## Summary Recommendations for ZEVTC on a Responsible and Sustainable Battery and EV Supply Chain.

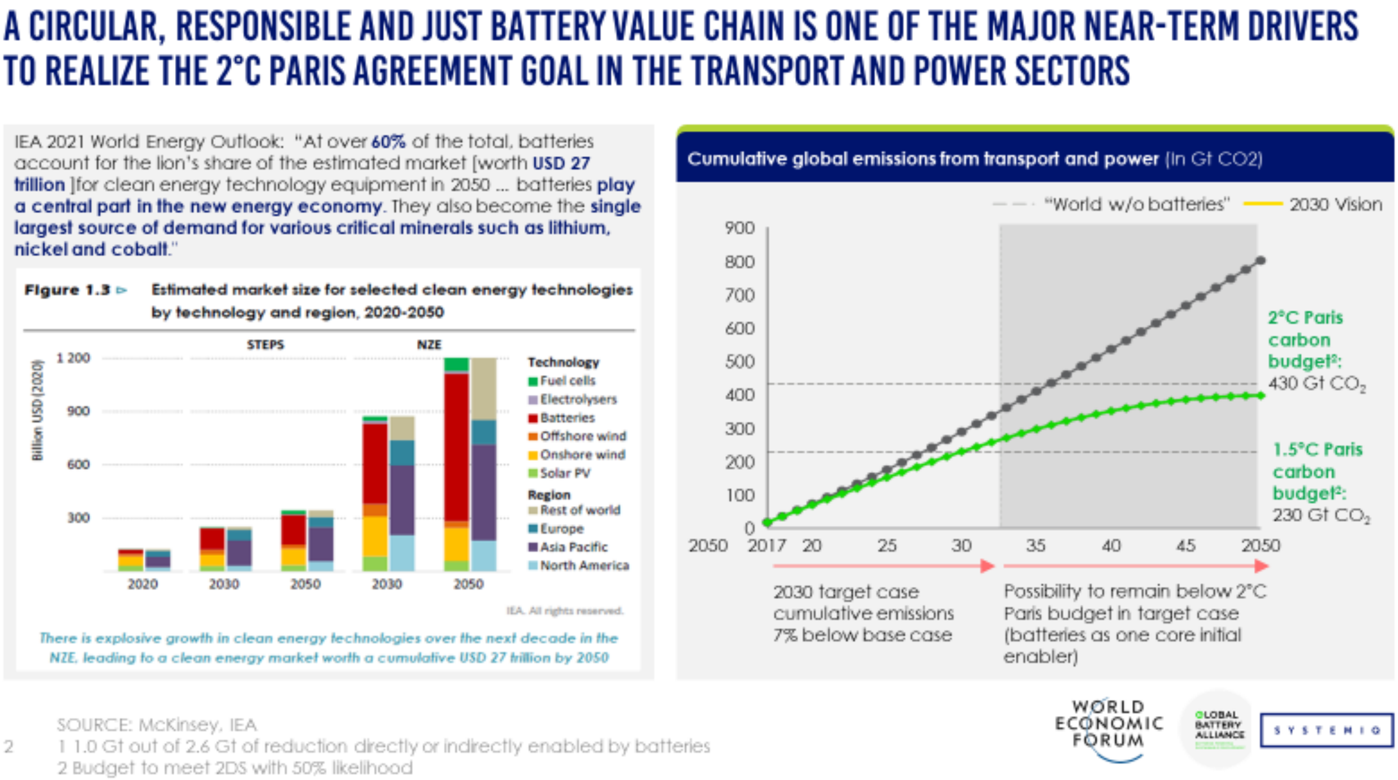
*Provided by the Global Battery Alliance and the World Economic Forum Circular Cars Initiative[1]*

# Executive Summary

The need for urgent and more intensive actions against the climate crisis is broadly recognized, and the increasing role of transport emissions warrants immediate action. A circular, responsible and just battery value chain is one of the major near-term drivers to realize the 2°C Paris Agreement goal in the transport and power sectors, setting course towards achieving the 1.5°C goal. Transportation and power currently comprise roughly 40% of global GHG emissions. With the right conditions in place, batteries are a systemic enabler of a major shift to bring transportation and power to greenhouse gas neutrality by decarbonizing and coupling both sectors for the first time in history and transforming renewable energy from an alternative source to a reliable base. Batteries could enable 30% of the required Paris Goals reductions in carbon emissions in the transport and power sectors, provide access to electricity to 600 million people who currently have no access, and create 10 million safe and sustainable jobs around the world.

Batteries can serve numerous purposes – if the expected scale up of the global battery demand by more than 19 times current levels over the next decade occurs sustainably. This expansion has the potential to create annual revenues of $300 billion along the value chain in 2030 – a factor of 8 more than today. The largest immediate revenue pool in the growing battery sector is in cell manufacturing with a share of 45% along the value chain. This is followed by refining operations accounting for 24% of global revenue pools. Supporting local value creation could help local economic development in several ways. This cannot be achieved without a fundamental change in the way materials are sourced and how this technology is produced and used.

Scaling up raw material production for batteries over the next decade will come at an unprecedented pace. Four battery metals are expected to be impacted the most by this growth towards 2030: lithium by a factor of 6, cobalt by a factor of 2, class 1 nickel by a factor of 24 and manganese by 1.2. This imposes a significant challenge to the battery value chain to manage the increase in raw material supply responsibly across different geographies and stakeholders. Separately, the entire value chain must be decarbonized with a verified demonstration of the carbon footprint to align with global and national policy carbon mandates. Lastly, circular economy must be integrated throughout the value chain to maximize the value of batteries through sector coupling, extending life of batteries, the recovery of valuable materials and for its decarbonization benefits.  Increased market take-up of EVs must go hand in hand with battery sustainability and performance. All aspects of the vehicle and battery lifecycle therefore need to be fully considered.




[1] Lead Authors: for GBA Mathy V. Stanislaus; for CCI Maya Ben Dror (World Economic Forum); Abhishek Gupta (World Economic Forum); Matthias Ballweg (SYSTEMIQ), and Tilman Vahle (SYSTEMIQ)

Building on our multi-stakeholder work over recent years, the following recommendations are made to the honorary ZEVTC members for adoption into national policies, where appropriate[2]:

1. **Establish a Global Data Governance Framework to Authenticate Nationally Determined Contributions (NDCs), Along with Responsible Sourcing and Circularity through Verified Data and Digital Traceability Systems**

   Realizing the ambition of the Paris Agreement and other global requirements needs authenticated data to provide the verification of GHG footprints of products. It is also vital for identifying interventions and investments to address segments of value chains and sectors that have excessive GHG emissions, as well as responsible sourcing and circularity. There is a need for policymakers, in alignment with the private sector, to agree to harmonized principles for digital traceability, access and transparency. This would allow businesses and other stakeholders to transfer or access relevant data with trust and certainty to enable digital systems. We suggest that this can be achieved with a traceability tool such as a battery passport.

   The GBA, in partnership with the German Ministry of Economic Affairs and Energy, is hosting a session at the Climate Conference of Parties, that will initiate a discussion on 1) the crucial role of authenticated data to realize global goals, such as the Paris Agreement and the UN Convention on Human Rights; and 2) safeguards for data security and protection of intellectual property, aiming to establish a foundation for a more formal policy framework. The Council could provide a forum to further develop and test principles for this framework on data governance. We recommend any work agreed in this area takes place in close coordination with other initiatives and groups, where appropriate, with the GBA supporting this effort.

2. **Incorporate Circular Economy Principles into Policymaking and Regulation**

   Current policy for a circular automotive industry, for the most part, takes place in isolation with vested interests complicating the policymaking process. Risk-based approaches to policymaking result in incremental changes only, and product-based optimization tactics omit system dynamics. A systemic approach to policy, with complementary tools and system-wide changes, will provide an opportunity to advance towards accelerated circularity.

   To help address these challenges, the GBA recommends countries consider adopting **four principles in the policymaking process for battery and automotive circularity and improved sustainability**:

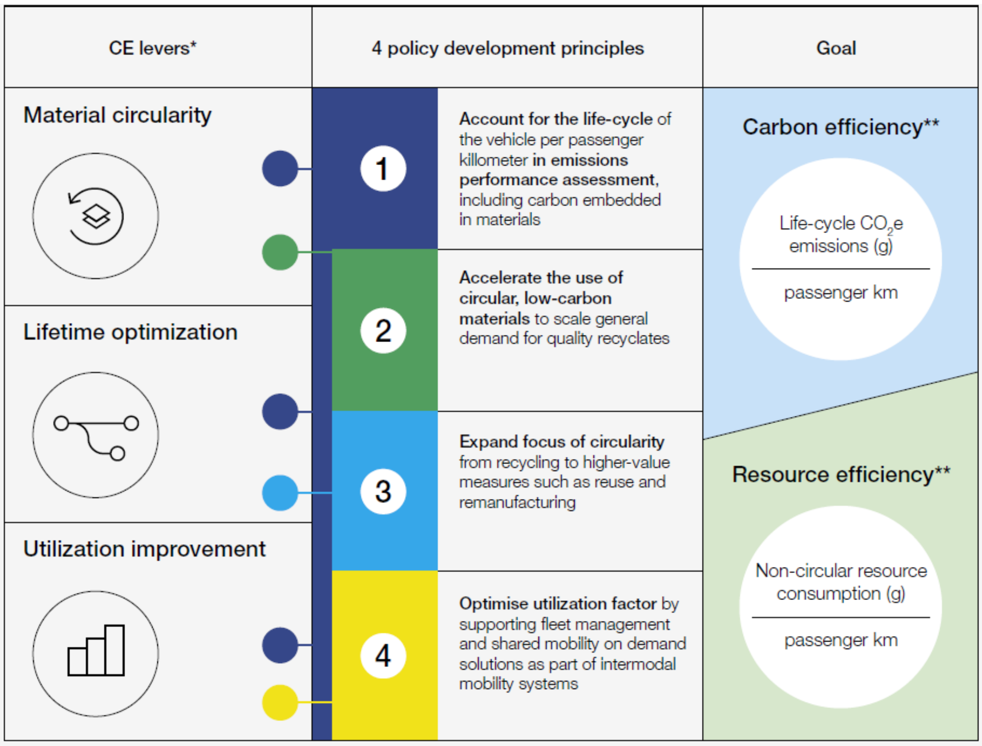
   (i) **Expand performance assessment from tailpipe emissions to a life-cycle-based perspective along the value chain**, to enable more rational and effective policy- and decision-making for the mobility and manufacturing sectors at large;

   (ii) **Accelerate the use of circular, low-carbon materials** to scale demand and improve recycling markets, with a focus on batteries, metals, and plastics that go into vehicles;

   (iii) **Re-focus circularity on higher value retention processes** by extending the practice from recycling to life extension via reuse and remanufacturing. For example, battery regulations and end-of-life vehicle directives could include targets for value-retention processes (e.g., remanufacturing), standardization of recycling (e.g., for cathodes), recovery targets differentiated by material type and quality, and well-functioning vehicle (de)-registration systems. There could also be opportunity to support Emerging Markets and Developing Economies in leapfrogging in these areas, such as through the establishment of recycling policy and investment in recycling infrastructure. Producer Responsibility and alternative ownership models is also recommended to be explored to ensure batteries are recovered and recycled using the best technologies and expertise. Separately, there a focus on recovery/recycling of materials during material extraction is recommended.

   (iv) **Improve the utilization of vehicles** by fostering fleet management and pooled vehicles.

[2] These are recommendations to ZEVTC members and does not represent the recommendations of ZEVTC




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

### 3. Advance actions for a global transboundary circular system

The used EV battery market could surpass 200 GWh/y by 2030 and provide up to 60% of stationary power storage capacity demand globally in 2030. High-performance recycling of EV batteries could provide approximately 10% of key battery materials, which would account for approximately US$10 billion based on current value. To enable transboundary transactions for circularity, there is a need to address key friction points that currently impede transboundary movement of EV batteries for repurposing and recycling.

The ZEVTC could explore options for convening policymakers and the private sector to advance key recommendations or conduct pilots amongst countries in this area. This could help shed a light on how and where countries and the private sector can collaborate to advance the standardization of definitions and transactions triggers. This could help to distinguish repurposing and recycling from waste transactions.

### 4. Enable Ethical and Sustainable Sourcing and Recycling of Minerals

Scaling up raw material production for batteries over the next decade will come at an unprecedented pace. While numerous governments have advanced requirements and initiatives to drive ethical sustainable sourcing of battery, the ZEVTC could lead or facilitate a globally harmonized approach for battery minerals which could include:

(i) Recognize compliance with “Best-in-Class” voluntary standards in supply chains;
(ii) Establish all Battery Minerals as Critical, and put in place sustainable mining practices, re-mining and land restoration requirements;
(iii) Advance the battery passport as a key mechanism for sustainable and responsible sourcing across the supply chain;
(iv) Foster the adoption and implementation of best practices of lead recycling.

As a start, the Council could look to convene a workshop for Senior Officials – with the GBA, CCI, OECD and others – to share experience and best practice across these recommended areas and identify ways to harmonize policy frameworks to advance the principles outlined in this report.

# Detail Discussion Paper of the key levers and recommendations

## 1. Establish a Global Data Governance Framework to Authenticate Nationally Determined Contributions (NDCs) Along with Responsible Sourcing and Circularity through Verified Data and Digital Traceability Systems

Data traceability and digital technology will act as a major overarching enabler to key circular economy actions, and it is also essential to ensure adequate safeguards for data security and protection of company secrets such as intellectual properties (IP). They are key to integrate batteries into power grids smartly, help to extend their lifetime, to repurpose them, to recover materials and to transport them across borders. Data analysis based on appropriate available data is key to support secondary market of electric vehicles: it can support an additional value add of 5% per vehicle, translating into €4.5 million of every 10.000 used electric vehicle transactions.[3] Data can also help verify compliance with human rights as well as social and environmental responsibilities across the battery value chain. Immediate opportunities for data management are recommended to be put into place as soon as possible to enable the optimum end-of-life management of batteries.

A battery passport would support data sharing across the battery value chain on dimensions such as materials chemistry, origin, the state of health of batteries, GHG at every stage of the battery production. It could provide a powerful means to identify and track batteries throughout the lifecycle and, hence, support the establishment of systems for authenticating GHG emissions, verify compliance with responsible sourcing requirements, life extension and end-of-life-treatment. Responsible value chain criteria should, ideally, be connected with data monitoring to enable the independent verification and assessments of key performance indicators that track batteries throughout their life cycle.

At the recent 2021 UK-hosted G7 Meeting, the G7 Leaders – along with the leaders of Australia, India, the Republic of Korea, and South Africa – set forth that the goal of net zero by 2050 requires "sustainable, decarbonised mobility and to scaling up zero emission vehicle technologies …[via] accelerating progress on electrification and batteries, hydrogen, carbon capture, usage and storage." In the G7 Communique, the Leaders noted the need for a digital ecosystem that ensures:

- "The development of harmonised principles of data collection which encourage public and private organisations to act to address bias in their own systems…"
- "Championing data free flow with trust, to better leverage the potential of valuable data-driven technologies while continuing to address challenges related to data protection."
- "Enabling businesses to use electronic transferable records in order to generate efficiencies and economic savings to support the global economic recovery."

Independent authentication of environmental, social and governance (ESG) requirements will enable:

- Demonstration of compliance with global goals such as the Paris Agreement and the United Nations Guiding Principles on Business and Human Rights and identification of targeted interventions and investments to address sectors or areas of significant non-compliance, e.g, "hot spots";
- Benchmarking of highest performers with the aim to provide a market advantage to those who perform well; and focused attention on 'hot spots' to spur improvement

Realization of this ambition requires authenticated data and digital systems, as recognized by the European Commission, in establishing digital product passports as a key mechanism for the authentication of greenhouse gas accounting and to drive circularity and responsible sourcing. Similar digital systems are being examined in Japan, China. The EU commission draft battery regulations recognized the Global Battery Alliance battery passport as a mechanism for reliable information.

To drive GHG authentication, circularity and responsible sourcing, there is a need for policymakers to agree to globally harmonized principles for digital traceability systems that is adopted at a country/regional level that allow businesses to use transferrable electronic records to demonstrate progress towards global targets, e.g., NDCs of the Paris agreement while ensuring adequate safeguards for data security and protection of IP. Together with the World Economic Forum, Global Battery Alliance and major German automotive and battery players, SYSTEMIQ, has initiated a consortia process backed by the German Ministry of Economic Affairs and Energy (BMWi) to rapidly propose key elements to the European Battery Passport in integration with the Global Battery Alliance Battery Passport.

GBA has started convening leaders from governments, key private sector and civil society to discuss the proposition that authenticated data is necessary to realize the GHG reduction potential of key sectors such as the transportation and energy. To advance this proposition discussion on the need for a data governance framework to establish confidence, and credibility regarding digital systems should take place.

The ZEVTC could explore options for supporting the establishment of a data governance framework. This could include providing a forum to further develop and test principles for a framework of data governance. We recommend any work agreed in this area takes place in close coordination with other initiatives and groups, where appropriate, with the GBA supporting this effort.

[3] https://twaice.com/wp-content/uploads/2020/06/202006_Battery_Health_Report_TWAICE_Autovista_T%C3%9CV-1.pdf?x52735

## 2. Incorporate Circular Economy Principles into Policymaking and Regulation

Circular economy levers are projected to reduce the total lifetime costs of batteries in 2030 by over 20%, in turn increasing the demand of EV batteries by 35% and simultaneously enabling 30% of the required emissions reductions in the transport and power sectors by 2030 to stay within the 2°C Paris Agreement goal emissions budget, compared to a scenario without concerted circular economy action. Hence, creating a sustainable, circular battery value chain will be a key driver to achieve the Paris Agreement's emissions reduction goals for the transport and power sectors.[4] However, the necessary carbon reductions through circularity and sustainable battery ecosystems growth benefits cannot be achieved without policy action. The same is true for the automotive sector at large. COVID-19 recovery funds offer a window of opportunity for policymakers and industry players to act and put the automotive industry on a transition pathway to a Paris-aligned, circular future.

To help address these challenges, the GBA recommends countries consider adopting **four principles in the policymaking process for battery and automotive circularity and improved sustainability**:

(i) **Expand performance assessment from tailpipe emissions to a life-cycle-based perspective along the value chain**, to enable more rational and effective policy- and decision-making for the mobility and manufacturing sectors at large,
(ii) **Accelerate the use of circular, low-carbon materials** to scale demand and improve recycling markets, with a focus on batteries, metals, and plastics that go into vehicles,
(iii) **Re-focus circularity on higher value retention processes** by extending the practice from recycling to life extension via reuse and remanufacturing. For example, the battery regulations and end-of-life vehicle directives could include targets for value-retention processes (e.g., remanufacturing), standardization of recycling such as for cathodes, recovery targets differentiated by material type and quality, and well-functioning vehicle (de)-registration systems. There could also be opportunity to support Emerging Markets and Developing Economies in leapfrogging in these areas, such as through the establishment of recycling policy and investment in recycling infrastructure. Producer Responsibility and alternative ownership models is recommended to be explored to ensure batteries are recovered and recycled using the best technologies and expertise. Separately, there a focus on recovery/recycling of materials during material extraction is recommended.
(iv) **Improve the utilization of vehicles** by fostering fleet management and pooled vehicles

**Policy action areas** that can also help countries to accelerate the adoption of circularity principles:

- **Creating new, cross-cutting market enablers** for the transformation to a circular automotive industry (i.e. integrate life-cycle perspectives in relevant carbon legislation and improve data availability via digital product passports and data spaces).
- **Reshaping economic incentives** (taxation systems, carbon pricing, access to investments) to enable profitability and investability of circular products and services.
- **Harmonizing and strengthening existing policy measures** (with a focus on legislative policies, such as the European End-of-Life Vehicles Directive, the Battery Regulation proposal, effective and efficient extended producer responsibility requirements and vehicle access regulation) across life stages and components.

With Circular Cars Initiative[5] facilitation, the European Commission collaborated actively in the industry dialogues ahead of its battery update last June, and endorsed an EU circularity in automotive agenda for Europe developed by SYSTEMIQ with participation of the CCI community of over 60 organisations and further leading experts including UN International Resource Panel (see here)[6].

The viability and economics of battery recycling depend first on the costs of collecting, handling and disassembling the batteries that enter the recycling process, and second on the scale of reliability and material value of batteries recycled. However, recycling processes are currently costly. The need for high safety precautions due to the fire hazard of large lithium-ion batteries and the toxic properties of some materials creates substantial hurdles to economic recycling practices. The recovery of materials, other than the most valuable ones like cobalt, copper or nickel, is limited in most current processes, lowering the benefits of recycling. Improved recycling technologies will be key to recover more materials, and at higher quality. Not all recycling processes currently deployed are environmentally advantageous, potentially emitting substantial GHG and pollutants into water and air. Significant technology and process improvement for higher recovery rates and better environmental performance are needed.

**Challenges ahead in 'Battery Recycling' that require regulatory/policy intervention include:**
- Inefficient processes due to lack of standardization and low transparency from OEM/battery manufacturer on battery content and structure.
- Fragmented recycling processes and low yield due to non-standardized batteries, immature technologies and lack of battery date gathering system.
- Downcycling of batteries into their raw content is highly resource-intensive (especially energy and emissions), requirements of extensive infrastructure and investments for smelters and leaching facilities

The regulation of and investment into collection and material recovery is necessary to incentivize the development and wide-spread application of high-quality recycling processes currently in early-stage development. This would raise recovery rates across all major

[4] https://www.weforum.org/whitepapers/a-framework-for-the-safe-and-efficient-global-movement-of-batteries
[5] The Circular Cars Initiative (CCI), launched by the World Economic Forum at Davos 2020, is a private/public sector collaboration platform focused on leveraging new technologies and business models to align the automotive industry with a 1.5 C climate scenario.
[6] Paving the Way: EU Policy Action for Automotive Circularity

markets. Consequently, battery recycling can provide 13% of the global battery demand for cobalt, 5% of nickel and 9% of lithium in 2030 – to grow exponentially in the years after that.

**Four underlying enablers that could help drive enhanced recycling:**

- Concerted regulatory action is taken, including harmonized regulations related to the transboundary movement of batteries; tightened recycling targets differentiated by material (rather than by average battery weight); and improved Extended Producer Responsibility schemes. Financial incentives support the use of secondary materials.
- Batteries and corresponding industry ecosystems are designed for disassembly. Via battery construction that allows for swift dismantling and standardized tooling and pushes for automation and extensive training available across a widespread web of qualified service stations, up to 50% lower cost of collection, transport and handling for recycling are achieved.
- Efficient and safe collection, transport and recycling of batteries is enabled technically, in particular via digital measures, such as battery passports and tracing and tracking technologies, leading to decreased transaction costs and higher collection rates.
- Accrediting of the environmental advantages of secondary raw materials strengthens the cost and climate competitiveness of recycling by creating demand and new quality standards.

The EU battery legislation update is an example demonstrating how an enabling policy environment demands that for all large batteries placed on the EU market (irrespective of origin of the manufacturer) significantly enhanced sustainability and transparency requirements are enacted. This includes detailed information of hazardous materials contained, the battery's specific carbon footprint, responsible supply chain related information and data relevant for circular activities (e.g., refurbishment, repurposing, and recycling). It also contains detailed and ambitious recovery targets both for the total battery and individually for critical battery materials, as well as minimum recycled content requirements. Lastly, it defines enforcement mechanism (e.g., mandating the introduction of a battery passport for all large batteries by January 2026). The Biden Administration has identified a sustainable, responsible and level battery chain as critical to realize global electrification.

## 3. Advance actions for a global transboundary circular system

In 2030, the repurposing of used EV battery market (for second life in stationary application) could represent 60 GWh/y by 2030 and provide up to 6% of stationary power storage capacity demand globally in 2030. Repurposing of EV batteries is likely to be prioritized by policymakers to maximize the utilization and benefits of batteries. Potential applications of second-life batteries include backup power (for example for decentralized installations such as transmission towers), off-grid and microgrid energy storage, reserve capacity (to balance the grid in case of supply/demand fluctuations) and arbitraging of grid energy prices (depending on local electricity markets).

For this, batteries are removed from vehicles, tested, refurbished if needed and, after being recertified for performance and safety, repurposed as-is or in parts. This has two major system effects: First, it may recover residual battery value at the end of life, helping improve the economics of batteries and thus accelerate market output. Second, repurposing can reduce the need for new batteries in the power sector. While there is a short-term trade-off with battery recycling, analysis suggests that life extension would be environmentally more beneficial and, therefore, preferable over immediate recycling. Challenges include potentially high transaction costs, lack of information about remaining battery health, and concerns regarding unwanted thermal events and performance compared to new batteries. The considerable uncertainty regarding the development of these factors means targeted action is required to enable key conditions for repurposed batteries.

Further, second-life applications could unlock additional value beyond the material value of batteries, namely by improved power grid performance, increased shares of renewable energy sources in electricity mixes and lower infrastructure costs for electric vehicle charging. High-performance recycling of EV batteries could provide approximately 10% of key battery materials, which would account for approximately $10 billion based on current value. This value is predicted to grow four-fold until 2040. Ultimately, all batteries will need to be recycled for environmental reasons.

There is a need to address key friction points that currently impede transboundary transactions for circularity. Based on consultation with stakeholders from multi-lateral institutions and private sectors, five recommendations have been developed:

1) advance standardization of definitions and transactions triggers to distinguish repurposing and recycling from waste transactions
2) preserve product characterization to foster product value preservation and recovery
3) establish traceability and disclosure systems
4) implement pilot programmes with compliant facilities to develop a full chain of custody disclosure[7].

The ZEVTC could convene policymakers and private sector stakeholders to advance key recommendations or conduct pilots among countries, in consultation with the Basel Convention Secretariat. This could help shed a light on how and where countries and the private sector can collaborate to advance the standardization of definitions and transactions triggers. This could also help to distinguish repurposing and recycling from waste transactions.

[7] https://www.weforum.org/whitepapers/a-framework-for-the-safe-and-efficient-global-movement-of-batteries

## 4. Enable Ethical and Sustainable Sourcing of Minerals

There is inconsistent compliance and performance along the value chain regarding social, environmental, governance and other key sustainability expectations, and limited third-party monitoring. In addition, material flows in the battery value chain lack transparency due to three main, underlying root causes: a diffuse and complex supply chain; lack of information management in sourcing and refining countries; few trusted and independent certification authorities.

Stakeholders across the battery value chain need to commit to established international expectations and key performance indicators on social and environmental practices, ensuring transparent impact measurement as well as the exchange of best practices. Such established expectations include the OECD Due Diligence Guidance for Responsible Supply Chains of Minerals from Conflict-Affected and High-Risk Areas, ILO Fundamental conventions and the UN Guiding Principles on Business and Human Rights. Consistent due diligence and reporting are necessary conditions to improve the sustainability performance of the value chain. The creation, safe transmission and use of verified data (for example via battery passports such as by the EU, the GBA or by other compatible bodies) could provide transparency with respect to key life cycle performance data on social and environmental dimensions. National legislation could support the implementation in harmonization with trans-national regulation and global industry initiatives.

Companies in the value chain, regulators across countries, as well as labour, civil society and international organizations should verify compliance with internationally accepted social and environmental practices. This should take place alongside rigorous monitoring and an evaluation framework based on best practices for sourcing to address child and forced labour and improve conditions in artisanal small-scale mining of materials used in batteries. Separately, safe production and transportation across the value chain, including at the end of life, must be verified.

A comprehensive evaluation of risks should guide the decision-making about commercial activity where it might cause harm and reverse the positive impact of batteries. Improving the safe and circular handling of lead-acid batteries globally is vital and urgent despite the emergence of opportunities in the vehicle traction batteries sector (primarily Lithium-Ion, and increasingly Lithium Iron Phosphate and Sodium Ion batteries). In several countries, up to 50% of end-of-life lead batteries are recycled in informal, or below standard, facilities, leading to substantial releases of lead into the environment and high levels of lead exposure with severe and permanent health effects especially in children. With up to a third of children globally exposed to toxic levels of lead due to such mismanagement and corresponding severe health burden[8], concerted action to raise circularity of this type of batteries is indisputably necessary.[9]

While maintaining an emphasis on responsibly sourced cobalt as the electric vehicle supply chain expands rapidly, including measures to improve sourcing of cobalt from DRC (e.g. support the efforts of the GBA's Cobalt Action Partnership), **the following policy reforms and actions can support the global transition, specifically promoting new, responsible supplies, across all batter minerals:**

- **Recognize Compliance with "Best-in-Class" Voluntary Standards in Supply Chains:** Establish a battery industry sourcing benchmark/label that sets OECD due diligence for mineral supply chains as a minimum and rewards mines following "best-in-class" standards on tailings management, greenhouse gas emissions, habit protection and restoration, transparency and reporting, and indigenous consultation and consent.

  Three leading upstream, mining focused standards can be used, ideally in sync: 1) the Initiative for Responsible Mining Assurance (IRMA), 2) Toward Sustainable Mining (TSM) a project of the Mining Association of Canada[1], and 3) the Performance Expectations of the International Council for Mining and Metals (ICMM). Each has strengths and weaknesses. Rather than pick a winner, policy makers would incentivize the best aspects of all three. New tools are being developed by members of the GBA, including RESOLVE, to support this which could be endorsed by policy makers and companies.

- **Establish Battery Minerals as Critical, and Sustainable Mining and Re-Mining Requirements and Land Restoration, where applicable:** Scaling up raw material production for lithium batteries over the next decade will come at an unprecedented pace. It imposes a significant challenge to the battery value chain to manage the increase in raw material supply responsibly across different geographies and stakeholders. We therefore propose to a globally harmonizes recognition of "Battery Minerals" to key battery minerals not currently included on some lists (e.g. copper, cadmium, nickel). The addition of a more focused list on battery minerals helps demonstrate a prioritization throughout the battery life cycle. This strategy could guide future policy innovation related to battery mineral supplies, battery component manufacturing, and end-of-life recycling. Plans for Re-Mining, Full-Value Mining and Land Restoration or support for efforts by ministers that oversee mining should be introduced.

- **Advance the battery passport as a key mechanism for sustainable and responsible sourcing across the supply chain** Approximately 65% of global demand for LABs is currently driven by automotive applications, with nearly every vehicle on the road currently requiring a LAB for starter, light and ignition (SLI) functions. The remainder of uses are as industrial batteries, with lead-based batteries becoming popular for off-grid energy renewable storage used in developing countries as a key enabling technology to deliver on SDG 7 for affordable and clean energy for all. LABs will be employed in cars, including EVs, for many years and the global market for them is expected to further grow. Fostering the adoption and implementation of best

[8] https://www.unicef.org/sites/default/files/2020-07/The-toxic-truth-children%E2%80%99s-exposure-to-lead-pollution-2020.pdf
[9] https://www.weforum.org/reports/a-vision-for-a-sustainable-battery-value-chain-in-2030

practices of lead recycling is critical as set forth in GBA's report "Consequences of a mobile future creating an environmentally conscious life cycle for lead acid batteries[10]"

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# Appendix on Ethical Sourcing Background

In some of the world's least developed countries cobalt is a core pillar of their respective economies. Millions of people depend directly or indirectly on mining and sometimes as much as 80% of exports are mining products. Most of the cobalt mined originates from industrialized operations. Largescale, industrial mines account often for the lion share of the cobalt market and represent an important source of national economic value. However, environmental, social and integrity risks have been documented in such operations. In addition to material mined in large-scale operations, sometimes between 15- 30% of the cobalt supply is extracted by hand using basic tools in so-called artisanal small-scale mines. These mines are often informal and basic international human rights expectations are often not implemented or enforced. However, artisanal mining is an important livelihood for communities. Severe social risks have been documented in the artisanal mining industry. They include hazardous working conditions; deaths due to poorly secured tunnels; potentially various forms of forced labour; the worst forms of child labour; and exposure to fine dusts and particulates and DNA-damaging toxicity. Hundreds of thousands people are estimated to work in dangerous conditions, of which a large percentage are children.. The root cause of child labour is that average households in mining communities are poor and vulnerable to income shocks. Different forms of child labour require different interventions, always with a focus on serving children's best interest.

In lithium, the nature of effects varies across the major lithium-producing regions. The extraction from brine in the "lithium triangle" in the Atacama Desert across Argentina, Bolivia and Chile raises very different risks than those from lithium mining from hard rock in Australia and other countries. For nickel, the management of acid leaching processes in extraction requires further scrutiny, for example in the Philippines and Indonesia. Manganese mining requires intensive land use and may disperse airborne contaminants.

The surging demand for battery materials is leading to increasing interest in deep seabed mining. The environmental effects of deep seabed mining on ocean ecosystems are not fully understood and could be irreversible, triggering wider direct and indirect negative consequences across the ocean system, and could impede the ocean's capacity to sequester $CO_2$. This is further compounded by the overall paucity of information and understanding of the deep ocean globally. It is expected that minerals from deep seas could be established as a source for raw material demand starting in 2030. This suggests that the economic viability of exploration and extraction in the deep sea as of 2030 must be carefully evaluated in light of advances in battery and other technology as well as circular economy benefits.

[10] https://www.weforum.org/whitepapers/consequences-of-a-mobile-future-creating-an-environmentally-conscious-life-cycle-for-lead-acid-batteries