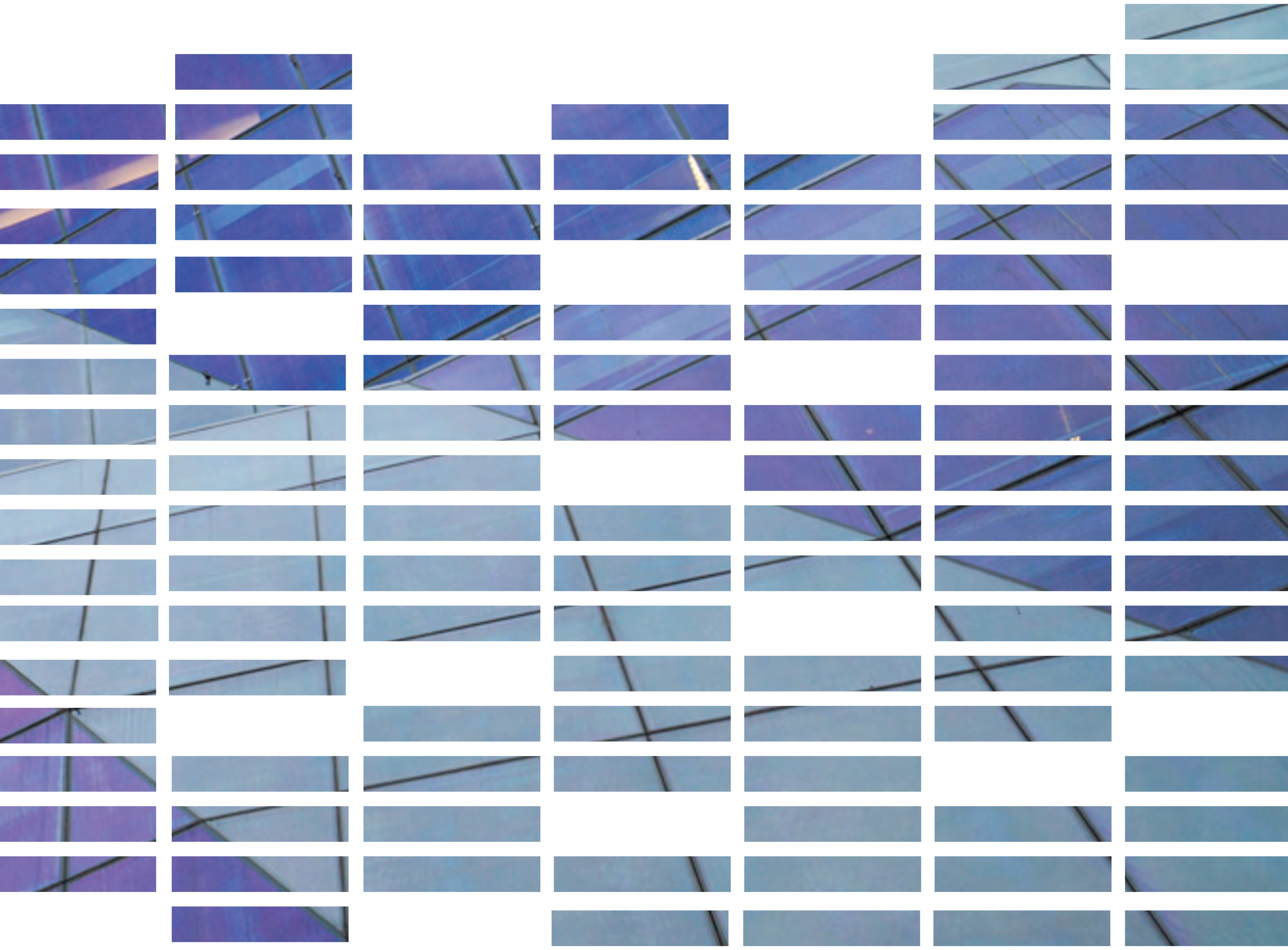
FUTURE BATTERY INDUSTRIES CRC

Australian Government
Department of Industry, Innovation and Science

Business Cooperative Research Centres Program

Certification and LCA of Australian Battery Materials – Drivers and Options

SCENE SETTING PROJECT PREPARED FOR FUTURE BATTERY INDUSTRIES CRC



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Executive Summary

This study by the Institute for Sustainable Futures, University of Technology Sydney and The University of Melbourne has been undertaken for the Future Battery Industries Cooperative Research Centre (FBICRC). It informs a planned 4.5-year collaborative project on establishing Australian industries as socially and environmentally responsible suppliers of battery minerals and materials for a circular economy. This scene-setting stage of the project is focussed primarily on lithium and its use in batteries within the electrical vehicle sector in Europe.

The study assesses the drivers for sustainability certification and the role of life cycle assessment in the battery value chain, the potential market advantage conferred, and the options and merits of alternative certification schemes. The research included a literature review and semi-structured stakeholder interviews.

The lithium market

Over the past decade, there has been considerable growth in lithium use in emerging battery technologies, resulting in the battery sector becoming the dominant consumer of lithium chemicals. Some producers expect annual demand for lithium to grow by 400% in the next five years (Albemarle, 2020a), driven largely by growth in the electric vehicles market. Australia is currently the largest producer of mined lithium, accounting for 54% of global production in 2019. If the Australian industry is to gain market advantage from end-users implementing responsible sourcing, it is important that Australian materials are demonstrably produced in accordance with best practice environmental, social, and economic sustainability. Transparency along the supply chain is also needed, so that consumers can see where the raw materials originated.

Existing certification schemes and drivers

We reviewed the main voluntary sustainability initiatives (VSIs) that could apply to lithium, as well as the main sustainability certification schemes for other metals. We found nine VSIs applicable to lithium, of which just two were certification schemes: Certification of Raw Materials (CERA) and the Initiative for Responsible Mining Assurance (IRMA). In general, we found far more schemes that offer standards than certification.

There was a high level of agreement between the views on certification found in the literature and the outcomes from our stakeholder interviews. The main drivers for certification were generally seen as market demand (purchasers requiring certification to demonstrate the environmental, social and governance sustainability credentials of their products), strategic considerations, reputational risk and corporate brand values.

In general, it was emphasised that maintaining credibility required scheme independence (and independent verification and audit), multi-stakeholder governance, and high degrees of transparency in the development and publication of standards and in the certification process.

A detailed comparison of the two certification schemes (CERA and IRMA) was undertaken, with the main differences arising in scope, governance, transparency, and current readiness. CERA is aiming to provide certification along the entire value chain, while IRMA certifies the mine site. The IRMA scheme is more mature, with detailed standards developed over a period of four years, while CERA is still in the process of setting up. CERA is currently piloting their Implementation Details (effectively their standards) at 2 mines, while IRMA has 2 mines undergoing independent audit for certification, 15 preparing for audit, and 3 mines were test-certified during the development process. IRMA has multi-stakeholder governance processes in place, while CERA is managed by a group of companies and universities. Table 1 summarises the main aspects of the two schemes.

IRMA is ready for mine site certification now, and appears to offer more advantages (transparency, governance, clear processes), while CERA will have the advantage of application along the entire value chain when the full scheme is in place. However, CERA states that they will accept certification from other schemes which are at least as rigorous for the elements they cover (and include IRMA in this), so IRMA appears to offer a no-regrets approach.

Table 1 : Summary comparison between CERA and IRMA

Categories	CERA	IRMA
System Boundary	4 standards within the CERA system: • Readiness (exploration) • Performance (mining, processing, refining) • Chain of custody • Final product standard	IRMA Standard for Responsible Mining: covers exploration and mining
Scope	Social, Governance, Environmental. Applicable to all raw materials, all operation sizes, mining and processing techniques and all countries throughout the entire value chain.	Social, Governance, Environmental, Legacy. Applicable to all types of industrial or large-scale mining and all mined materials (minerals, metals) with the exception of energy fuels.
Establishment	Founded in 2017 by a group of companies and universities as part of an EU funded project (EIT RawMaterials). CERA is currently managed by DMT, a subsidiary of the Tüev Nord Group.	Founded in 2006 by a coalition of NGOs, purchasers, organized labour (e.g., trade unions), affected communities and mining companies. Standard published 2018.
Governance and decision making	The intention is to incorporate a CERA association in 2020. The Association will have an advisory board made up of industry, civil society, and experts. The advisory board will not have formal decision-making powers.	IRMA is a not-for-profit governed by a board of directors with 2 representatives from each of the five sectors mentioned. Decision making aims at consensus, and decisions may not be taken if both representatives from one sector object.
Transparency and engagement	High-level standards published (limited online consultation with more planned). Draft Implementation Details (equivalent to standards or protocols) have not yet been published for consultation.	Draft standards published, followed by two rounds of public consultation in 2014 and 2016, two field tests and various working groups. The final standard published in 2018 after feedback from more than 120 organisations.
Current status	CERA plans to pilot the lithium performance standard at a lithium mine and a processing plant during 2020/21.	2 mines are currently undergoing independent audit, 3 mines are publicly at the pre-audit (self-assessment) stage, and 12 are preparing for audit (not public). Three mines were test-certified in 2015 & 2016. Mines (and companies) at different stages of the process can be shown on IRMA's responsible mining map. Not yet applied to a lithium mine.
ISEAL compliance	No (lack of multi-stakeholder governance, lack of transparency in governance & standard setting)	State that standard-setting meets ISEAL codes, but not an ISEAL member.

Life cycle assessment

Life Cycle Assessment (LCA) is a framework methodology for quantifying the environmental impacts of products, processes or services, and is widely used within various industries, particularly in Europe, for comparing and communicating the environmental performance of products (e.g. carbon footprint), optimising the eco-efficiency of production processes and supply chains, and for making the material selection and procurement decisions. A typical LCA of a battery for electric vehicles covers all life cycle stages from mineral processing, cell and module production, battery assembly, distribution and use to final recycling and end-of-life disposal.

Several industry stakeholders noted the importance of life cycle assessment to battery supply chains and the electric vehicle industry. The primary motivation is to identify hotspots for improvement in the entire life cycle. Carbon footprinting was also highlighted as an area where LCA is extremely important.

Table 2 gives an overview of the differences and similarities between LCA and certification. Both certification and life cycle assessment are used by companies operating along the lithium-ion battery supply chain and share some commonalities in their focus on environmental impacts. However, the two serve very different purposes. LCA is typically used for assessing potential environmental impact, although it can also be extended to social and economic assessment. Sustainability certification is used to demonstrate that materials, a site or company meet specific standards, which usually cover environmental performance, social aspects, human rights, management and monitoring systems, governance, and reporting.

Table 2 : Comparison between sustainability certification and LCA

Categories	Certification	LCA
System Boundary	Depending on the standard, can include: raw materials at exploration, mining, processing, refining and product stage	Can include the entire lifecycle of a product or process or service, including exploration, transport, usage, end-of-life
Scope	To verify that raw materials, a mining site, company, or product meet a published standard. A standard can include requirements such as assessments, management and monitoring systems, reporting and meeting targets/ thresholds (e.g. for air/water quality).	A tool for quantifying environmental (and sometimes social or economic) impacts arising from all inputs and emissions required to deliver a product, process or service, using a standardised methodology.
Purpose	To assure purchasers that environmental, social and ethical standards are being upheld.	Can be used to support decision making by quantitative comparisons and/or identifying hotspots in the lifecycle, and as the basis for Environmental Product Declarations.
Data requirements	Data collection is usually done at individual mine sites or company level, with audit to verify results. Data is both quantitative and qualitative, and includes business information such as policies and targets.	Data collection is done for individual product, process or service in conjunction with existing LCI databases, with impacts derived from established models. Data is quantitative. Comprehensive data may be required.

What does certification offer the Australian lithium industry?

Consumer-facing industries using batteries, such as car manufacturers and electronics, are under considerable consumer pressure to ensure the sustainability of their products, particularly regarding human rights and environmental impacts. This is particularly strong in the EV market, where much of the impetus to switch to EVs is driven by environmental concern. Manufacturers cannot afford a repeat of the human rights scandals associated with cobalt, nor of mischaracterising environmental impacts as occurred in 'diesel gate', and certification offers assurance. In the case of battery materials, it is likely that importers will want assurance of environmental credentials, with some manufacturers already actively investigating their supply chains (e.g. visiting mine sites) and requiring certification.

There may also be strategic advantages. Australia has relatively stringent labour and environmental laws compared to some other producers. In this case, achieving best practice certification may require less effort for Australian mines than for some competitor countries. Normalising the use of stringent "best in class" standards such as IRMA may be in Australian producers' best interest for maintaining competitiveness.

What does life cycle assessment offer the Australian lithium industry?

LCA is a tool or methodology used in some of the key import markets for battery materials, particularly Europe and Japan, and plays an important role in product design decisions and material selection. LCA utilisation is expected to increase with the increasing emphasis being placed on circular economy thinking and the need for mitigation of greenhouse gas emissions.

LCA is data-intensive and the datasets available for Australian production systems are not well developed. This means when LCA is undertaken generic datasets are used, as Australian battery mineral data is not available. This will become increasingly important as complex decisions are made about product design, materials recycling, and sourcing and process options.

The development of accurate Australian datasets of LCA for lithium production will allow rigorous assessment of the environmental footprint of Australian battery materials and production processes. This will give customers of Australian battery materials and products access to LCA data to support their procurement, product design and marketing decisions. Additionally, accurate datasets and modelling tools will allow the Australian industry to identify opportunities for improvements through process hotspot analysis, which may further improve their competitive advantage.

Looking ahead, the emergence of product certification in the next few years will almost certainly require LCA, and being prepared with Australian data will assist the industry to meet customer requirements.

Conclusions and recommendations

The Australian battery material supply industries can benefit through certification, and IRMA presently offers a well-developed option for the sector. Implementing mine site certification will enable future integration into the broader supply chain and/or product certification such as will be offered by CERA.

Developing LCA datasets for Australian battery materials would support customers in the battery value chain to make informed decisions that consider the carbon footprint of their supply chains. LCA also provides Australian producers with an opportunity for process optimisation through the identification of key 'hotspots' of environmental footprint.

Following the findings of the study, we recommend the FBICRC:

1. Works with the Australian Government and State Governments to assist the Australian battery materials industries (this report focuses particularly on lithium), to implement mine site certification, including:
    - Mapping the alternate scheme (IRMA and CERA) requirements against current industry practices and regulatory requirements,
    - Running information workshops for the industry on the certification process and advantages,
    - Assisting with common guidance documentation and processes.

2. Assists industry to undertake LCAs of Australian battery materials by:
    - Mapping the data needed for LCA of lithium and other battery materials against what is needed for certification.
    - Undertaking LCA studies of Australian battery materials in collaboration with industry, in order to allow comparison between Australian sourcing and other materials, and to identify processing hot spots to improve industry performance and support the development of a circular economy.
    - Providing seminars on the use of LCA with the Australian industry.
    - Developing modelling platforms based on LCA in order for suppliers and end-users to identify actionable areas to improve their environmental performance.

Contents

Tables and Figures

Glossary

ASI	Aluminium Stewardship Initiative
CCCMC	China Chamber of Commerce of Metals, Minerals, & Chemicals
CERA	Certification of Raw Materials
CoC	Chain of Custody
CRM4EV	Critical Raw Materials for Electric Vehicles
DS	Drive Sustainability
EITI	Extractive Industries Transparency Initiative
EP	Equator Principles
FBICRC	Future Battery Industries Cooperative Research Centre
ICGLR	International Conference on the Great Lakes Region
ICMM	International Council on Mining and Metals
IFC (Guidelines)	International Finance Corporation (Environmental Health and Safety Guidelines)
IGF	Intergovernmental Forum on Mining, Minerals, Metals and Sustainable Development
IRMA	Initiative for Responsible Mining Assurance
KPCS	Kimberley Process Certification Scheme
LCA	Life Cycle Assessment
OECD	Organisation for Economic Co-operation and Development
OEM	Original Equipment Manufacturer
RJC	Responsible Jewellery Council
RMAP	Responsible Minerals Assurance Process
RMI	Responsible Mining Index
TSM (MAC)	Towards Sustainable Mining (Mining Association of Canada)
TPA	Tonnes per annum
VSI	Voluntary Sustainability Initiative
WEF	World Economic Forum

1. Introduction

Purpose

This study has been undertaken by the Institute for Sustainable Futures, University of Technology Sydney and The University of Melbourne for the Future Battery Industries Cooperative Research Centre (FBICRC). The purpose of the study is to inform a proposed 4.5-year collaborative project – with industry, research and government participants – to be undertaken by the FBICRC on how to enhance the Australian industry as a socially and environmentally responsible supplier of battery minerals and materials in a circular economy.

The research aims to assess the drivers for sustainability certification in the battery value chain and the role of life cycle assessment, the potential market advantage conferred, and the options and merits of alternative certification schemes. This scene-setting stage of the project is focussed primarily on lithium and the electrical vehicle sector in Europe whilst the full project would cover a broader range of battery materials and geography of end-uses. A companion scene-setting project is being undertaken by Curtin University looking at geochemical fingerprinting and the use of blockchain technology to certify the provenance of materials and communicate this information through supply chains.

Methodology

The methodology of the project is a combination of desktop research and stakeholder consultation, including:

- Extensive web research of the certification schemes and associated documentation
- Literature review of battery LCA studies
- Stakeholder consultation on drivers for certification and LCA using semi-structured interviews.

Stakeholder interviews included representatives from civil society, regulators, OEMs, industry associations, mining companies, and research institutes and standards bodies. Appendix 1 gives a list of the organisations who gave interviews, and Appendix 2 lists the interview questions.

The COVID-19 pandemic meant it was not possible to conduct as many interviews as intended, particularly with OEMs, as companies were dealing with emergency responses to the lockdowns around the globe. However, interviews still gave valuable insights on the drivers for adopting certification and LCA.

Report structure

A brief overview of the lithium market is given in Section 2, followed by a review of existing certification schemes in Section 3. Battery LCA studies are covered in Section 4. Stakeholder perspectives from both literature and from the interviews undertaken for this project are presented within Sections 3 and 4. Section 5 then offers a discussion of the roles of LCA and certification, and what each offer the Australian battery materials industries. Conclusions and recommendations are given in Section 6.

2. The Lithium Market

A number of end-uses for lithium exist, including uses in ceramics and glass manufacture, battery products, lubricating greases, flux powders, air treatment systems and within primary aluminium production. Over the past decade there has been considerable growth in lithium use within emerging battery technologies, which has resulted in the battery sector becoming the dominant consumer of lithium chemicals (see Figure 1). A number of different battery chemistries are employed depending upon the use cases[1], which can require different lithium feedstocks, for example lithium hydroxide, lithium carbonate or lithium chloride. There is expected to be continued significant growth in demand for lithium batteries for battery electric vehicles, consumer electronics and also for stationary energy purposes. Albemarle, a leading lithium producer, expects annual demand for lithium carbonate equivalent (LCE) to increase from 275,000 tonnes in 2019 to potentially 1,000,000 tonnes by 2025 (Albemarle Corporation, 2020a). This is driven largely by expectations that market penetration of electric vehicles will reach 18% of new car sales over this period, resulting in an additional 557,000 tonnes of LCE consumption per annum for electric vehicle battery production.

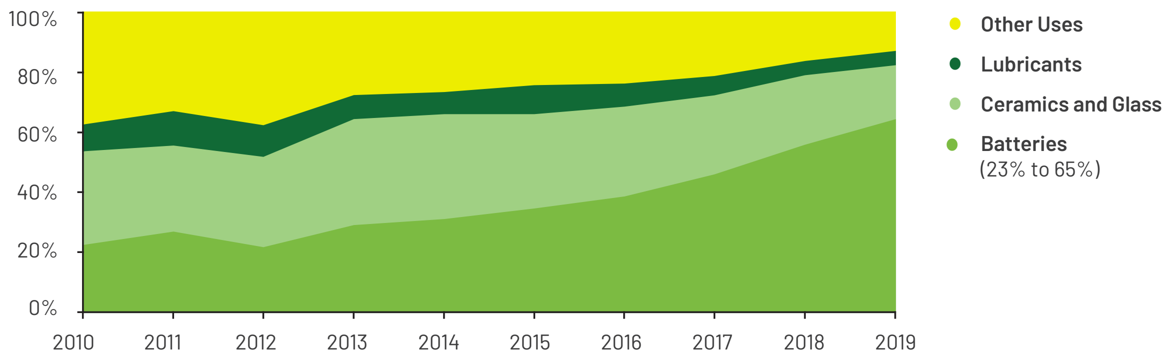


Figure 1: Global share of lithium end-uses over the period 2010-2019. Data sourced from USGS, 2020.

Australia's position

Australia has consolidated its position within the global lithium supply chains over the past decade with significant growth in mined lithium output. Since 2013, Australia has been the largest producer of mined lithium, with annual production in 2019 amounting to 42,000 tonnes of contained lithium or 54% of global production (see Figure 2). Australia's lithium production is sourced from hard-rock mining of spodumene deposits, whereas production from lithium brines is more common in other major producing countries, such as China, Chile and Argentina. Lithium production from brines and hard rock deposits have very different cost structures for producing different lithium chemicals.

[1] Including: Lithium cobalt oxide (LCO; $LiCoO_2$), nickel manganese cobalt (NMC; $LiNi_xCo_xMn_xO_2$), lithium manganese oxide (LMO; $LiMn_2O_4$), lithium iron phosphate ($LiFePO_4$) and lithium nickel cobalt aluminium (NCA; $LiNi_{0.8}Co_{0.15}Al_{0.05}O_2$).

Australian supply has responded relatively quickly to the significant increase in lithium demand that is being driven in large part by growth in the use of lithium battery technologies. This has created a situation where the Australian lithium supply chain has the potential to operate as a leader in determining market behaviour and the implementation of best practices for driving positive economic, social and environmental outcomes.

Underpinning Australia's position in the market is the vast geological resources of lithium contained within Western Australian pegmatite deposits. In 2018, Australia held 4.7 million tonnes of contained lithium within economically demonstrated resources, with a further 1.4 million tonnes within inferred resources, which allows for a resource life of approximately a hundred years at present rates of extraction (Geoscience Australia, 2019).

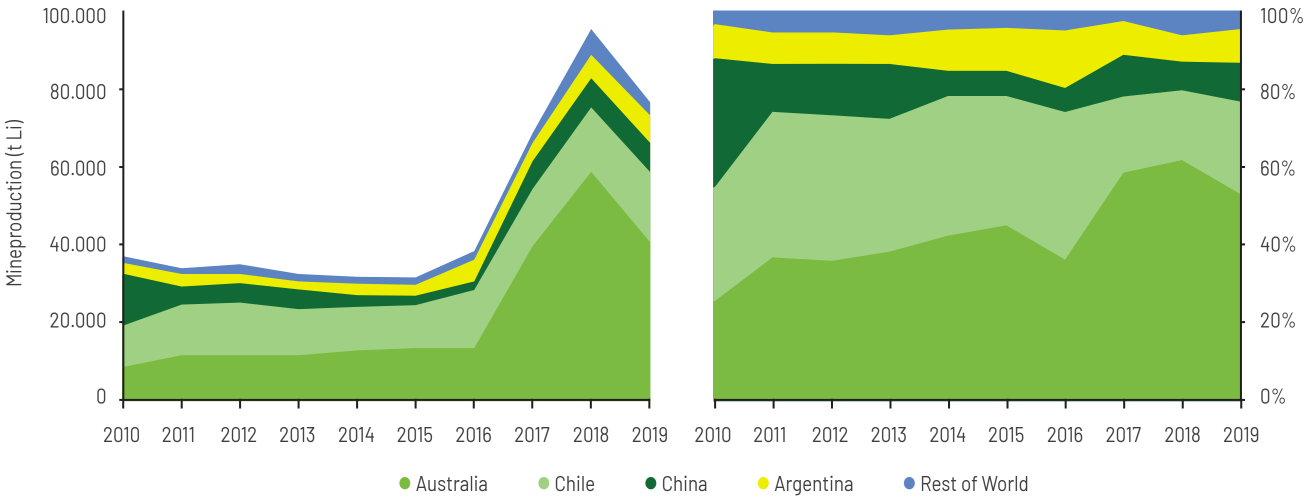


Figure 2: Annual lithium production (contained) by country for the period 2010-2019.

Data sourced from USGS, 2020.

The large potential for growth in Australian lithium export is being supported by significant industry investment in lithium refining capacity, which will value-add to Western Australia's lithium concentrate exports through conversion to lithium hydroxide and lithium carbonate. Tianqi has constructed the first phase of a plant in Kwinana that will have a total capacity of 48,000 tonnes per annum (tpa) of lithium hydroxide, however, the second phase of construction has been put on hold (Thompson, 2019). Albemarle is developing a plant in Kemerton to produce 60-75,000 tpa of lithium hydroxide with potential to scale up to 100,000 tpa over time (Albemarle, 2020b), and Covalent Lithium is looking to develop a facility in Kwinana to produce 45,000 tpa of lithium hydroxide, although the investment decision has been delayed (Covalent Lithium, 2020). An overview of Australia's position in relation to end-consumer markets and manufacturing regions is shown in Figure 3.

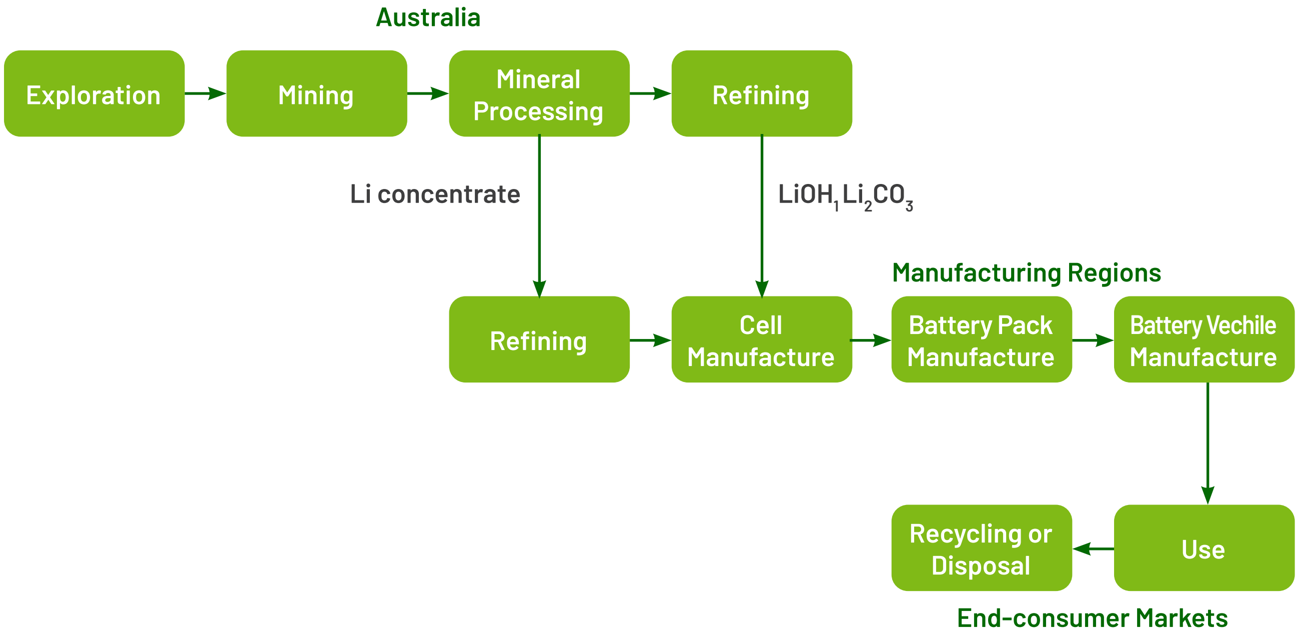


Figure 3: Major process stages associated with Australian lithium supply chains to battery EV markets.

Australian lithium exports flow through manufacturing processes in other regions (e.g. China) before ending up within products being used in end consumer markets (e.g. Germany). This can create potential barriers to transparency for consumers regarding the origin and production standards of materials contained within consumer products. The industry in Australia is nascent regarding end-of-life battery collection and recycling; most valuable materials are currently exported for further processing following collection.

If Australian battery materials are to gain market advantage from OEMs implementing responsible sourcing, it is important that Australian materials are demonstrated to be produced in accordance with best practice and with minimal environmental impacts, and that there is transparency along the entire supply chain so that consumers can see where the raw materials originated.

3. Existing Certification Schemes

There has been a proliferation of voluntary sustainability initiatives (VSIs) in the mining sector over the last twenty years. A review of mining sector VSIs by the Intergovernmental Forum on Mining, Minerals, Metals and Sustainable Development (IGF) (Potts et al, 2018) started with a long list of a hundred and fifty-eight initiatives, while a World Economic Forum review (WEF, 2015) lists forty initiatives.

However, following a detailed review of the literature and documentation, we found that most of these are not applicable to lithium. Of the forty included in the World Economic Forum review, seven were essentially guidance schemes, while seventeen were focussed on a single issue (most commonly human rights, particularly conflict minerals and/ or child labour). Of the sixteen remaining which were either multi-issue or comprehensive and relevant to large scale mining, four were focussed on a single commodity other than lithium.

Table 3 lists sixteen of the major VSIs and two mandatory certification schemes that apply to mineral extraction. We have included the main sustainability certification and standards that could be applicable to lithium, as well as the main sustainability certification schemes for other metals, and a selection of sustainability standards that are referenced very frequently (such as the OECD Due Diligence guidance for conflict materials). Only nine could apply to lithium; with eight for restricted commodities and five of those focussed on conflict minerals only.

Of the nine applicable to lithium, two are standards for financial institutions, one is a financial disclosure scheme (the Extractives Industry Transparency Initiative, or EITI), two are ISO standards for general environmental management and stakeholder engagement in the extractive sector, and one (the Responsible Mining Index, or RMI) is associated with a rating system,

where the organisation scores mines and lists the outcomes. The remaining three are the Certification of Raw Materials (CERA) and the Initiative for Responsible Mining Assurance (IRMA), both certification schemes, and the Towards Sustainable Mining (TSM) standards that were created by the Mining Association of Canada.[2] TSM publishes principles and standards and requires annual self-reporting with three-yearly external verification.

In general, there are far more schemes that offer standards, guidelines or policies than offer certification. Seven schemes were identified that offer sustainability certification for mineral extraction, with five of those for specific commodities, leaving just two schemes that are available for certification of lithium, the IRMA and the CERA schemes.

We note that there is a global alliance of Sustainability Standards, ISEAL, set up in 2002, which does not certify products or processes, but aims to ensure the credibility of the standards themselves. ISEAL publishes Codes of Good Practice to cover the establishment (process) of standard setting, the content of any standards, and the audit process. Sustainability standard setters or accreditation bodies must demonstrate their compliance with the ISEAL codes to become full ISEAL members (ISEAL, 2018).

In the following section we will give an overview of the main components of certification schemes and provide a comparison of the key differences and similarities of IRMA and CERA.

[2] The TSM is compulsory for member companies of the Mining Association of Canada. Finland and Norway's mining industries have also adopted versions of the TSM standards.

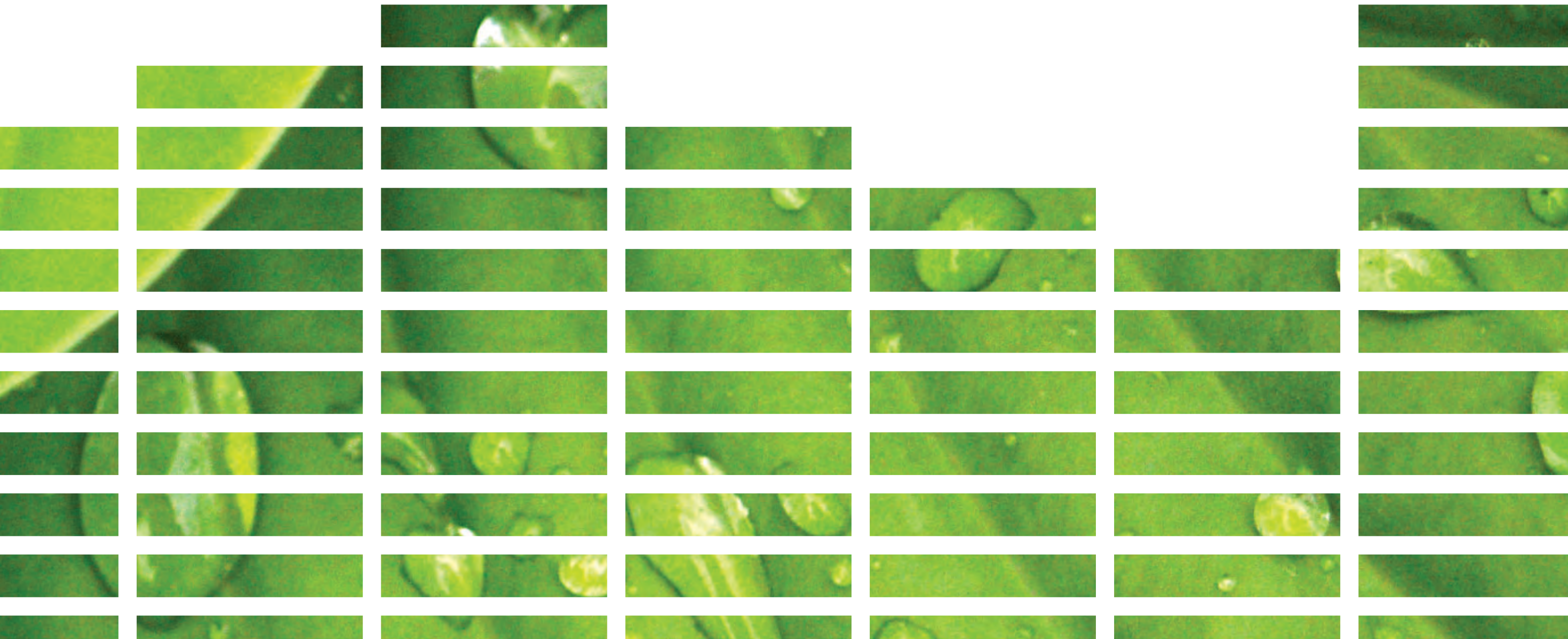


Table 3 : Summary of certification and standards schemes

Scheme	Applicable to Li? (coverage)	Certification/ standards?	Geographic/ establishment	System boundary	Scope	Governance	Current status
Certification of Raw Materials (CERA)	Yes (All minerals)	Certification & Standards	Global Set up 2017, pilot 2019, implementation details to be published	Entire value chain, broken into stages[3]	Social, Environment, Governance	Managed by a group of companies and universities. Intention to incorporate CERA association in 2020; it will have advisory board (no decision-making power).	CERA association to be set up 2020, pilot certification planned for 2020/2021
Initiative for Responsible Mining Assurance (IRMA)	Yes (All minerals except fuels)	Certification & Standards	Global Set up 2006 Draft standard 2014, revised draft 2016, standard 2018	Exploration and mining at individual mine sites (industrial mining)	Governance, Environment, Social Legacy	Cross-sectoral, 2 representatives from mining, purchasers, NGOs, unions and communities	Standards developed, 2 mines undergoing certification and 15 in pre-audit. Three pilot certifications in 2015/16. Follows ISEAL standard development codes
Towards Sustainable Mining, Mining Association of Canada (TSM)	Yes (All mined commodities)	Standard plus formal reporting process	Canada, Finland, Argentina, Botswana. Set up 2005, standards 2009	Facility	Social, Greenhouse, Biodiversity, OH&S, Mine closure, Tailings, Water [4]	Community of Interest panel meets twice yearly to review verification reports. Advisory role.	Mandatory for Mining Association of Canada members; formal reporting plus 3 yearly audit
Equator Principles (EP)	Yes (All projects)	Principles for financial institutions	Global	Project finance /advisory services for large projects[5]	Biodiversity, Climate change, Social	Unincorporated association governed by members (financial institutions adopting EP principles).	105 financial institutions in 38 countries

[3] Value chain broken into 4 stages: "Readiness" (exploration), "Performance" (extraction and process), "Chain of custody", and "Product".
[4] Until 2021 reporting on tailings management and water protocols is internal only; from 2021 all reports to be pubic.
[5] For projects, where CAPEX > US$10m, for project related corporate loans > US$10m (some additional inclusions)

Scheme	Applicable to Li? (coverage)	Certification/ standards?	Geographic/ establishment	System boundary	Scope	Governance	Current status
Extractives Industries Transparency Initiative (EITI)	Yes (All minerals)	Standard, reporting, verification	Global Set up 2002, standard published 2013, revised 2016	Extractive industry of country	Financial transparency [6] Some countries[7] have made reporting under EITI mandatory.	Not-for-profit. Governance via the EITI Association[8]. Country implementation must be managed with multi-stakeholder process.	53 countries have implemented, with 5 suspended or listed as inadequate progress; 6 yet to be assessed.
OECD Due Diligence Guidance for stakeholder engagement in the extractive sector	yes (All minerals)	Standard (stakeholder engagement)	Global Adopted 2018	Multi-national Companies	Ethical business, Human Rights, Social, Environment Bribery, Disclosure	Council made up of ambassadors of 37 member countries and the European Commission.	Referenced in many other standards
ISO 14001 - Environmental	Yes (All companies)	Standard	Global	Project (e.g. mine)	Environmental Management System	International Standards Organisation (NGO, membership comprises 164 national standards organisations)	First published 2004, 3rd edition 2015
ISO 26000 - Social Responsibility	Yes (All companies)	Guidance	Global	Company	Environmental, Resources, Analysis & measurement		First published 2010 (still current).
Responsible Mining Index (RMI)	Yes (All minerals)	Standards plus scoring	Global, set up 2012	Primarily company, but includes data for individual mines	Ethical business conduct, Lifecycle management, Social, Environment	Not for profit company, with board of trustees and advisory board plus expert review committee.	Publishes bi-annual report; 2020 report included 38 companies, plus individual mine data for > 100 mines.

[6] Including: contracts & licenses, production, revenue collection per company and resource, revenue allocation, and social and economic spending.
[7] Liberia, Nigeria, and Norway
[8] Comprised of Board (20 members representing civil society, companies, member countries, supporter countries), Secretariat, and Members.

Scheme	Applicable to Li? (coverage)	Certification/ standards?	Geographic/ establishment	System boundary	Scope	Governance	Current status
Responsible Steel	No (Steel)	Certification & standards	Global Set up 2009, draft standard 2017, approved 2019, auditor applications 2020	Processers or steel product makers (not mine sites, or final products); will be extended to raw material sourcing	Governance, Environment, Social, Decommissioning	Community of Interest panel meets twice yearly to review verification reports. Advisory role only.	Following ISEAL standard development codes
Responsible Jewellery Council (RJC)	No. (Diamonds, gold, platinum group)	Certification & standards	Global 2008	Supply chain	Social, Environment, Economic	Not for profit company with elected board, membership open to all businesses in jewellery supply chain (mines to retail)	ISEAL member
Kimberley Process Certification Scheme (KPCS) (Mandatory)	No (Diamonds)	Certification & Standards	Global Set up 2000, KPCS in force from 2003	Supply chain to diamond shipment	Social (conflict free)	Member countries, plus observers	56 participants representing 82 countries, 99.8% of world trade
Aluminium Stewardship Initiative (ASI)	No (Aluminium)	Certification & standards	Global. Set up 2009, 1st performance standard 2014, 2nd 2017, CoC 2017.	Performance standard and chain of custody standard (Site/ company respectively)	Governance, Environment, Social	Governance via elected multi-stakeholder board	First certification 2018 ISEAL member
Copper Mark	No (Copper)	Certification (uses RMI standards, accepts others where equivalent)	Global. Stakeholder consultation from 2018.	Company (copper producers)	Environment, Governance, Community, Business & Human Rights, and Labour	Developed by the International Copper Association, now a registered entity in the UK. It will have an Advisory Board.	Opened for applications in April 2020

Scheme	Applicable to Li? (coverage)	Certification/ standards?	Geographic/ establishment	System boundary	Scope	Governance	Current status
International Conference on the Great Lakes Region (ICGLR) (Mandatory)	No (3Ts[9], gold, cobalt)	Certification (primarily uses OECD Due Diligence)	The Great Lakes region (Central and East Africa)[10] 2006	Mine site and chain of custody	Human rights, Conflict. Certification mandatory from 2015	12 member States from the Great Lakes region, plus international partners	Mandatory for any trading or export of included materials (applies within member states and exports to trading partners)
Chinese Due Diligence Guidelines for Responsible Mineral Supply Chains (CCCMC)	Not yet (currently 3Ts, gold, cobalt)	Guidance	Global Released 2015	Chinese companies undertaking mining activities outside China	Implements OECD Due Diligence		
OECD Due Diligence Guidance for Responsible Supply Chains of Minerals	No (3Ts, gold, cobalt)	Standard	Global First released 2011, 2nd edition 2013	Company (supply chain)	Human rights, Conflict, Bribery, Money laundering, Compliance EITI Initiative	Council made up of ambassadors of 37 member countries and the European Commission	Referenced in many other standards
Responsible Minerals Assurance Process (RMAP)	No (3T's, gold, cobalt)	Standards	Global Set up 2008	Smelter or refiner (+ supply chain to that point)	Human rights, Conflict, Governance	Steering committee composed of member companies	380 member companies
International Council on Mining and Metals (ICMM)	Yes (All minerals)	Standards / Guidance	Global 2001, standards 2003-2015	Company (must report on assets)	Governance, Human rights, Risk & H&S, Social, Environment, Biodiversity	CEOs of member companies	27 mining or metals companies and 36 trade associations

[9] 3T's = Tin, Tantalum, and Tungsten
[10] Member states: Angola, Burundi, Central African Republic, DRC, Kenya, Rwanda, South Sudan, Sudan, Uganda, Tanzania, Zambia. Other partners included RMI

Components of certification

The main components of certification schemes are listed here and discussed below:

System boundary
Facility (mine site or processing plant), supply chain, company.

Scope
What is covered by the certification, for example, social, environmental factors.

Standards
A detailed description of scope, criteria, and processes to demonstrate compliance. Standards provide the basis of how compliance is measured.

Certification process
How certification happens, for example, self or third-party certification, reporting process.

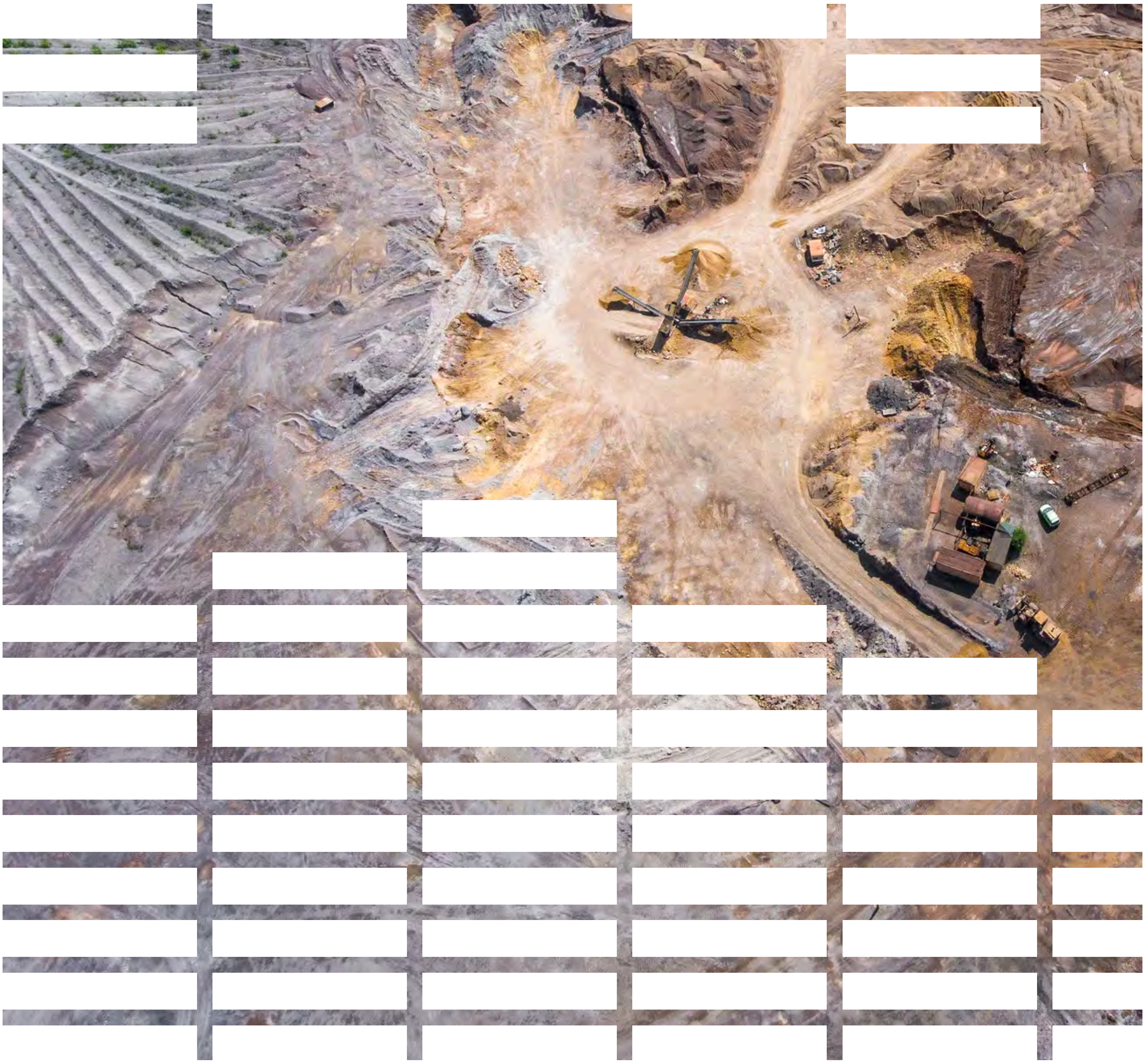
Governance
How is the scheme run, who is involved, how transparent is it?

System boundary – company, mine site, processing site, supply chain, or product

Certification schemes can have different system boundaries describing what is included or excluded from the certification processes and what is actually being certified. Depending upon their purpose, certification schemes can certify a company (including across multiple facilities), a production facility (a mine site or processing plant, for example), a supply chain, or a product.

Certification schemes for conflict minerals all focus on the chain of custody along the supply chain, with one scheme also requiring mine certification as a separate step. This is in line with the objective, which is to prevent conflict minerals entering the supply chain.

The five more generalist mineral certification schemes are CERA, IRMA, the Aluminium Stewardship (ASI), Copper MarkTM and ResponsibleSteel^{TM}. Their certification is based on Performance or Process standards in four cases, and Chain of Custody (CoC) standards in two cases. None are product based, although CERA intends to introduce this in the future. Two are exclusively site focussed (IRMA and ResponsibleSteel™), with IRMA focussed on the mine site and ResponsibleSteel™ focussed on the processing site; ResponsibleSteel™ reports that it is working with both IRMA and TSM so that their respective certification or reporting can feed into the chain of custody requirements for the processor. Copper Mark offers company focused certification and provides an equivalency matrix so that schemes such as IRMA or the TSM reporting can be used to demonstrate compliance. ASI certification includes both performance (site-based) standards, and chain of custody (company based) standards. CERA aims to provide certification across the entire supply chain, of which two elements will be site-based performance certification (mine and processing plant).



Scope

Three of the eight certification schemes are exclusively focussed on human rights and conflict, including both mandatory schemes, the Kimberley process and the International Conference on the Great Lakes Region (ICGLR), run under international agreements to remove conflict minerals from the supply chain and requiring exported minerals to be certified. The remaining five all include governance, social (human rights, labour conditions, cultural heritage), environmental (water, noise, resources and biodiversity, climate impact) and stakeholder and community engagement.

Standards

Standards are the basis of how compliance is measured. The published standards vary considerably, not only in specific content but in the level of detail provided. ISEAL provides some useful guidance that standards should:

"be expressed in terms of process, management and performance criteria, rather than design or descriptive characteristics" (ISEAL Alliance, 2014)

To be used in certification, standards must be sufficiently specific and detailed that an auditor is able to assess compliance. Most bodies publish the Standard as the detailed document containing performance standards and metrics (for example, ASI and IRMA). Some publish principles supplemented by protocols to enable entities to report or determine whether they comply. For example, the Towards Sustainable Mining (TSM) initiative of the Mining Association of Canada publishes principles supplemented by detailed protocols in seven performance areas. CERA has published very high-level standards, which could more aptly be described as principles, which refer to Implementation Details that correspond more to the ISEAL description of a standard (the Implementation Details are not yet public documents).

Standard development is a lengthy process, with multi-stakeholder processes usually taking upwards of five years to agree a draft (most of the standards noted in Table 1 took between five and eight years to reach the first draft standard, with a further 2–4 years to achieve an agreed standard).

The development process is important for credibility and uptake, particularly for voluntary initiatives, and the ISEAL guidance for standard-setting is explicitly about multi-stakeholder involvement, engagement, transparency, and governance. At the very least, it is expected that draft standards are published for consultation, there are transparent processes for standard-setting and governance, and there is genuine engagement with a balanced and representative group of stakeholders before arriving at a standard.

Certification process

Certification processes vary from self-certification to independent third-party audit with considerable rigour about ensuring independence, with some intermediary systems based on self-reporting with different degrees of verification. Similarly varied are the reporting requirements from the certification process, from entirely public to almost entirely optional.

Other than the two mandatory schemes (the Kimberley Process Certification Scheme and the International Conference on the Great Lakes Region) participation is voluntary. However, it is generally true that once an entity is a member or has started a certification process, reporting becomes mandatory to retain the listing or accreditation.

Payment and audit processes are also important. It is considered good practice that the selection and payment of the auditor is not done by the entity to be certified, to guarantee independence. There are various ways to achieve this, which generally include registration of the certifiers by the standards body, and may require payment to go via the Standards body so that a client relationship is not established between the certifier and the entity to be certified.

Governance

Governance is a key issue for certification in order to maintain the credibility of the scheme. ISEAL requires multi-stakeholder governance, including those who might be directly impacted, with transparent membership and decision-making processes. Consensus decision making is described as desirable, with clear processes for when and how alternate decision making applies if consensus cannot be achieved. In effect this means good practice governance includes representatives from a balanced group of stakeholders, with transparency on who is making decisions, how decisions are made, and how stakeholders can participate.

Stakeholder perspectives on components of certification for lithium (from interviews)

Perspectives on scope:

Several interviewees noted the importance of certification for the mine site as it is where the most significant issues occur and said that certifying the mine site would meet most purchasers' needs. One noted that certification should cover the 'choke points' (the mine site, smelters, and refineries), while one noted that even if certification covered the entire value chain, that certification of the raw materials from the mine site would still be of particular importance. In contrast, several interviewees said that they would expect the entire value chain to be certified eventually. One noted that if the focus is on reducing carbon emissions, a product-based approach is useful, as changes anywhere along the value chain can change the footprint.

One interviewee noted that mine site (and processing site) certification would be required as elements in any value chain certification.

One noted that they didn't want a new initiative for every material but one that is comprehensive and covers all.

One noted that the shift towards direct purchases of lithium (and cobalt) by EV manufacturers is driven by the lack of transparency in the supply chain.

Perspectives on governance:

Interviewees who commented on the governance of standards and certification schemes all agreed on the importance of the governance structure and processes. One interviewee noted that the development of standards was only a small part of setting up a new initiative and "a lot of work also has to happen outside of this to set up governance structures, set up assurance models, engage stakeholders and implement these standards, and then to audit performance".

The following principles for governance were noted as important by interviewees:

- **Multi-stakeholder governance:** engaging stakeholders from the mining industry, purchasers, civil society, affected communities, organised labour and investors was considered vital for credibility (note this is a strong element in the ISEAL Codes).
- **Third-party verification:** Third-party, independent certification is vital and important for trust. The standard provider must act as accreditor (and not be the auditor themselves). There should not be a direct relationship between companies and auditors so there is no conflict of interest.
- **Transparency:** Transparency is important to deliver credibility and effective accountability. It is important that the audit results are published.
- **ISEAL Codes of Good Practice:** The ISEAL codes set a good framework for the kinds of issues that should be covered by standards and certification programs, and should be considered as a starting point for any certification.

Perspectives on sustainability considerations:

Most interviewees said that sustainability was important to the EV and battery industry and to their organisations, although one said that cost was more important. Carbon was put as the most important by two respondents, but overall human rights was ranked the number one consideration by the highest number of respondents.

One interviewee noted that there are 'red line' issues which companies cannot accept, relating to the worst human rights abuses, but that provided those are de-risked then the other aspects (social, environmental, carbon) all have equal weight.

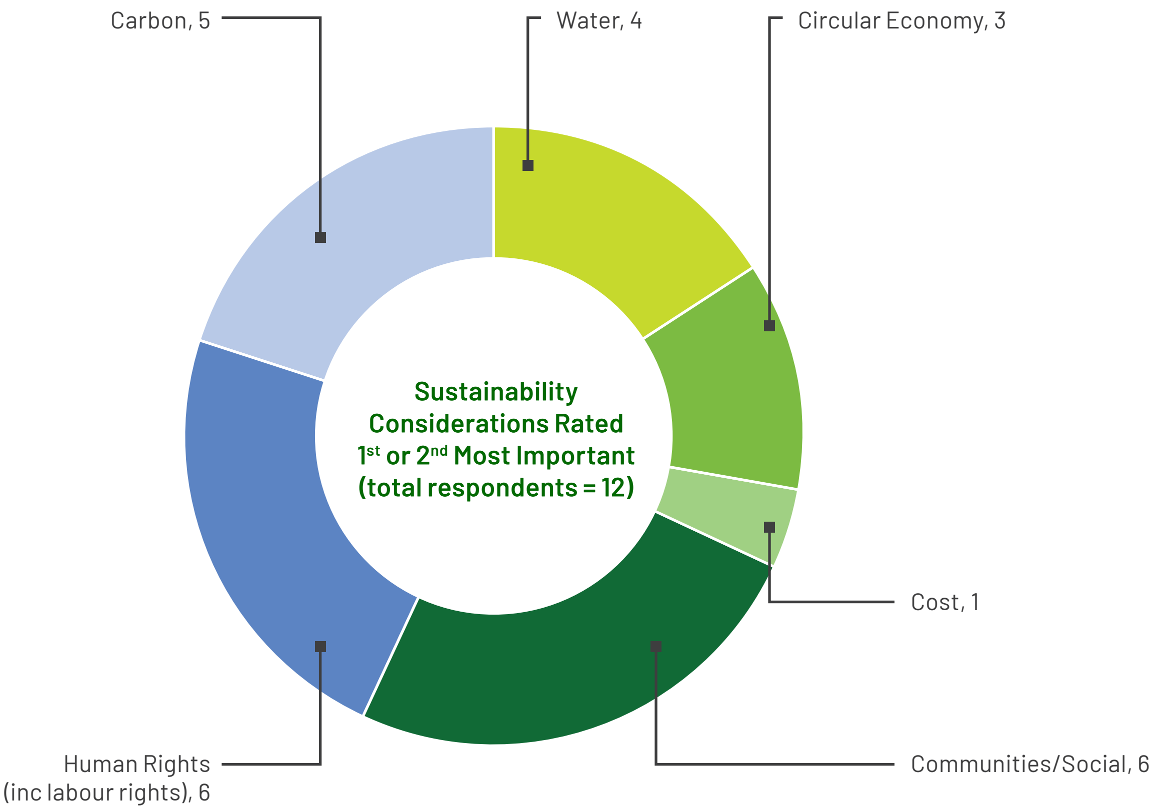


Figure 4: Respondent rating of sustainability considerations

Voluntary sustainability initiatives

Stakeholder perspectives from literature

The World Economic Forum undertook a survey of a range of stakeholders in 2015, with approximately 35% response from industry (WEF, 2015). These are some of their headline conclusions:

"Pressure from downstream companies, investors and regulators is expected to increase. Generally, downstream consumers are calling for 1) certification mechanisms that allow companies to know they have "best-in-class" minerals in their products; and/or 2) de-risking supply chains in an effort to exclude "worst-in-class" actors, with a current focus on human rights compliance, avoiding conflict zones and blocking illicit sources."

"While the awareness of new initiatives is high, respondents place greater value on long-standing, established initiatives, particularly those linked to credible institutions. Being "well-established, with credibility across sectors" is a critical characteristic. Ninety-six per cent of survey respondents agree that there is potential to create linkages or efficiencies between voluntary initiatives. Respondents emphasized the value of prioritization and consolidation."

"Transparency was emphasized as a key ingredient. Stakeholders are seeking transparent reporting on sustainability performance, backed up with third-party verification, which is a growing trend."

"Stakeholders, especially from industry, are looking for initiatives that are practical and can be implemented through management systems."

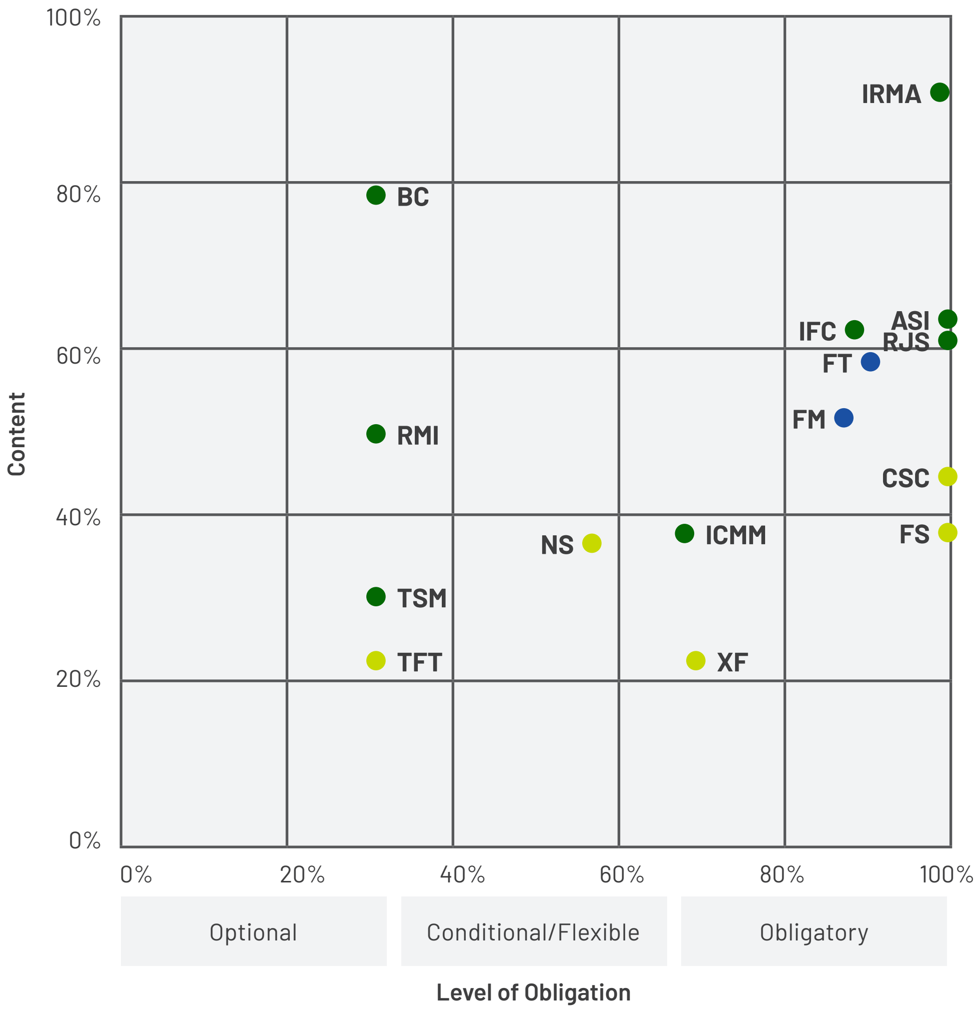
(World Economic Forum, 2015)

The IGF undertook an assessment of VSIs in 2018 and scored the different initiatives (Potts et al, 2018). Figure 5 shows the content along the y-axis (with equal weight given to social, business practice and environmental groupings), and the x-axis represents the level of obligation in the standard or certification. Thus IRMA (top right) is comprehensive in coverage, and has a high level of obligation, although it is noted IRMA has introduced a partial compliance level, so that mines can be partially compliant for a lower certification level and still participate. CERA was not included in this assessment as it was not launched at the time; however, it is likely that it would not be scored even now, as there is insufficient detail available on process or standards.

Potential risks of certification

Many of the risks associated with certification stem from the proliferation of schemes, and the difficulties the sector has in choosing among them. The World Economic Forum survey reported that the sheer number of schemes and the lack of linkages between them makes it challenging for mining companies to decide which ones to adopt and makes implementation more costly. This relates directly to some of the drivers for certification, as choosing the "wrong" initiative would mean that the expected strategic advantages do not materialise. At the other end of the spectrum, mines will not want a certification scheme in which they do not score well, as this may actually do reputational damage.

The actual cost (both in time and money) of implementation is also a concern, particularly if other social or environmental initiatives are competing for the same resource. One of our stakeholder interviews reported that companies do not want to reveal their certification scores (which is often a requirement) until they are scoring highly, so there may be additional costs for remediation works. In some cases there may be concerns about publicly reporting company details.



ASI : Aluminium Stewardship Initiative
BC : Bettercoal
IRMA : Initiative for Responsible Mining Assurance
ICMM : Intertional Council on Mining and Metals
IFC : International Finance Corporation Environmental and Social Perfomance Standards
TSM : MAC's Towards Sustainable Mining
RJC : Reponsible Jewellery Council
RMI : Responsible Mining Index
CSC : Cornerstone Standards Council
FS : Fair Stone
NSC : Natural Stone Council
TFT : The Forest Trust Responsible Stone Programme
XF : XertifiX
FM : Fairmined
FT : Fairtrade Gold and Silver

Figure 5: Comparison of different standards and certification for the extractive sector.

Reproduced from Potts et al, 2018.

Certification options for lithium – IRMA and CERA compared

It is in Australia's interest to use existing certification providing there is a suitable scheme, as both previous work (WEF, 2015) and our own stakeholder consultation indicates a desire for consolidation and using recognised schemes.

This presents two main options for certification of lithium and other battery materials, namely the IRMA and the CERA schemes. The characteristics of the schemes are compared in Table 4.

Table 4 : CERA and IRMA compared

Categories	CERA	IRMA
System Boundary	4 standards within the CERA system: • Readiness (exploration) • Performance (mining, processing, refining) • Chain of custody (traceability of traded raw materials) • Final product standard (raw materials in end-product) CERA intends to develop a framework to integrate other standards and certification schemes.	IRMA Standard for Responsible Mining: covers exploration and mining. Currently working with other certification bodies (Responsible Steel) to enable the use of IRMA in chain of custody certification.
Geographic scope	Global (certification body Europe based)	Global (certification body US based)
Applicable materials	Applicable to all raw materials, all operation sizes, mining and processing techniques and all countries throughout the entire value chain.	Applicable to all types of industrial- or large-scale mining and all mined materials (minerals, metals) with the exception of energy fuels.
Scope (coverage)	**Social:** Human & Community rights, Labour conditions, OH&S, Safety & Security, Cultural Heritage **Governance** **Environmental:** water, noise & vibration, resource and energy use, land use, biodiversity	**Social:** Human rights, Community & stakeholder engagement, Fair labour and terms of work, OH&S, Community Health & Safety, Cultural heritage **Environment:** Water management, Noise & Vibration, Energy use, Land use, Biodiversity, ecosystem services, protected area, Marine services
Establishment	Founded in 2017 by a group of companies and universities as part of an EU funded project (EIT RawMaterials). CERA is currently managed by DMT, a subsidiary of the Tüv Nord Group.	Founded in 2006 by a coalition of NGOs, purchasers of minerals and metals, organized labour (e.g., trade unions), affected communities and mining companies. Standard published 2018.

Categories	CERA	IRMA
Governance and decision making	The intention is to incorporate a CERA association in 2020. The Association will have an advisory board made up of industry, civil society, and experts, noting the advisory board will not have formal decision-making powers; the current advisory group meets annually. The project group makes the decisions on standards.	IRMA Is a not-for-profit governed by a board of directors with 2 representatives from each of the five sectors mentioned above. Decision making aims at consensus, and decisions may not be taken if both representatives from any one sector object.
Transparency and engagement	High level standards published with some consultation online and further consultation planned. Draft Implementation Details (equivalent to standards or protocols) have not been published for consultation. Governance structures and procedures for audit and registering auditors are not published.	Draft standards were published, followed by two rounds of public consultation in 2014 and 2016, two field tests and various working groups. The final standard published in 2018 after feedback from more than 120 organisations. Governance structures & decision-making procedures published. Audit procedures published.
Current status	**Standards** Standards (in effect principles) are published for each of the four stages, however they are not sufficiently detailed to enable certification or compliance. These are to be supplemented with "Implementation details" for each standard, and potentially for each mineral. Implementation Details are close to publication for lithium and cobalt and are expected to be piloted this year. These will in effect be the performance standards for mines and processing plants. CERA expects to have draft Implementation Details for CoC ready to pilot at the end of 2020, and to have draft Implementation Details for Readiness in 2021, and for products in the future. **Certification / standard pilot** CERA plans to pilot the lithium performance standard at a lithium mine and a processing plant during 2020/2021.	**Standards** Draft standard published 2014, final 2016, additional guidance published 2018. Investigating working with other certification schemes to feed into their processing certification. **Certification progress** 2 mines currently undergoing independent audit for certification (details on public map). 3 mines undergoing self-assessment (pre-audit, details on public map), with 12 mines at self-assessment level confidentially. **Company involvement** 3 major purchasers involved with IRMA –Tiffany, Microsoft, BMW. 9 mining companies engaged, with 15 mines in 7 countries. 5 mines mapped, in US, Zimbabwe, South Africa, Mexico, and Brazil.
ISEAL compliance	No (lack of multi stakeholder governance, lack of transparency in governance, lack of transparency in standard setting)	State that standard setting meets ISEAL codes; not an ISEAL member.

> We don't want a new initiative for every raw material, so we want every raw material to be certified using IRMA. We don't demand it to already be in place before we purchase - as no mines are yet IRMA certified - however we expect each supplier to bring it in.
>
> - Claudia Becker, BMW.

Stakeholder perspectives on IRMA and CERA (from interviews):

Some interviewees were aware of the IRMA and the CERA schemes, as well as commodity-specific standards and the OECD Due Diligence guidelines. However, some interviewees had low awareness of which schemes would be applicable for lithium.

Several interviewees noted the advantages of the IRMA scheme. These included that they considered the IRMA certification process to be "most thorough" and "best standard and process", and "the most comprehensive of existing schemes". One noted that the "standard is very high, in terms of social and environmental impacts; integrity really shows". It was also noted that IRMA could be applied to hard rock mining lithium as it stands, although it may need an addendum to be applied to brine extraction projects.

Advantages of the CERA standard noted by interviewees were that is was "holistic and very promising as it combines mining and sourcing" and a "good starting point". It was noted that the standard is under development but is very European focussed, rather than having a global perspective. One stakeholder described it as "unknown". Disadvantages noted were that the governance of CERA was not multi-stakeholder nor sufficiently transparent to give the scheme credibility.

Drivers for responsible sourcing and certification

The IGF (Potts et al, 2018) identified a number of key drivers for sustainability standards, including:

- **Strategic considerations** – participation in VSIs can be a strategic advantage if the company is close to meeting a high standard, as this both differentiate their product and may put cheaper competitors at a disadvantage if they come under pressure to implement the same standards. It may also be advantageous if the company anticipates either regulatory or consumer pressure to improve performance.
- **Market demand** is perhaps the strongest driver for participation in VSIs – if your customer requires it, you do it. Downstream customers may well be driven by the same factors, such as reputational risk, and maybe more sensitive to consumer and civil society demands. Similar arguments apply to **Investor and lender requirements** – if investors require participation in a VSIs, it is likely that companies will comply, and there may well be situations where participation fulfils investor requirements even if they were not specifically requiring a particular initiative.
- **Reputational risk and corporate brand values, and product branding:** many companies perceive a corporate advantage in being shown to meet environmental and social standards, and conversely, a reputation risk in being associated with bad practice. There is a similar equation for products.

> From an industry perspective, VSIs may be a way to differentiate products in the global marketplace, they may represent the desire to contribute to good corporate governance and sustainable development, they might be good for business reputation, or they might stem from a frustration with the absence of robust regulations and implementation by the public sector. In short, there is a market for sustainability standards and a corresponding response to this market demand.
>
> - Potts et al, 2018

- **Regulatory benefits:** voluntary initiatives may be useful to demonstrate regulatory compliance.
- **Social license to operate:** voluntary initiatives may be very important in gaining social license, and this may be important where companies are dependent on communities for operation, and is distinct from their legal license to operate.
- **Direct cost reductions:** implementing environmental standards may result in cost savings from reduced energy or water use, and greater cost savings may come from reductions in delays or stoppages due to improved planning, fewer accidents, better labour relationships, and better relationships with local communities and regulators.

Drivers for responsible sourcing and certification for EV and battery manufacturers

Previous stakeholder research by ISF found that the security of supply of battery materials at a stable price, particularly cobalt and lithium, is a top priority for global battery and EV manufacturers. At the same time many battery and EV companies are looking to ensure the sustainability of their raw materials and engage in certification schemes, but some have concerns about getting adequate volumes of supply from responsibly sourced mines (Dominish et al, 2019).

Various industry initiatives have formed in relation to responsible sourcing for EV and battery manufacturers. Drive Sustainability (DS), a partnership of ten major auto manufacturers[11], has been formed to influence the sustainability of the automotive supply chain. In order to address the challenges of responsible sourcing of raw materials, DS developed a 'Raw Materials Observatory', to help identify risks, impacts and opportunities for collective action of DS partners. In 2018 they published an assessment of 37 raw materials essential to the automotive and electronics industries. This report found that lithium had a very strong association of "Incidences of conflict with Indigenous Peoples" (Drive Sustainability, the Responsible Minerals Initiative and The Dragonfly Initiative, 2018).

Critical Raw Materials for Electric Vehicles (CRM4EV) is a taskforce of the International Energy Agency (IEA) begun in 2018 which aims to assess the impacts of EV on critical raw materials and provide up to date information to participants[12]. Participants include countries, national mining centres, mining companies and research organisations.

[11] Members include BMW Group, Daimler AG, Ford, Honda, Jaguar Land Rover, Scania CV AB, Toyota Motor Europe, Volkswagen Group, Volvo Cars and Volvo Group. See more at: https://drivesustainability.org/
[12] See: https://crm4ev.org/about-crm4ev/

> The demand for voluntary initiatives typically originates from civil society organizations, investors or downstream companies... Regulation is a key driver of responsible mining, topping the survey with a response rate of 49%. Significantly, downstream pressure, community accountability, reputational issues associated with environmental performance and the cost of conflict all topped 40%.
>
> - World Economic Forum, 2015.

Amnesty International's 2017 study on responsible sourcing of cobalt found that consumer facing companies, such as EV manufacturers and electronics companies, have led industry efforts to improve the cobalt supply chain, rather than battery manufacturers (Amnesty International, 2017). Public commitments to responsible sourcing practices by EV manufacturers can influence the upstream supply chain and may encourage more mines to engage with responsible certification schemes. The benefits for mining companies can include preferential purchasing contracts, which may also provide EV manufacturers with security of supply (Dominish et al, 2019).

In relation to lithium, various EV manufacturers have made public announcements on their supply chain. For example, Volkswagen have published a summary of their efforts to visit lithium producers in the Atacama Desert in Chile.[13] BMW have a five year contract with Ganfeng Lithium Co., Ltd. based in Jiangxi, China to supply lithium that is mined to strict sustainability standards in Australia (Ganfeng have offtake agreements with several Australian lithium mines), which is then supplied to their battery manufacturers CATL and Samsung SDI.[14]

Stakeholder perspectives on drivers for responsible sourcing and certification (from interviews)

Stakeholders perspectives from this study were consistent with the findings in the literature. Stakeholders noted that there was broad interest in responsible sourcing and certification in the battery supply chain and EV sector. A range of drivers were mentioned as important by interviewees:

- **Meeting investors' and insurers' expectations:** Several interviewees noted that investors are expecting clean value chains and higher levels of sustainability for companies they invest in. Mining is increasingly seen as high risk by insurers, so certification may give rise to other benefits such as lower insurance premiums, or beneficial relationship with investors.
- **Reputation and consumer expectations:** Several interviewees highlighted the importance of consumer expectations and public acceptance of the EV industry. The impact of negative press was noted by one stakeholder to have a huge impact on industry, for example Amnesty International's report on child labour in cobalt supply chains has led to a "heightened degree of sensitivity with anything to do with renewable energy and EVs".
- **Market advantage from demonstrating good practices:** Purchasers of raw materials, such as auto-manufacturers but also electronics manufacturers, have been the main push towards certification. One interviewee noted that purchasers want to be able to demonstrate

[13] See: https://www.volkswagenag.com/en/news/stories/2020/03/fact-finding-expedition-to-the-lithium-desert-of-chile.html

[14] See: https://www.press.bmwgroup.com/global/article/detail/T0303684EN/securing-raw-material-supplies-for-battery-cells:-bmw-group-signs-supply-contract-with-ganfeng-for-sustainable-lithium-from-mines-in-australia?language=en

through certification that they are doing the right thing. Adoption of a rigorous standard can give a market advantage, particularly in times when the end users are demanding good practices and long-term contracts.

- **Improving sustainability and transparency in the supply chain:** One interviewee noted that certification can help in countries with poor regulation, and ensure a minimum standard applies, and can provide clarity and transparency. It was identified that certification can be a trade tool to assist other countries to develop sustainable mining, with the intention to explicitly raise standards globally. Another interviewee outlined that EV manufacturers requiring certification would mean mine certification would become more widespread. It was also recognised that certification is an instrument for tracking sustainability along the supply chain.

Stakeholder perspectives on policy drivers for certification

Policy was not considered to be a major driver currently for responsible sourcing and certification. However, stakeholders noted the following potential drivers:

- **European Commission Strategic Action Plan on Batteries:** In 2018 the EU developed a Strategic Action Plan on Batteries[15] following the launch of the European Battery Alliance in October 2017[16]. The action plan covers the whole battery value chain and focuses on sustainability. This includes "the extraction and processing of raw materials, the design and manufacturing phase of battery cells and battery packs, and their use, second use, recycling and disposal in a circular economy context". The implementation report from 9th April 2019[17] directly refers to the need for responsible sourcing, noting the "downstream industry plays a major role in creating the necessary market expectations for clean battery raw materials, for example through responsible sourcing". This report proposed an action "to help to develop a sustainability code of governance for European Battery Manufacturers that commit to comply with recognised international responsible business conduct and sustainability standards such as the OECD Guidelines for Multinational Enterprises and the OECD Due Diligence Guidance for Responsible Mineral Supply Chains" and "to explore developing a model contract clause for suppliers in clean battery value chains to promote similar commitments along the battery value chain".
- **Green New Deal:** The Green New Deal is a roadmap for sustainability for the EU economy, with a goal of zero GHG emissions by 2050[18]. Sustainable Mobility is one of the key policy initiatives, with an aim to reduce GHG emissions in the transport sector by 90% by 2050. Several interviewees noted that this policy would increase the focus on carbon emissions in the sector and the importance of carbon footprinting. The strategy also includes a Circular Economy Action Plan which was noted as important by one interviewee. A communication about the Green New Deal in Dec 2019 noted that the Commission will "propose legislation in 2020 to ensure a safe, circular and sustainable battery value chain for all batteries, including to supply the growing market of electric vehicles"[19].

15 See: https://eur-lex.europa.eu/resource.html?uri=cellar:0e8b694e-59b5-11e8-ab41-01aa75ed71a1.0003.02/DOC_3&format=PDF
16 See: https://ec.europa.eu/growth/industry/policy/european-battery-alliance_en
17 See: https://ec.europa.eu/commission/sites/beta-political/files/report-building-strategic-battery-value-chain-april2019_en.pdf
18 See: https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal_en
19 See: https://ec.europa.eu/info/sites/info/files/european-green-deal-communication_en.pdf

There is also the potential for national policies to drive responsible sourcing and certification schemes, particularly in Europe in response to the Strategy Action Plan or Green New Deal. The following box section explains the different ways that policy could drive the uptake of certification.

Summary of links between policy and voluntary sustainability initiatives (VSIs)

Government policy can be a driver for the uptake of VSIs. Examples of this include:

- **Incorporating compliance with VSIs into laws:** VSIs could be incorporated into law, becoming a requirement for legal compliance. For example, the OECD Due diligence guidance for responsible supply chains of minerals from conflict-affected and high risk areas is a voluntary framework to help companies avoid contributing to conflict through their mineral purchasing decisions and practices in conflict-affected areas.[20] Under the EU's 2021 Conflict Minerals Regulation all EU importers of tin, tantalum, tungsten and gold will be required to use this framework.
- **Regulation on reporting:** Government financial, social and environmental regulations can lead to the emergence of VSIs that provide companies a way to demonstrate compliance with a regulation.
- **Public procurement:** If procurement criteria for government purchasing of goods and services are in line with VSI criteria, this can create market demand for VSIs.
- **Public information on company performance:** Government publication of company environmental and social performance can provide an incentive for companies to engage with VSIs.
- **Creating of incentives:** Government policies can encourage the uptake of VSIs through regulatory or financial incentives (such as reduced permits or taxes for companies that use VSIs.
- **VSIs can also emerge where there is a lack of government policy.** For example, VSIs can provide a framework for sustainability performance and act as a "defacto" regulator in regions where there is a lack of regulation or weak enforcement of regulations.

List adapted from Potts et al, 2018.

[20] See: http://www.oecd.org/corporate/mne/mining.htm

4. Role Of Life Cycle Assessment and Social/ Environmental Footprinting Activities

Life Cycle Assessment (LCA) is a methodology for quantifying the environmental impacts of products, processes or service. Due to the flexibility of these methods, LCA is widely used within industry (particularly in Europe) for communicating the environmental performance of products, optimising the eco-efficiency of production processes and supply chains, and also for making the material selection and procurement decisions. LCA is also used for research and development to guide product and process design decisions, to understand the potential benefits of new technology, and to aid decision making through understanding of the environmental implications of consumer, engineering, management and policy decisions.

Standards for LCA have been developed through the International Standards Organisation (ISO 14040: 2006) and detailed methodological guidance for LCA is provided through organisations such as the Life Cycle Initiative hosted by UN Environment and the Australian Life Cycle Assessment Society (ALCAS). Key components of LCA based studies and decision-making tools include the development of Life Cycle Inventory datasets that describe the interaction of production processes and supply chains with the natural environment (e.g. pollutant emissions, water consumption); the characterisation of environmental impacts such as contributions to climate change or water scarcity; and presenting the data or analysis in a way that aids decision making. A key use of LCA is to quantify the environmental footprint of products. Standards for Product Environmental Footprints (PEF) and Environmental Product Declarations (EPDs; ISO14025) have been developed based on LCA in order to enable standardised communication of life cycle inventory and impact assessment data to consumers and the market. Environmental LCA has also been extended to analyse other metrics of sustainability, including social life cycle assessment (SLCA) and economic Life Cycle Costing (LCC).

A typical LCA of an electric vehicle battery covers life cycle stages from mineral processing, cell and module production, battery assembly, distribution and use phase to final recycling and end-of-life disposal. Circular economy is a great vision for the battery supply chain system. For quantifying the impacts of circular economy throughout its life cycle stages, LCA is highly beneficial to justify the assumptions in a circular economy model in a supply chain thus identifying the limitations of the model while exploring alternative design approaches.

This section aims to provide insights about the relevance of LCA for the global battery supply chain and to identify knowledge gaps that are specifically relevant to the Australian batteries industry. The information is based on stakeholder interviews, a review of corporate reports, and a systematic literature review.

Stakeholder perspectives on LCA

During the stakeholder interviews, we asked about the relevance of LCA to their organisation or the battery supply chain, and how and whether LCA supports decision making. In addition, we reviewed corporate sustainability reports from main car manufacturers globally including BMW, Daimler, Ford, General Motors, Nissan and Volkswagen.

Several stakeholders noted the importance of life cycle assessment to battery supply chain and the electric vehicle industry. The primary motivation of conducting LCA is to identify hotspots for improvement in the entire product life cycle (from mining to manufacture and recycling) in order to ensure the next vehicle generation will be a more sustainable mobility solution and enable environmentally conscious decisions at various points, in particular product design, and some overarching questions on material selection. Carbon footprinting was also highlighted as an area where LCA is extremely important.

The use of LCA in the automotive industry was also highlighted in all six company reports reviewed. One of the main purposes of LCA is to manage and reduce the overall supply chain impact. For example, General Motors apply LCA to understand their 18,000 suppliers throughout the world (General Motors, 2018). Similarly, Volkswagen involves suppliers in their efforts to minimize environmental impact early by using LCA to identify production hotspots (Volkswagen, 2019). LCA is also commonly used to support research and development of electric vehicle design, purchased materials, and technologies (Nissan, 2019, Daimler 2018, Ford, 2019). BMW uses LCA with an aim to achieve substantial improvement from one vehicle generation to the next by reducing greenhouse gas and other emissions (Berger et al (BMW), 2019).

The role of LCA in the battery supply chain (perspectives from interviews)

Four stakeholders noted that automotive industries use LCA for decision making. Three noted that it is central to product design, while one noted that LCA is extremely important for European lithium because LCA is included in many decision-making processes regarding the circular economy.

Three stakeholders noted LCA is particularly relevant to carbon footprinting, and one that CO_2 emissions audits are required in their tendering processes, with all suppliers required to fill in comprehensive questionnaires. Two stakeholders noted that LCA is likely to be used to compare alternative methods of lithium production (for example brine and hard rock), or is likely to be required when making regional material sourcing decisions.

One stakeholder noted that LCA is on the EU radar for its use in ecolabelling and it is used for the EU Raw Materials Scoreboard. It was noted that LCA is a good quantification tool and very valuable for comparisons of virgin and recycled material, as LCA is where those type of benefits show up.

One stakeholder took a cautionary approach and noted that for LCA to be useful it needs to be simple, actionable and in easily digested format.

The role of LCA in certification (perspectives from interviews)

Several stakeholders confirmed that current minerals certification does not include LCA, and that mine site certification is achievable without LCA. Another mentioned that a major challenge in trying to incorporate LCA would be the lack of transparency along supply chains.

Two stakeholders said that LCA would be more appropriate for downstream producers, and product certification (rather than at mine sites).

CERA certification expected LCA to be a major pillar of the recycling and product standards, while the integration of IRMA certification with Chain of Custody certification might also include LCA.

One stakeholder noted that the creation of standardised LCA datasets for lithium will enable comparison along the entire batteries value chain.

Systematic Literature Review of Life Cycle Assessment

Life cycle assessment of the battery and electrical vehicle industry has attracted considerable research activities globally. A systematic literature review was conducted to outline the existing body of knowledge and to identify the gaps relevant to Australian lithium mining[21]. After reviewing 177 research articles, we narrowed this down to 73 related to lithium-based batteries for electric vehicle and then synthesised the key data according to a set of seven criteria (i.e. geographic, system boundary, scope, functional unit, data source, impact categories, findings). The key findings from this review are summarised in Table 5.

[21] We used the Scopus© database and applied search keywords "life cycle assessment" and "battery" to retrieve articles that utilized them in the title, abstract, and/or keywords.

Table 5 : Summary of the number of LCA studies by review criteria

Categories	Summary of the LCA state-of-the-art review
Geography	10 studies: Global 16 studies: Europe 10 studies: US: 12 studies: China 25 studies: Others
System boundary	38 studies: Cradle to gate (without considering the end-of-life scenario) 29 studies: Cradle to grave (considered the end-of-life scenario) 6 studies: Not explicitly mentioned
Scope	61 studies: Environmental LCA 9 studies: Environmental and cost analysis based LCA 2 studies: Social LCA 1 study: Environmental, economic, and social LCA
Data source	22 studies: used firsthand production dataset and commercial database (EcoInvent or Gabi) 26 studies: used a mix of datasets from literature and commercial database (EcoInvent or Gabi) 7 studies: used a combination of production data, literature sources and commercial databases 18 studies: the data source was not mentioned
Impact categories	68 studies: Climate change 32 studies: Toxicity 31 studies: Acidification potential 25 studies: Eutrophication potential 23 studies: Resource depletion 21 studies: Cumulative energy demand

Based on the literature review and stakeholder interviews, we consider the following would assist the Australian batteries industry to be accurately represented in LCAs undertaken either domestically or internationally and would contribute to the body of knowledge of battery chain:

- **Filling the gap of Australian battery material LCA:** Among the 73 articles, only 2 studies partially consider Australian mining. As a result, Australian battery material supply chains are not being adequately considered within LCA studies of electric vehicles and related products.
- **Improving the data source with quality primary information for Australian mining and resources:** Quantification of Australian activities based on primary data will significantly improve the transparency and quality of the LCA studies that include Australian materials, and allow

comparison between Australian sourcing and other resources. The Australian Life Cycle Inventory Database (AusLCI) includes no data for Australian battery materials. The largest commercial Life Cycle Inventory database, Ecoinvent, only includes generic data for lithium chemical production from brines and does not include any regionally specific data for lithium sourcing or hard-rock lithium mining. Therefore, LCA practitioners do not have access to representative data for Australian produced battery materials and will be required to resort to generic data or data from other regions as a proxy when guiding decision making.

- **Providing Social LCA and LCC studies of Australian battery operations:** We have observed only 2 social LCA studies, 9 LCC studies, and 1 combined study among the literature sample. As the prominence of social LCA and LCC continues to grow, there will be increasing demand for industry data that can support the assessment of social and economic impacts in addition to environmental impacts.
- **Demonstrating comparative advantage between Australian resources and others:** Previous literature has compared electric vehicles and combustion engine vehicles, different battery types from a life cycle perspective. Stakeholders have expressed that the environmental impacts of lithium production from brines and hard rock resources are a point of debate, particularly with regards to water impacts and carbon footprint. However, available studies provide very limited quantitative comparison of these impacts. A comparative LCA between Australian resources and other regions will provide quantitative evidence to support material sourcing decisions grounded in a holistic understanding of environmental impacts and responsible sourcing.
- **Offering a user-friendly and actionable guide for Australian industry based on LCA:** Published LCA studies often identify which life cycle stages contribute the most to the total impact of a battery life cycle. However, the studies fail to derive actionable plans for industry to reduce and improve their environmental performance. In order to achieve a wider adoption and greater benefit of LCA, an end-user-oriented guide should be developed in a simple, actionable and in easily digested format.

5. Discussion and Implications for Industry

Complementary roles of certification and life cycle assessment

Sustainability certification and life cycle assessment are both used by companies operating along the lithium-ion battery supply chain and share some commonalities in their focus on environmental impacts. However, the two serve very different purposes.

LCA is typically used to quantify environmental impact potentials, although it can also be extended to social and economic assessment. Sustainability certification is used to demonstrate that materials, a site or company meet a set of standards, which usually include environmental, social, human rights, and governance aspects. For example, while a certification scheme verifies whether a mine site has an emissions gas reduction target that they report against, an LCA will quantify the amount of GHG emissions for that site or process.

From the point of view of the producer, certification may improve market access, while from the consumer or purchaser point of view, certification allows them confidence in the environmental impact of their purchase. From a civil society point of view, certification may drive improvement across industry and ensure that relevant standards are met. LCA, on the other hand, helps to make decisions about process or product improvement, by quantifying impacts of alternative choices. The different roles reflect the fundamental methodological difference, as certification is based on verification of a set metric, while LCA is based on attribution.

Table 6 summarises the similarities and differences between certification and Life Cycle Assessment in terms of the system boundary, purpose, data requirements and metrics, while Appendix 3 gives a more detailed breakdown of the information which might be required in each case.

Table 6 : Comparison between certification and LCA

Categories	Certification	LCA[22]
System Boundary	Depending on the standard, can include: Raw materials at exploration, mining, processing, refining and product stage (CERA all stages, IRMA exploration, mining stage).	Can include stages throughout the lifecycle of a product or process or service, including exploration, mining, processing, refining, manufacturing, transport, usage, end-of-life.
Scope	To verify that raw materials, a mining site or company meet a published standard. A standard can include requirements such as assessments, management and monitoring systems, reporting and meeting targets/thresholds (e.g. for air/water quality).	A tool for quantifying environmental (and sometimes social or economic) impacts arising from all inputs and emissions required to deliver a product, process or service using a standardised methodology.
Purpose	To assure purchasers that environmental, social and ethical standards are being upheld.	Can be used to support decision making by quantitative comparisons and/or identifying hotspots in the lifecycle. Can be used as the basis for Environmental Product Declarations.
Data collection and requirements	Data collection is usually done at an individual mining site or company level, with an audit to verify results. Data is both quantitative and qualitative and includes collecting business information such as the existence and implementation of policies and procedures.	Data collection is done for individual product, process or service in conjunction with existing LCI databases, with impacts derived from established models. Data is quantitative. Extremely detailed data for all components and inputs may be required.

The Global Battery Alliance (GBA) launched 10 key principles for a sustainable battery value chain at the World Economic Forum in Geneva in January 2020. These principles, signed by 42 global organisations, are based on the GBA's report "A Vision for a Sustainable Battery Value Chain in 2030" (World Economic Forum, 2019). They also launched the concept of developing a "battery passport" – a digital battery information disclosure system that enables transparency in the global supply chain of batteries.

Both LCA and certification can be used to support the GBA principles. LCA can provide data to support two of the ten principles: ensuring the circular recovery of battery materials and the transparency and reduction of greenhouse gas emissions. LCA can provide a complete assessment of the battery manufacturing supply chain. For example, LCA enables battery manufacturers to take material sourcing decisions based on mineral processing which is less resource and energy intensive and quantifies the environmental burdens on ecosystems, and the impact of recovery techniques. LCA supports the decision making needed for battery production within a circular economy. Certification schemes can increase and demonstrate compliance with two of the principles that come under safeguarding human rights and the UN Sustainable Development Goals, firstly to eliminate child and forced labour and strengthen communities and protect the human rights of those affected by the value chain; and secondly to foster the protection of the environment and minimize and remediate adverse impacts.

[22] Institute for the Environment and Sustainability in the European Commission Joint Research Centre (JRC), ILCD Handbook, Http://Lct.Jrc.Ec.Europa.Eu/Assessment/Assessment/Projects, 2012, mmxii <https://doi.org/10.278/33030>.

What does certification offer the Australian lithium industry, and what are the options?

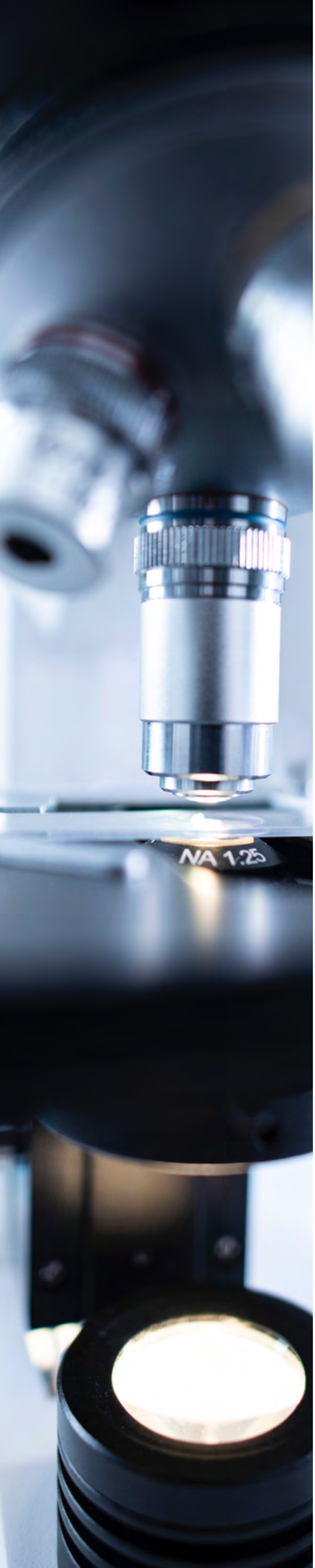
Consumer-facing industries using batteries, such as car manufacturers and electronics, are under considerable consumer pressure to ensure the sustainability of their products. This is particularly strong in the EV market, where the main impetus to switch to EVs is environmental. Manufacturers cannot afford a repeat of the human rights scandals associated with cobalt, nor of mischaracterising environmental impacts as occurred in 'diesel gate'.

Certification offers assurance, and as manufacturers increase their requirements, the pressure on suppliers will increase. In the case of battery materials, it is likely that importers will want assurance of environmental credentials, with some manufacturers already investigating their supply chains (e.g. visiting mine sites) and some requiring certification.

There may also be strategic advantages. Australia has relatively stringent labour and environmental laws compared to some other producers. In this case, achieving best practice certification may require less effort for Australian mines than for some competitor countries. Normalising the use of stringent "best in class" standards such as IRMA may be in Australian producers' best interest and ensure continued market advantage. There is however a risk that the strategic advantages of certification may not materialise depending on the chosen scheme and there is a cost for implementation.

Once the decision to undertake certification is taken, it is both easier and significantly more advantageous to use existing schemes than to develop a new Australian scheme given the considerable time and resources involved. Stakeholders also emphasised that recognition is important and that they did not wish to participate in multiple initiatives. This currently leaves only two substantive options for Australian battery materials, namely IRMA and CERA. The main differences are that IRMA applies to the mine site, while CERA will eventually apply to the full supply chain. There are also some unresolved issues about CERA governance and transparency, and the option to certify the full supply chain is unlikely to be ready for some years.

Thus, certification of Australian mines under the IRMA scheme seems to offer a no-regrets approach, as mines certified under IRMA are anticipated to be accepted into the CERA chain of custody and/ or product certification when it becomes available.



What does life cycle assessment offer the Australian lithium industry?

LCA is commonplace in some of the key import markets for battery materials, particularly Europe, with LCA already playing an important role in product design decision making as well as process design and improvements. LCA utilisation is expected to increase as the demand for circularity becomes an expectation.

LCA is data-intensive and Australian materials are not well characterised, which means that when LCA is undertaken, generalised datasets are used, simply because data from Australian or other countries with battery minerals are not available. This will become more important going forward, as complex decisions are made about design, product and process, materials recycling, and alternate sourcing and processes considered. The emergence of product certification in the future will almost certainly need LCA, although it is not currently required as product certification is not available.

However, LCA studies vary in terms of scope, assumptions, and scenarios. It is also production data-intensive which should ensure the accuracy and transparency to cope with the varied production techniques. Expert knowledge is required for results interpretation and performing case studies for suitable design alternatives throughout the supply chain. To overcome these risks in the battery supply chain system and avoid confusion among stakeholders, it would be helpful to generate Australia specific life cycle inventory datasets for battery minerals manufacturing processes. An effective data management framework would also enable design engineers to access the data they need to improve the sustainability of their products.

The creation of accurate Australian LCA datasets for lithium production will mean that we can both make environmental footprint assessments to identify opportunities for improvement and ensure that when customers wish to undertake LCA for their decision making, accurate datasets are available. This will call for LCA of Australian lithium and battery industry by adopting standard methodologies covering extraction and processing, at the site and regional levels. Due to the large potential data requirement, the industry will benefit from a generic and scalable model for gathering and generating the required input data, and from an accessible database for non-confidential Australian data.

6. Conclusions and Recom-mendations

The Australian battery material supply industry is well placed to respond to changing societal and consumer expectations regarding the sustainability dimensions of extractive industries and production systems. Implementation of certification and the development of representative LCA data for the Australian lithium sector may support end-user material sourcing decisions and ensure long-term market access.

IRMA presently offers a well-developed option for certification of lithium mining operations, offering the most credible assurance of "best-in-class" materials. Implementing mine site certification will also mean companies are prepared for the full supply chain and/ or product certification, which is a direction the broader market appears to be moving.

Developing an LCA dataset for Australian battery materials would enable customers in the battery value chain to make decisions on carbon footprinting based on relevant data and allow Australian producers to gain expertise in applying LCA to alternative process technology. It will further allow Australian industry to conduct process performance optimisations that meaningfully improve the environmental outcomes of these processes, which can be communicated to the market and demonstrate Australian leadership in sustainability-oriented decision making.

The Australian battery material supply industries can benefit through certification, and IRMA presently offers a well-developed option for the sector. Implementing mine site certification will enable future integration into broader supply chain and/or product certification such as will be offered by CERA.

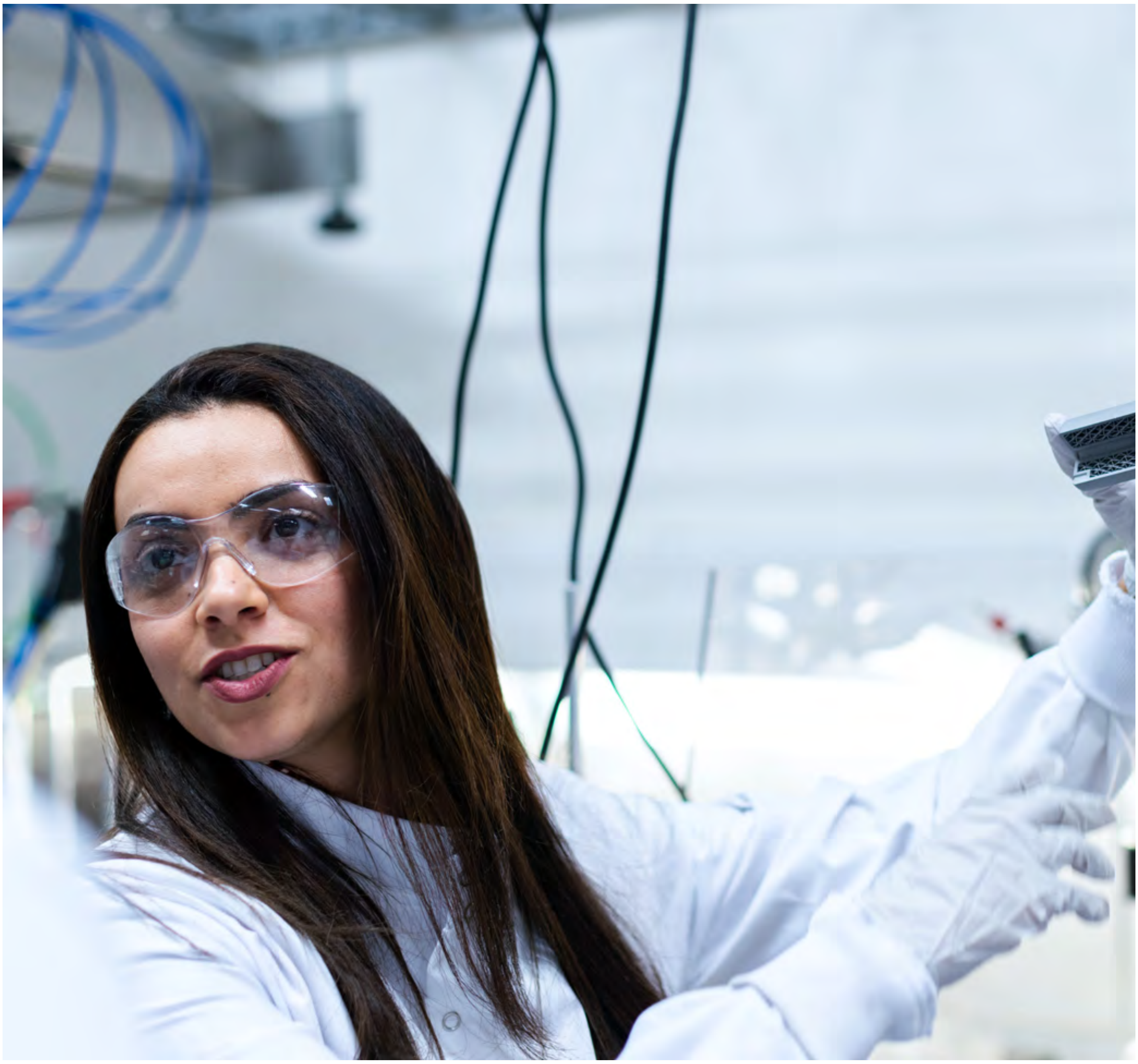
Developing LCA datasets for Australian battery materials would support customers in the battery value chain to make informed decisions that consider the carbon footprint of their supply chains. LCA also provides Australian producers an opportunity for process optimisation through identification of key 'hotspots' of environmental footprint.

Following the findings of the study, we recommend the FBICRC:

1. Works with the Australian Government and State Governments to assist the Australian battery materials industries (this report focuses particularly on lithium), to implement mine site certification, including:
    a. Mapping the alternate scheme (IRMA and CERA) requirements against current industry practices and regulatory requirements,
    b. Running information workshops for the industry on the certification process and advantages,
    c. Assisting with common guidance documentation and processes.

2. Assists industry to undertake LCA of Australian battery materials by:

    a. Mapping the data needed for LCA of lithium and battery materials against what is needed for certification.
    b. Undertaking LCA studies of Australian battery materials in collaboration with industry, in order to allow comparison between Australian sourcing and other materials, and to identify processing hot spots to improve industry performance and support the development of a circular economy.
    c. Providing seminars on use of LCA with the Australian industry.
    d. Developing models based on LCA in order for suppliers and end-users to identify actionable areas to improve their environmental performance.



References

Albemarle Corporation (2020a) Investor Presentation, March 2020. https://investors.albemarle.com/presentations

Albemarle Corporation (2020b) Kemerton, Western Australia. https://www.albemarle.com/businesses/lithium/locations/western-australia/kemerton-western-australia

Amnesty International (2017) Time To Recharge: Corporate Action And Inaction To Tackle Abuses In The Cobalt Supply Chain, https://www.amnesty.org/download/documents/afr6273952017english.pdf

Berger,E, Hilmer,M., and Zöbelein,K. (2019) Sustainable Value Report 2019. https://www.bmwgroup.com/content/dam/grpw/websites/bmwgroup_com/responsibility/downloads/en/2020/2020-BMW-Group-SVR-2019-Englisch.pdf

Covalent Lithium (2020) Our project. https://www.covalentlithium.com/our-project

Daimler (2019) 'Daimler Sustainability Report 2018', https://www.daimler.com/documents/sustainability/other/daimler-nachhaltigkeitsbericht-2018-en.pdf

Dominish, E., Florin, N. and Teske, S. (2019) Responsible Minerals Sourcing for Renewable Energy. Report prepared for Earthworks by the Institute for Sustainable Futures, University of Technology Sydney.

Drive Sustainability, the Responsible Minerals Initiative and The Dragonfly Initiative (2018) Material Change: A Study of Risks and Opportunities for Collective Action in The Materials Supply Chains of The Automotive and Electronics Industries, https://drivesustainability.org/wp-content/uploads/2018/07/Material-Change_VF.pdf

Ford (2018/19) 'Our Future Is In Motion Sustainability Report 2018/19', https://corporate.ford.com/microsites/sustainability-report-2018-19/assets/files/sr18.pdf

General Motors (2018) ' Transformation in Progress 2018 Sustainability Report', https://www.gmsustainability.com/_pdf/downloads/GM_2018_SR.pdf

Geoscience Australia, Australia's Identified Mineral Resources 2019. https://www.ga.gov.au/scientific-topics/minerals/mineral-resources-and-advice/aimr

ISEAL Alliance (2014) Setting Social and Environmental Standards. ISEAL Code of Good Practice. Version 6. Available https://www.isealalliance.org/

ISEAL Alliance (2018) Codes of Good Practice: Assuring Compliance with Social and Environmental Standards Version 2.0. Available https://www.isealalliance.org/

Nissan, (2019) 'Nissan Sustainability Report 2019', https://www.nissan-global.com/EN/SUSTAINABILITY/REPORT/SDGS/

Potts, J. et al. (2018) Standards and the Extractive Economy. Intergovernmental Forum on Mining, Minerals, Metals and Sustainable Development.

Thompson, B. (2019) Tianqi puts brakes on landmark WA lithium plant expansion, 10 September 2019, Australian Financial Review https://www.afr.com/companies/mining/tianqi-puts-brakes-on-landmark-wa-lithium-plant-expansion-20190910-p52ppp

USGS (2020) Mineral Commodity Summaries, Lithium. https://www.usgs.gov/centers/nmic/lithium-statistics-and-information

Volkswagen (2019) 'Sustainability Report 2019', https://www.volkswagenag.com/presence/nachhaltigkeit/documents/sustainability-report/2019/Nonfinancial_Report_2019_e.pdf

World Economic Forum and Resolve Solutions Network (2015) 'Voluntary Responsible Mining Initiatives: A Review', (August). http://www3.weforum.org/docs/Voluntary_Responsible_Mining_Initiatives_2016.pdf.

World Economic Forum (2019), A Vision for a Sustainable Battery Value Chain in 2030 Unlocking the Full Potential to Power Sustainable Development and Climate Change Mitigation. http://www3.weforum.org/docs/WEF_A_Vision_for_a_Sustainable_Battery_Value_Chain_in_2030_Report.pdf

Appendix 1. Stakeholders interviewed and number of answers per subject

Table 7: Stakeholders interviewed in this study

Interviewee	Type of organisation
Earthworks	Civil society
BMW	EV OEM
Daimler	EV OEM
EuroBat (Association of European Automotive and Industrial Battery Manufacturers)	Industry association (battery manufacturers)
EIT InnoEnergy / Euro Batteries Alliance	Industry association (battery value chain)
International Copper Association	Industry association (copper value chain)
Australasian Pozzalan Association	Industry association (mining)
Covalent Lithium	Mining company
European Commission	Regulator
European Lithium Institute (ELI)	Research institute
Fraunhofer / TUB	Research institute
Aluminium Stewardship Initiative	Standard
CERA	Standard
Copper Mark	Standard
IRMA	Standard

Table 8: Number of answers by subject

Important sustainability considerations	Drivers for certification	Scope of certification	Perspectives on certification schemes	Links between policy and certification	Governance	LCA perspectives
12	12	8	10	5	5	13

Appendix 2. Interview questions

1. **Could you describe your current battery material supply chain, and any challenges? (how does lithium fit in)**

2. **How important are sustainability considerations with regard to lithium and or battery supply chain to your organisation?**
   a. What aspects are most important (e.g., social, environmental, carbon, etc.)?
   b. What are the main drivers for certification?
   c. Do you need, or will you need, lithium certification for your business, and will it affect your choice of supplier?
   d. Are there, or do you anticipate, regulatory requirements for certification?
   e. What should certification cover, e.g., mine site, company, or the entire supply chain?
   f. What are your thoughts on scheme governance, e.g., self-certification or third party?

3. **Experience or comments on Certification**
   a. What certification schemes are you aware of? (please list and comment)
   b. Are you involved with any certification schemes?
   c. Do you have any comments on them?

4. **Role of environmental and social Life Cycle Assessment**
   a. Are you aware of life cycle assessment?
   b. Have you ever used LCA for decision making?

5. **Certification Development (only for people involved in certification)**
   a. Who initiated development of the certification and why?
   b. How long did development take?
   c. How much did it cost?
   d. Why did you take the approach you have taken?
   e. What do you see as the pitfalls?

6. **What uptake has there been (unless available on website)**
   a. Number/ geography/ sector / company size
   b. Geography (e.g. country)

7. **Any other comments?**

Appendix 3. Indicative data requirements for sustainability certification and LCA

Table 9: Potential data requirements for certification and LCA

Metrics	Certification	Life Cycle Assessment
Environmental metrics	Potential requirements include: Waste management (e.g. policy for identifying and managing waste, risk assessment of mine waste facilities) Water management (e.g. monitoring water quality and quantity) Air quality (e.g. meeting standards, management plan and monitoring) Noise and vibration (e.g. meeting standards) Greenhouse gas emissions (e.g. policy, quantification, emissions reduction targets and emissions reporting) Biodiversity and ecosystems (e.g. impact assessment, mitigation and management)	Standard indicators include[23]: Resource extraction (kg) Water footprint (m3) Energy (MJ) Land use (m2) Climate change (CO2 equivalent) Ozone depletion (kg) Photochemical ozone formation (kg) Acidification (kg) Eutrophication (kg) Human toxicity (kg) Ecotoxicity (kg) Ionising radiation (kBq)
Social metrics	Potential requirements include: Fair labour and terms of work (incl. child labour) Occupational Health & Safety Human rights due diligence Community & stakeholder engagement (e.g. Free, Prior and Informed consent processes) Safety & security Cultural Heritage	Social life cycle assessment (SLCA) indicators[24]: Human rights Working conditions Health and safety Cultural heritage Socio-economic repercussions
Governance Metrics	Potential requirements include: Legal Compliance Community and Stakeholder engagement Business Integrity Complaints and Grievance Mechanism Revenue and Payments Transparency Management approach	Social life cycle assessment (SLCA) indicators: Governance
Economic Metrics	Not included	Life Cycle Costing (LCC) indicators: Net present value ($) Internal rate of return (%) Simple payback (Days)

[23] Institute for the Environment and Sustainability in the European Commission Joint Research Centre (JRC), ILCD Life cycle indicators for resources, products and waste Framework https://eplca.jrc.ec.europa.eu/uploads/LCindicators-framework.pdf
[24] https://www.lifecycleinitiative.org/wp-content/uploads/2013/11/S-LCA_methodological_sheets_11.11.13.pdf

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