

A WIDER PERSPECTIVE ON SLOVAKIA'S AUTOMOTIVE CIRCULARITY



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October 2021



Executive Summary

Slovakia's economic dependence on industrial production and old and aging passenger vehicle stock, traits common across the Central and Eastern Europe (CEE) region, make the decarbonization of the industrial and transport sectors especially challenging on the path to 2050 carbon neutrality. As a major steel producer, automotive manufacturing powerhouse, and second-hand vehicle graveyard, the medium and long-term climate solutions should incorporate a holistic, cross-sectoral approach to circularity contributes directly and indirectly to emissions reductions in these sectors.

The old and aging vehicle stock in Slovakia is a phenomenon felt across the wider CEE region as a result of 'diesel leakage', whereby tightening environmental standards in Western Europe continue pushing older petrol and diesel vehicles into Eastern European second-hand markets at cheaper prices. This further dampens already weak new vehicles sales that emit much less even if they are not electric. As long as this stream of affordable polluting vehicles continues uninterrupted, it will be nearly impossible for these countries to tackle transport emissions. The longer term integrated solution is a modal shift away from the personal vehicle model, but in the meantime a two pronged strategy should

be discussed by CEE authorities to **(i) stem the flow of second-hand cars through environmental-aligned vehicle tax reform and (ii) incentivize the removal and recycling of near waste vehicles that will otherwise continue polluting the roads for several more years.**

This report begins by examining Slovakia's automotive circularity potential with a case study on the recycling of the two largest shares of vehicle materials in older (12 years) vehicles - metal and rubber - which account for close to 75% of the composition. This assesses the potential of ferrous scrap metal as an input for low carbon steelmaking and end-of-life tyres which have several well-established commercial industrial applications. Circularity of plastics, the second largest and rising material in newer vehicles, is a complex topic in its own right, beyond the scope of this report.

The next section provides an EU context for Green Deal measures under review that aim to raise the standards and benchmarks for recycling of these materials, followed by an overview of EU scrappage schemes in response to the 2008 and 2020 economic crises before closing with the outlook and opportunities for Slovakia.

Introduction and Slovakia case study

The wider automotive sector has been integrating circular economics into core business practices for decades but ambitions must be raised in the sector's approach to effectively address climate change and resource depletion. In keeping with the Paris Agreement's less than 1.5°C of global warming target, the automotive industry would need to target a 50% reduction in absolute carbon emissions by 2030 when mobility demand is expected to increase by 70%.¹

It is clear that future sustainable mobility solutions require a modal shift away from cars, especially in urban areas, but the future automotive industry will have a key role to play in meeting this mobility demand while still reducing its life-cycle carbon footprint. Electrification of vehicles will progressively cut tail pipe emissions and

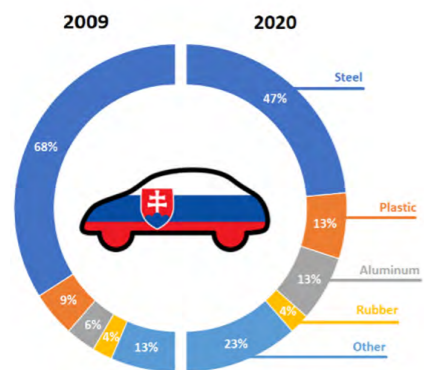
shift the decarbonisation onus onto the manufacturing processes, which is where circularity and climate goals can be mutually reinforcing. On the one hand, shared, connected autonomous vehicle technologies will enable new products and services for more sustainable and economically efficient use of the vehicle stock, disrupting the current private ownership model and softening demand for passenger cars in the medium and long term. In other words, as digital services and software capture more value added at the expense of manufacturing parts and vehicles themselves, road transport emissions will naturally fall. On the production side, circularity refers to a cross-cutting minimization of raw material inputs through innovative processes and substitution with end of life and/or waste material and coordinating value ecosystems more effectively. These circularity segments can add

value not only for society but incumbent and emerging companies.

The growing demand for more fuel efficient, lighter, and safer vehicles that is re-shaping the global automotive industry landscape is driven by regulators and customers, pushing vehicle manufacturers to focus on design efficiencies using advanced technologies and materials. These factors have made vehicle material composition a vital part of every OEM's overall manufacturing strategy.

Pie Chart 1 shows the average material composition of old and new passenger vehicles. Over the last ten years there is a clear trend away from steel and iron components towards plastics.

Pie Chart 1: Passenger vehicle average material composition comparison 2009 and 2020



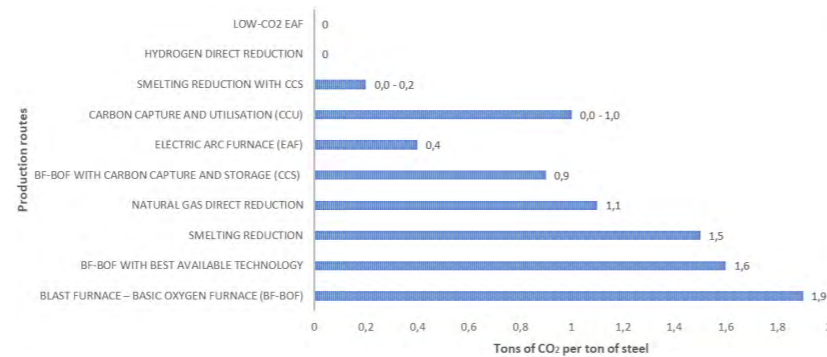
Source: Lodz University of Technologyⁱⁱ, 2009 and Tohoku Universityⁱⁱⁱ, 2020

Once all fluids have been drained and reusable parts removed from an automobile, scrap processors shred and sell the valuable ferrous material to steel mills. The average recycling rate for steel and iron from cars is about 90% and 1 tonne of steel scrap saves around 1.7 tonne of CO2 emissions.^{iv v}

STEEL AND SCRAP

According to the IEA sustainable development scenario, for emissions from the steel industry to halve by 2050 emissions per tonne of steel produced should be reduced from the current average of 1.4 tonnes of CO2 to 0.6 tonnes.^{vi} Chart 1 shows the CO2 intensity of steelmaking processes. **About 70% of global steel production today uses the most carbon intensive basic oxygen furnace (BOF). Electric arc furnace (EAF) is not only lower in carbon intensity but uses more than 90% of ferrous scrap input while BOF is limited to 30%. This should make it clear that metal waste is a strategic raw material that will play an increasingly important role in the medium term decarbonisation of steelmaking.**

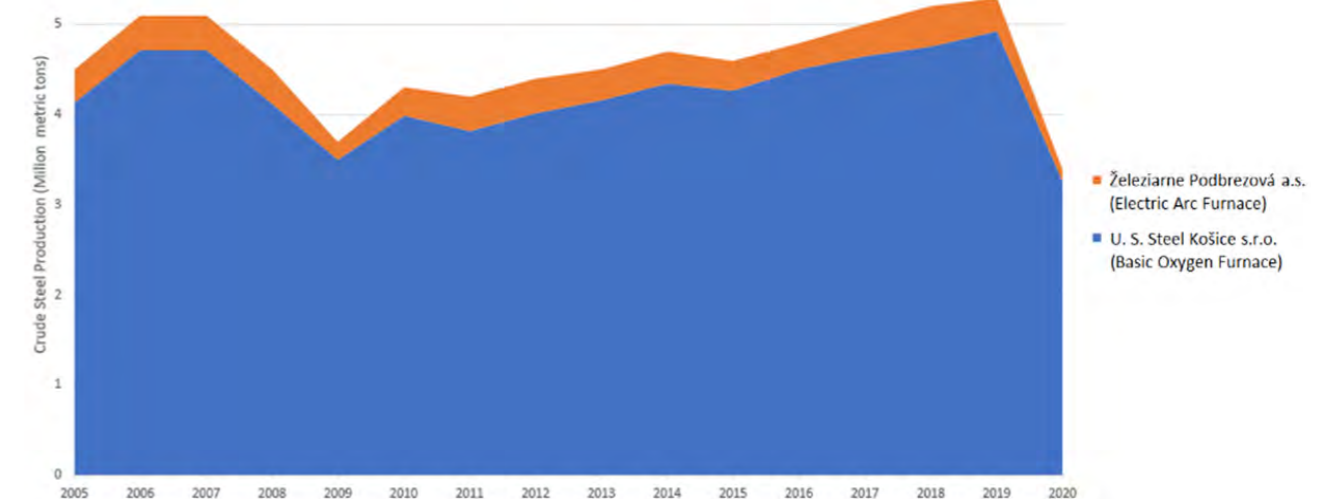
Chart 1: CO2 intensity of EU steel production processes, tons of CO2 per ton of steel



Source: Industrial Transformation 2050, Material Economics^{vii}

U. S. Steel Košice is by far the largest of two steel producers in Slovakia and, consequently, by far the largest emitter of CO2 emissions in the country. As illustrated in Graph 2, Železiarne Podbrezová produces much less steel but entirely via EAF processes.^{viii} United States Steel Corporation recently pledged to carbon neutrality by 2050 which will depend on green hydrogen in the long run and switching from BOF to EAF in the interim.^{ix} The current annual U. S. Steel Košice consumption is only 850,000 tons of scrap metal which would grow significantly in the medium term with a strategic rollout of EAFs.

Graph 2: Total Slovak crude steel production (million metric tons)

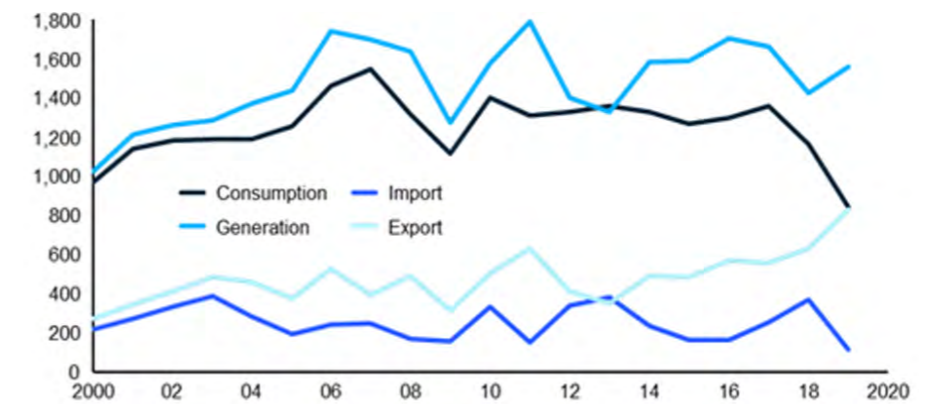


Source: World Steel^x

Graph 2 also shows the steep decline in Slovakia's steel production in 2019 when U. S. Steel Košice cut production as a result of rising input prices and a flood of cheap steel from third countries. This impacted Slovakia's steel scrap market, as shown in Graph 3. After a relatively stable period up to 2018, the drop in domestic demand combined with higher international prices led to rising

exports of scrap metal. Nonetheless in 2021 U. S. Steel Košice returned to full production boosted by demand from the economic recovery.^{xi} The future fundamentals of Slovakia's steel scrap metal market will largely be determined by the company's climate strategy and the role of EAF.

Graph 3: Slovakia's steel scrap market



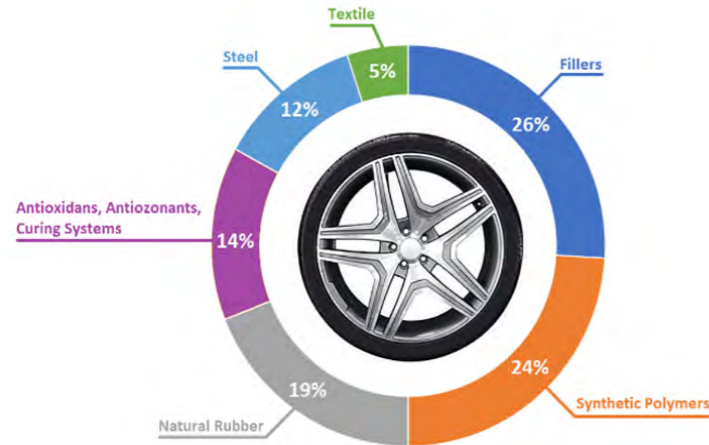
Source: World Steel^{xii}

RUBBER AND TIRES

Typically end-of-life tyres (ELT) are collected and treated with material recycling and energy recovery organized by an ELT Management Company operating under the European Tyre and Rubber Manufacturers' Association (ETRMA). ETRMA consolidated data on the management of ELTs for 2019 covering 32 countries (EU27, Norway, Serbia, Switzerland, Turkey and UK) across which 94% of ELTs were collected and treated for material recycling and energy recovery.

One type of ETL transforms old tires (or other waste plastics) into carbon inputs compatible with EAF processing, typically sourced from coal and anthracite. As illustrated in Pie Chart 2, used tyres contain carbon in the synthetic and/or natural rubber, which could be a viable carbon-neutral substitute for fossil-based carbon charge and injection. ETLs also contain a significant amount of steel wire which can be recycled as an EAF input.^{xiii}

Pie Chart 2: Passenger car tyre material composition



Source: Materials, Science and Engineering, 2018^{xiv}

ELTs treated through material recovery recycling includes granulation and the incorporation of the inorganic content in cement manufacturing sent to cement kilns as co-processing. Compared to the large-scale recovery of energy from waste incineration plants, tyre-derived fuel (TDF) made from ELT is a lower cost alternative to fossil fuels for cement manufacturers, whose energy consumption is one of their largest expenditures.^{xv}

Slovakia's Považská cementáreň, a.s., Ladce started operations in 1983 as the first European plant to co-burn ELT, and by the end of 2019 it has cumulatively recovered more than 119,000 tons. From 2010 - 2019, the co-combustion of alternative fuels, tyres and solid alternative fuel in the rotary kiln line produced 98,000 tons of ash used to produce clinker. Without the ash, 163,000 tons of limestone would have been needed to produce the clinker, and 523,000 tons of waste would remain in landfills.^{xvi}

As shown in the detailed analysis of Table 1, Slovakia has improved from 70% ELT treatment in 2017 to 85% in 2019 while falling in absolute terms by approximately 20% (27 475 tons).^{xvii} What is most striking is the quantity of ELTs, stocked or unknown, and waiting for treatment has significantly declined from 2018 to 2019 (8000 to 363 tonnes).

Table 1: End of Life Tyres Management – Slovakia (Tonnes)

Year	ELT	Elt Recovery				Unknown /Stocks	ELT Treated
		Material		Energy			
		Civil engineering, public works and backfilling (B)	Recycling	Total mat. Recovery	Energy Recovery		
2017	34 500	1 000	20 000	21 000	3 000	10 500	70%
2018	29 000	-	20 000	20 000	1000	8 000	72%
2019	27 475	-	22 675	22 675	632	363	85%

Source: ETRMA - End of Life Tyres Management – Europe

Cement producers in Slovakia have long used ELT as an alternative fuel, but year-on-year consumption of tyres for energy recovery has fallen dramatically. Similar to the decline in scrap metal demand, this situation is largely explained by an increase in the prices of input materials for cement production.

PLASTICS

Plastics are the second largest material component in newer cars, comprising items such as bumpers, seat belts, and steering wheels. Scaling up the use of plastics in cars is viewed as a way to lower the weight of vehicles, reduce fuel consumption and lower CO₂ emissions.^{xviii} From a circularity perspective, plastics present the biggest material challenge because of the difficulty replicating the properties of virgin material with recycled components. For now, most of this plastic comes from virgin sources which mostly ends up in landfill.

The European Recycling Industries' Confederation (EuRIC) is calling for binding targets for use of recycled plastics that would escalate every 5 years in the new EU circular economy action plan elaborated in the next section. Some car producers like Fiat and Renault are already scaling up use of recycled plastic, but EU automotive industry body (ACEA) does not believe fixed targets are a viable solution because of the difficulty in recreating and matching the exact technical and quality properties of the virgin material. Without guaranteed matching there is a risk to meeting quotas.

As lighter and stronger polymers become more prevalent in place of metals, plastic recycling and use of recycled rather than virgin material will be crucial to close the automotive circularity loop.

European Green Deal context: Synergetic climate and circularity measures

EU CIRCULAR ECONOMY ACTION PLAN AND INDUSTRY EMISSIONS REVISION DIRECTIVE

The European Commission proposed its new circular economy action plan (CEAP) in March 2020 aiming to reduce pressure on natural resources and create sustainable growth and jobs. It is an integral building block for the EU to achieve 2050 carbon neutrality and reverse biodiversity loss. **The measures that are to be introduced under the new action plan will focus on sectors and value chains that use the most resources and where the potential for circularity is also high, which includes batteries and vehicles^{xix}.**

In December 2020 the European Council provided guidance on the plan in the conclusions of 'Making the Recovery Circular and Green'. Then, in February 2021, the European Parliament ENVI committee adopted a draft text on the CEAP, making more than 130 individual circularity policy recommendations for the Commission, including (i) binding science-based mid and long-term EU targets for reducing the use of primary raw material and environmental impacts and (ii) binding material and environmental footprint targets for the whole product life cycle for each product category on the EU market, including product specific and/or sector specific binding targets for recycled content.^{xx}

The CEAP is meant to be more synergetic with several mutually reinforcing strategies under the European Green Deal (EGD), especially the EU Industrial strategy for circularity in production processes and the Industrial Emissions Directive (IED) and best available techniques (BAT) for resource and energy efficiency and waste management, including material recycling. **As such, the IED should drive the phase out of older carbon intensive techniques relying on fossil fuel and feedstock where alternative technology is available, like the case of EAF replacing BOF processes. In this way industry resource efficiency, and steel in particular, can also deliver decarbonisation goals.**

The EU has integrated circular economy objectives into the EU Taxonomy Regulation with the Circular Economy Finance Support Platform offering guidance

for project promoters on circular incentives. EU financial instruments like SME guarantees, InvestEU, the European Regional Development Fund (ERDF) through LIFE and Horizon Europe, are also intended to compliment private funding for circularity and support the innovation cycle. Furthermore, the recovery and resiliency facility (RRF) will boost efforts across the EU to reduce the environmental impact of energy intensive industries and shift to a net zero emissions trajectory over the next 30 years.

THE VALUE OF KEEPING END-OF-LIFE VEHICLES IN THE EU

At face value, the European ELV recycling process is one of the most effective and advanced in the world. Although the directive is now more than 20 years old, it placed the burden on car manufacturing and set high material recycling targets that have largely been met by EU member states. **Nonetheless it should be updated and modernized in accordance with the EU's twin green and digital transformations under the European Green Deal, especially to close loopholes for untreated and illegal ELV exports.**

The European Commission initiated the review process in 2018 with an evaluation and fitness check followed by two rounds of stakeholder consultation, the last closing at the end of 2019. During the June 2020 European Council ENVI meeting EGD Commissioner Franz Timmermans announced the ELV proposal will be ready at the end of 2022.^{xxi}

In recognizing the millions of tonnes of waste the EU has exported to non-EU countries with lax environmental standards over the past decade, often without proper waste treatment, the Commission will review rules on waste shipments and move to restrict exports that can be treated domestically within the EU. **According to Eurofer industry association data, scrap metal is the most exported waste outside the EU, typically to Turkey, Pakistan, Egypt, and India where it is remelted with carbon intensive processes. The European Aluminium association has also expressed concern over illegal shipments of ELVs and treatments to third countries, imploring the EU to improve the registration**

and deregistration system.^{xxii} They are among several industry associations pushing for Europe to curb exports of ferrous scrap to third countries that don't meet the same environmental standards, especially as European steelmakers invest in EAF processes to reduce carbon emissions.^{xxiii xxiv} Therefore it is imperative that the ELV Directive avoids added costs and administrative burdens that can jeopardize the economics, especially for SMEs, and undermine the value-added proposition for member states.

EU vehicle scrappage and subsidy schemes for economic stimulus

EU OVERVIEW

The vehicle scrappage scheme was a common fiscal stimulus tool used by EU member states in the wake of the 2008 global financial crisis to support automotive industry production. It was a direct response to the weakening in demand across the automotive value chain which represents a huge part of the EU area economy. The underlying assumption is that as long as member states do not discriminate against foreign car producers the rising tide will lift all boats. These schemes were purely economic in purpose with the associated reduction of tail pipe emissions a co-benefit of newer more efficient vehicles.

These policies did stimulate EU demand for cars, with new registrations in 2009 surging, especially in Germany, Austria and Slovakia, and result in a measurable positive macroeconomic impact. However, it did not compensate for the massive fall in exports to foreign markets outside the EU and the knock-on effect only delayed the drop-off to 2010. The ECB concluded that the short-term impact on EU real GDP growth in the first half of 2009 was likely positive but small.^{xxvi} **It is a reminder that the crowding out effect must be measured against the opportunity cost of other demand boosting targets like building renovation and construction, not only the economic impact but emissions reductions.**

Fast forwarding to April 2020, **EGD Commissioner Timmermans spoke out in favour of scrappage schemes to revive vehicle sales as long as green conditions are attached and backed by binding guidance for member states to ensure polluting vehicles do not receive**

Demand for ELV material utilization will be boosted by the broad aims and specific measures of the CEAP. As alluded to in the previous section, the CEAP identifies vehicles as a key product value chain for circular business models linking design to end-of-life treatment. It supports the expansion of the recycling sector marketplace with requirements and criteria for recycled content while encouraging cross-border initiatives for cooperation and harmonization through a market observatory for key secondary materials.^{xxv}

support.^{xxvii} The EU pledged to block or limit funds from the Next Generation EU to programmes supporting conventional vehicle sales and in February 2021 adopted guidance that would assess recovery funded scrappage schemes replacing petrol and diesel cars with combustion powertrains against zero emission EVs according to the do no significant harm principle.^{xxviii}

Yet ecologically oriented vehicle subsidy schemes have been the method of choice for member states to stimulate demand and encourage the uptake of EVs in response to the 2020 COVID-19 crisis. By August 2021, Italy joined France, Spain, Germany and Austria in introducing greater financial aid for the purchase of new cars but only the latter two countries do not include end subsidies for petrol or diesel vehicles in their RRFs.^{xxix} France, Spain and Italy provide the highest incentive for BEVs but the bonus extends to conventional cars with CO2 emissions above the EU's 2020/21 climate target of 95 gCO2/km, as high as 137 gCO2/km in France, 120 gCO2/km in Spain and 110 gCO2/km in Spain. Despite global car sales contracting by an estimated 14% in 2020, EV sales in Europe more than doubled, owing partly to Chinese demand boosted by a generous subsidy scheme that has been extended through 2022.^{xxx}

In principle, the early destruction of functioning cars by fiscal incentives to private households reduces the economic wealth of a country, but this does not capture the positive environmental impact or contribution to climate targets of an ecologically motivated scheme replacing polluting for zero emission vehicles.

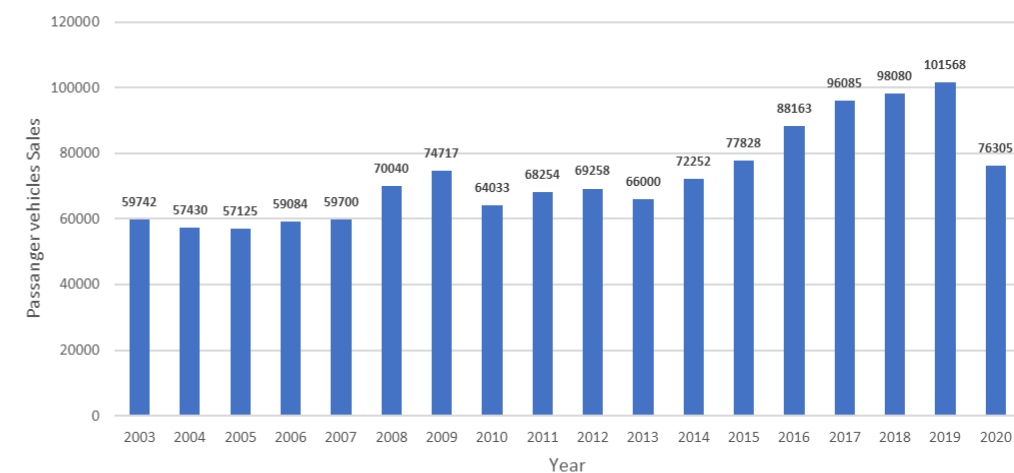
SLOVAKIA EXPERIENCE

Slovakia's 2009 scrappage scheme was also 'stimulus first' without any climate objective other than the prevailing logic of newer cars being more environmentally friendly than older ones (cars at least 10 years old to qualify). In the end it distributed EUR 33 million for 40,000 units. As shown in Graph 3, the widespread use of EU member state scrappage schemes helped buoy Slovakia's vehicle sales in 2009, and subsequently its own 9-month scheme was mostly viewed as a success. However, the knock-on effect can be observed the following year in 2010, when sales fell by 14.3%. This can be compared to the more dramatic year-on-year decline of 25% in 2020 as a result of the COVID-19 crisis.

In 2019, Slovakia was considering an ecological vehicle scrappage and subsidy scheme for 2020 as part of its

e-mobility strategy to support the uptake of EVs. During early inter-ministerial consultations, a vehicle scrapping scheme was discussed and listed on the official agenda by the Ministry of Environment but in the end it was left out. Instead the Slovak Ministry of Economy introduced a subsidy programme 'Chceme elektromobil' which provided a generous EUR 8,000 for EVs and EUR 5,000 for PHEVs. The last round of subsidies totalling EUR 6 million was famously absorbed in 3 minutes 41 seconds by those faster and more proficient with the technical application procedure, leaving most citizens out of the process. Due to this perceived failure, the programme has been postponed to 2022 to allow time for redesign and align with the first year of the new tranche of EU Cohesion funds. The 2022 scheme will provide a lower level of subsidy (EUR 2,200) with the aim of spreading to more citizens.

Graph 3: Slovakia automotive industry passenger vehicle sales



Source: Car Sales Base^{xxxi}

Fit for Slovakia

Slovakia's economic growth is significantly dependent on industrial production (almost 30% of GDP) which creates a long term decarbonisation challenge. Furthermore, the dominance of the automotive industry followed by materials and mechanical engineering makes resource efficiency and the transition to a circular economic model of paramount importance for the country's sustainable growth, future competitiveness and prosperity.

In order for industry to make the necessary green investments into low carbon processes and R&D

innovation for clean technologies the government needs to provide for a clear national strategy with benchmarks under the European Green Deal. Slovakia's RRF should provide a good starting point, allocating EUR 370 million of the EUR 2 billion green investment share to industrial innovation and R&D, but more direct state support will be needed (see previous AutoFocus Slovakia report, 'An Automotive Industry Perspective', July 2021).

Steel is commonly labelled the material of the future due to its special properties, namely 100% recyclability and

direct connection to other industries like automotive. By promoting synergetic use of waste material from the car production process and their recycling in various industries such as steel and cement, Slovakia can move closer to its twin goals of achieving economy-wide circularity and emissions reductions of industrial processes.

Slovakia does very well in the reuse and recycling and reuse and recovery of vehicles, exceeding the EU ELV requirements of 85% and 95% with 95.1% and 96.8% respectively between 2015-2018, but both scrap metal and rubber ELV inputs declined in 2019.^{xxxii} Slovakia's

current vehicle stock is representative of the region, averaging 14 years with 60% over 10 years old.^{xxxiii} **If U. S. Steel Košice chooses an EAF decarbonization investment strategy it would significantly increase demand for scrap metal inputs. Given this scenario in 2-3 years' time, an ecological scrappage scheme would therefore merit consideration in Slovakia and other CEE countries targeting the oldest and worst rated vehicles on the roads.** This would have to be coupled with political progress on environmental vehicle and mobility tax reform at least curbing the flow of diesel leakage.

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