Annual report 2021

– Focusing on the CARBON CYCLE

SWEDISH
TYRE RECYCLING
ASSOCIATION

Welcome to this annual report focusing on the carbon cycle and tyre recycling

Carbon, tyres, life and the atmosphere – how are these things connected? This will be discussed in this report focusing on the carbon cycle. Tyres are made of rubber, oils, carbon black, textiles and steel (along with small quantities of additives to improve their properties). Practically all of these components contain carbon. Also the steel contain small amounts of carbon in the form of carbon alloys.

About 20% of the rubber comes from plantations and crops, as does a small percentage of the oil, while the rest is produced from fossil raw materials. Fossil carbon comes from plants and animals too, but they lived millions of years ago. These organisms directly and indirectly bound carbon from the atmosphere during their lifetime, but after their death they settled as sediment, decomposed and were packed under layers of other materials and gradually formed coal, oil and gas.

From the 19th century onwards, humans have extracted these substances, primarily as high-grade fuel but also to manufacture products, such as plastics and tyres. When used products are combusted or fossil energy is used in recycling processes, the carbon is released back into the atmosphere in the form of carbon dioxide.

Carbon dioxide is vital for photosynthesis and all vegetation, but it also acts as a greenhouse gas, i.e. it prevents heat radiating from Earth into space. Carbon dioxide's impact on the climate is a major topic of environmental research alongside species extinction, ecosystem impact and chemicals respectively.

The questions we discuss in this annual report are how the carbon in tyres can be part of a planned cycle and whether recycled tyre-derived material can facilitate a continued positive carbon cycle that promotes life on the planet.

Welcome to the world of carbon!

Fredrik Ardefors, CEO

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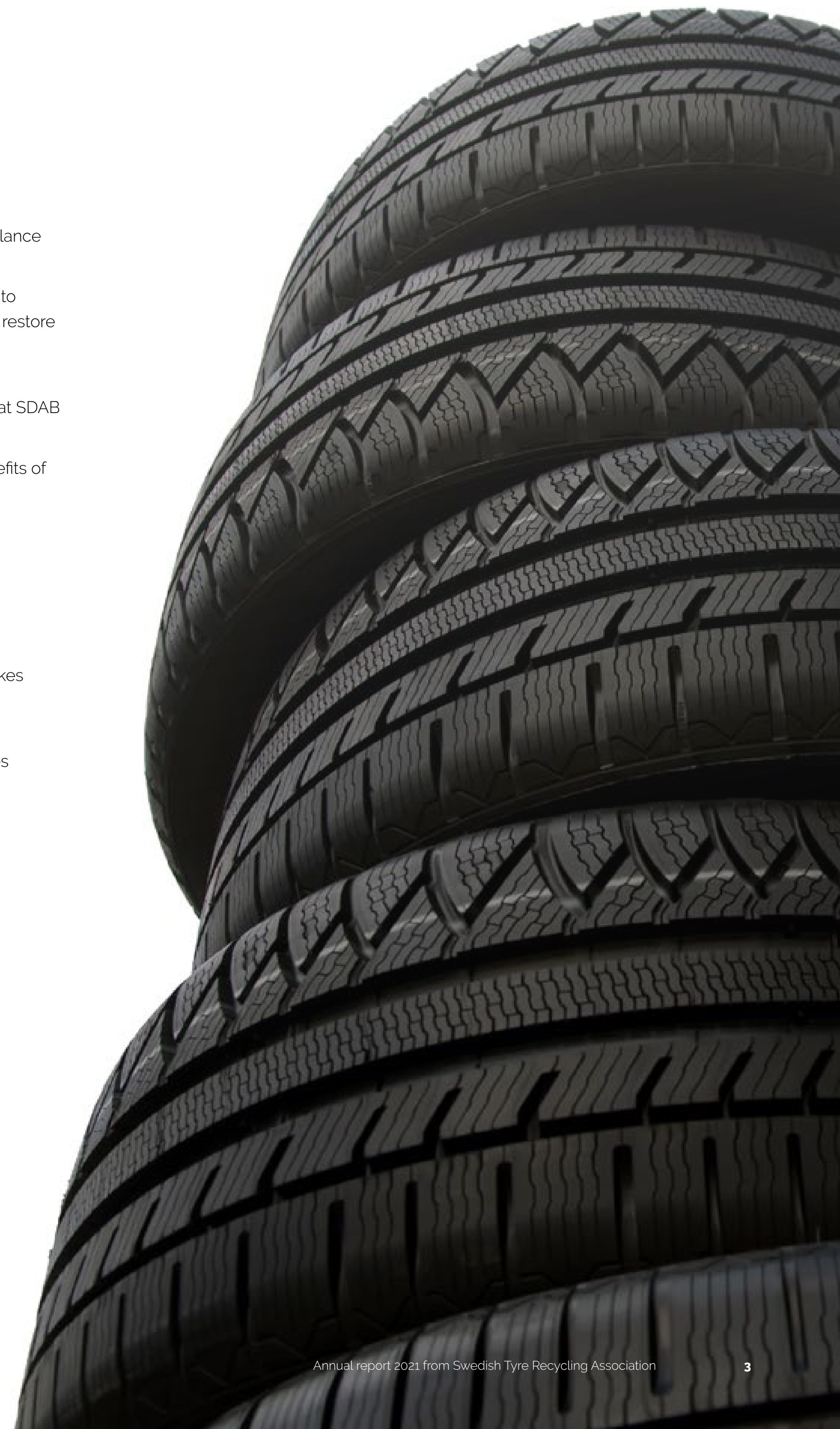


Tyre recycling at present

Swedish Tyre Recycling Association (Svensk Däckåtervinning, SDAB) aims to find the best possible use for recycled tyres for society as well as for the environment. This means we need to be at least as interested in what's good for society and nature as we are in tyres. In 2019, the Swedish Tyre Industry Association launched a white paper on sustainability, where we presented our models, principles and knowledge regarding how recycled tyres can help reduce society's overexploitation of natural resources. One of the fundamental ideas in the white paper is to extend the lifespan of existing materials by at least the same factor as Swedish society's overexploitation of earths resources. Furthermore, this reduces society's dependence on energy for manufacturing and transport and it has less total environmental impact than the production of new materials does. In this way, we can help reduce the burden on our planet.

If we go to the heart of the sustainability issue, what is the challenge we're facing? We believe that it is in our societies power to influence the biosphere, of which the atmosphere is a part. This is an influence that, on the whole, is still more negative than positive. If we look at the imbalances in the carbon cycle caused by our industrialised societies, it is obvious that it is up to our generation to reverse the trend in a sustainable direction.

Many opportunities for a tyre taken out of service

Sooner or later most products are no longer fit for their original purpose and are taken out of service. In many cases the material can be reused after being processed. The material can also be used in other, new products, sometimes in combination with other materials. After some time, also the recycled product will need to be decommissioned. Eventually, after one or several recycling loops, there will come a point where continued material recycling no longer makes sense as it costs more in the form of energy, money and environmental impact than it saves. Direct energy recovery or chemical disaggregation, e.g., through pyrolysis, may then be the best final destination for the material. Pyrolysis and devulcanisation may also create opportunities earlier in the process for further material use, e.g., in the form of carbon black, oil or raw rubber. System and lifecycle analyses provide guidance on which recycling options are preferable from an overall perspective.

From burden to balance

In energy recovery, there is often no difference in chemical or practical terms between recycled materials that are fossil-based or renewable (biological), but our societies have amassed an environmental debt (especially since the dawn of industrialisation), which means that we need to reverse the trend of overloading the biosphere (which include the atmosphere) with more greenhouse gases than it can handle, while at the same time supporting the biosphere's ecosystems so that the greenhouse gases can be brought into balance. Instead, ecosystems are currently being depleted, which is exacerbaing the imbalance. From this perspective, recycled material is preferable if it does not burden ecosystems more than the exploitation of virgin resources.

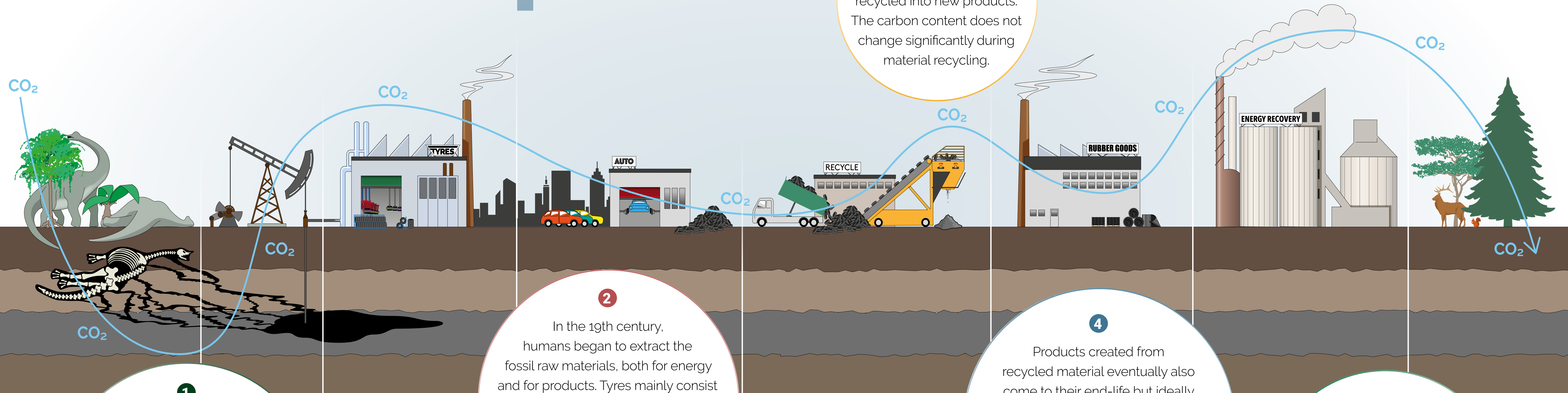
Bringing the carbon cycle and greenhouse gases back into balance

Carbon's journey began many millions of years ago. When life first began on the planet, the level of carbon dioxide in the atmosphere was perhaps eight times higher than it is today. The amount of living biomass on the planet is assumed to have been far higher during the era of the dinosaurs 120–60 million years ago than it is today. The various life forms gradually and via photosynthesis bound the atmospheric carbon to green plants and then to animals. The planet was warm, but a rapid cooling (probably after a meteorite struck and led to dust clouds obscuring the sun's rays) wiped out large swathes of life. The plants and animals gradually decomposed and settled as sediment and were squeezed together in pockets over the years. Bacteria and microorganisms broke the mass down into the coal, oil and gas that humans extract today. The fossil fuels are combusted by humans for energy, which releases the carbon atoms back into the atmosphere in the form of carbon dioxide. Fossil raw materials are sometimes also used for materials and products, such as plastics, but these too have a limited lifespan before, usually, being used to recover energy.

Thus, the effect is that human activity is transferring carbon from underground to the atmosphere, and at a rate such that today's vegetation on the planet is unable to absorb enough to achieve a natural balance.

The question that arises is whether we can make it easier to close the cycle of carbon being transferred back to biomass by an amount equal to or greater than the carbon each product is today ultimately likely to risk contributing to the atmosphere?

Carbon's path



1

In prehistoric times, large quantities of carbon dioxide were present in the atmosphere. Over millions of years it was absorbed by plants and indirectly by the animals that ate the plants. Dead animals and plants settled as sediment and were subject to high pressure. Over time, fossil oil, coal and gas were formed.

2

In the 19th century, humans began to extract the fossil raw materials, both for energy and for products. Tyres mainly consist of rubber, oils, carbon black, steel and textiles. The average car tyre weighs 11 kg and contains just under 7 kg of bound carbon. A large proportion of the carbon in the tyre is biobased.

3

When the tyres have been used, they are recycled into new products. The carbon content does not change significantly during material recycling.

4

Products created from recycled material eventually also come to their end-life but ideally the material can be recycled into new products again. In the end, however, pyrolysis or energy recovery are the only recycling options available. Energy recovery once again free carbon dioxide that is released into the atmosphere.

5

SDAB is striving for the equivalent of the entire quantity of carbon found in a tyre at the first stage of recycling to be bound to the biosphere, where it can support the ecosystems and contribute to regenerative food supply, etc.

The ecosystems know what to do

Fortunately, the ecosystems are experts at binding large amounts of carbon, to bestow it with life and then to settle it as sediment and fossilise it. They can handle far larger quantities than we have put into circulation – but it takes time.

One key to binding carbon is the green plants that grow on land and in lakes and seas. The plants convert atmospheric CO_2 and water into oxygen and carbohydrates (sugar and building materials for plants). The plants can absorb other nutrients from their surroundings by working with mycelia and bacteria, for example.

If soil were managed such that it binds carbon instead of releasing it as it does now, our dependence on fossil fertilisers could be reduced or eliminated, and plants could instead extract minerals and nutrients from the land and rock by working with mycelia and other life forms in the soil. Such soil binds a lot of carbon dioxide, and relatively quickly. Increasing the carbon content of the soil by four thousandths a year would correct the imbalance from the additions of carbon dioxide.

Furthermore, there are opportunities for humans to support ecosystems in forests and oceans.

The role of the oceans

Oceans in particular deserve a special section because they are the largest reservoir of carbon dioxide. Carbon dioxide in the oceans is dissolved in the surface water and then absorbed by plankton and algae in an interplay between marine ecosystems. Unfortunately, more carbon dioxide is being added than the marine ecosystems can absorb. This results in a fall in the oceans' pH value, and a further negative impact on already stressed vital marine ecosystems.

What can and should SDAB do to support ecosystems in order to restore climate balance?

SDAB aims to find the best possible use for recycled tyres, both for society and for the environment. SDAB's organisational and operational scope begins when the tyres are no longer used as tyres and ceases when the tyre-derived material is converted into a new product and has a new owner. However, this does not prevent SDAB from taking responsibility for ensuring that the tyre-derived material will be used in the best possible way from a societal and environmental perspective. If the tyre-derived material is used for energy recovery, the carbon will be released whether or not the material is a product beforehand.

A tyre contains just under 7 kg of carbon in various forms from the rubber and the additives. Furthermore, the steel cords are alloyed with carbon. SDAB aims to ensure that the atmospheric impact of the carbon contained in the tyre is compensated for in advance by helping to bind the amount equivalent to that put on the market in the biosphere.

We assume responsibility by planning in advance for where 'our carbon' may end up. In the worst-case scenario, the carbon ends up in the atmosphere after the material no longer falls under our responsibility and, in that case, we have already compensated for it.

We do this in the following five ways.

1. Compensating in advance

Some of the tyre-derived material will be sent directly for combustion. This may happen if the tyres have anti-puncture systems that render material recycling impossible. These carbon dioxide emissions are neutralised prior to combustion in a way that strengthens ecosystems. This might take the form of measurable activities to stimulate growth in the biosphere. SDAB chooses to prioritise neutralisation by actively supporting ecosystems that bind carbon. Several companies today are opting to invest in solutions that use industrial technology to capture carbon dioxide, which is then stored underground. These so-called CCS technologies may be a more obvious choice for companies whose facilities already have flows of carbon dioxide in circulation; however, they can also serve as a valuable complement to other solutions.

2. Easing the burden

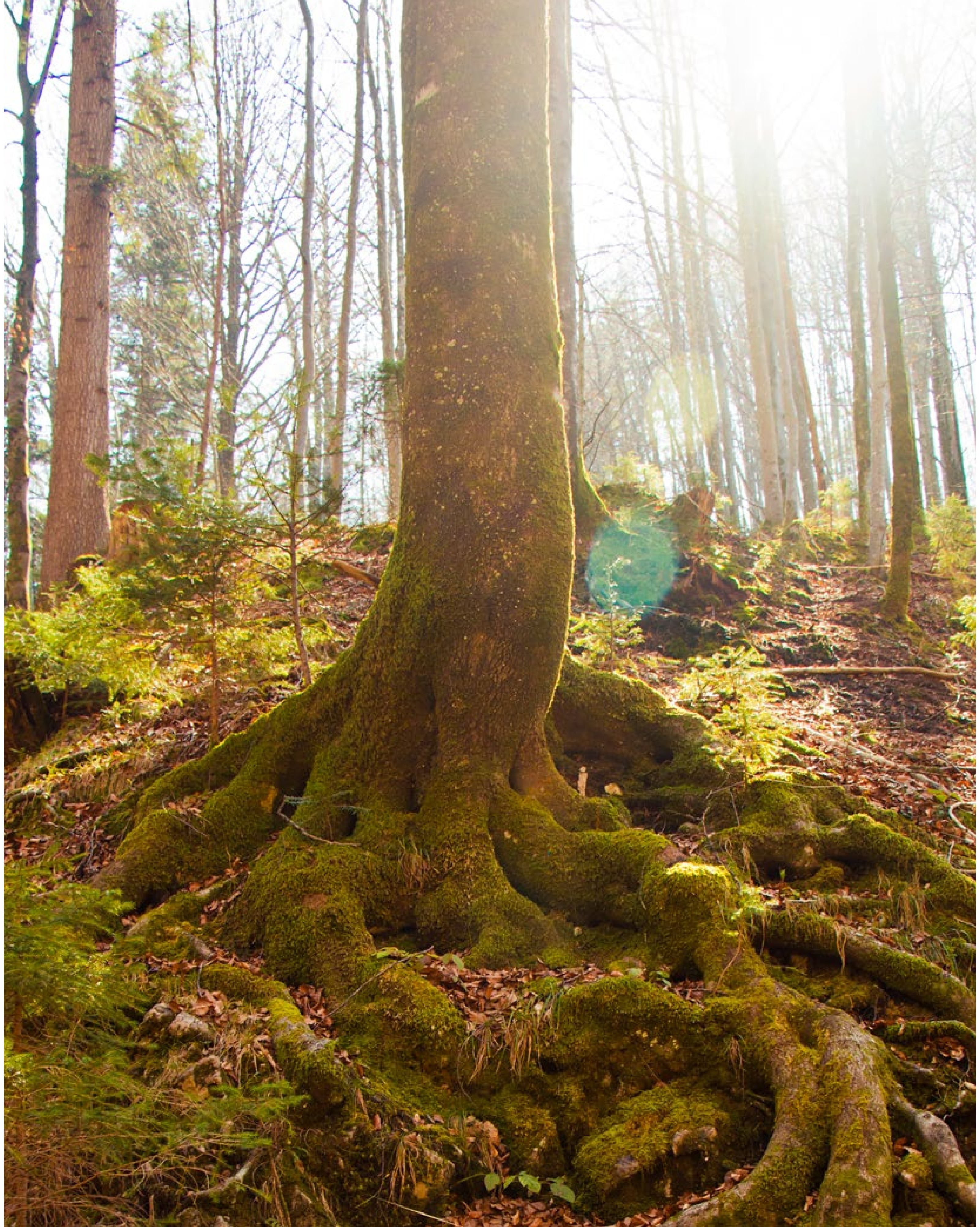
SDAB works with several players to identify applications for tyre-derived material that actively lift the burden on ecosystems and climate. Examples include cast products. Artificial surfaces are another example of an application that eases the environmental burden. Artificial surfaces that allow greater access than natural surfaces (they can withstand more wear and tear, which saves land) can be helpful here because they use less space to provide the same function. The principles for this are described in detail in the Swedish Tyre Industry Association's white paper. The material replaces virgin materials that would otherwise produce higher emissions and have a greater impact on ecosystems. Since the endpoint for tyre-derived material is largely combustion or pyrolysis, we neutralise the carbon content of the tyre-derived material while it is still our responsibility.

3. Supporting ecosystems

One example of this is drainage layers. Tyre shreds are successfully used today to drain land in various situations. Tile drainage using tyre shreds instead of drainage pipes reduces waterlogging in growing areas and also purifies the water before it is released into ditches and watercourses. The effect is increased growth on the surface. Tyre shreds also work very well as a drainage layer under large areas of lawn. SDAB is conducting research into the use of tyre-derived materials to capture and recycle phosphorus from wastewater. Phosphorus is a substance vital to plants and animals, but in excessive amounts it passes the roots without being absorbed, resulting in eutrophication in lakes and seas. By capturing the excess phosphorus, the problem is avoided and the natural balance in the watercourses can be restored, which promotes carbon sequestration. The phosphorus captured in the tyre rubber can then be harvested and reused as fertiliser, thereby increasing growth and carbon sequestration in our arable land. The capture and reuse of phosphorus is another example of ongoing research. Specially treated tyre rubber can bind water-dissolved phosphorus from passing surface water, wastewater and slag, etc. Growing bases in urban environments are another application. A mixture of granulate and sand or soil makes an excellent substrate and growing base for trees in urban environments. Long living trees increase carbon sequestration. This is where tyre-derived material can have a supportive impact on ecosystems and climate. The aim is to promote the growth, recovery and development of plants and animals. However, even though the applications have a strong positive impact on the ecosystems, there may still be CO_2 left, which must be neutralised by SDAB before the material is sent to its endpoint of combustion or pyrolysis.

4. Becoming an active part of carbon sequestration

Tyre-derived material can also be made an active part of carbon sequestration, which would mean none of the tyre-derived material entering the atmosphere. For example, tyre-derived material can be converted into soil through interaction with plants, bacteria and mycelia in ecosystems that increase the soil's carbon sequestration. This is due to the fact that living organisms can digest the material. In this scenario, there is no CO_2 to neutralise. However, this requires further research and development before it can become a reality. Mycelia have developed astonishing abilities and can, for example, obtain selected minerals from inside rock in exchange for carbohydrates from plants that need the minerals and 'pay' with carbonhydrates. Various mycelia specialise in finding and accessing different substances. There are special mycelia that extract zinc and others that focus on polycyclic aromatic hydrocarbons (PAHs). If the conditions are right, then, in collaboration with UV degradation, bacteria and nematodes etc., the tyre-derived material can be broken down into nutrients that are absorbed by the food chain. There is great potential here but there is still a lot of research and development to conduct before tyre-derived material can become 'food' in this way. SDAB is involved in such projects and it is hoped that solutions will be identified by 2030.



5. Utilising capital

SDAB uses its funds to fulfil its commitment to taking care of all the tyres on the market that come under the organisation's area of responsibility. SDAB has invested its capital in the highest rated 'dark green' funds. The organisation is currently conducting a review into how capital investment can be activated to accelerate the protection and rebalancing of Earth's living systems. Using capital for investments that support carbon sequestration in the biosphere, either directly or via processes or products, can supplement the above four areas. Examples under evaluation include the creation of nature reserves, returns to carbon sequestration activities and investments in tech companies in this area.

SDAB strives to ensure that asset managers can offer investments with positive returns, both financially and environmentally. New key ratios and e.g. p/e ratios could be CO_2 sequestration per million invested per year.

Development work underway at Swedish Tyre Recycling Association

In parallel with SDAB taking over operational responsibility for tyre recycling in Sweden on 1 January 2023, along with sales responsibility for the recycled raw material, an active operation is being run to identify new sales areas in accordance with the guidelines set out in the white paper, the ecosystems work and our line of reasoning regarding the carbon cycle.

Rubber concrete
Mixing recycled rubber with concrete creates a lighter material that places less of a burden on the planet during transport and handling and saves on materials.

Water purification
Clean water is essential for good cultivation and ecosystems. The use of tyre shreds in treatment beds makes this possible in a cost-effective way.

Phosphorus capture and harvesting
Specially pre-treated tyre rubber can bind phosphorus from municipal and private wastewater and from agriculture and mining slag. By separating the phosphorus, it can be reused as fertiliser. Eutrophication in seas, lakes and other watercourses decreases and vegetation increases where it is wanted.

Casting of products where tyre-derived material replaces virgin materials
Recycled rubber reduces the burden from extraction of virgin materials, according to known mechanisms. Recycling allows recasting in the same or new compounds as the material retains its properties for a long time.

Artificial surfaces
Surfaces for play, games and sport, as well as cycle paths and pavements, etc. are designed to provide good accessibility in all weather conditions and a high level of protection against personal injury while having a small environmental impact and being low cost. Surfaces built with recycled rubber often replace areas that are several times larger and provide the same accessibility, thereby saving land from development. The rubber surface can then be recycled again.

Reinforcement
Reinforcement of sheet materials for the construction industry and furniture production, etc. The textiles from recycled tyres replace fiberglass and biomaterials, thereby reducing the thickness required to achieve the same strength.

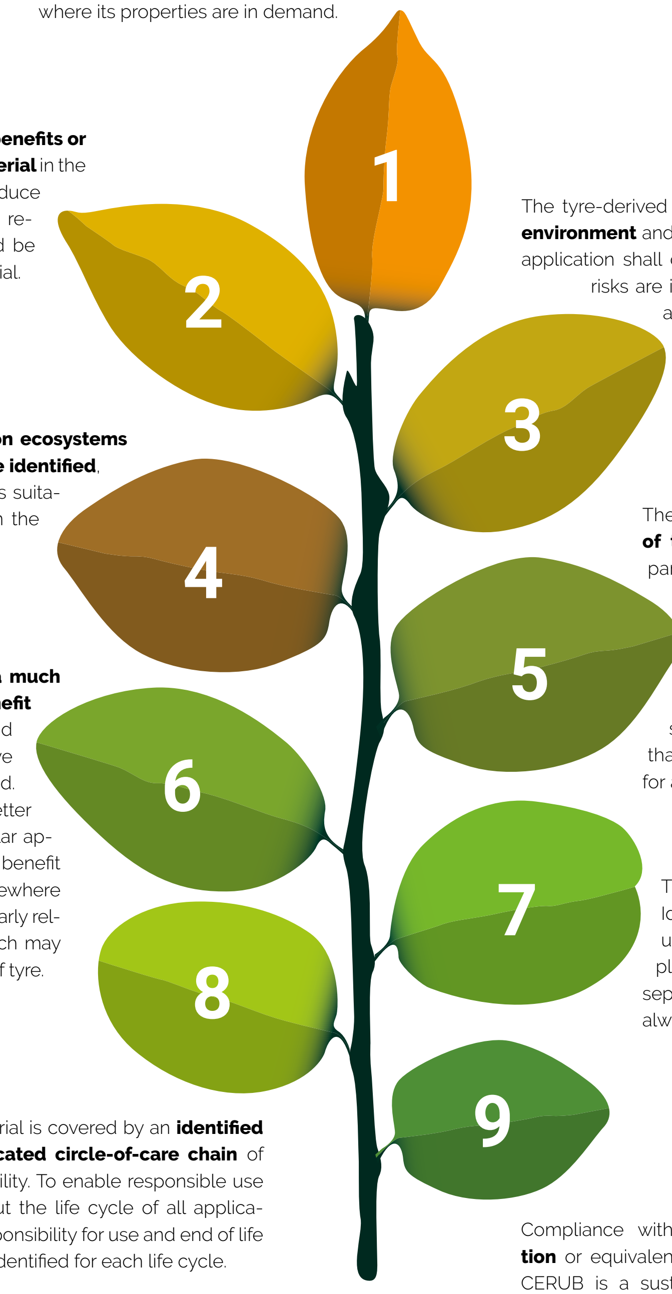
Facade materials
Facade materials made from rubber concrete and combinations of rubber reduce both material consumption and the impact of transport because they are lighter than conventional stone and concrete materials.

A model for optimising the benefits of material

The current ‘linear’ economy, which is not sustainable, entails, for example, accelerated species extinction, unnatural climate change, ocean acidification, the depletion of natural resources and the destabilisation of ecosystems – the planet’s life support systems. This is a sign of a larger problem of how we manage the planet’s resources, how we view nature. It is also about the present and the future, about not recoiling from difficult issues and about making it possible to work in a circular way. One obvious conclusion of this reasoning is that we need to make the best possible use of the products and materials that are already in circulation.

Recycling is not enough

Unfortunately, recycling is not enough. In order to meet the challenges in our time of adapting so as to operate within the planet’s boundaries, we need to target our initiatives where they can be of the greatest possible benefit for the environment. Resource consumption and the land use perspective are the main drivers of the destabilisation and depletion of ecosystems, as well as of the imbalance in the carbon cycle, which SDAB can influence through its recycling solutions. Another company’s greatest influence may take the form of phasing out harmful chemicals. Quite simply, the system perspective needs to be adapted. Further information on how we have achieved this can be found in the Swedish Tyre Industry Association’s white paper on sustainability (2019). In the white paper, we define a number of criteria for recycling tyre-derived material. This is based on a system perspective of sustainability and where the company can make the biggest difference. The criteria primarily apply to new applications for recycled tyre-derived material, but in the long term they can be applied to all types of material recycling and material usage, including for biological materials. Here are the criteria, now updated in line with the ecosystem perspective:



1. The material is in **demand based on real needs** for its properties and on commercial terms. This ensures that the material provides a real benefit where its properties are in demand.

2. The material provides **unique benefits or replaces the use of virgin material** in the application. In order to help reduce the overexploitation of Earth’s resources, virgin resources could be replaced by tyre-derived material.

3. The tyre-derived material is **safe for health and the environment** and potential risks can be managed. The application shall comply with laws and regulations. If risks are identified, the application can still be accepted if the risks can be managed. This can be achieved by restricting use in terms of time or space by using special equipment or through reduced exposure.

4. The **impact of the material on ecosystems and the carbon cycle must be identified**, and a conscious decision on its suitability must be documented on the basis of this impact.

5. The material **performs well in terms of total environmental impact** compared with the alternatives. A Life Cycle Analysis (LCA) measures how the material performs based on total environmental impact compared to other options for the same application. The recycled material should not perform decisively worse than other options for it to be suitable for a particular use.

6. The material does **not have a much greater environmental benefit in another use**. In order to avoid sub-optimisation, alternative uses should be investigated. Even if a product performs better than other options in a particular application, the environmental benefit may be better when used somewhere else. This perspective is particularly relevant to limited resources, which may be the case with certain types of tyre.

7. The material **can be recycled again**. Ideally the material should not become unusable after being used for an application. Therefore, the ability to sort, separate and reuse the material should always be valued.

8. The material is covered by an **identified and allocated circle-of-care chain** of responsibility. To enable responsible use throughout the life cycle of all applications, responsibility for use and end of life must be identified for each life cycle.

9. Compliance with **CERUB certification** or equivalent, where applicable. CERUB is a sustainability label that guarantees traceability, documentation and transparency for recycled tyre-derived material.

Closing reflections

Resource extraction and processing accounts for 50% of global carbon dioxide emissions and 90% of the loss of biodiversity. In its April 2022 report the IPCC stated for the first time that circular material flows are essential for industry to achieve its climate ambitions in the fulfilment of the Paris Agreement. The sustainable use of materials is therefore crucial if we are to succeed in fulfilling the Paris Agreement.

It is therefore a joy to read about SDAB's ambitious work and goals. The organisation's work to extend the lifespan of products, reduce the exploitation of virgin resources and optimise the utility of materials are among the most important efforts to achieve sustainable material use. Further research and innovation will be required to identify new, more sustainable solutions and it is important that industry participates and works together, so all credit to SDAB for its efforts in that area.

We need to find new ways of designing, manufacturing and using materials, along with new ways of doing business. This calls for courageous leaders and pioneers, as exemplified by SDAB.

Elin Larsson*, Program manager*

Re:Source – resource-sip.se

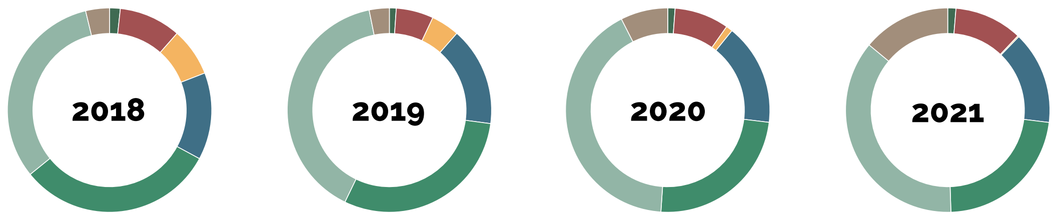
This is Swedish Tyre Recycling Association

Producer responsibility means that anyone putting tyres on the market must also take responsibility for what happens to them once they come to the end of their lifespan. Sweden has the oldest producer responsibility scheme for tyres in the world, established in 1994. Similar regulations have gradually been brought in for cars, electric and electronic products, newspapers, corrugated cardboard, paperboard, metal, plastic and glass, in Sweden and in other countries. These producer responsibility schemes are all aimed at increasing collection rates and material recycling and thereby supporting a circular economy. Producer responsibility schemes for tyres are currently in place in 15 countries in the EU and in a handful of countries in other parts of the world. SDAB is the tyre industry's response to Sweden's Ordinance on Producers' Responsibility for Tyres (1994:1236) and is tasked with organising the collection and recycling of all used tyres. The supervisory bodies are the Swedish Environmental Protection Agency and municipal environmental departments. Since operations began in January 1995, between 90% and 100% of all used tyres have been collected every year. In recent years the collection rate has exceeded 100%. The producer responsibility scheme is financed through recycling fees paid by importers. However, these fees are usually charged to the distributor, who in turn passes them on to the consumer. Consequently, the consumers take responsibility in environmental terms by paying a recycling fee when they buy new tyres.

80,348 tonnes of tyres recycled in 2021

In 2021, Swedish Tyre Recycling Association's (Svensk Däckåtervinning, SDAB) contractor, Ragn-Sells Däckåtervinning AB (RSDAB), recycled 80,348 tonnes of tyres on behalf of SDAB, which is a decrease on the 84,574 tonnes recycled in 2020. 91,081 tonnes were collected in 2021 compared with 90,548 tonnes in 2020. Tyre sales at SDAB's affiliated tyre workshops increased slightly in 2021 compared with 2020, which in turn led to more used tyres being returned for collection and recycling. The lower figure for recycling in 2021 compared with 2020 can be attributed to the contractor accumulating collected (but not recycled) tyres during the year. The main reason for this is that RSDAB sells significant amounts of tyre-derived material to the foreign cement industry and the availability of ships to transport the material has been far lower than normal since the COVID-pandemic. RSDAB reports increased sales for material recycling through sales for the manufacture of blasting mats and sales for material substitution in factory constructions, for example.

Recycled tyres by recycling category 2018–2021 (tonnes)



Recycling category	2018	2019	2020	2021
Retreading	0	0	0	**0**
Export of whole tyres	1529	1002	982	**1040**
Material recycling: blasting mats	8874	5495	7290	**8639**
Material recycling: granulate	6905	4174	883	**161**
Other material recycling	12505	14552	13608	**11800**
Energy recovery	28357	27952	20427	**18135**
Energy recovery: cement industry	29065	36870	35053	**29344**
Material substitution	3422	2964	6331	**11233**
Total recycling	**90657**	**93010**	**84574**	**80348**

World-leading tyre recycling takes shape

As of January 2023, a unique tyre recycling system will be established, a project that is far and away the biggest thing to happen to SDAB since its launch in 1994.

Why are we taking this step?

Based on a changing world and more stringent requirements from legislators and tyre producers alike, in 2020 SDAB conducted an external environment analysis of future recycling alternatives. Several parameters had begun to point in the wrong direction and material recycling had decreased when it should have been increasing. The idea of a brand new type of system was born, one where self-resolution and dynamic collaboration were identified as parameters of success.

The project, called SDAB 2.0, entails a modernising of the current tyre recycling system under producer responsibility in Sweden, with SDAB, under its own auspices and together with a number of partners, setting its sights higher. In connection with operational responsibility for tyre recycling in Sweden, it also means that SDAB has sales responsibility for the recycled raw material. New recycling facilities are being established across Sweden in 2022, with the largest being next to Tekniska verken's power and heating plant in Linköping. At the same time, the infrastructure for tyre collection is being updated with regard to both new transport procurement and logistics. Tyre workshops, recycling facilities or other tyre collection points will be able to order tyre collections by mobile phone or computer through a custom-made app. The updated collection service will also enable the recycling of tyres that could not previously be recycled, in part by asking the tyre collection points to sort retread- ed tyres and tyres containing puncture prevention fluid into separate bags. In the long term, tyres will also be sortable according to tyre type and brand.

New applications

The changes also mean more opportunities for tyre-derived materials to be used in new product applications that recycle more material. Different types of tyres and different parts of the tyre have different material properties. Improved sorting creates opportunities to make better use of the benefits offered by these various material properties in diverse applications.

Photography: Tekniska verken's power and heating plant in Linköping, which is nextdoor to the new tyre recycling facility. Photographs: Jeppe Gustafsson.

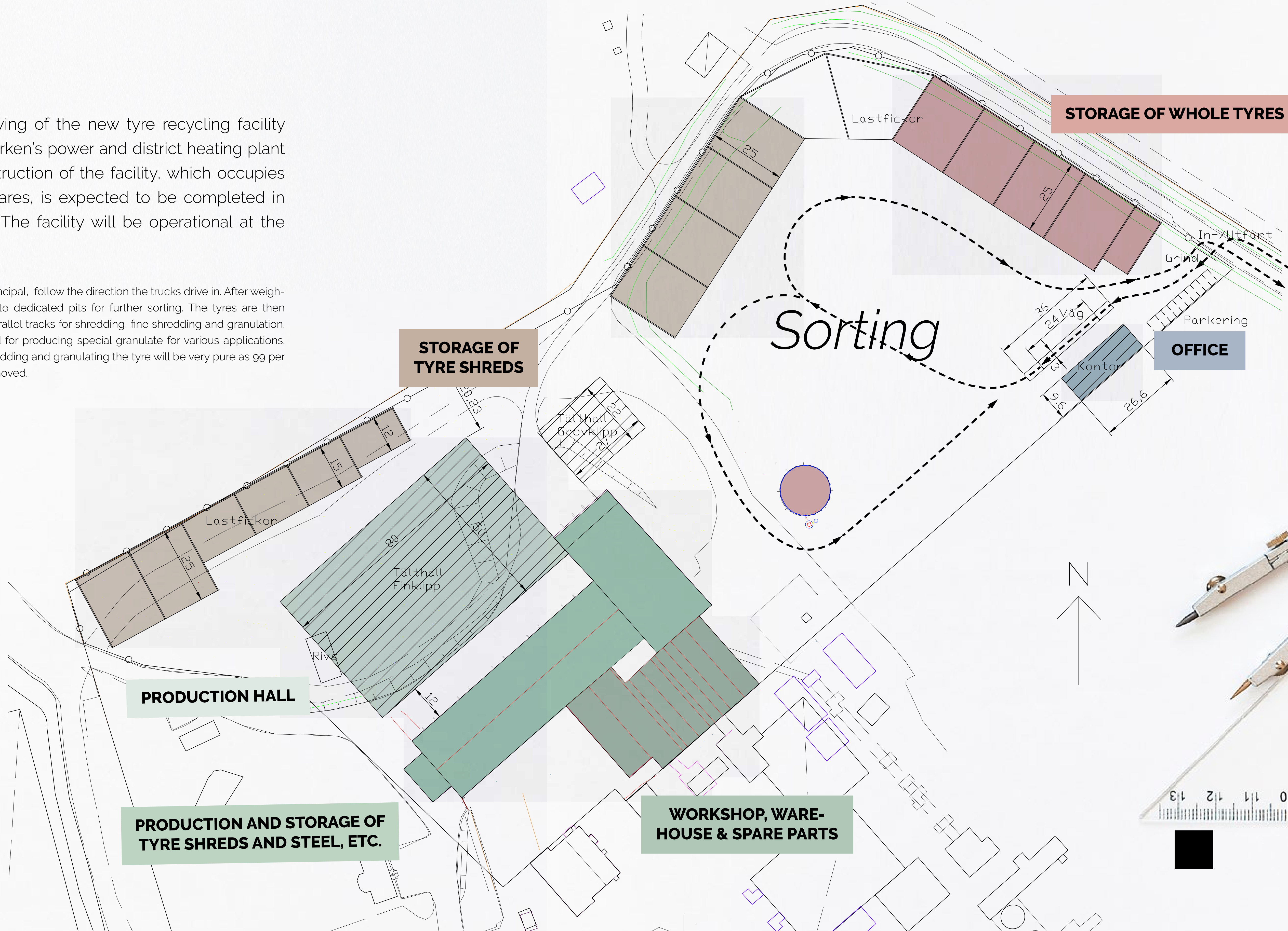
Exhibition and research

In order to continue exploring the opportunities offered by tyre-derived material, a laboratory and research section will be established at the large facility in Linköping. In connection with this, an exhibition on tyre recycling will be created to display recycled products. An exhibition with a similar concept and workshop space will also be created at SDAB's head office in Vaxholm, outside Stockholm. The rapid pace of development also requires the organisation to show that everything is being done in a responsible manner. To this end, we are developing a research portal to bring together facts and research about recycled tyre rubber. The recycled products will also bear the CERUB label, a sustainability label showing that the material has been recycled responsibly.

There are many hopes for the new tyre recycling system, but the aim is to inspire creation, imagination and new perspectives on tyre recycling, as well as producer responsibility that adds and contributes knowledge about a balanced circular economy with the material as a long-term investment. In many ways, it is unexpectedly a real gold mine.

An architect's drawing of the new tyre recycling facility next to Tekniska verken's power and district heating plant in Linköping. Construction of the facility, which occupies just over four hectares, is expected to be completed in late autumn 2022. The facility will be operational at the beginning of 2023.

The recycling flow will, in principal, follow the direction the trucks drive in. After weighing, the tyres are placed into dedicated pits for further sorting. The tyres are then brought into a building in parallel tracks for shredding, fine shredding and granulation. The granulation is optimised for producing special granulate for various applications. The steel obtained after shredding and granulating the tyre will be very pure as 99 per cent of the tyre rubber is removed.



Tyre rubber has many properties that have been refined over the years

The unique properties of tyre-derived materials enable a wide range of applications. Today, these advanced rubber materials are produced in accordance with strict rules and customer requirements regarding health, the environment and sustainability. This is why the materials are suitable for new applications for many years after the tyre has been removed from the car.

For over 100 years, the materials have been developed to be:

- **ELASTIC**
- **TEMPERATURE-RESISTANT**
- **UV-RESISTANT**
- **INSULATING**
- **DRAINAGE-BOOSTING**
- **LOAD-DISTRIBUTING**
- **SHOCK-ABSORBENT**
- **FRICTION-CREATING**
- **SOUND-ABSORBENT**

Biofilm and load distribution

Tyre shreds distribute loads and provide an excellent surface for biofilm.

Insulates, provides support and can be re-cast

Free-form rubber granulate insulates, provides support, reduces wear, etc. and can be re-cast in new products. When added to concrete and asphalt, it improves their properties.

Fibreboard, concrete and textiles

The textiles provide extra strength to the tyre and the strong fibres reinforce fibreboard, concrete and textile fabrics, etc.

Used again and again

The steel from the reinforcement layers and wires is well-known in recycling circles and can be used as it is or be re-cast.

Binding agents and pigments

Carbon black from pyrolysis becomes a new raw material to act as a binding agent or pigment, etc.

Oils, lubricants and fue

Pyrolysis oil from tyres has a low sulphur content and is refined into high-tech oils, additives or lubricants, or it becomes liquid fuel.

Rubber products

Devulcanised rubber is ready to be turned into new rubber products.

High energy

Rubber has a high and even energy content during final energy recovery.

Important events in 2021

QUARTER 1

During the first month of the year, it was announced that the Swedish Environmental Protection Agency had been commissioned by the government to investigate the introduction of national end-of-waste (EOW) criteria in Sweden. This is very pleasing to hear because the current waste classification makes recycling more difficult. SDAB has long sought criteria for when tyres should cease to be classified as waste.

In March, the Swedish daily Dagens Nyheter highlighted the possibility of reducing the risk of accidents on cycle paths and pavements by using a softer surface made from recycled tyre rubber. The report was conducted by the Research Institute of Sweden (RISE), which contacted SDAB in connection with the project for further collaboration.

As a result of the EU's potential plans to ban the use of rubber granulate as a filling material in artificial turf, in March, SDAB developed the campaign site 'The circular pitch'. In parallel, a local campaign was carried out with several opeds on how the EU ban threatens club activities in Sweden's municipalities. The campaign achieved a broad reach and most of the news media highlighted the issue.

QUARTER 2

In May, SDAB, together with Norway, Denmark and Finland's tyre recycling organisations, sharply criticised certain ministers with regard to the EU proposal on the use of rubber granulate in artificial turf pitches. The criticism was formulated in a letter signed by the person in charge of each organisation handling tyres in Sweden, Norway, Denmark and Finland.

In the same month, SDAB published a groundbreaking annual report on the topic of tyre recycling and ecosystems. This was a natural continuation of the 2019 white paper on sustainability in the tyre industry. The white paper is based on the idea of extending the lifespan of tyre rubber in new ways and thereby reducing the burden on the planet created by exploiting virgin resources. The annual report for 2020 on tyre recycling and ecosystems was one way of further developing this important topic.

In June, it became official that SDAB would change its model in 2023, when it will be responsible under its own auspices for the Swedish system for recycling tyres. It thereby entered into a long-term agreement with contractor Ragn-Sells.

QUARTER 3

In August, we welcomed the European Commission decision to restrict levels of polycyclic aromatic hydrocarbons (PAHs) in fillers for artificial turf and play surfaces. The new limit is 20 mg/kg, a level that recycled tyre granulate easily comes below. In September, Veronica Roth took over as customer services manager at SDAB. Veronica will also play a key role in developing a customised app to streamline collection of used tyres.

During the Swedish parliament's general round of bills in September, several bills were drawn up on tyres. For example, there were proposals regarding the circular economy, an extended change-over period between winter and summer tyres, and requirements for tyre quality. It is gratifying to all parts of the tyre industry that tyres are being highlighted to this extent – something that has never happened before. In late September, Swedish parliament members Betty Malmberg (Moderate Party) and Marlene Burwick (Social Democratic Party) organised a seminar in parliament on the end of waste. SDAB which is actively campaigning for the introduction of end-of- waste criteria for used tyres, was one of the speakers invited to the seminar.

QUARTER 4

Construction of the inspiration platform Rubber Hall, initiated by SDAB, began in October. Rubber Hall aims to create awareness, inspiration and fresh perspectives with regard to products and applications involving recycled tyre rubber. Rubber Hall was launched in late spring 2022. Read more at rubberhall.com. In October, SDAB switched to MyNewsDesk, which offers a broad communication platform with opportunities to publish and distribute press releases, news in general and videos. In connection with the changeover, SDAB chose to integrate the newsroom with sdab.se in order to increase accessibility and awareness about the organisation's activities and external communication. In November, we launched sdab2023. se in connection with the establishment of the new organisation for recycling tyres in Sweden. The site brings together information about the project's background, aims, goals and milestones. Also in November, SDAB began a feasibility study on building a central research portal with scientific reports about recycled tyre rubber. The portal will go under the name of ELTRP (End of Life Tyre Research Portal). Its launch is scheduled for the beginning of 2023. During the last month of the year, SDAB took another step into the digital world and ordered a custom made application with the aim of modernising, customising and optimising the process for collecting and recycling used tyres. The launch is scheduled for the start of 2023. After a break in 2020, the annual Tyre Industry Day was scheduled for the end of 2021, but it was postponed to May 2022 due to an increase in the spread of coronavirus. All of the presentations from the Tyre Industry Day are available at dackbranschen.se.

Glossary

Biomass – *Matter contained in living organisms, particularly from large volumes.*

Biosphere – *A collective name for the parts of Earth where life exist. It can be viewed as a large ecosystem that contains all of the smaller ecosystems on Earth. In the biosphere, life is preserved through material cycles and the flow of energy from the sun.*

Circular economy – *An economy in which economic resources are managed in cycles inspired by nature. Circular economic models are often the opposite of a linear economy, in which raw materials and products move in a straight line from extraction and production to consumption and destruction.*

CCS – *An abbreviation for Carbon Capture and Storage. Bio-CCS refers to carbon capture and storage from renewable sources.*

Down-cycling – *Recycling where the resulting product has a lower value than the original item.*

Devulcanisation – *When rubber is manufactured, long carbon chains are bound together by sulphur bonds in a process called vulcanisation. It is during the vulcanisation process that the tyre is turned into a flexible, durable and chemically very stable material. Devulcanisation is the process in which these sulphur bonds are broken through the use of various processes (mechanical, microwave, chemical or biological).*

Tyre shreds – *Also known as tyre chips. Shredded pieces of tyre around 50–250 mm in size and used in ground and construction work, e.g. drainage layers as the material's properties mean it does not freeze and it does not allow water through. Further shredding produces finer 15–50 mm pieces, which are used as surfaces and base courses and in sand filters for water purification as a substitute for natural gravel. Specially treated tyre shreds can capture phosphorus and thereby purify wastewater. This is an ongoing project that SDAB is working on.*

Energy recovery – *Material is combusted and converted into energy in the form of district heating and electricity. Used tyres have a high and even energy content and are used in the production of cement, for example. Several components of the tyre-derived materials are used here to replace virgin alternatives.*

Ecosystem – *Plant and animal communities that live together in the same place. The area may be large or small, e.g. the area around a tree stump, garden, forest or lake or the whole Earth.*

Photosynthesis – *The process whereby plants store energy from the sun as sugar molecules and release oxygen. It can be thought of as the other half of cellular respiration, whereby organisms – such as humans – utilise the stored energy of sugar for various processes and reactions. Cellular respiration and photosynthesis are both, in their own ways, absolutely essential for life on Earth. Overall equation for photosynthesis: Water + carbon dioxide + solar energy => carbohydrates + oxygen. Overall equation for cellular respiration: Carbohydrates + oxygen => carbon dioxide + water + energy.*

Fossil raw material/fuel – *Organic carbon and hydrogen compounds in sediment or sediment-ed bedrock originating from small aquatic animals and plants that have died and come to rest at the bottom of lakes and seas. Over millions of years these organic remains have been covered by layers of sediment and subject to high pressure and temperatures. Over time, they have slowly been converted into coal, oil and gas.*

Granulate – *When the tyre has been shredded into small pieces and separated from any steel, textiles, studs or gravel. Granulate is obtained with selected granule sizes of 0 to 5 mm. Granulate has sought-after properties as a filling material in artificial turf, in rubber asphalt and in foundry items, etc. The finest granulate, a powder, can be mixed in paint to absorb sound or used as a sub-component in newly produced tyres and other cast products.*

Carbon black – *A black colour pigment consisting of soot, a fine carbon powder used e.g. as an additive in car tyres, as well as in paints and inks.*

Carbon – *A non-metallic element found in all living things, for example. Carbon occurs in bound form in fossil fuels (e.g. hard coal, lignite and petroleum) and in free form as graphite and diamond.*

Carbon cycle – *A description of how carbon moves between different pools on Earth. The transfer of carbon is a basic precondition for life, such as when carbon, in the form of carbon dioxide, is taken from the atmos- phere and bound in vegetation through photosynthesis. Humans affect the carbon cycle to a large extent through the combustion of fossil fuels, deforestation and land cultivation.*

Carbon compound – *An organic chemical compound containing carbon and at least one other substance.*

Carbon dioxide– *A chemical compound of carbon and oxygen that is formed during cellular respiration and when substances containing carbon are burnt in the air or in oxygen. Chemical formula* CO_2

Material recycling – *The process of reusing materials that can replace other production or construction materials. Using recycled materials reduces the exploitation of virgin materials and saves energy.*

Microorganisms – *Organisms that cannot be seen by the naked eye, i.e. they are less than a few tenths of a millimetre. Examples include bacteria and algae.*

Mycelium – *Can be described as the root system of fungi. The well-known fruiting body of fungi is the part of the fungus that the mycelium produces when it is time for it to reproduce and propagate via the air. There are species that distribute 30,000 million spores per day. Mycelium is much more extensive than can usually be observed. For example, there may be several tonnes of mycelium in one hectare of natural forest.*

Nematodes – *A microorganism and a type of roundworm, one of Earth's most common multicellular animals. They are simple, invertebrate, non-segmented animals.*

PAHs *(polycyclic aromatic hydrocarbons) – A large group of compounds that are formed when carbon or hydrocarbons are heated or combusted without sufficient access to oxygen.*

pH value – *A measurement, expressed as a number, of how acidic or alkaline a solution is.*

Pyrolysis – *Heating tyre-derived material without adding oxygen can cause the rubber to vaporise. Steel, textiles, oil and carbon black are then released from their bound form in the product.*

System perspective – *Used to obtain an overview of a complex problem, challenge or situation. The aim is to identify the total impact of various courses of action.*

Greenhouse gases – *Natural and artificial gases that underlie the greenhouse effect, which is the warm- ing effect that the atmosphere exerts on Earth's surface due to its ability to let through, absorb or reflect radiation of different wave lengths.*

Eutrophication – *Caused by excessive levels of nu- trients, such as nitrogen and phosphorous, being added to land or water to such an extent that the ecosystems' capacity to benefit from the nutrients is exceeded.*

Rubber Hall, an inspiration platform that strives to shine a spotlight on recycled tyre rubber and its areas of use. It also aims to increase awareness, interest and curiosity with regard to this sustainable modern material that is playing an increasingly common and more practical role in our everyday lives than is often realised.

Find out more at **rubberhall.com**

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Swedish Tyre Recycling Association
(Svensk Däckåtervinning, SDAB)
Box 124, SE-185 22 Vaxholm
Visiting address. Strandgatan 3
08-50 60 10 55
info@sdab.se
sdab.se
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ABOUT SWEDISH TYRE RECYCLING ASSOCIATION (SVENSK DÄCKÅTERVINNING, SDAB)

Our task is to organise the collection and recycling of used tyres in Sweden. The recycling fee that producers pay when they bring new tyres to the Swedish market finances the collection, processing and recycling of used tyres. We have engaged Ragn-Sells as a contractor for the collection, treatment and sale of the recycled material. SDAB is a non-profit organisation. We have great aspirations for tyre recycling to set an example in the transition to a circular economy.

SWEDISH
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