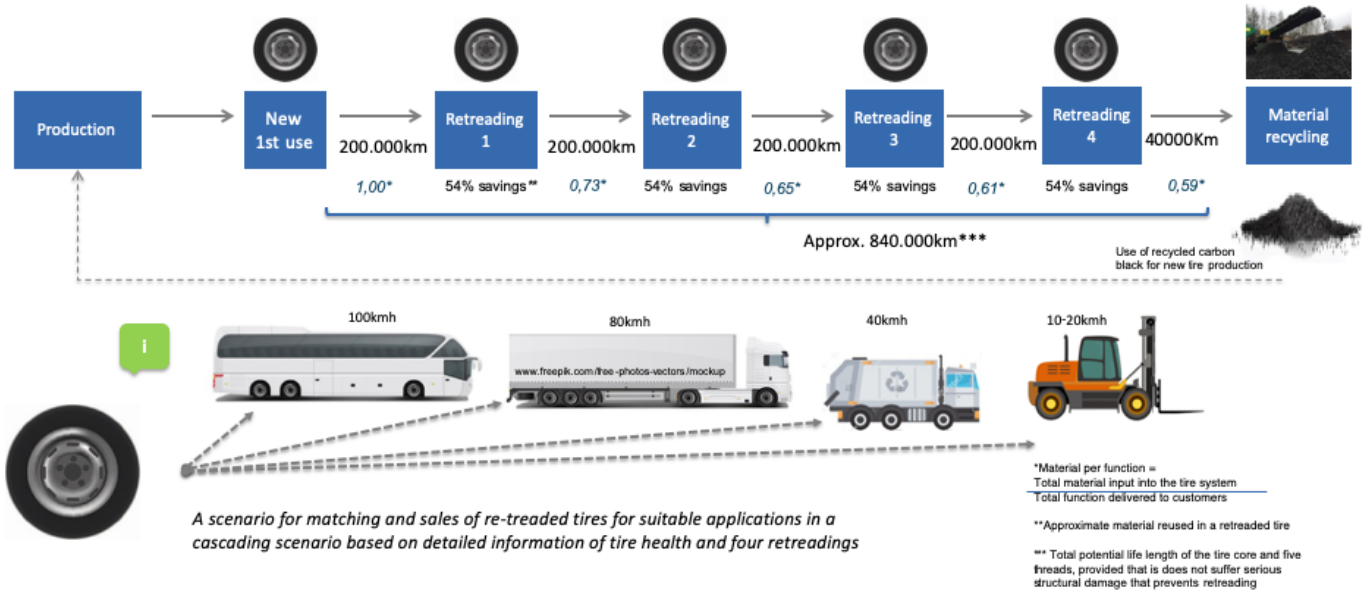


Depicting increased resource productivity via tire life extension and cascading use. Material per function delivered is reduced for every retreading and reuse. Tires could be used in a planned cascade in which the function delivered is not less but slightly different for each application. Considering material efficiency gains and the costs of new tires for each of these applications, there are potentially huge gains to be had for the system. However, risk for individual actors builds up and can dissuade later reuses. A circular business ecosystem in which data about tire use and health is monitored and collected could help mitigate this risk and result in greater economic and environmental productivity.

How can a (more) circular business ecosystem for heavy truck tires lead to improved resource productivity?

The problem:
Globally, about 14 million tonnes of car tires are discarded annually and current handling of end-of- life vehicle tires can be significantly more resource-productive by using more of the theoretical potential of a heavy tire's useful life by retreading and reusing tire material in several use cycles during the total life cycle(1).

Retreading of heavy truck tires is a well-established practice and a practical example of value retention by extending product life. However, its prevalence has decreased in Europe over the past decade. This holds even if the value for retreading is many times higher than granulation and much higher than recycled carbon black(2).

In a circular economy, economic values are created and preserved through reuse, remanufacturing, material recycling and ultimately energy recovery. Today's premature end of life scenarios for tires, e.g. energy recovery, mixing in asphalt or as a base on artificial turf has a high potential for improvements.

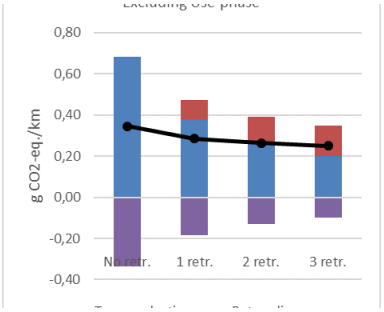
Hypothesis:
In a circular tire system, resource productivity is improved by using tire material many times in tires first and later in other non-tire applications.

Enablers for a more circular tire eco-system:
Functional sales of tires can give the service provider incentives to keep the tires at their highest utility as well as preserving economic values by retreading tires many times.
Embedded sensor which, during the tire's use cycles, can identify damage due to impacts, collisions, improper air pressure, and increased heat, can provide the tire service providers, haulers, retreading companies, vehicle manufacturers and recyclers with valuable information for preserving economic value. There is also a potential for generating valuable information for other actors, e.g. road authorities and actors involved in road maintenance.
To enable a more circular tire ecosystem the following key areas for further exploration have been identified:

- What information is needed and what information can be shared without having negative implications on the actors' own business?
- What sensor technologies can provide business-critical data for the actors?
- How can all valuable and risk-minimizing information about the tires (distance, pressure, temperature, fuel consumption, tread depth, sound, shaft adjustment) be collected in the best way? How to collect this information for the entire vehicle (incl. trailer)? Who owns this information?
- What added value does the information above provide, (more automated inspection and sorting of tires?) and for whom?

Critical success factors:
1. Developing capabilities: When selling tires as a service, increased business risks related to tire health arise. To address these risks, actors will need to develop internal organizational capabilities for circular business model innovation and to develop technologies such as sensors that can be used to monitor tire health.
2. Mapping information needs in the ecosystem: As indicated above, tire use and health data are valuable for actors in the business ecosystem. Identifying and visualizing this data and who values it can help determine what potentials there are for actors in the business ecosystem to share or monetize this data and lead to increased productivity for the business ecosystem as a whole.
3. Determining resource productivity for a "circular" system that operates in non-circular reality: A system like a tire ecosystem resides in a linear economy that's driven by fossil fuels and where tire retreading often happens as an afterthought. As such, reductions to life cycle environmental impact related to retreading exist but are minimal in comparison to the impact that results from the fuel burn required to overcome a tire's rolling resistance. In order to gauge potential environmental impact reductions for such a system, potential should be assessed for the current system, e.g. with traditional drivetrains and use in single applications as well as for future systems, for example with electric drivetrains and cascading applications, in which benefits are even greater.

Conclusions:
A more circular tire system can be achieved by combining organizational innovations, such as circular business models, and technological innovations, such as sensor technologies that provide detailed information about tire health and health history of the individual tires used in the system. Thus, the life length of the tires used can be extended and thereby slow down the material flow in the overall system. Moreover, such a circular system has the potential to be significantly more resource efficient than the existing one, given that also material recycling of valuable tire ingredients, such as carbon black, can be implemented.
However, as tire properties and tire health affect the vehicles fuel consumption significantly, tire related factors that might increase fuel consumption, such as tire cores, rolling resistance of treads has to be better understood, as well as tread development for optimal rolling properties. Building internal capabilities for servitization and integrating predictive maintenance technologies among actors in the existing tire eco-system will significantly increase the internal organizational possibilities to establish a more circular tire system.



Global warming potential – production phase

About the project:

"Circular economy in a business ecosystem: Integrated sensors and new recycling technology for heavy-duty vehicle tires" is a collaborative research project financed by the Swedish Innovation Agency, Vinnova, directed by the nonprofit research institute RISE in collaboration with Volvo Truck Center (part of AB Volvo), Galdax, Ragn-Sells and Scandinavian Envirosystems. The project has been underway for 2.5 years, from the end of 2016, and is expected to be completed in 2019.

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