Circular Cars Initiative

In collaboration with Systemiq

WORLD ECONOMIC FORUM

Paving the Way: Policy Action in the European Union, China and the United States for Automotive Circularity

BRIEFING PAPER

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Images: Getty Images

Contents

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Executive summary

While several policy tools have been successfully implemented to encourage the circularity of the automotive sector in the European Union, China and the United States, these efforts still mostly occur in isolation.

To close existing knowledge and understanding gaps in these geographies, the Circular Cars Initiative (CCI) and Systemiq developed seven insight pieces, focused on batteries and steel. These pieces examined the status quo and direction of travel of public policy action in these three geographies.

The analysis of this synthesis report builds on these seven insight pieces to derive recommendations for policy-makers globally to advance automotive circularity. It relates these to the four policy development principles shaped originally in the Systemiq/CCI report endorsed by EU Transport Commissioner Adina Valean, *Paving the Way: EU Policy Action for Automotive Circularity* (2021):

1. Account for the life cycle of the vehicle per passenger kilometre in emissions performance assessment, including carbon embedded in materials
2. Accelerate the use of circular, low-carbon materials to scale general demand for quality recyclates
3. Expand focus of circularity from recycling to higher-value measures such as reuse and remanufacturing
4. Optimize utilization factor by supporting fleet management and shared mobility-on-demand solutions as part of intermodal mobility systems

The policy review conducted across the seven insight pieces and completed in this synthesis report indicates that there are positive developments under way in all geographies but policy-makers must do more to enable the transition to a low-carbon, resource-efficient automotive sector.

Five overarching recommendations are derived from the previously formulated insight pieces. Policy-makers should take action to:

1. Scale digital battery and vehicle passports
2. Close the loop on battery materials
3. Chart a path towards closed-loop automotive steel
4. Incentivise delivery of end-of-life vehicles to authorised treatment facilities
5. Prioritise reuse, repair, and remanufacturing of batteries and vehicle components

FIGURE 1 **Overview of insight papers published by the CCI in collaboration with Systemiq**

Overview of the seven insight pieces published by the CCI in 2023			
	Title of the insight piece	Batteries	Steel
1	Accelerating Policy Action for Safe and Green Electric Vehicle Battery Recycling	●	
2	Digital Battery Passports: An Enabler for Sustainable and Circular Battery Management	●	
3	New Value from Used Vehicles: A Policy Agenda	●	●
4	Closing the Loop on Automotive Steel: A Policy Agenda		●
5	Accelerating Policy Action for Near-Zero Emissions Steel in the Automotive Industry		●
6	A Circular Economy Approach to Battery Electric Vehicle Supply Chains	●	
7	Enabling Automotive Circularity through Digital Vehicle Passports		●

*Stakeholders & their needs differ between levers

1 Global policy action is needed to create conducive framework conditions for automotive circularity

The growing market share of battery-electric vehicles (BEVs) will increase materials' share of automotive life-cycle emissions in both relative and absolute terms. BEVs have around 1.5-2.0x higher material emissions than internal combustion engine vehicles (ICEVs). Batteries and steel are the biggest drivers of a BEV's materials emissions, accounting for up to 40% and 16% respectively. These materials emissions need to be addressed to enable the transition to a low-carbon, resource-efficient automotive sector.

Circular economy measures, including vehicle-sharing, smart-charging, refurbishing, repurposing and recycling are effective measures to lower lifecycle environmental footprints and costs. Nevertheless, creating business value from circularity is challenging for most solutions today.

Policy action plays an important role in creating the conducive framework conditions for circular material and product use and for circular business models. While several policy tools have been successfully implemented to encourage the circularity of the automotive sector in the EU, China and the US, these efforts still mostly occur in isolation.

In 2021, the World Economic Forum Circular Cars Initiative, in collaboration with Systemiq, published the report, *Paving the Way: EU Policy Action for Automotive Circularity*. Endorsed by EU Commissioner for Transport Adina Valean, it shaped a framework for the development of circularity policy and provided the first comprehensive mapping and review of EU policies for the same.

In 2023, the CCI policy workstream, led by Systemiq, expanded its focus to close gaps in the knowledge and understanding of EU, Chinese and US decision-makers. To this end, the CCI developed seven insight pieces that covered the status quo and direction of travel of public policy action regarding automotive circularity in these three geographies. This piece synthesizes the findings and derives overarching policy recommendations to decision-makers in these geographies.

2 The CCI, in collaboration with Systemiq, developed seven insight pieces covering high impact topics of circularity

As previously mentioned, steel and batteries account for the majority of a vehicle's materials emissions, which prompted the selection of topics examining how to increase the circularity of these materials. In addition, the topics were informed by the **circular economy** levers as defined by the CCI. These include:

- **Material circularity:** Enabling resource recovery and closing material loops (e.g., end-of-life disassembly and reverse logistics)
- **Lifetime optimization:** Increasing the lifetime of the vehicle and its components (e.g., subscription-based ownership, reuse and remanufacturing at scale)
- **Utilization improvement:** Ensuring efficient vehicle use over time and occupancy (e.g., vehicle-on-demand, mobility-on-demand, breathing fleets)

In total, **seven "insight pieces"**, short papers with quick-to-digest analyses and facts, were developed leaning heavily on previous in-depth research and advisory practice by Systemiq (see Figure 1).

In each of the insight pieces, a status quo assessment and outlook on policy in the three geographies – EU, China and US – was provided regarding the respective topic.

TABLE 1 **Summary of the seven insight pieces**

Number	Insight piece title	Summary of insight piece
1	Accelerating Policy Action for Safe and Green Electric Vehicle Battery Recycling	Electric vehicle (EV) battery recycling offers the chance to: cut up to 40% of a battery's lifetime carbon footprint; create jobs; and use fewer virgin materials and more recycled inputs. This insight piece sets out five recommendations for policy-makers on how to develop the framework conditions to enable the safe, green and efficient recycling of EV batteries globally.
2	Digital Battery Passports: An Enabler for Sustainable and Circular Battery Management	Batteries play a critical role in the shift towards low-carbon transport and renewable energy. The circular and sustainable management of EV traction batteries is essential for meeting net-zero goals and decoupling production from the consumption of finite resources. This insight piece outlines how the digital battery passport has the potential to increase transparency across the battery value chain by collecting, exchanging, collating and reporting trusted data.
3	New Value from Used Vehicles: A Policy Agenda	Almost 5 million used light-duty vehicles are exported every year from high-income to low- and medium-income countries. This paper highlights that the circular economy offers a lens to transform the used vehicles trade from a burden to an opportunity. It provides an in-depth overview of the proposed EU Circular Vehicles Regulation and makes five recommendations to policy-makers in the EU, China and the US for enabling the scaling of circular business models.
4	Closing the Loop on Automotive Steel: A Policy Agenda	At 16% of BEV material emissions, steel is crucial for achieving deep decarbonization in the automotive sector. It highlights a range of supply- and demand-side measures as well as cross-cutting market enablers that can facilitate the widespread use of secondary steel in automotive applications. The paper makes five recommendations for policy-makers in the EU, China and US.
5	Accelerating Policy Action for Near-Zero Emissions Steel in the Automotive Industry	The automotive ecosystem is uniquely positioned to drive decarbonization in the global steel industry, since it constitutes around 12% of global steel demand. Although the pipeline for near-zero emissions steel projects is growing, planned capacity still falls short of what is needed to put the industry on a path to net zero. This insight piece sets out three recommendations for how policy-makers can support the commercialization of breakthrough steel projects.

TABLE 1 | **Summary of the seven insight pieces** (Continued)

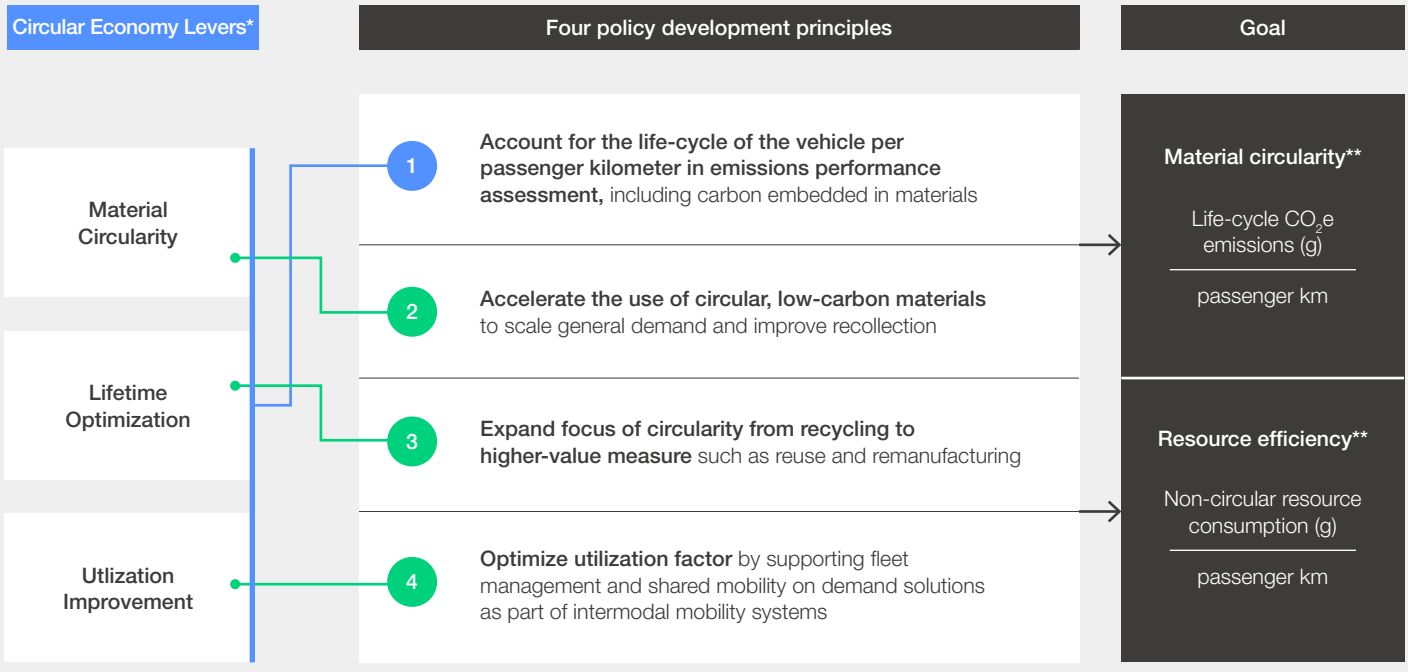
Number	Insight piece title	Summary of insight piece
6	A Circular Economy Approach to Battery Electric Vehicle Supply Chains	Critical raw materials (CRMs), including cobalt, copper, graphite, lithium, neodymium and nickel, are essential for BEV manufacturing but face challenges of scarcity and supply chain complexity. A circular economy approach that focuses on rethink, reduce, reuse and recycle strategies can contribute to addressing these issues. This insight piece makes five recommendations to enhance CRM supply security through policies and incentives promoting the circular economy.
7	Enabling Automotive Circularity through Digital Vehicle Passports	The EU recently announced the introduction of a digital vehicle passport to enable repair, remanufacturing and recycling. This insight piece argues that building on this proposal, a holistic digital vehicle passport that integrates upstream, use and downstream information could become a powerful enabling tool for global automotive circularity. The paper makes three recommendations to seize this opportunity.

3 The CCI's policy development principles provide the basis for the analysis of the policy status quo

The analysis was guided and informed by the automotive circularity policy framework that was developed by Systemiq and the CCI for the 2021 report, *Paving the Way: EU Policy Action for Automotive Circularity*. Based on the CCI framework, four high-level **policy development principles** for automotive circularity were developed to guide policy action to ensure compatibility with carbon and resource goals (see Figure 2). These ask policy-makers to:

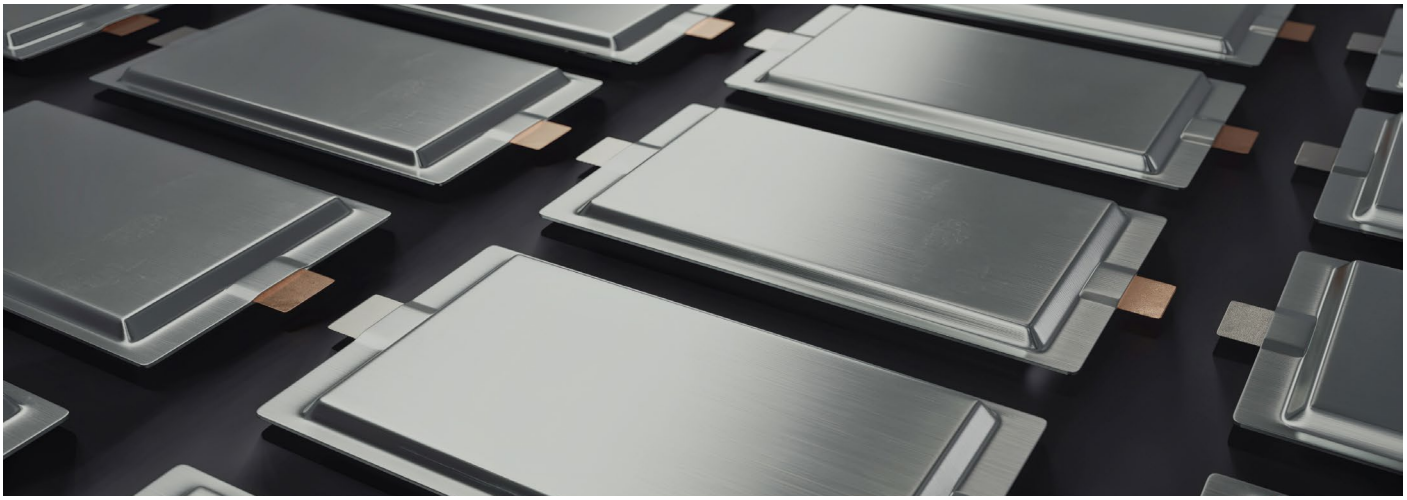
1. (Re)design policies to **account for the life cycle** of the vehicle per passenger kilometre in emissions performance assessments
2. Accelerate the use of **circular, low-carbon materials**
3. Expand the focus of circularity from recycling to **higher-value measures**
4. Optimize the **utilization** of vehicles

FIGURE 2 **Automotive circularity policy framework**



* Stakeholders and their needs differ between levers ** at vehicle level, simultaneously ensuring that absolute transport sector impacts are reduced in line with planetary boundaries

Source: Systemiq, CCI, 2021



4 Taking stock of the global policy status quo on automotive circularity

The CCI policy development principles are used in this paper to analyse the current policy landscape in the EU, China and US. The analysis synthesizes the findings from the previous seven insight pieces (see Table 1).

TABLE 2 **Overview of automotive circularity policies in selected geographies**

	European Union	China	United States
Principle 1 Life-cycle-based perspective	**Batteries:** Introduced a digital battery passport.	**Batteries:** Introduced a traceability system and is also working towards implementing a digital battery passport.	**Batteries:** Introduced the Inflation Reduction Act which increases the importance of provenance data.
Principle 2 Circular, low-carbon materials	**Batteries:** Introduced recycled content targets, design for recycling and incentivizes recycling. **Steel:** Considering introducing a recycled content target as well as disassembly requirements. Introduced measures to support take-up of near-zero emissions steel.	**Batteries:** Introduced several measures to increase the quantity and quality of EV battery recycling and to improve transparency of recycling processes. **Steel:** Introduced comprehensive vehicle design and recycling requirements for end-of-life vehicles.	**Batteries:** Incentivizes scale-up of domestic recycling industry.
Principle 3 Reuse and remanufacturing	**Batteries:** Introduces product and labelling requirements and makes state of health information transparent. **Steel:** Suggests to require disassembly of certain components and to promote their reuse and remanufacturing.	**Batteries:** Implemented requirements for batteries to be reused or repurposed before being recycled. **Steel:** Incentivizes the remanufacturing of key automotive assemblies.	**Steel:** Drives demand for remanufacturing through public procurement.
Principle 4 Utilization increase	The review indicates there were no policies currently planned or implemented at national/EU level that actively promoted business models or practices that could increase vehicle utilization rate and occupancy.		

4.1 Principle 1 – Life-cycle-based perspective

This principle focuses on expanding GHG performance assessment from tailpipe emissions to a life cycle-based perspective along the value chain. This would influence the perspective of policy and industry away from purely optimizing tailpipe emissions and units sold to a circular life cycle-based view that also includes carbon emissions embedded in the vehicle materials and effects from end-of-life management.

The assessment of the current practice regarding principle 1 in the three geographies in scope shows the following:

European Union

To date, the EU is the main region pursuing this principle. By 2025, the EU aims to provide a common methodology for assessing the full life cycle of CO_2 emissions of cars and vans by 2025 as part of the revision of CO_2 emissions standards. This can lay the foundation for mandatory emissions targets across the full life cycle and full decarbonization of battery materials and steel. The EU is also developing measures that support the adoption of a life-cycle-based perspective. These include:

- **The revised Battery Regulation (2023)**: By covering the full product life cycle of batteries from mine through production to end of life and recycling, it introduces components of life-cycle measures to (vehicle) batteries. It also introduces comprehensive requirements to make a battery's carbon footprint transparent on the digital battery passport.
- **Circular Vehicles Regulation Draft (2023)**: The EU Commission proposes a digital vehicle passport in its Circular Vehicles Regulation draft. While mainly focused on the safe removal and replacement of vehicle parts and components, this could also be used to increase transparency of upstream materials emissions.

China

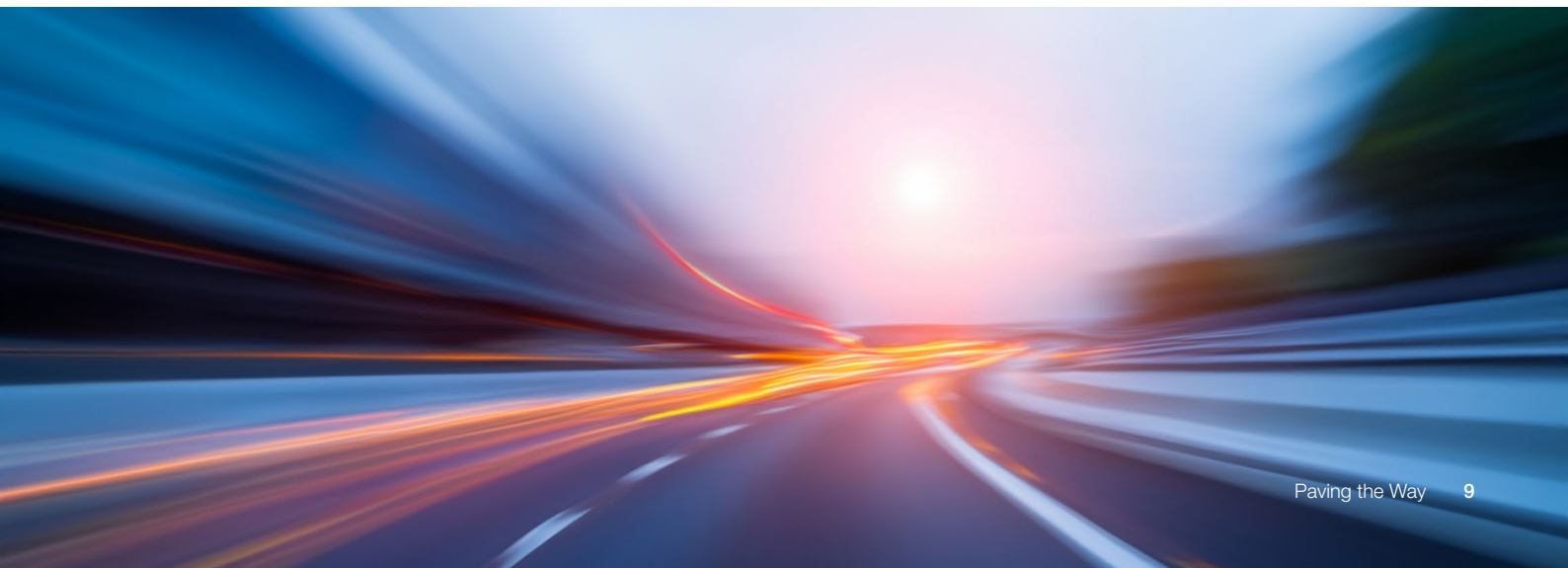
China is not currently addressing this principle in its policy-making. Nevertheless, it has initiated several transparency and traceability measures, especially along the EV battery supply chain, that can facilitate future life-cycle-based performance assessments.

In 2018, China passed the Interim Provisions on Traceability Management of Power Battery Recycling in New Energy Vehicles, which mandates information at all stages from cell manufacturers, automotive original equipment manufacturers (OEMs) and recyclers to determine recycling effectiveness. In the same year, a traceability system was introduced that collects information on maintenance, battery retirement, recycling and reuse, but does not yet include carbon footprint data.

Following the passing of the EU Battery Legislation, the government launched the development of a Chinese digital battery passport. The aim is to facilitate trade with the EU by requiring similar data transparency requirements along the EV battery value chain in China, such as the carbon footprint, circularity and ESG.

United States

Similar to China, the US is not currently pursuing this principle. Nevertheless, the recent US Inflation Reduction Act promotes supply chain localization, which increases the importance of provenance data for battery materials and components. This will likely result in the implementation of some form of product passport or traceability system, which could potentially enable life-cycle-based performance assessments in the future.



4.2 Principle 2 – Circular, low-carbon materials

This principle focuses on accelerating the use of circular, low-carbon materials to scale demand and improve recycling markets. This is especially important for critical battery materials – or indeed all materials that are affected by at least temporary supply shortages and therefore warrant additional effort to recover them – and materials with high carbon intensity such as steel.

European Union

The EU has prioritized this policy principle in several legislative efforts in recent years. For batteries and steel, these are as follows:

Batteries:

- 2023 EU Battery Regulation: Introduces material-specific recycling and recycled content targets for key battery materials. For lithium, for example, which is not recovered in large quantities today, the regulation requires recovery and recycling rates of 50% by 2027 and 80% by 2031, and recycled content targets of 6% by 2031 and 12% by 2036.
- 2021 EU Taxonomy: Incentivizes manufacturers to design recyclable batteries and use recycled materials. Recycled materials may cover both production and end-of-life scraps.
- 2023 EU Critical Raw Materials Act **Proposal**: The proposal includes a target that at least 15% of the EU's annual consumption should be covered by domestic recycling capacity. In addition, the act also aims to improve the circularity and sustainability of critical raw materials. The European Commission proposes investing €200 million to increase their recovery and recycling.

Steel:

- 2023 Circular Vehicles Regulation draft: Considers introducing a recycled content target for steel in vehicles. In addition, the government is considering mandating the removal of certain components in the disassembly process, such as wire harnesses.
- 2023 Carbon Border Adjustment Mechanism (CBAM): In 2023, the EU launched the CBAM to prevent carbon leakage by adding a fee on imports to the EU if they are more carbon-intensive than their EU equivalent.
- EU Taxonomy **and** EU Net-Zero Industry Act: The EU also shapes economic incentives to guide investments in near-zero emissions steel manufacturing through the EU Taxonomy regulation. In addition, it recently proposed the EU Net-Zero Industry Act, which aims to create better conditions to set up net-zero projects in Europe and attract investment. This builds on efforts to provide subsidies for key near-zero steel inputs, such as hydrogen, through the European Hydrogen Bank, Innovation Fund grants, or as Important Projects of Common European Interest.

China

China has also advanced its policy efforts to increase the use of circular and low-carbon battery materials and steel. Measures include:

Batteries:

- Interim Measures for the Management of Recycling and Utilization of New Energy Power Vehicle Battery: Makes automakers responsible for EV battery recycling.
- Interim Provisions on the Management of Traceability of Recycling and Utilization of New Energy Vehicles Power Battery: Mandates information on battery recycling at all stages from manufacturers, automakers and recyclers to determine recycling effectiveness.
- Guidelines on Construction and Operation of Power Battery Recycling Service Network for New Energy Vehicles: Narrows definitions for lithium-ion battery recycling facilities.
- Measures for the Administration of Echelon Utilization of Power Batteries in New Energy Vehicles: Standardizes and ensures the quality and recycling of second-life, repurpose and remanufactured batteries.

Steel:

- 2019 Measures for the Administration of the Recycling of End-of-Life Motor Vehicles: Established an ELV collection system to prevent accidents caused by old vehicles. The law also established basic requirements for the establishment of dismantling and recycling facilities.
- 2015 Requirements for the Management of Hazardous Substances and Recyclable Utilization Rate of Automobiles: China introduced comprehensive eco-design requirements for vehicles (e.g., use of non-toxic materials and recyclability), requirements for vehicle recycling at end-of-life and increased transparency over materials used in vehicle components.

– In regard to near-zero emissions steel, China is planning to bring steel under the national emissions trading scheme by the middle of the decade. In addition, China's National Green Development Fund established a fund with approximately $680 million to enable the green transition of its steel industry, together with its state-owned steel company.

United States

While the US has traditionally lagged behind the EU and China in terms of circular economy policy-making, there have been some recent developments, especially on battery materials.

Batteries:

– The **2022 Inflation Reduction Act**: Includes EV tax credits with domestic production requirements that also include materials recycled in North America. It includes tax credits for battery recycling projects but it does not include outright targets for collection at end-of-life or recycling; recovery rates are missing from the act. In addition, the Federal Bipartisan Infrastructure Law dedicated $3 billion to a battery material processing programme and $3 billion for domestic battery manufacturing and recycling.

Steel:

– In the US, the recycling of ELVs is only managed through cross-sector regulations on environmental protection, such as the Resource Conservation and Recovery Act, Clean Air Act and Clean Water Act. There is currently no formalized requirement to recycle steel from end-of-life vehicles.

4.3 Principle 3 – Reuse and remanufacturing

This principle focuses on strengthening higher value retention processes associated with vehicle life extension, such as reuse, repair and remanufacturing. This would promote higher retention of economic value and embodied energy – as well as lower total environmental footprint as fewer vehicles have to be produced to provide the mobility needs of the market.

European Union

In the EU, several policy measures aim to increase the reuse and remanufacturing of batteries and steel.

- **Batteries:** The 2023 EU Battery Regulation enables battery reuse and repurpose through the introduction of product and labelling requirements and through the introduction of a digital battery passport that makes state-of-health information available across the supply chain.
- **Steel:** As mentioned, the 2023 Circular Vehicles Regulation draft requires the design for disassembly and the disassembly of certain components at end-of-life. In addition, member states are required to adopt incentives that promote component reuse or remanufacturing; for example, through value-added tax reductions for secondary components.

China

One of the key pillars of Chinese policy-making has been to encourage the remanufacturing of vehicle parts, including batteries:

- **Batteries:** The Ministry of Industry and Information Technology has outlined requirements for end of life for batteries through a series of directives in recent years, aiming to expand reuse. These include adopting an end-of-life hierarchy where batteries first are reused in lower-capability applications (e.g., stationary storage or light electric vehicles) before eventually being recycled.
- **Steel:** The 2013 Swap the Old for Remanufacturing policy incentivizes swaps of old with remanufactured parts through subsidies. In addition, the 2019 revision of the Measures for the Administration of the Recycling of End-of-Life Motor Vehicles stipulates that the key "five assemblies" of dismantled end-of-life vehicles (i.e., engine, steering machine, transmission, front and rear axle and frame) should be remanufactured and not recycled if possible.

United States

The US is the world's leading producer, consumer and exporter of remanufactured goods. Similar to the recycling industry, the development of the remanufacturing industry has been primarily driven by market forces. However, the government has also been supporting the development of this industry through demand-side public procurement policies. For example, under the Resource Conservation and Recovery Act, the government also encourages the public procurement of vehicles with remanufactured parts.

4.4 Principle 4 – Utilization increase

This principle focuses on improving the utilization of vehicles by fostering fleet management and pooled vehicles. Improving both the vehicle utilization rate and occupancy can spread vehicle impacts across more utility (passengers or goods transported). The review suggests there were no policies currently planned or implemented at national or EU level that actively promoted business models or practices that could increase vehicle utilization rate and occupancy.

In the EU, for example, this is because European institutions have no direct legislative power regarding mobility. Policies affecting, for example, public transit design, vehicle occupancy incentives or residential parking pricing, are left to national (and subnational) legislators. While the European Urban Mobility Framework of 2021 did provide guidance, funding and some reporting requirements to the largest cities in the EU, it does not have regulatory status and merely encourages member states to take action.

5 Recommendations: Paving the way to automotive circularity in the EU, China and the US

Resetting the automotive industry on a path to circularity globally requires policy-makers to drive ambitious policy changes instead of maintaining the status quo. The policy recommendations derived by the CCI in the seven insight pieces chart a way towards this transition (see Table 3 below).

TABLE 3 **Overview of main policy recommendations derived in the insight pieces**

Number	Insight piece title	Overview of main recommendations to policy-makers
1	Accelerating Policy Action for Safe and Green Electric Vehicle Battery Recycling	– Standardize definitions and transaction triggers – Develop and harmonize standards for black mass composition – Increase information availability through traceability – Provide incentives for new recycling technologies that can economically treat LFP batteries – Support the development of safety measures
2	Digital Battery Passports: An Enabler for Sustainable and Circular Battery Management	– Introduce digital battery passports globally – Standardize reporting parameters and technical frameworks – Integrate with existing systems and initiatives – Advance and supporting industry action
3	New Value from Used Vehicles: A Policy Agenda	– Pass comprehensive ELV legislation – Incentivize delivery to authorized treatment facilities – Enforce import standards at the point of export – Align ELV policies with the waste management hierarchy – Support capacity development in importing countries
4	Closing the Loop on Automotive Steel: A Policy Agenda	– Introduce material-specific and quality of recovery-related recycling targets – Minimize illegal exports and dismantling of vehicles – Ensure sufficient supply of high-quality scraps before introducing mandatory recycled content targets – Improve transparency on steel scrap quantity, quality and prices – Invest in the development of sorting, separation and scrap upgrading beneficiation technologies
5	Accelerating Policy Action for Near-Zero Emissions Steel in the Automotive Industry	– Support the aggregation of private and public sector demand – Forge alignment on product standards, definitions and certification – Form carbon clubs to accelerate the scale-up through transnational cooperation

TABLE 3 | **Overview of main policy recommendations derived in the insight pieces** (Continued)

Number	Insight piece title	Overview of main recommendations to policy-makers
6	A Circular Economy Approach to Battery Electric Vehicle Supply Chains	– Implement material efficiency standards or incentives – Prioritize reuse and standardization – Drive the development of new battery chemistries – Create economic incentives to scale up the recycling of critical materials – Support the scale-up of new business models
7	Enabling Automotive Circularity through Digital Vehicle Passports (DVPs)	– Expand the intended scope of the DVP in the draft EU circular vehicles regulation and create synergies with the environmental vehicle passport – Advance DVPs in China, the US and other geographies – Advance and support multistakeholder initiatives

From this list, five recommendations are derived. Policy-makers should take action to:

1. **Scale digital battery and vehicle passports:** Digital product passports have the potential to enable a circular and sustainable life cycle management of batteries and vehicles globally. While policy-makers in China and the EU are working towards implementing digital battery and vehicle passports, other countries, such as the US, should follow suit. These should integrate upstream, use phase, and downstream information and align with existing compliance requirements, such as sustainability reporting frameworks, product labelling schemes or due diligence obligations. Policy-makers in the EU, China, the US could start policy initiatives as well as support multistakeholder initiatives, similar to the Global Battery Alliance (GBA), Battery Pass, or Catena-X, to introduce holistic digital vehicle passports.

2. **Close the loop on battery materials:** This could involve specifying recycled content requirements in batteries, such as in the EU Battery Regulation. In addition, countries could support the commercialization of new battery recycling technologies, such as direct recycling, through research and development support or other public-private partnerships. Targeted subsidies for recycling processes that are currently not cost-effective, could gradually reduce these subsidies as technologies mature and become more cost-effective. An initial subsidy ranging from $5 to $20 per kilowatt-hour may be required, depending on location and approach, to kickstart the recycling efforts of lithium-iron-phosphate (LFP) batteries.

3. **Chart a path towards closed-loop automotive steel:** While there are several policy efforts underway across all three geographies to increase the recycling of battery materials, there is currently less of a focus on steel. To drive closed-loop automotive steel recycling, policy-makers should focus on setting conditions that help increase the supply of high-quality scraps, for example, by introducing quality of recovery targets for steel recycling and financially supporting the development of advanced recycling technologies and infrastructure.

4. **Incentivize delivery of end-of-life vehicles to authorized treatment facilities:** Policy-makers could introduce well-designed financial incentives, such as a financial penalty or pay out. Better specified border controls, ideally mutually aligned with potential importing countries, would additionally help reduce illicit trade and leakage of vehicles to sub-optimal treatment destinations. This could help to discourage illegal dismantling and exports. Potential best practice examples already exist in Denmark, the Netherlands and Portugal.

5. **Prioritize reuse, repair and remanufacturing of batteries and vehicle components:** Across all three geographies, there is insufficient support for lifetime optimization. For batteries, this could be supported by mandating suitability testing for reuse, repurposing, or remanufacturing before considering recycling. For other vehicle components, remanufacturing could be supported by establishing uniform definitions and standards, including quality benchmarks and transparency requirements (e.g. labels) for remanufactured products. In addition, there could be economic incentives, such as subsidies or tax exemptions for repair or remanufacturing, and support to adjusting insurance rules to allow remanufactured components more readily.

Automotive pioneers along the value chain are called upon to co-shape and drive these developments by advocating the recommended policy priorities with a united voice.

Acknowledgements

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