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Battery minerals: a changing context for ESG reporting

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Abstract

Background Growing expectations for transparent environmental, social and governance (ESG) reporting are influencing battery minerals supply. Yet consistency across reporting mechanisms remains challenging. Australian mining and processing companies producing battery-grade materials—including lithium, nickel, cobalt, vanadium and graphite—must increasingly navigate a proliferation of regulatory requirements and voluntary standards designed to demonstrate responsible practices. This study examines how aligned mechanisms are in terms of data requirements, methodological guidance, scope and transparency.

Methods The study undertook a comparative review of eleven ESG reporting and management mechanisms relevant to Australian battery-mineral producers. The voluntary and regulatory mechanisms were assessed against a common set of criteria, including: the ESG categories addressed, required data types, methodological specifications, level of site versus corporate reporting, and transparency provisions. A matrix-based comparison was then used to identify areas of convergence and divergence. Frequency counts and cross-tabulation were used to map overlaps in data and disclosure requirement for ESG categories.

Results The analysis found partial alignment across mechanisms, with several ESG topics—such as energy use, greenhouse gas emissions, labour practices and community engagement—appearing consistently. However, there was considerable variation in the depth and specificity of requirements, particularly regarding methodology, data quality and verification expectations. Some voluntary initiatives demonstrated high adherence to best-practice principles, whereas others offered flexibility that resulted in inconsistent data robustness. Differences in scope (corporate versus site-level) also contributed to limited comparability among reporting outputs.

Conclusions Overall, the current ESG reporting landscape for Australian battery-mineral producers exhibits moderate overlap but lacks full standardisation. This fragmentation risks undermining comparability and stakeholder confidence. The study outlines several divergent future pathways, highlighting the need for greater harmonisation to support credible ESG claims and strengthen sustainability performance in both Australian and international battery-mineral supply chains.

Keywords Environmental, social, governance (ESG), Corporate social responsibility (CSR), Battery, Mining, Sustainability, initiative for responsible mining assurance (IRMA)

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Background

The global transition towards renewable energy supply and storage technologies is coinciding with increased scrutiny on systems of production and raw material sourcing. Yet Australian based mining and processing companies that produce battery grade materials are experiencing overwhelm with the proliferation of schemes emerging regarding responsible sourcing and disclosure of credible environmental, social, and governance (ESG) performance [1].

Australia has had mandatory corporate environmental reporting since 1998 [2], with approaches and apparent motivations underpinning reporting practices varying across companies [3]. However, meeting stakeholder expectations requires disclosure of information that goes well beyond these minimum requirements. In the absence of a universally accepted ESG reporting framework, battery material producers are required to grapple with reporting to both Australian regulatory mechanisms and several voluntary ESG reporting mechanisms, to fulfil ESG reporting and management expectations of end markets.

The extent to which ESG reports can be relied on as credible representations of industry practice continues to be debated [4]. Greenwashing in Australia has been under the spotlight with the investigation by the Australian Competition and Consumer Commission [5]. Quality and credibility of ESG reporting is under increasing scrutiny, evidenced through discussions with battery material producers involved in our research project, where end market purchasers are increasingly relying on third-party verified assurance of sustainability reporting, associated with responsibly produced product. Data comparability is important in the context of battery material traceability where material purchasers on the open market are comparing products using reported ESG data. A review of ESG reports from 90 corporate entities found that company sustainability-related disclosures lack completeness, consistency and comparability, with wide variations in reporting practices [6]. Etsy and Cort highlight that while the development of ESG standards over time has resulted in increased transparency, a useful level of comparability of data in disclosures for the purpose of decision making has not yet been achieved globally [7]. An analysis of Australian mining companies also found different degrees of compliance with the Global Reporting Initiative (GRI) standard and exacerbating this is the difference in interpretations of standard requirements [8]. ESG reporting quality and comparability challenges are being met with concerted effort to align and standardise reporting outcomes, with varying degrees of success. The aim of this study is to examine how aligned mechanisms are in terms of data requirements, methodological guidance, scope and transparency. To set up the analysis, an overview of the evolving context of ESG reporting is provided in the next section.

Evolving context for voluntary and mandatory reporting

The institutionalisation of sustainability reporting has evolved considerably since the establishment of the Global Reporting Initiative in 1997, guided by a desire to increase company or brand legitimacy [9–11], manage negative stakeholder perceptions, and gain social license [12]. Examples of sustainability reporting in the mining sector predate the GRI. Notably Western Mining Corporation (WMC; later acquired by BHP Billiton) distributed to their shareholders their 1994/95 Environmental Progress Report that was partially developed based on guidelines established by the North American Public Environmental Reporting Initiative in 1993. The site-based data disclosures made in their initial and subsequent reports are not dissimilar to the level of data disclosure in modern day reporting.

Over time, the culturally contextual and geographically specific nature of sustainability issues has resulted in an increase in the number of ESG indicators that companies are required to report, increasing the complexity of data required for compliance, and a proliferation of voluntary standards available to guide ESG reporting and management practices. Despite the uptake of ESG reporting at the corporate level, ESG reporting frameworks are yet to reach a level of standardisation that is helpful for sustainability performance comparison, however, instances of standard consolidation are emerging. A draft of the Consolidated Mining Standard was released in October 2024 by the International Council on Mining and Metals (ICMM), which is a consolidation of the ICMM's Mining Principles, The CopperMark, the Towards Sustainable Mining Standard, and the World Gold Council Standards. However, the degree to which consolidation of select standards solves the issue of equivalency, comparability and data quality issues are yet to be seen. Additionally, the future uptake of the consolidated standard by mining companies and downstream purchasers is uncertain, with the standard due to be implemented in 2026.

A lack of equivalency and comparability of sustainability reporting data across voluntary mechanisms creates considerable challenges for product or material comparison via product passport style platforms. Despite these issues, sustainability data that is available is currently being used to compile datasets to benchmark eco-efficiency in the Australian and international minerals industry, evidenced in a body of research performed over a decade [13–16]. Continual improvement of data quality and equivalency will enhance the quality of these performance measurement efforts. The Global Battery Alliance's Battery Passport and the London Metal Exchange have responded to this challenge by mandating

specific reporting requirements on their product and exchange platforms, however, these platforms are limited in their material scope. In the absence of a 'one stop shop' for commodity or product comparison and global material exchange, equivalency and comparability issues must be understood when relying on data produced from the plethora of internationally available voluntary ESG reporting mechanisms. These issues include differences in the data requirements to meet both voluntary and regulatory reporting mechanisms [17]; diversity of sustainability metrics and indicators to track progress [18, 19]; lack of consistency in requirements for transparency which enables selective reporting, or presenting a 'hyper-reality' [20]; and methodology and metric inconsistencies [21]. Many of the issues outlined here relate to a tendency for some reporting and management mechanisms to lean towards guidance principles rather than detailed step-by-step methodology and data frameworks [17], which, has resulted in greater potential for differing interpretations of requirements, and therefore variation in reporting and management outcomes and potential for greenwashing. Public disclosure and third-party verification are widely viewed as important for establishing credibility of voluntary reporting. In the extractives sector, (Rutovitz et al. 2020b) identified the following governance principles that stakeholders commonly agreed were important: multi-stakeholder governance, third-party verification, transparency and ISEAL good practice. In addition to specific issues within ESG reporting mechanisms, the voluntary nature of compliance has come under criticism [22, 23] and in response ESG reporting and management is trending towards a mandatory requirement.

Regulation of ESG reporting has been considered a positive step towards ensuring credibility and accountability [18], citing the increase in carbon-related disclosures in response to developments in Australian regulation [24]. Comprehensive disclosure requirements for ESG have not been mandated in Australia to date, with the exception of modern slavery and greenhouse gas emissions reporting focused on larger companies. However indications of a future Australian framework are found in a position statement by the Australian Government with the announcement of an 'Extended External Reporting regime' [25]. International expectations regarding full supply chain visibility are increasing in line with recent guidance from the International Sustainability Standards Board [26, 27]. Elements of mandatory ESG disclosure requirements have recently been introduced, both in Europe and in the USA in the form of the European Union's proposed Carbon Border Adjustment Mechanism (CBAM) and the US Securities and Exchange Commission's regulatory reporting requirements for Climate Related Financial Disclosure, and the Dodd-Frank Act. In the European Union the EU Battery Regulation, targeted at battery material supply chains, will directly impact Australian battery materials producers. Downstream battery material purchasers, such as car manufacturers are also influencing sustainability disclosure throughout the battery supply chain via procurement influence, and innovative transparency and traceability solutions like product passports are being developed to suit this purpose [28].

Scope of this research

This study contributes to the evolving context and discussion by providing a summary of recent research into the reporting and management requirements of ESG mechanisms, conducted as part of a project for the Future Battery Industries Cooperative Research Centre (FBI CRC). This portion of the research explores the types of voluntary mechanisms, including certifications, that are available to Australian battery material producers to demonstrate the sustainability credentials of mined battery materials. To understand how different mechanisms compare with each other, the research explores the degree to which ESG reporting and management mechanisms are aligned in their scope, feature similar key metrics to evaluate performance, and whether they provide sufficiently detailed guidance to reduce differences in interpretation of reporting requirements. Due to the emphasis placed on reporting credibility, the research also investigates whether ESG mechanisms incorporate markers of quality and credibility.

Methods

A qualitative content analysis method was used to collect information from ESG mechanisms according to a common set of criteria. These criteria included the ESG categories addressed, required data types, methodological specifications, level of site versus corporate reporting, and transparency provisions. A matrix-based comparison was then used to identify the number of reporting requirements in each ESG category and the areas of convergence and divergence. Frequency counts and cross-tabulation were used to map overlaps in data and disclosure requirement for ESG categories. This approach has conceptual similarities to research previously conducted to evaluate the scope and degree of compliance with corporate sustainability reporting mechanisms, notably the Global Reporting Initiative [29, 30]). This is also similar to research that has sought to understand commonalities and divergences in the scope of mandatory and voluntary corporate reporting of mine sites within Australia (e.g. with respect to water [31]).

Key considerations when selecting the ESG reporting, management and assurance mechanisms for evaluation and comparison were:

- Relevance for Australian material producers: A handful of mechanisms are only relevant for material issues in certain geographical regions, or they cover materials that are not mined in Australia.
- Relevance for a diverse set of battery materials: Core battery materials of focus for this study include lithium, nickel, cobalt, vanadium and graphite. However, given that some of these materials are produced as product and co-product at the same production site, only ESG mechanisms that are commodity agnostic were considered. Mechanisms that only cover specific metals or materials were excluded, for example CopperMark. The analysis focused on mechanisms that could be applied more broadly to mining and processing sites relevant to a set of core battery materials.
- Good practice principles: Mechanisms were selected if they contained one or more elements considered good practice principles such as public disclosure, third-party verification, and multi-stakeholder governance,
- Detailed guidance documentation: A necessary requirement to complete the content analysis was the provision of sufficiently detailed guidance documentation, outlining specific reporting and management expectations that could be compared with other mechanisms.

The ESG reporting and management mechanisms included in this study do not represent an exhaustive list.

Following a desktop review of available mechanisms, a total of eight voluntary sustainability certification standards, assured standards, non-assured standards were selected for evaluation and comparison. Two sustainability certification mechanisms were selected:

- The Initiative for Responsible Mining and Assurance (IRMA)
- Certification of Raw Minerals (CERA)

In addition, six sustainability reporting and assurances were selected:

- Towards Sustainable Mining (TSM)
- Global Reporting Initiative (GRI)
- Carbon Disclosure Project (CDP)
- Dow Jones Sustainability Index (DJSI)
- Responsible Mining Index (RMI)
- OECD Due Diligence Guidance on Stakeholder Engagement for the Extractives Sector

Also, the reporting requirements of three Australian Federal Government legislative instruments with policy objectives that align with the principles of ecologically sustainable development were considered, including:

- National Greenhouse and Energy Reporting Act 2007 (NGER Act)
- National Environment Protection (National Pollutant Inventory) Measure (NPI)
- Environmental Protection & Biodiversity Conservation Act 1999 (EPBC Act)

In addition to collecting data on ESG indicators and scope of requirements, data was also collated for a range of parameters to inform analysis of quality and credibility. It is important to emphasise and identify the level of engagement of ESG reporting and management mechanisms with data quality principles due to the continual challenges with data quality in reporting and the impact on effective performance benchmarking and comparison. The key principles derived to analyse data quality and credibility are informed by the ISEAL best practice guidelines and credibility principles [32], information gleaned through industry engagement during this research project, and definitions identified during literature review, including Darnall et al.'s [33] analysis of sustainability reporting by Japanese firms and the close correlation between independent third-party verification and the credibility of ESG reported information, see Table 1 for an outline of key principles.

Table 1 Key principles for data quality and credibility

Data quality principles	Trust/credibility principles
Timeliness - Defined periodic reporting of performance data and monitoring/disclosure of progress against performance targets.	Transparency - Reported information is publicly available
Detailed guidance documentation - Clearly stipulated data requirements to meet specific indicators. Reducing the potential for differing interpretations and methods to meet indicators.	Accountability - Clearly identifiable grievance mechanisms for impacted stakeholders.
Methodology and data source transparency - Requirements to disclose methodology for modelling, calculations, data sources, and reasoning for any omissions.	Truth in reporting – reporting all information, not selective reporting positive information.
Third-party verification - Verification of reported data by an independent third-party entity	Public disclosure of incidents of non-compliance.
	Multi-stakeholder governance - Governance by a range of stakeholder groups
	Third-party verification - Verification of reported data by an independent third-party entity

Results

The results presented below represent a body of research, including a recent report for the Future Battery Industries CRC on the Requirements and Data Commonalities

for sustainability certifications and reporting in the battery mineral sector [17].

Summary of ESG reporting topics and indicator requirements

The list of ESG indicators and the results of total indicator requirements for each standard and mechanism can be found in Fig. 1. Further in-depth results and discussion are available in a public report noted above [17].

As is evident in Fig. 1, there is a large degree of variance in focus for ESG indicators between voluntary and regulatory reporting and management mechanisms. This is illustrated through instances of higher reporting requirements for some mechanisms in certain ESG indicators and a lower number or lack of reporting requirements in others. Variation is evident across most ESG indicators. Particularly strong examples are found in water, air quality, climate change, energy, waste, and habitats and mine closure. When multiple mechanisms were found to address similar ESG categories, analysis of detailed requirements found significant differences in methods for deriving results and the degree of information required to meet reporting expectations. Approaches to ensuring the data integrity of reported information varied between schemes and include detailed descriptions of reporting requirements, specified frequency of reporting updates, externally verified or assured reported information, and public reporting requirements. Schemes such

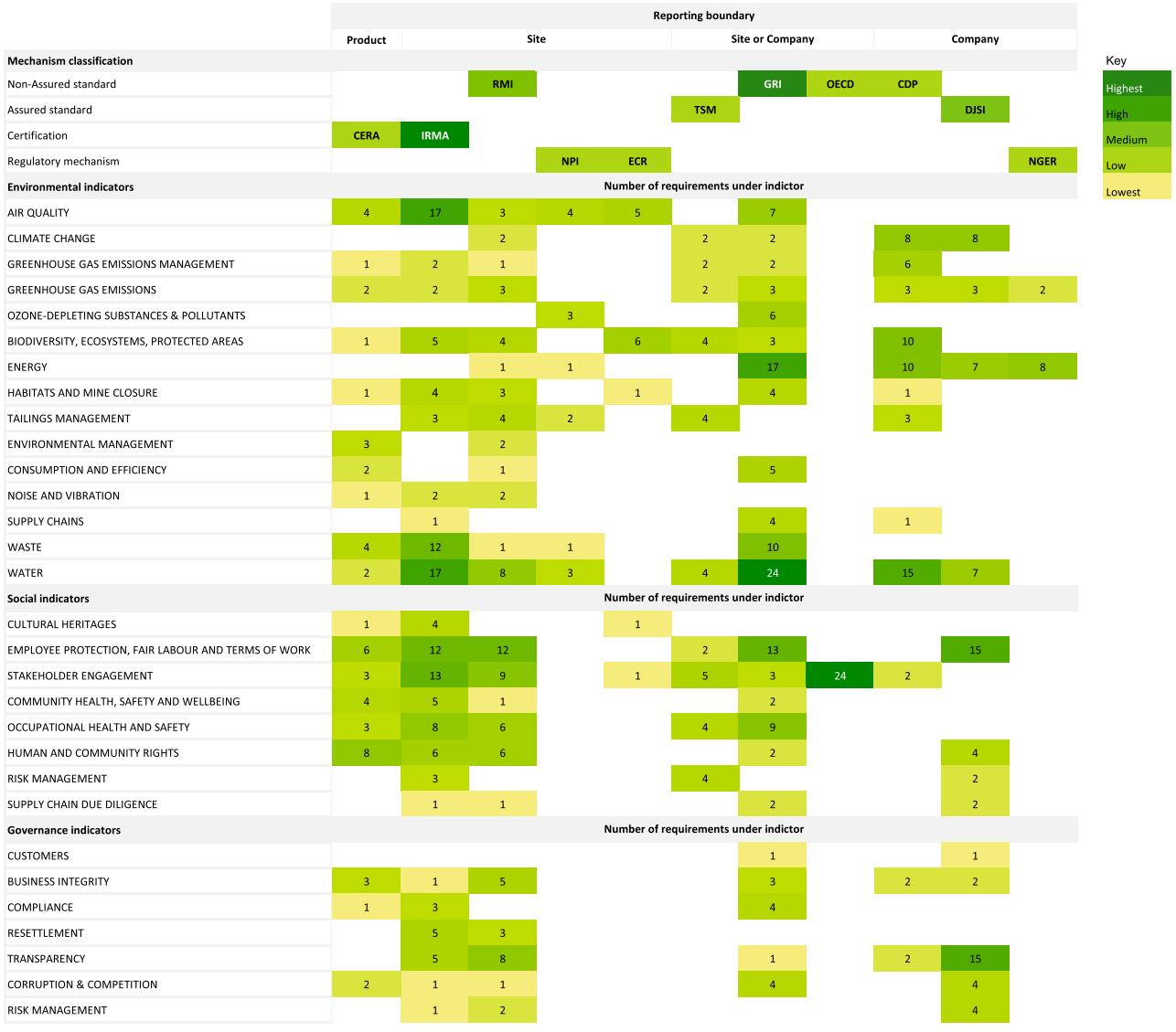

Fig. 1 Comparing the number of reporting requirements for regulatory and voluntary ESG mechanisms. Scheme acronyms: IRMA – the Initiative for responsible mining and Assurance; CERA – Certification of raw Minerals; TSM – towards Sustainable Mining; GRI – Global reporting Initiative; CDP – carbon disclosure project (incl. CDP Water); DJSI – Dow Jones sustainability Index; RMI – responsible mining Index; NPI – National pollutant Inventory; NGER – National greenhouse and energy reporting scheme

Table 2 Mechanism adherence to data quality principles

Mechanism	Type of initiative	Data requirements	Timeliness of reporting	Verification requirements
NPI	Regulation	Y	Y	N
NGER	Regulation	Y	Y	Y
IRMA	Standard and assurance mechanism	Y	Y	Y
CERA	Standard and Certification	S	Not specified	Y
TSM	Standard	S	Y	S
GRI	Standard	Y	Not specified	N
CDP	Disclosure standard and comparison index	S	S	N
DJSI	Disclosure standard and comparison index	S	Y	S
RMI	Standard and comparison index	S	Y	N

Y = meets, S = Somewhat meets, *N* = Does not meet

Table 3 Mechanisms adherence to data integrity principles

Mechanism	Type of initiative	Governance structure	Grievance mechanisms	Public disclosure
NPI	Regulation	NA - Federally regulated	Not specified	Y
NGER	Regulation	NA - Federally regulated	Not specified	S
IRMA	Standard and assurance mechanism	Y	Y	Y
CERA	Standard and Certification	N	Y	S
TSM	Standard	Y	S	S
GRI	Standard	Y	Not specified	S
CDP	Disclosure standard and comparison index	N	Not specified	N
DJSI	Disclosure standard and comparison index	N	Not specified	S
RMI	Standard and comparison index	Y	S	S

Y = meets, S = Somewhat meets, *N* = Does not meet

as IRMA feature highly detailed descriptions and criteria for meeting individual reporting categories including the frequency at which reporting should be updated, and specify assurance requirements to verify reported information. In other examples, such as GRI, requirements for reporting criteria and evidence to support reported information are less prominent. Expectations around reporting transparency varied between schemes, with some specifying transparent reporting practices such as making reported information publicly available (e.g., IRMA requires public reporting of information on company websites). Whilst other schemes lacked mention of public reporting altogether or lacked clarity on what information is expected to be reported publicly. In some cases, the level of compliance with the requirements of a scheme equated to a grading, for example TSM's assessment criteria levels range from C, B, A, AA, and AAA, whilst IRMA's grading system is a percentage score based on the percentage of assurance requirements met. Whilst there are positives in enabling minerals producers to show continual improvement towards achieving a higher grading, this introduces added complexity for downstream purchasers or external stakeholders when comparing product gradings across a range of standards.

An evaluation of the adherence of standards and disclosure mechanisms to best practice data quality and credibility principles is presented in Tables 2 and 3, based on the principles established in Tables 1. Table 2 assesses data quality based on three principles: detailed data requirements, timeliness of reporting and verification requirements. Detailed documentation on reporting requirements is essential for data quality, consistency and comparability. Mechanisms that feature detailed and specific reporting requirements reduce the potential for differences in data outputs, at least within each mechanism. In contrast, mechanisms that rely more heavily on self-defined data inputs, methodologies, and metrics increase the potential for a high level of variation in data outputs, impacting data comparability. The degree to which mechanisms are meeting these data quality principles are evaluated below.

Data integrity principles are assessed based on three criteria outlined in Table 3: governance structure, the requirement for grievance mechanisms, and the requirement for public disclosure of reported information. Where voluntary mechanisms evolve through multi-stakeholder governance throughout the development

period of the mechanism, these have been evaluated as meeting the requirements of good governance practice. IRMA, TSM, GRI and RMI have all been developed under multi-stakeholder governance principles, which include the involvement of indigenous groups, worker organisations, industry representatives, financial organisations, and research institutions. CERA was developed with a limited group of stakeholders consisting of consultants and universities. It was not clear whether DJSI and CDP was developed through multi-stakeholder governance, however, there has been considerable evolution of these schemes over time and the DJSI has indicated that any methodological iterations are performed in consultation with relevant stakeholders.

IRMA and CERA specify a requirement for grievance mechanisms. TSM requires grievance mechanisms for workers. The remaining mechanisms under study did not specify any requirement for grievance mechanisms.

The analysis uncovered significant differences between sustainability reporting and management mechanisms in relation to verification requirements and public disclosure. Only one regulation, the NGER, required third-party auditing of reported GHG accounting information. Under voluntary mechanisms internal and third-party auditing requirements were more prevalent, however, verification via auditing was not always a strict requirement. For example, assurance is performed via approved third-party auditing services on behalf of IRMA. The same is true of CERA. IRMA's audit cycle consists of surveillance audits 12 to 18 months after initial audit reports and re-audits every three years to ensure compliance. DJSI also required third-party verification of reported information every four years, however, this is not required for all reported information. For TSM, third-party verification is required for some reported information. RMI required public disclosure of some reported information, however, third-party verification of this information was not required. Other sustainability management and reporting mechanisms not previously mentioned (e.g. GRI, CDP) have varied requirements to verify reported information or display it publicly.

Discussion

Given the current context, there is uncertainty regarding how the future landscape of ESG, sustainability and responsible supply disclosure and assurance mechanisms for the battery material extraction and supply sector will evolve. The research undertaken as part of the Future Battery Industry CRC is revealing a complex set of challenges being faced both by downstream material purchasers in evaluating the ESG performance of battery minerals on the global market and by mineral producers in converging on the best path forward for evidencing the ESG credentials of their product. The macro level barriers and drivers to adoption of voluntary sustainability initiatives in particular are complex and varied [34].

Australian producers are adopting several approaches to ESG reporting practices to address the rapidly evolving international reporting landscape. Larger companies prepare to report to a broad range reporting standards with elaborate and bespoke concordance matrices that align reporting criteria across reporting standards. This approach enables adaptable and timely reporting to the preferred reporting standards of downstream material purchasers but relies on a reasonably sized internal sustainability team or the ability to pay for external specialised consulting services. For smaller mineral producers or for mine sites still in the scoping phase of the project, investment in this approach can be significantly higher than the perceived value. In other cases, companies consider adopting one standard they perceive to be strong across all ESG indicators in the hope that reporting to this standard will meet the requirements of others, IRMA has been considered for this purpose. The IRMA auditing process is, with good reason, rigorous and transparent, which may result in hesitation from mineral producing companies to commit at the risk of negative perceptions. Despite the range of approaches to addressing the current scope of available ESG reporting standards, differences in methods embedded within each standard continue to drive data quality and comparability issues. These challenges should be overcome for effective and streamlined comparison of battery mineral product ESG performance on the global market.

Based upon research observations and ongoing developments in the sector, there are a range of plausible futures that could emerge. Here two alternative trajectories are explored - one towards consolidation of ESG standards and mechanisms, and the other towards further proliferation of new standards and growing complexity. The value of articulating distinct trajectories is to explicitly ground future discussions with stakeholders about the benefits, drawbacks and potential effectiveness of each.

A trajectory towards consolidation

One potential trajectory is that the proliferation of ESG and responsibility assurance standards that has been observed over the past 30 years undergoes a reversal and consolidation, whether through digitally-enabled approaches such as the Battery Passport, or arising from other standards.

There is evidence of developments along this trajectory for corporate sustainability standards. With examples such as emergence of the International Sustainability Standards Board (ISSB), following the prior merger of the Sustainability Accounting Standards Board (SASB) and the International Integrated Reporting Council (IIRC)

into the Value Reporting Foundation. The ISSB is working to consolidate the SASB Standards, Task Force for Climate-related Financial Disclosures (TCFD) recommendations, the Integrated Reporting Framework and the Climate Disclosure Standards Board (CDSB) Framework [35]. In addition, there is also the emergence of the Battery Passport, where guidance documents have been developed to ensure standardised methods for calculating production impacts and approaches to reporting the outcomes of these impact methods [36].

There is also evidence of an industry-led push towards this trajectory within the minerals sector. For instance, the gradual spread and adoption of Towards Sustainable Mining (TSM) by industry associations internationally. This standard, originally developed by the Mining Association of Canada, has now been adopted by industry associations in several countries including by the Minerals Council of Australia. There are also examples of commodity specific assurance standards that have emerged and are now being adapted to new commodity groups. Most prominently, the Copper Mark has been adapted and translated to new commodity groups by the International Molybdenum Association (IMOA), the Nickel Institute and the International Zinc Association – with them having launched the Molybdenum Mark, Nickel Mark and Zinc Mark respectively in 2022 [37]. The Consolidated Mining Standard, previously discussed, is also a considerable indicator that there may be movement towards a trajectory of consolidation [38]. However, the consolidated standard has seen some pushback from civil society, with an open letter being signed by more than 35 community groups, unions, NGOs and other organisations that advocates for adoption of alternative standards such as IRMA – which they perceived as being "developed through an equal governance model" [39]. This demonstrates a tension between the expectations placed on industry by industry representatives, and the perspectives of broader stakeholders with respect to governance models and requirements for ensuring responsible mineral supply. It is unclear how far this push for consolidation of assurance standards will continue, but what does seem to be emerging is a recognition of the need for assessing the degree of equivalency of reporting requirements and assurance mechanisms between schemes.

A trajectory towards proliferation

An alternative potential trajectory is one where there is further proliferation of new ESG, responsibility and sustainability assurance standards. This could take the form of new ESG management and assurance standards focused on specific topics of concern (e.g. modern slavery), commodity supply chains (e.g. cobalt), or to present information in formats suitable for specific stakeholder groups (e.g. local communities, investors, procurers, etc.). A geographic fragmentation of approaches between USA, China, Europe is also possible. Moreover, as earlier there is potential for overlaps across mechanisms, which might lead to a potential interoperability, especially if coupled with robust data collection and management systems supported by a decentralised ledger or blockchain technology to enable secure and auditable communication of information along supply chains [28], corroborated by protocols to make ESG criteria assessment seamless, such as the United Nations Transparency Protocol (UNTP) [40]. This research has contributed significantly to the development of ESG criteria for critical minerals and metals with UNTP test pilots now underway in Canada, Australia and the Democratic Republic of Congo.

Limitations of the study

The ESG reporting landscape is evolving rapidly along with endeavours to streamline ESG reporting standards and frameworks, this study is not comprehensive as it does not cover all ESG reporting mechanisms available on the market. Additionally, the analysis and discussion describes the context, standard structures, and stakeholder ecosystem at the time research was being undertaken as part of the FBI CRC project, and should be interpreted with that in mind.

Conclusion

Battery material supply chains and extractive industries are rapidly scaling to meeting current and future expected demand for ESG reporting and disclosure. Due to this, improvements in the effectiveness of ESG management and performance disclosure may have large benefits over time in ensuring that any harmful ESG impacts of battery material production are minimised and opportunities for benefits are maximised. In this article, the current context of some of the voluntary and mandatory ESG standards and disclosure mechanisms of potential relevance to Australian battery material producers are explored. There is broad overlap between these mechanisms in terms of the ESG topics and indicators that they address, however, the level of data comparability remains a challenge. These mechanisms also differ significantly in their design, governance, adoption, and acceptance – with potentially significant long-term implications for the ability to promote positive industry transformation and transparency. Two alternative possibilities for the future have been proposed: a future of consolidation or a future of proliferation of ESG mechanisms and standards. It is recommended that all stakeholders to battery material supply chains consider the different possibilities for the future and attempt to articulate the vision they would like to see when advocating for change in the sector.

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RL wrote the main manuscript text, contributed to the conceptualisation, methodology development, and formal analysis. SN also contributed to writing the main manuscript text. FB, HBL, SN contributed to investigation and formal analysis. DG supervised the research, review and editing. BMS, WL and all authors reviewed/edited the manuscript.

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Data will be made available on request.

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Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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