The Strategic Role of Data in Advancing a More Circular Economy for Metals in the Automotive Supply Chain

Workshop SUMMARY REPORT

June 2021

CIRCULAR ECONOMY SOLUTIONS SERIES

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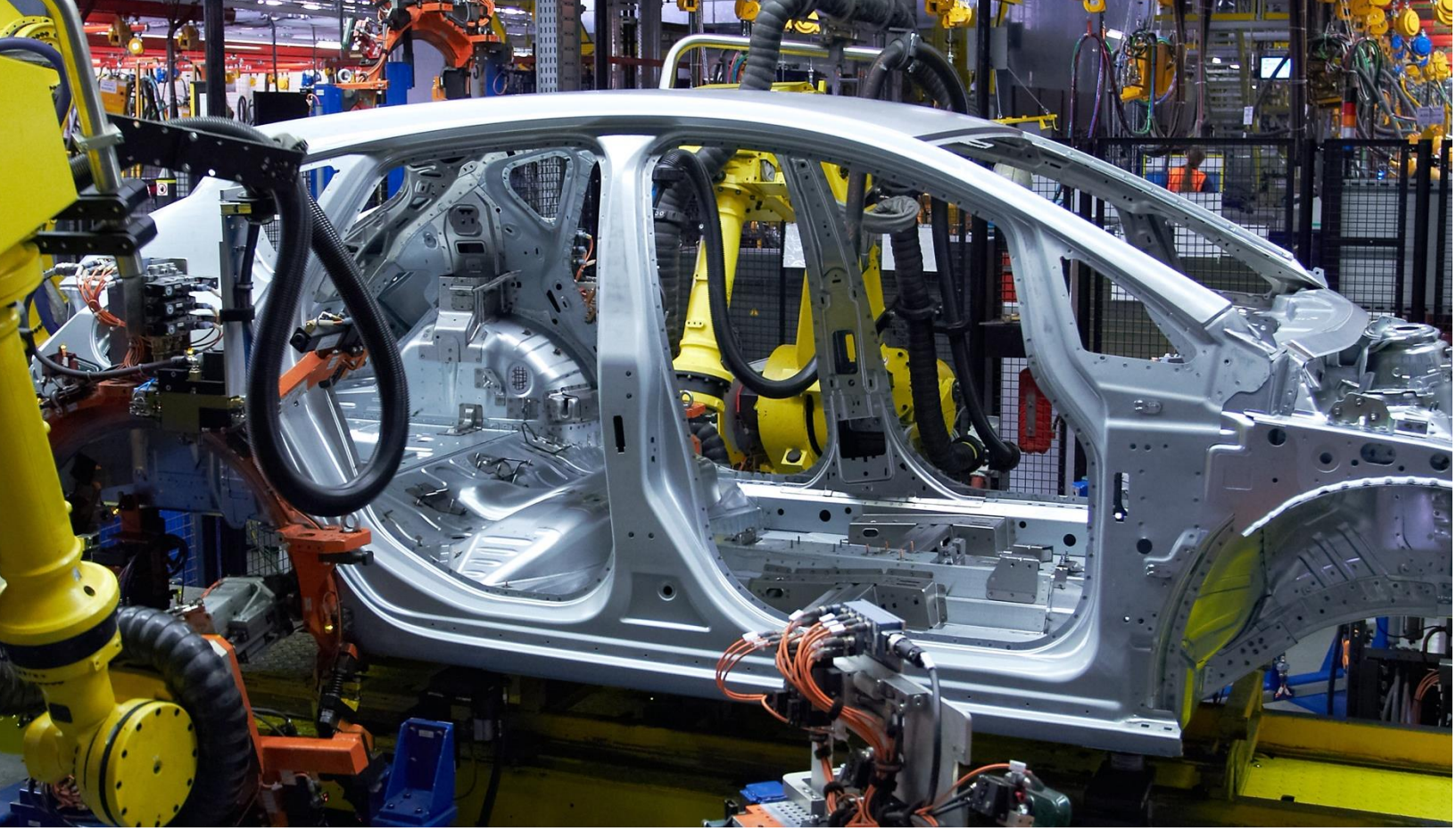


1. Background

Over the past decade, the rise in awareness and concern about the social and environmental footprint of mining has led to calls for greater accountability throughout the minerals supply chain. Downstream users such as jewelry, electronics, automotive sectors, as well as investors, have increasingly called for assurance regarding the waste, carbon, and other impacts associated with the extraction of minerals.

With the emergence of blockchain technology, a wide variety of traceability tools, and the use of systems like mass-balance materials accounting, there is a growing sense that it is possible to design data systems at different levels of complexity to not only improve the efficiency of industrial systems, but also the ability to provide some transparency (and potentially market recognition) for a number of key minerals. These systems can contribute to the capacity for sensing, storing, and communicating information about the location, condition, and composition of different materials.

The automotive sector provides a valuable case study for these issues, given the wide range of minerals and metals in vehicles, combined with the marked increase in the sector's commitment to responsible materials sourcing and reducing greenhouse gas (GHG) emissions.

About this Workshop

On June 10, 2021, Circular Economy Leadership Canada (CELC), the Materials Efficiency Research Group (MERG), Metal Tech Alley, Smart Prosperity Institute (SPI), and GLOBE Series convened a group of stakeholders for a solutions-oriented, interactive, virtual workshop focused on potential applications of advanced data systems in the automotive supply chain. See **Appendix A** for the Workshop Agenda.

Held on the sidelines of the Industrial Circular Economy Conference (ICE2021), the workshop's objectives were to build a broader understanding of the potential value of deploying these systems under a range of conditions; examine the technical, policy, and market issues involved; and explore practical next steps for advancing the opportunities and addressing key barriers.

The workshop, part of the **Circular Economy (CE) Solutions Series** ***Circular Mining and Metals Work Stream***, featured expert insights into practical applications, as well as interactive breakout discussions that allowed participants to strategize together on how to scale ideas and overcome barriers to advancing information, data tools, and transparency for metals within the automotive sector supply chain globally.

The workshop was part of a broader set of activities being jointly convened by CELC, MERG, and SPI and supported by a range of other partners over the past year, including:

- A "**Mining for Circularity**" webinar in October 2020 during the World Circular Economy Forum 2020 Online event; and
- An online forum on this topic held in March 2021 as part of an ongoing SPI project to advance new research and engagement on the role of primary material producing economies in a circular economy.

The program for this workshop, as well as the content in this Summary Report, was put together by Alan Young, Principal at MERG. Insights from this Summary Report will be used to guide future research and activities, including potential programming and side events linked to the World Circular Economy Forum in September 2021, as well as Phase 2 activities of the CE Solutions Series *Circular Mining and Metals Work Stream*.

Participant Profile

Approximately 90 stakeholders participated in the workshop, from 12 countries globally. Workshop registrants included representatives from industry, academia, not-for-profits, and government at all levels. **Figure 1** provides a breakdown of attendees by sector. See **Appendix B** for the list of registered organizations.

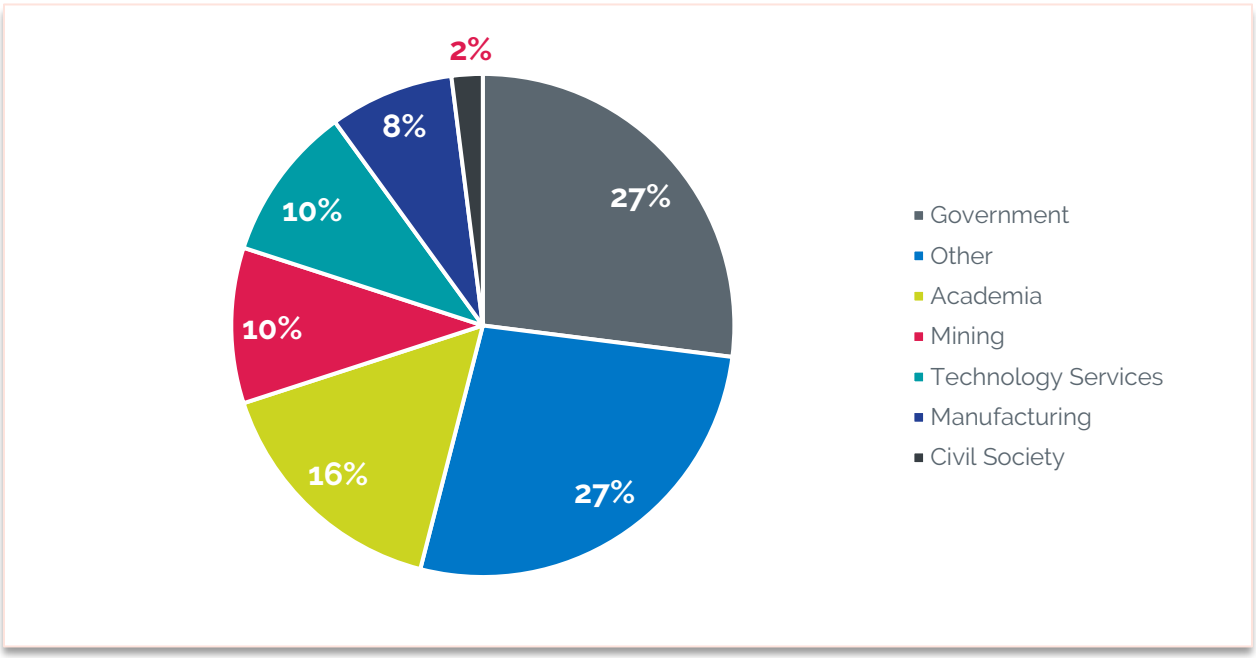


Figure 1: Responses to poll question #1 "What sector do you work in?" (N=49)

2. Key Takeaways: Panel Presentation

To view a recording of the presentations, click the 'Play' button.

Context-setting Panel: The rise of demand for transparency and performance assurance in the mining and minerals sector

Session Moderator: **Alan Young, Principal, Materials Efficiency Research Group**

The first panel discussion set the context for why data is increasingly being recognized as an essential strategic asset and tool for managing responsible, circular supply chains. In this case, the focus was on minerals, with a particular interest in the automotive sector which uses a wide range and high volume of minerals. That said, there is also strong interest in the electronics and clean energy sectors, and even governments recognize the need for verifiably responsibly sourced minerals. Additionally, within supply chains that aim to close loops for materials recovery (such as supply chains for electric vehicle batteries) traceability and embedded data are becoming ever more important to assist in efficient recycling and re-use related circular economy strategies.

Speaker #1: Malcolm Shang, Global Mine Closure and Reclamation Specialist / Circular Economy Champion, ArcelorMittal Mining

Malcolm is an experienced leader and environmental engineer with a special focus on mine closure and reclamation, circular economy principles applied within mining, and mine waste management. His experience is global; having worked in Africa, Eastern Europe, Central Asia, South America, and North America. In his current roles, his responsibilities are to lead and improve the state of the mine closure and reclamation planning practice within the global company and promote the adoption of Circular Economy principles in the mining sector.

Topic: Why and how is data relevant for your sustainability goals as the largest steel producer in the world?

Business Case Insights

- The biggest benefit of a more transparent and traceable value chain in terms of minerals in the value chain is having a competitive advantage on the pathway to the future and being a preferred supplier of "more green responsibly sourced materials."
- We are seeing this advantage materialize from different customers along our value chain who have a preference for these types of metrics as proof that our product has been responsibly sourced, which really shows a shift in customer sentiment.
- In terms of data and it's uses, the data really helps our operations be more efficient and therefore allocate capital better. So, there are benefits for customers, and for us as we use our resources better internally.

The Need for a Strategic Focus for Data Collection

- Applying strategic filters to data collection is critically important, given there is so much data out there. What do people need to know and why?
- The other step which is very critical is verifying and certifying data so that the public and our customers have confidence in the data. This underscores the need for a globally standardized way of doing verifying and certifying data that a lot of companies can buy into. In this light, it is encouraging to see more participation in standards like IRMA.
- On the mining side of the business, there is an emphasis on how we can either minimize, eliminate, or re-purpose the waste that we produce and to have more of a circularity loop in the system that we could create if we found some industrial partners to look at ways to minimize and reuse our tailings, which is a major challenge for the mining industry.
- In terms of data, especially with tailings, it's really about what the tailings are composed of. Some internal oversight is needed in terms of understanding what is in the tailings and what is not, especially when our process changes, will allow us to better understand how we could use the tailings and how they can feed into another resource system.

Speaker #2: **J.J. Messner de Latour, Senior Program Manager, Responsible Sourcing, Microsoft**

J.J. Messner de Latour's work focuses on Responsible Sourcing of Raw Materials in Microsoft's Devices supply chain. J.J. has extensive experience in the natural resources sector, on Environmental, Social and Governance (ESG) compliance, supply chain due diligence, human rights, and security.

Topic: As a global leader in electronics and sustainability, how do you think about the strategic role that data can play in realizing Microsoft's business objectives?

Business Case Insights

- As a manufacturer, and a consumer products manufacturer in particular, our customers need to be able to trust the integrity of our products. In addition, when a customer buys a Microsoft product, they need to be able to do so knowing that the materials that went into building it were responsibly sourced. This is a source of competitive advantage for our business.
- The electronics industry has come a long way in mapping out supply chains, but there are gaps that still remain. That said, we need to be deliberate and intentional about the strategic value of the data we are collecting and sharing.
- Some people may expect that we might be able to control our supply chains, but it is really more about *influencing* relationships.
- It is important to address the cost of due diligence, which is very different across various places around the world and between different minerals supply chains.
- Then we need to build value for due diligence, so that it becomes meaningful for affected communities as much as it does for downstream customers, who are asking for it. Key questions to ask are, *who is this data actually for* and *who is going to benefit from it in the long run?*
- Due diligence is critical; however, we need to realize that it tends to only address the symptoms and not the causes. Traceability is important, but once the minerals are mined the impacts have already occurred, and so I think that we have to focus our efforts on how we improve ESG standards at the mine site, and I think that that is why standards like the Initiative for Responsible Mining Assurance (IRMA) are so important.

On secondary/recycled materials use

- Microsoft has made a commitment to produce a 100% recyclable surface laptop by 2030 and obviously there is a lot that will go into making that happen.
- This requires infrastructure for take-back and collection schemes for the end-products. Also, we have to incentivize consumers to actually return products into that loop.
- Government regulations are essential elements that direct how recycled material is used and reused and even how it crosses borders. More needs to be done to allow these flows to be both circular resource loops and accountable in terms of impacts at each stage of the process.
- It is critically important to be mindful of how to design for recycling. Microsoft is thinking about how to differently design a laptop so that it still performs well, but so that we can more easily recover the materials.
- As much as we are trying very hard to bring more recycled material into our products, let's not forget this is against the backdrop of rapidly increasing demand. I know this is a very rough number, but even if we were able to recover all the materials from 1 million laptops today, we will be producing 2 million laptops tomorrow.
- There is a gap in supply and demand and this speaks to the fact that that it is not going to be possible to fill that gap from recycled materials alone, as much as we try as an industry.

Speaker #3: **Ferdinand Geckeler, Senior Expert Sustainable Supply Chain Management, BMW Group**

Ferdinand Geckeler has been working for the BMW Group since 2002 in operational and strategic purchasing functions. Since 2011, he has been responsible for the sustainability program in the purchasing and supplier network of the BMW Group. Among other things, the program focuses on corporate due diligence in the supply chain, ensuring environmental and social standards are met in raw material supply chains and ensuring resource efficiency in relevant stages of the value chain.

Topic: How do traceability and supply chain transparency factor into BMW's strategies for ESG leadership in the automotive sector?

Business Case Insights

- BMW has been a pioneering force in the drive for sustainable mobility and continues to lead on a range of issues from design to responsible sourcing of materials and closed loop production systems.
- Initial intensive work around a wide range of sustainability parameters began with a focused effort around the development of the BMW i3, which was BMW's first mass produced zero emissions vehicle. The design and production required deep investments in both supply chain mapping and secondary materials use.
- Now these concepts are being applied across a broader range of BMW products and there is a need to scale up the early initiatives, which were very time and resource intensive, to more efficient systems, both internally and with supply chain partners. Intelligent and broadly applied data systems are essential for achieving traceable and transparent supply chains.
- The existing International Material Data System for the automotive industry, which catalogues the relationships and connection of the supplier network, is a good starting place. However, there are gaps in the data availability, and also proprietary limitations on the use of some of that data.
- As a result, BMW has designed and is implementing a second in-house system that specifically allows for the efficient gathering of a range of traceability and transparency related data throughout their supply chains.

Key Supply Chain Challenges

- The biggest challenge at the moment is not to convince Tier 1 suppliers (companies that supply parts or systems directly to original equipment manufacturers (OEMs).Rather, it is to convince the Tier 2 and 3 suppliers who provide more generic parts and materials (including computer chips, metals, and plastics) and in turn supply the Tier 1 production systems.
- Where possible, BMW can act like a trader and complete direct contracting with the mine. In these cases, they are pushing the mine sites to get certified against credible third party-verified systems, such as the Initiative for Responsible Mining Assurance standard. Then, the challenge is to follow the transactions from the mine to the Tier 1 supplier. One of the goals of the new in-house data system is to track material flow from source to consumer, however part of the challenge is to convince

all companies in between the mine and the Tier 1 suppliers to enter their important information into that system.
- The economic system and many of the business models at the moment are, in part, actually based on non-transparency and non-traceability, especially for raw materials. Contractual information is often considered private and part of a competitive business strategy. This is one of the biggest challenges, and hopefully it can be solved because at the end, customers want to see that BMW's products are based on raw materials which are certified as responsibly sourced.

Speaker #4: **Aimee Boulanger, Executive Director, Initiative for Responsible Mining Assurance (IRMA)**

The IRMA Standard is the globe's most comprehensive and rigorous definition of environmental and social responsibility in mining, and yet allows mines at any level of current performance to engage and show improvement over time. At IRMA, Aimee's role is to guide an organization fully accountable to multistakeholder leadership -- creating market value for more responsible business practices while ensuring credibility and accountability to all stakeholders. She holds a degree in Environmental Studies and Politics from Mount Holyoke College and has served IRMA's leadership since 2011.

Topic: Key data challenges and strategic priorities for ESG standards organizations?

Standards System Insights

- IRMA's standard seeks to drive greater environmental and social responsibility where mining happens and throughout the mining supply chain, down to the end customer through multi stakeholder accountability.
- So far, it has not been that clear - most end consumers do not have their supply chains mapped, but the reality is that these are complex supply chains. There are technological reasons why that has not happened, and largely it is that the market has not valued it before.
- In some commodities, high volumes and diverse sources create complications to creating a simple formula for the buyer to leverage their purchasing dollars to influence the performance of materials producers. We need to de-tangle some of that complication in order to create value and accountability for NGOs, labour unions, and mining affected communities that want to know where these things are coming from, so that they can reduce that harm and create value for those investing and doing better.

The need for engaging the processors and refiners

- The supply chain for these commodities are genuinely complex and if we are asking processors and refiners to segregate material, we need to address the question of whether they are catching part of that value in there, particularly when they are operating in tight margins.
- So, it is important to bring those processors refiners, smelters, and traders into this discussion, so they see that value.
- Weare going to need to innovate beyond simple traceability, because traceability and tracking do cost a lot of money. It is a very good thing for us to know where our food, coffee, water, power, and now our mined materials come from, but if we can help to raise market value for environmental and social responsibility at *all* sites, it becomes less important to know, "did I get the tin in my phone from any one specific mine?"

The importance of secondary minerals recovery

- As much as it is important mine responsibly, it is equally important to value materials retrieval and recycling as well. There is a mining company, I know that puts out more by volume from materials retrieval than they do from new extraction, but they do not talk about it a lot, because even though they know it would bring positive reputational value, they make a greater profit margin from new extraction and that is largely because of subsidies built into new extraction, which are not built into the value of the materials, retrieval, and recycling ends of it.
- If we want to move towards a more circular economy, we are going to have to adjust some of those policies that are built to value new mining over materials retrieval.

At the beginning of the workshop, participants were invited to respond to a poll that assessed the most significant barriers to fully traceable minerals throughout supply chains (see **Figure 2**).

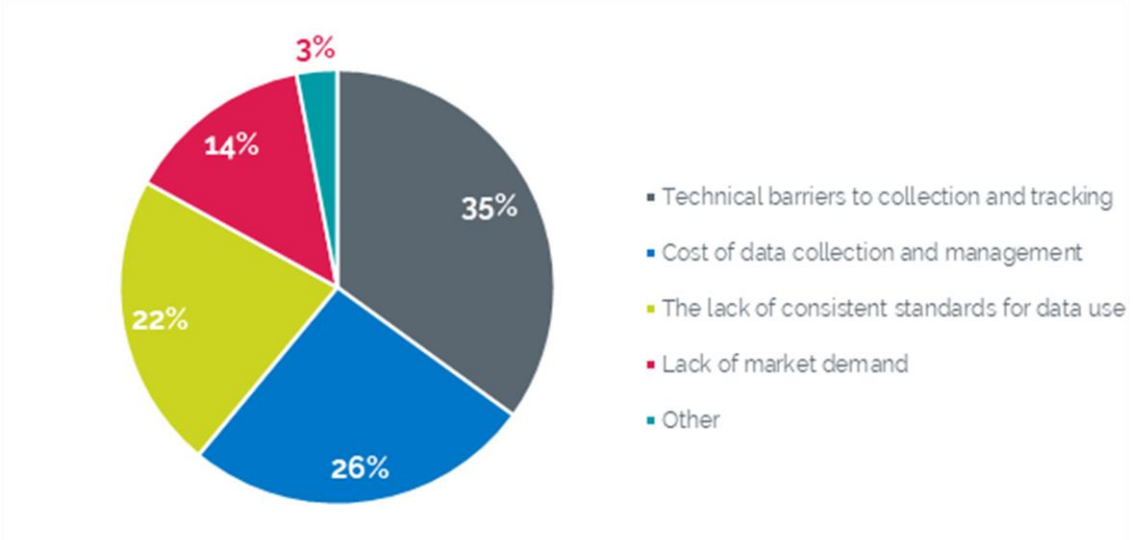


Figure 2: Responses to poll question #2, "Where are the most significant obstacles to fully traceable minerals throughout supply chains?" (N=72)

Rapid Presentations: Strategic Data Applications for Primary Materials

Session Moderator: **Jacomien van Tonder, Director, Metal Tech Alley**

This section of the workshop program focused on the use of data for circular economy and responsible sourcing from the mine site and as materials feed into upstream supply chains. What kinds of data is important to understand during the extraction phase and how are these being made available to downstream users?

Presenter #1: **Ian Hudson, Head of Environment, Anglo American**

Ian leads a multi-disciplinary team covering a broad range of areas including Biodiversity, Carbon & Energy, Air Quality & Emissions, Environmental Geochemistry & Water Quality, Circular Economy, and Materials Stewardship. Ian is a marine biologist by trade with a PhD in deep ocean ecology and has remained active in this space since his early work at the National Oceanography Centre.

Topic: What are some examples of data tracking systems that are being deployed to achieve strategic objectives around CE and responsible mining assurance? Does proprietary knowledge pose an issue for you?

Business Case Insights

- Anglo American is actively investigating a range of CE applications across its business units.
- Anglo American has taken an operational view to circular economy strategies, to understand the opportunities that we have to bring circularity into our operations: the way that we manage our resources, the way that we manage our materials, and ostensibly the way that we then drive a culture around effectively ending up with waste not being a word that we use in a company.
- We want to start referring to all materials as those that might have a secondary or tertiary life, as opposed to just referring to those materials as waste.
- The second lens for us, which is becoming more and more important is then understanding, where we sit within the value chains that we are in. In some cases where we are multiple steps from an end consumer, and in some cases it might only be one or two steps, so we have been doing a lot of work to map where our materials are within those value chains that we are in, and also to try to understand what influence we have both directly and indirectly in service of what happens to those materials when they are within that value chain, which requires a different approach from a data and technology perspective than what we have been deploying on an operational level.

What does a circular economy mining company look like?

- Key CE-related questions are: What are the mineral materials within our operational assets - where are they physically located? How much of them do we have? What are the mineralogy and the geochemical properties of those materials that can be found within tailings facilities, waste dump facilities, and process materials? We have been deploying a geospatial tool and spatial inventory modeling tool that allows us to understand at any time, on a geographical level, what we have within those

particular mineral deposits, where they are in order to try to form the basis of what options we have to then transform those into something of value.

- For example, what options do we have to do something with that waste rock to place that waste into additional value chains where it can add commercial value that might be for?
- We are seeking to exploring the role that blockchain can play to provide transparency on a range of GHG data parameters.
- The goal is to understand where our materials are at any point within that value chain and for people within that value chain to be able to interrogate that information at any point through the cycle. If there is an end consumer that wants to understand the carbon embedded within that product from the mine, or the water footprint that was used to extract that material, or the biodiversity footprint in terms of land impacted versus an offset or land managed, they can access this information easily.
- To help drive innovation we have created an electronic platform called CircuLab, which is an electronic incubator where people can submit their CE-related ideas electronically from around the company.
- We are also working with some of our key suppliers, like a Michelin, for example, on how we can never dispose of a tire at all, but so that it runs through the system getting re-purposed in various ways.

Presenter #2: **Anne-Claire Howard, Chief Executive Officer, ResponsibleSteel**

Anne-Claire Howard was appointed as ResponsibleSteel's first CEO in March 2021, joining from her previous role as Executive Director of Bettercoal. She leads the steel industry's first global multi-stakeholder standard and certification initiative aimed at maximising steel's contribution to a sustainable society. She has over 15 years' experience in raw materials (mining, oil, and gas) sustainability, good governance, and responsible supply chains. She has held positions with Royal Dutch Shell, Eurasia Group, the International Finance Corporation, Adam Smith International, and Doctors Without Borders.

Topic: How are you using traceability to provide assurance of responsible practices throughout the steel supply chain?

<u>Standards System Insights</u>

- ResponsibleSteel is in the midst of establishing a system for certified steel against a variety of sustainable development criteria from the mine site to the smelter. The system explores ways for producers to use traceability to provide assurances of responsible practices throughout the steel supply chain.
- Steel is central to the whole circular economy story because it is one of those materials which, in an ideal world, could be infinitely recycled and reused. Potentially one day we hope to reach the stage where we do not need to produce virgin steel anymore, but that is a very long time away.

- In terms of sourcing responsible materials, the steel sector faces a double challenge – it must identify the mining materials that it is using, and scrap materials which play a significant role in the supply chain.

Getting the Right Data, in the Right Way

- Traceability is not the panacea. It is not necessarily about tracing your materials, rather it is about understanding what materials are in your supply chain and ensuring that you are mitigating risk and improving the performance of the company supplying you with a product.
- There is a plethora of data, but the questions are "what is the right kind of data?" and, "what is the purpose of that data?" and importantly "whom is it empowering and whom is it helping to actually get us data?" Is the data for customers to make informed choices? Is it for local communities to hold the companies that they work with accountable? How this data is collected will affect the trust people have in it.
- As a co-producer, you need to know that you can trust the data that you're being given, which involves trust building, in part through third party assurance.
- When it comes to mined materials what we are doing is assessing credible third-party mining assurance schemes such as IRMA, which is one of the schemes we are looking at, but also the Mining Association of Canada's *Towards Sustainable Mining*[1] initiative in Canada and others across the globe. We have decided to work with other initiatives, as opposed to creating something new from scratch. We are trying to reduce duplication and encourage integration through this collaboration with other initiatives that are doing the same thing.
- Ultimately, it is about ensuring that we know the data that is being provided through traceability initiatives is accurate data, and that it is not just data about performance today - it is also data about how your performance is going to improve through time. That is why I think continuous improvement and data need to fit together at some point.
- For ResponsibleSteel there is a double objective to get the right data from the upstream part of the supply chain, and then for the steel makers themselves to use that data to address their own challenges around the processing of steel, the greenhouse gases emitted during the processes. and making sure that the whole data set is relevant for the end consumer.

Presenter #3: **Ryan Forman: Executive Director, Strategic Initiatives Branch, Government of British Columbia**

Ryan is an executive member with the BC public service, he works for the Ministry of Energy, Mines and Low Carbon Innovation. He leads a multi-disciplinary team that includes policy development, intergovernmental relations, sustainable finance, digital delivery, and reporting for the ministry. Ryan has over 15 years of experience with public service delivery focused on the natural resource sector and he is an expert in process improvement. Most recently he is leading government efforts to establish an open-source platform to track raw materials and GHG attributes for international operators**.**

[1] See: https://mining.ca/towards-sustainable-mining/

Topic: British Columbia (BC) is interested in demonstrating leadership as a low carbon, responsible materials producer. What is the BC Government doing to help companies and downstream buyers track the kinds of data that will assist them in better understanding the materials being extracted and produced in BC?

Provincial Regulator Insights

- There is an increased global demand for responsibly sourced materials and we fundamentally believe that producers in BC have an advantage to be able to meet this demand due to abundant clean energy sources, advanced indigenous rights policies, as well as environmental regulations.
- In shaping a low carbon future, the provincial government established Clean BC to set the pathway to achieve our climate targets and reduce emissions by 2030.
- At the operational level, regulatory data that supports industry performance, contribution, and meeting global demands does not always get surfaced in a way that our industrial operations can benefit from.
- To get at the best and most effective way to surface this type of data, BC is working on a "digital trust marketplace," which involves a unique open source software initiative that provides self service "digital wallet" tools for companies to prove the origins and characteristics of mineral resources.
- The idea is to leverage distributed ledgers that bring both public and private data sets together in a very trusted manner. These capabilities will be foundational to be able to track attributes like carbon intensity in a manner that is verifiable and will scale up to naval global carbon accounting.

The Importance of Interoperability and Open Source

- What is critically important to companies who are selecting solutions now is the interoperability across solutions, which will be key to scale this globally in order to empower all members along supply chains to request and share information needed to make decisions around sourcing and investment.
- There are many solutions regarding traceability and ESG disclosure beginning to emerge. However, the majority of these are proprietary and focused on vertically integrated supply chains. The efforts of good intentions, but in terms of scaling globally and reaching everyone in your entire supply chain, it will be lacking.
- A centralized, proprietary platform will not be accessible enough to the global mining sector and its value chain, which is why this initiative is focused on advancing an open source solutions.
- I want to challenge all of us in our thinking around the solutions that your organizations are choosing. By looking to areas of open source to ensure we can we can sort of scale up globally, this really becomes also the beginning of global carbon accounting using distributed ledger's.

Rapid Presentations: Strategic Data Applications for Secondary Minerals Sourcing and Use

This series of rapid presentations focused on the use of data to track and better utilize secondary minerals for deconstructing, recycling, and/or reusing from existing products. Challenges range from initial product design to various supply chain coordination issues as well as the technical means to access these minerals in a cost-effective manner.

Session Moderator: **Geoff McCarney, Director of Research, Smart Prosperity Institute**

- Smart Prosperity Institute, supported by various partners including UNEP, has been doing a range of research and stakeholder convening to better understand the challenges of transitioning to a circular economy in the minerals sector.
- It is clear that meeting the increasing demands for mineral resources from growth emerging economies, increasing demand for electronics, and the needs of a low carbon energy transition, (for example, EV batteries) will require more effective integration of primary and secondary materials in what must become increasingly circular value chains.
- Even models with aggressive assumptions on secondary material production and recyclability, ramping up recyclability to 100%, (which is not going to happen in the near future), show that we will still need primary materials for at least the medium-term going forward, for up to 60 years. Over that time, it will be critical to understand and optimize the potential for blending these new materials along with those already in use throughout various supply chains.
- The strategic use of data is critical to track and better utilize secondary minerals for deconstructing recycling and reusing from existing products. Applications range from initial product design to supply chain coordination issues as well as a technical means to assess, trace, and integrate these minerals in a cost effective manner.

Presenter #1: **Sarah Houde: CEO, Propulsion Québec**

Sarah Houde spent her early career as a communications and public relations director in the private and non-profit sectors before becoming Executive Director of Youth Fusion, a pan-Canadian charity that doubled in size in its three years under her leadership. She then joined private equity firm XPND Capital as Vice President of public and government affairs, steering a number of transport electrification projects. In the fall of 2017, she was named CEO of Propulsion Québec, Québec's new cluster for electric and smart transportation and was tasked with positioning the province as one of the sector's global leaders.

Topic: Propulsion Quebec is working with the Global Battery Alliance on a "Battery Passport" pilot project that would allow various actors in battery supply chains to understand the properties of each of the elements in batteries and their movement throughout supply chains to optimize the recovery and re-use of all battery materials.

EV Battery Data Management System Insights

- The Battery Passport project focuses on one specific portion of the battery value chain - the mining, refining, and production of a number of materials made of graphite.
- It starts with the mining operation, and it extends to the purification stage leading to the production of purified graphite - a key product in the anode of most lithium-ion batteries.
- The core objective of the project is to implement a traceability mechanism in order to demonstrate the value proposition of the battery passport as proposed by the Global Battery Alliance and its members.
- The value proposition includes a) transparency, making sure that relevant data is collected and made available, b) data verifiability, making sure the data is validated by independent third parties and c) traceability, making sure data is gathered at one stage of the value chain and follows the product of the next stage, thus enabling stakeholders at the end of the value chain to have full information on the associated supply chain, and not just on the final product.
- The battery passport provides distinct value to stakeholders in the value chain by enabling tracking a battery's ESG profile from the mining of raw materials, or their recycling, to the production of cells and their final integration into an electric vehicle.
- Data collected includes a wide range of topics: greenhouse gas emissions, water use, waste management, human rights, fair labour practices, progressive board composition, business ethics community relations, First Nations engagement, etc. These data are collected at each stage of the value chain so that not only do end users have information on the environmental footprint of their EV, but also all stakeholders along the value chain can get information on their suppliers which can influence their procurement strategy to minimize their own footprint..
- The end goal is to achieve a range of positive impacts along the full value chain for both primary and secondary materials.
- Manufacturers can also realize higher resident values via increased utilization of batteries and extending the life of batteries for EV purposes with reliable battery passport data.
- The battery passport is a key enabler of a sustainable and circular battery value chain, and it provides detailed information not only on a battery's ESG profile, but also on its chemistry and ultimately its recycled material content, all of which will increasingly become required disclosures through mechanisms like the EU Battery Directive.

Presenter #2: **Ferdinand Geckeler, Senior Expert Sustainable Supply Chain Management, BMW Group**

Ferdinand Geckeler has been working for the BMW Group since 2002 in operational and strategic purchasing functions. Since 2011, he has been responsible for the sustainability program in the purchasing and supplier network of the BMW Group. Among other things, the program focuses on corporate due diligence in the supply chain, ensuring environmental and social standards in raw material supply chains and resource efficiency in relevant stages of the value chain.

Topic: What are some areas of strategic priority and some of the key challenges for BMW Group?

CE Design and Manufacturing Insights

- BMW is developing a variety of systems to improve materials use efficiency and recovery that can contribute to a more circular economy of automobile construction.
- BMW's in-house CE data system applies to both primary and secondary materials; for both open loop and closed loop.
- The BMW i3, which launched eight years ago, uses about 25% secondary material, but now we are seeking to use about 40% secondary material.
- One of the biggest challenges regarding the use of secondary material is technical restrictions and regulatory requirements regarding the stability or quality of the material in terms of safety. For example, at the moment, you cannot use secondary material for the bumper or certain other parts of the car. However, you can use secondary material for interior materials.
- It is important to understand that both regulatory and performance constraints can affect secondary materials markets.
- For certain raw materials, like copper, it is easy to have a closed loop. We have only one quality of copper and it stays in the car for 20 years. If there is a closed loop, we can simply use that copper again, without worry of changes to its quality.
- With other sorts of the materials, things are more complicated. For example, we have more than 40 different sorts of plastic in our car. It is much more difficult to collect these materials, let alone recycle them. Further, when BMW recycles these, the quality becomes poorer. So, in the future, BMW has to rethink the development of its cars to use less diverse materials, which means that the company may have only one or two sorts of plastic in its car in the future.
- All of this underscores the importance of building CE principles into product design and the associated need for accessing and tracking quality primary and secondary materials. This is what we are doing now, but BMW has to drastically speed this up.
- At the moment, BMW is sourcing open loop. For example, using plastic of PT bottles for interiors and also for seats.
- The vision that BMW has is to be closed loop, using 100% of the raw materials to produce exactly the same car or another car in the future. A circular BMW by 2030 or 2040 could become a new BMW without using any additional extracted materials.

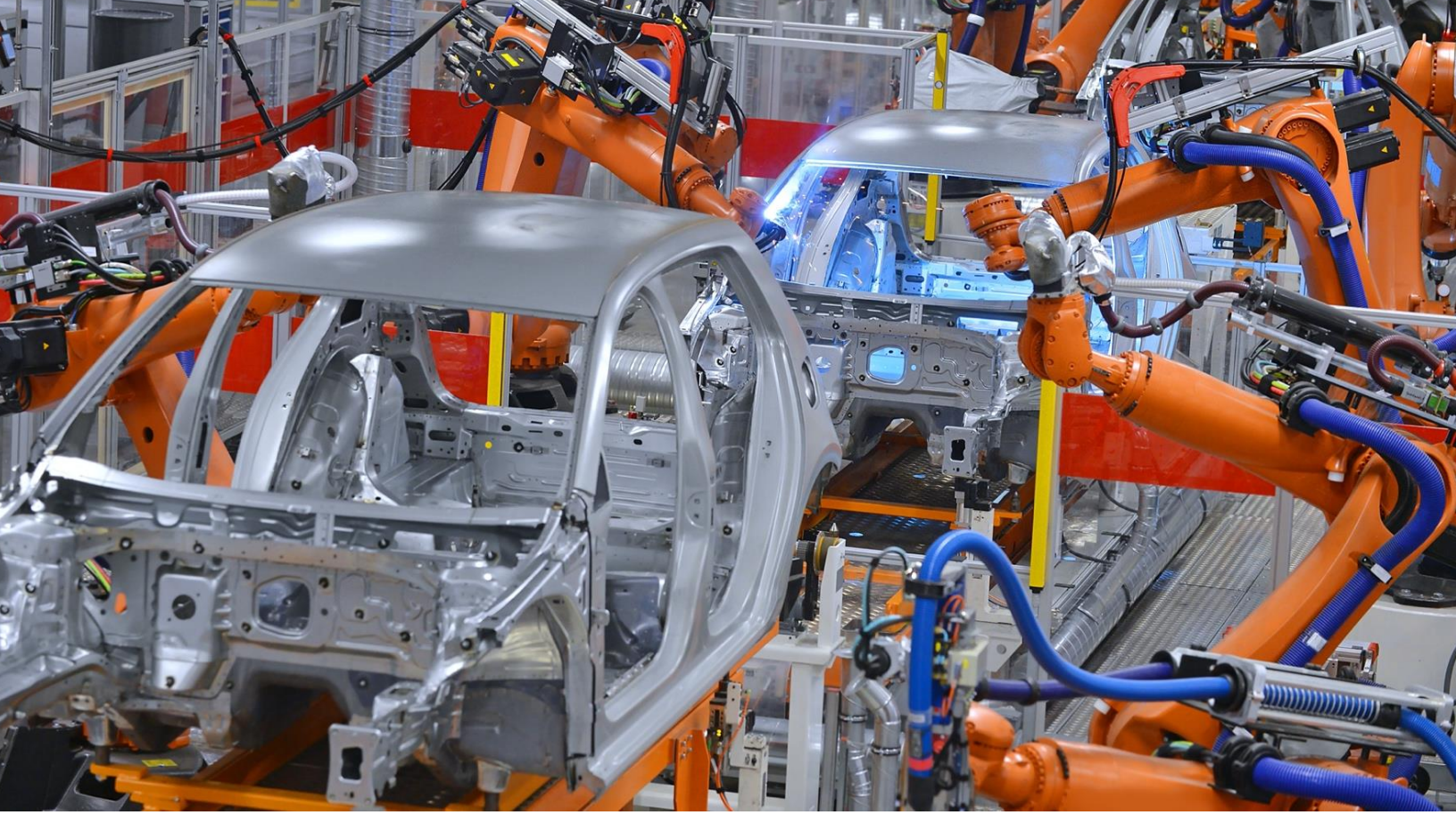
Presenter #3: **Jérôme Petry, Circularity Dataset Standardization Initiative, Project Leader**

Jérôme has an educational background as a physicist and holds an MBA. He worked for 15 years in the electronic industry before joining the Ministry of the Economy of Luxembourg in 2018. He is in charge of circular economy projects and leads the Product Circularity Data Sheet Initiative.

Topic: The Circularity Dataset Standardization Initiative was established to address the issue that circular economy data tracking is vitally important, but is also expensive, difficult, and non-standardized throughout the existing linear economy. The Product Circularity Data Sheet Initiative has been developed to try address some of those problems.

Data Standardization Insights

- Our analysis has shown that there are several showstoppers to getting the correct, standardized circular economy properties on products.
- It is currently quite difficult to go up the supply chain to get all this data, which you need to be able to reuse or re-loop your products for a new circular economy business model.
- Different suppliers in that whole value chain have different understandings of all the terms and definitions of the schemes we are asking for.
- There are so many different schemes out there, and most of them are very sector-specific, so for base material suppliers, a huge effort is required to respond to all these systems to collect this data.
- Many producers are reluctant or unwilling to share some sensitive data, which they would consider trade secrets or proprietary data.
- So, we have developed a detailed data template called the Production Quality Data Sheet (PCDS) to make sure that people are putting the exact and necessary circular properties on the products. The data templates start at the very beginning of the supply chain and are intended for use directly by the base material manufacturer or the secondary material provider.
- Once the data sheet is filled out, it is given to the next customer who fills it out, aggregating the different PCDSs they get from their suppliers, adding the effect of their processes, and then it is provided to the next customer, and so forth.
- It is important to note that these questions are asked in a way that is not sector specific - so not looking at the particular application of the product.
- The PCDS tries to use clear terms and definitions, based as much as possible on existing standards, norms, and regulations, to make sure that people are really speaking the same language throughout the whole value chain.
- To overcome the fact that some producers are reluctant to provide data, the PCDS is based on true/false statements, and is accompanied by the guidance document, which explains how to answer to these true/false statements.
- Finally, in terms of verification of data, we are developing open and international standards which will make it possible to have audits of this data by third party, which is very important to providing trust in the tool.
- Providing a simple solution to reporting circular properties on products will save a lot of money for the suppliers and the customers who provide and use the data. It will also promote many new circular business models and encourage producers to improve the product design to enable more circular properties.
- This initiative also fits well within many requirements for digital product passports, and we believe that this will easily support the upstream input of circular data to these product-related data templates.



3. Key Takeaways: Breakout Discussions

Topic #1: Policy options for enabling advanced materials tracing systems

1. **What are the most important things that governments can do to accelerate progress towards strategic circular economy data applications?**

- Address trade policies that affect material flow across borders. Effective and enabling trade policies must be in place that encourage supply chain traceability and transparency.
- Data disclosure standards can lead to behaviour change and drive innovation across sectors. Develop standards on what data is going to be used for and how it can improve practices. Focus on circularity and recommendations on consumer labelling, where there are obvious implications on traceability.
- Implement regulations that allow and encourage waste to be used (safely) as a resource. Current waste regulations often impede or disincentivize effective waste to resource loops.
- Adapt and expand good policy mechanisms like Individual Producer Responsibility (IPR) and Extended Producer Responsibility (EPR). Assigning responsibility for the products is powerful and appropriate.
- Leverage critical and strategic minerals supply chain focus to encourage use of traceability systems that allow for better materials recovery.

- Ensure that voluntary standards complement regulations and do not compete with them. Both have a distinct role and this needs to be defined to avoid duplication of efforts. We need to have market standards work more closely with the regulators.
- Encourage traceability instruments regardless of the jurisdiction, so that downstream users can be confident that wherever they source from, local issues are being considered and captured in the standards.
- Need to engage all stakeholders (government, industry, academia, civil society) in standards development. Need a consensus-building process that combines the interests and capacities of all stakeholders.
- Recognise that different businesses are at different stages of CE awareness. For some of the smaller companies, the business case for circularity is not on the radar or they are not sure what to do with it. They need to understand the issues better and also require more government support to get on an even playing field with larger players.
- Frame the discussion on CE to include and integrate both primary and secondary producers.

2. What poses the most significant obstacles to accomplishing these steps towards progress?

- Diversity and complexity of rules and regulations across various jurisdictions. Need for greater international alignment.
- Lack of capacity to participate in data traceability schemes and systems among smaller companies with limited resources in the absence of any government incentives.
- Regardless of capacity for traceability, the cost of recovery is often more expensive than the revenue of the produced material. Address the current economics for waste value capture. For example, EV batteries are arriving in scrap yards, and they are being turned away, because they are too dangerous or too expensive to recycle or recover.
- As we look at advanced technologies, the collection infrastructure and systems must also be advanced to recycle and break them down and enable circularity at scale.

3. What specific actions can be undertaken to overcome these barriers?

- Mandatory reporting of all inputs and outputs of primary materials and waste products.
- Focus on how the data can be most useful in making the behavioural changes.
- Work collaboratively on developing/implementing consistent CE standards around handling the devices at the end of life that address labour and safety concerns and encourage repurposing wherever possible.
- Work with provinces and territories to ensure EPR programs are better harmonized to allow traceability systems to be used to greater effect.
- Encourage product design-level standards that enable greater traceability and circularity.
- Use CE data and traceability to inform and empower consumer choices.

Topic #2: Technical and research needs for increasing the strategic use of data

1. **What are the most important things that can be done to accelerate progress?**

- Lifecycle indicators that enable technical traceability - indicators encompassing water use, GHG emissions, etc.
- Chain-of-evidence systems.
- Standardization for data flow - identifying ideal use case(s) for comprehensive data.
- Research through organizations like Mitacs (non-profit national research organization) and students on supply chain management.

2. **What poses the most significant obstacles to accomplishing these steps towards progress?**

- Data privacy – security and proprietary issues are a key barrier to transparency. People do not want to share, because they do not know what other people are going to do with the data.
- Feedstock for recycled materials is unstable - the quality of material flowing in (chemical composition) is broad
- Monopolistic material suppliers can cause data transparency barriers (to ensure continual market dominance/competitiveness). For example, China and Rare Earth Elements (REE).
- Technical uncertainty with maintaining data integrity - is blockchain the solution? Maybe *a* solution, but does not address data gathering and transparency issues
- Added cost with ensuring and monitoring/tracing data - who pays this cost?
- License fees are expensive.
- Innovation investment risk limits access to finance.

3. **What specific actions can be undertaken to overcome these barriers?**

- Standardization of data collection and monitoring across the supply and value chains. There has to be a regulated body to set up CE and data ground rules and establish clarity for all players.
- Cost needs to be passed down to the end users.
- Industry groups are the big enablers - based on impact or public (consumer) pressure (industrial standards).
- Having more accessible open-source data would be beneficial. Open-source data can limit cost.
- De-risking investment through co-funding and analyzing the market.
- Establishing a “pre-competitive” alliance that addresses areas of mutual interest and need, including data and traceability coordination.

Topic #3: Market drivers, needs, and barriers for wider adoption of materials traceability systems

1. **What are the most important things that can be done to accelerate progress?**

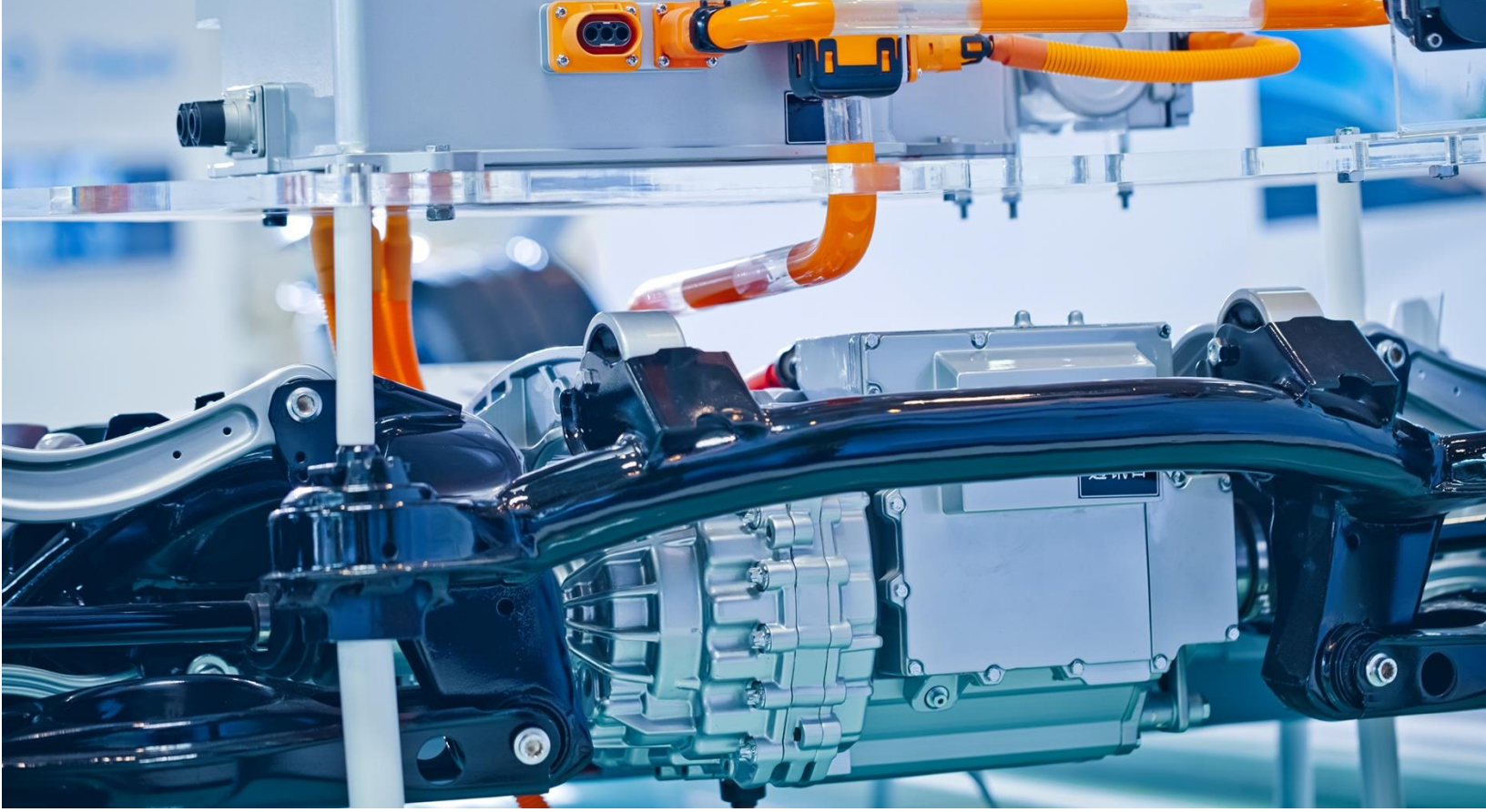
- Grants for funding to cover the cost of transitioning to CE.
- Standardization (open and acceptable internationally).
- Need to change the financial accounting when moving from linear to CE. Properly price items for disposal.
- Policies will create the movement, but big companies will provide momentum.
- Consider recycling-as-a-service as a business model.
- Look at lessons from plastics to be used in circularity to learn about how to use data in a way to earn public trust, while addressing key business interests.
- Address consumer price sensitivity issues – some can and will pay premiums, some will not. Use data to accurately pass along value so consumers can buy-in to the idea.
- Need to go with upcycling of reusable components.
- The companies that have successfully overcome barriers are the ones who control the nodes in their own supply chain.

2. **What poses the most significant obstacles to accomplishing these steps towards progress?**

- Fragmentation or disconnection of information flow and understanding across supply chains.
- Transparency and accountability - Lack of accountability or trust and lack of transparency can lead to tensions between communities and corporations.
- Companies are audited to be conflict-free but there is an abundance of confidentiality and information that is only shared business to business, creating a lack of connection to communities.
- As long as all standards are voluntary you will have companies choosing what is easiest for them. Then all certification becomes distrusted, making accountability and standardization so important.
- Different capacities of different scales of business can exclude some from responsible supply chains (e.g., obstacles around the verification of artisanal mines).
- End consumers are often reluctant to pay real costs.
- Lack of investment in innovative products.
- The ability to link waste flows with resource needs.
- Subsidies allow traditional business as usual to continue.

3. What specific actions can be undertaken to overcome these barriers?

- Taxes that will shift focus towards new tech and funding these new models.
- Appropriate taxation and other tools to ensure there is real pricing for waste (e.g., carbon tax model).
- Create differentiated markets for value-added (responsibly-sourced) commodities.
- Build trust through collaboration and commitments to transparency.
- Trade policies that allow for coordination and standardization across jurisdictions.
- A global standard is required for collecting information. Information used may vary by stakeholders but transparency should be complete and consistent.
- Training and formalization for small-scale or marginalized actors seeking market access.
- Industry-driven initiatives to build a secondary materials exchange marketplace.
- Make circular products more visible to consumers.



4. Summary of Actions & Recommendations

Participants discussed strategic priorities for next steps to advance the ways in which data collection could be strategically deployed and coordinated to advance a more circular economy for minerals in the automotive sector and elsewhere. There are important roles and actions for governments, for markets, and for technology developers to play. These activities are inter-related and often interdependent, so there is a primary need for ongoing collaboration and communication among private, public, and civil society stakeholders in order to ensure that the design and implementation of next steps are well informed and sequenced to maximize impacts and accelerate progress.

One critically important insight from the discussions focussed on the outcomes and ultimate objectives of all this data collection and reporting. Due diligence and transparency are essential; however, there is a need to realize that they tend to only address the symptoms and not the causes. Traceability is important but, once minerals are mined, the impacts have already occurred, and so this data has to be used to focus efforts on how to advance CE strategies and improve Environment Social and Governance (ESG) standards throughout supply chains.

Top Policy Issues and Priorities

1. Establish common data transparency standards throughout supply chains to enable manufacturers and consumers to understand and act on CE best practices.
2. Data systems must be designed first and foremost to address the needs of directly affected communities. Key questions to ask are, *who is this data actually for*, and *who is it going to benefit in the long run?*

3. Coordination of CE rules and standards across jurisdictions (regionally, nationally, internationally) is critical to optimizing materials flow and addressing significant existing market impediments.
4. Ensure that data requirements and supports are provided in a way that are accessible also to smaller companies in a way that is appropriate to their capacities.
5. The roles of the private sector (voluntary standards) and government need to be clearly defined so that they do not overlap and duplicate efforts. Prioritize working together so that private and public roles complement each other, and data collection is not duplicated.

Top Technical Issues and Priorities

1. Chain of evidence already exists in many supply chains, but there is a need to evaluate tradeoffs between enabling a chain of evidence to promote ESG/CE and ensuring data privacy. Need to design supply chain data systems that are not broken or devalued by privacy or proprietary considerations.
2. Need for standardization of data collection and monitoring protocols and practices across the supply/value chains.
3. Private sector role vs government role (national and industry standards need to be harmonized) – industry knows industry best and can raise the ceiling, while governments can raise the floor (ensuring stringent mandates).
4. A commitment to, and investment in, open-source data accessibility would be beneficial and should be made a priority for a variety of reasons, including cost, inclusivity, and transparency.

Top Market Issues and Priorities

1. Open, inclusive, and internationally acceptable standardization is important.
2. Public policy investments, funds / grants, are important to cover the initial cost of a transition towards CE. These include the need for pricing externalities to disincentivize waste, as well as a commitment to convening diverse players around standardization and cooperation.
3. It is essential to focus on developing systems that establish and reinforce trust in the veracity of data and the transparency of supply chain transactions. The quality of data and reporting that inspires public confidence is a primary task.
4. Market shifts require drivers, including economic incentives, premiums, and preferential markets. While government policies can create the movement and innovation and can drive innovation, big companies will provide the most momentum.

Appendix A: Workshop Agenda

Below is the agenda from the workshop hosted on June 10, 2021.

Program Overview	**Timing**

Opening and Context-setting Panel
Format: Plenary and Panel
 	
Introductions, Session Objectives & Agenda
• Host: Paul Shorthouse, Circular Economy Leadership Canada (CELC)
 	
Context-setting Panel
• The rise of demands for transparency and performance assurance in the mining and minerals sector.
  ○ Facilitator: **Alan Young**, Materials Efficiency Research Group (MERG)
  ○ **Malcolm Shang**, ArcelorMittal Mining
  ○ **J.J. Messner de Latour**, Microsoft
  ○ **Ferdinand Geckeler**, BMW Group
  ○ **Aimee Boulanger**, Initiative for Responsible Mining Assurance (IRMA)
	45 mins

Presentations: Strategic Data Applications *Format: Rapid Presentations* • Facilitator: **Jacomien van Tonder**, Metal Tech Alley / Lower Columbia Initiatives Corp. Presenters: • Presentation 1: **Ian Hudson**, Anglo American • Presentation 2: **Anne-Claire Howard**, ResponsibleSteel • Presentation 3: **Ryan Forman**, Province of British Columbia (Ministry of Energy, Mines, and Low Carbon Innovation)	30 mins
Presentations: Materials for Secondary Minerals Sourcing and Use *Format: Rapid Presentations* • Facilitator: **Geoff McCarney**, Smart Prosperity Institute Presenters: • Presentation 1: **Sarah Houde**, Propulsion Quebec • Presentation 2: **Ferdinand Geckeler**, BMW Group • Presentation 3: **Jérôme Petry**, Government of Luxembourg (Product Circularity Data Sheet Initiative)	30 mins

Facilitator-led Breakout Room Discussions: *Format: Breakout Room Discussions* Topic #1: Policy options for enabling advanced materials tracing systems: • Room 1 Lead: **Rebecca Richards**, Metal Tech Alley / Lower Columbia Initiatives Corp. • Room 2 Lead: **Stephanie Cairns**, Smart Prosperity Institute • Room 3 Lead: **Mike Wilson**, Smart Prosperity Institute Topic #2: Technical and research needs for increasing the strategic use of data: • Room 1 Lead: **Bruce Dudley**, The Delphi Group • Room 2 Lead: **Jacomien van Tonder**, Metal Tech Alley / Lower Columbia Initiatives Corp. Topic #3: Market drivers, needs, and barriers for wider adoption of materials tracing systems: • Room 1 Lead: **Alan Young**, MERG • Room 2 Lead: **Paul Shorthouse**, CELC • Room 3 Lead: **Geoff McCarney**, Smart Prosperity Institute	35 mins

Report Out & Wrap-up
Format: Plenary
 	
Collective return to the plenary for close out, including:
• Facilitators briefly report back on the key takeaways from group discussions.
  ○ Facilitator: **Alan Young**, MERG
• Closing and next steps / wrap-up.
  ○ Host: **Paul Shorthouse**, CELC
	20 mins

Appendix B: Registered Organizations

Aboriginal Peoples Television Network - APTN
ALARA Environmental.com
Altus Group
AngloAmerican
ArcelorMittal
Asset Management Ontario (AMONTario)
Attaverse
Automotive Recyclers of Canada
Battery Metals Association of Canada
BC Ministry of Environment
BC Ministry of Jobs, Economic Recovery and Innovation
BCAA
BC Institute of Technology
Biological Carbon Canada
BKL
BMW AG
BNAC Environmental Solutions Inc.
British Consulate-General Toronto
Canada Plastics Pact
Canadian Critical Minerals & Materials Alliance (C2M2A)
Canadian Museum of Nature
Canmet MATERIALS, NRCAN
Carbon Consulting Company
Carleton University
CEC
CEI
Centro Mexicano de Derecho Ambiental (CEMDA)
CEPMLP
CERIEC
City of Richmond
CKP & Associates
CN Investment Division
Consultant
CSA Group
CUNY
Dell Technologies
DIALOG-Vancouver
Digitalist
Dillon Consulting
DIT
Embassy of Finland
Energy and Mines
Envirolum Consulting Inc.
Environment and Climate Change Canada
ERM
Euro Lithium Inc.
Export Development Canada
Food Health and Consumer Products of Canada
Foresight Cleantech Accelerator Centre
Future 500
HARTING Stiftung & Co. KG
HSR Zero Waste
Hudbay Minerals Inc.
ICTC
IKCO
Imacro Inc
Impact Zero Corp.
Imperial Oil
Initiative for Responsible Mining Assurance (IRMA)
InnovFin
International Royalties Corp
Japan Oil, Gas and Metals National Corporation
Kite Company Creator
Kwantlen Student Association
Liberty Power
Library of Parliament
Lower Columbia Initiatives Corporation
Luxembourg MAEE
MaRS Discovery District
Materials Efficiency Research Group (MERG)
MERN
Metal Tech Alley
Metro Inc.
MGRID ENERGY INC
Microsoft
Minehub
Mining Association of BC
Mining Association of Canada
Ministry of the Economy Luxembourg
Mitacs Inc.
Mount Royal University
Municipality of Sioux Lookout

National Research Council of Canada
Natural Resources Canada
NRC-IRAP
Ontario Government
Ontario Ministry of the Environment
Oxum Creative
Pacific Institute for Climate Solutions
Pollution Probe
Propulsion Quebec
RBC
RECYC-QUÉBEC
ResponsibleSteel
Schooley Mitchell
Scientific & Technical Advisory Panel of the Global Environment Facility
Seerang Consulting
Selkirk College
Senate of Canada
Simon Fraser University
SII
Smart Prosperity Institute
SMARTNet Alliance
Standards Council of Canada
Stellantis
Sterling Strategic Business Development Inc.
Stratos
Suez
Sumitomo Corp
Summit Earth
SunHub Inc.
Sustainable Apparel Coalition
Sustainable Development Technology Canada
Sustainable Strategic Solutions
Sustentable Consulting
The Delphi Group
Torngat Metals
Toromont.
Toronto Hydro
Trade Commissioner Service
UBC Okanagan
UBC Sauder School of Business
University of Alberta
University of Luxembourg
University of Ontario Institute of Technology
Upswing Solutions
Uva Wellassa University
V.E Affiliate of Moody's
Viami International Inc.
Walker Environmental Group
WeRcircular
Zimpatica, LLC
ZS2 Technologies

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