Product Carbon Footprint Report
Average Special High Grade Zinc (SHGZ) Product
Average Low Carbon Special High Grade Zinc (SHGZ) Product

Hindustan Zinc Limted

Introduction

Hindustan Zinc, a Vedanta Group company in Zinc-Lead and Silver business is world's 2nd largest integrated Zinc producer and now the 3rd largest Silver producer. The company has a market share of ~75% of the growing Zinc market in India with its headquarters at Zinc City, Udaipur along with Zinc-Lead mines and smelting complexes spread across the state of Rajasthan.

Hindustan Zinc is self-sufficient in power with captive thermal power plants and has ventured into green energy by setting-up wind power plants. The company ranked first in the S&P Global Corporate Sustainability Assessment in 2023 amongst Metals & Mining companies reflecting & reaffirming its constant commitment towards sustainable and responsible mining practices. Hindustan Zinc is a certified Water Positive company. Hindustan Zinc is also the only Indian company in Mining sector with validated & approved SBTi targets in alignment with 1.5 °C target. Learn more about Hindustan Zinc on – https://www.hzlindia.com/home/

The goal is to assess the product carbon footprint (PCF) of Average Special High-Grade Zinc (SHGZ) Product and Average Low Carbon Special High-Grade Zinc (SHGZ) Product following a "cradle to gate" approach as per ISO 14067: 2018 standard and GHG Protocol Product Life Cycle Accounting and Reporting Standard (the GHG Protocol Standard) and allocate the quantity of Low Carbon Special High-Grade Zinc (SHGZ) product to the total production of Special High-Grade Zinc (SHGZ) product using mass balance approach with the allocation of the gradual increase of renewable electricity projects implemented to source electricity in the electricity mix of HZL over the next two financial years.

Sphera Solutions carried out the Product Carbon Footprint as per ISO 14067:2018 Greenhouse gases - Carbon footprint of products – Requirements and guidelines for quantification standard, GHG Protocol - Product life cycle accounting and reporting standard (the GHG Protocol Standard) and International Zinc Association (IZA) guidance.

A third-party review is carried out according to ISO 14067:2018 Greenhouse gases - Carbon footprint of products – requirements and guidelines for quantification standard and GHG Protocol - Product life cycle accounting and reporting standard (the GHG Protocol Standard) by Dr. Hüdai Kara, PhD, Managing Director, Metsims Sustainability Consulting, UK.

The third-party review statement is appended in Annex A of the report.

Product Carbon Footprint

Product System

Hindustan Zinc Limited manufactures the zinc product predominantly by two process routes i.e. hydrometallurgical zinc smelting route and pyro-metallurgical zinc smelting route which are conformed to BS EN, ASTM and IS standards.

Products under scope are:

1. **Average Special High-Grade Zinc (SHGZ) Product and**
2. **Average Low Carbon Special High-Grade Zinc (SHGZ) Product**

The Average Low Carbon SHGZ is produced using allocation of 100% renewable electricity.

All manufacturing sites of HZL are covered as given in the Table below. Data collection period is FY 2023-24.

Details of Mines, Smelter and Casting Sites

Site Name	Processes	Product(s)
Rampura Agucha Mines (RAM) + Kayad Mines (KM)	Mining & Milling	Zinc concentrate, Lead concentrate
Rajpura Dariba Mines (RDM)	Mining & Milling	Zinc concentrate, Lead concentrate
Sindesar Khurd Mines (SKM)	Mining & Milling	Zinc concentrate, Lead concentrate
Zawar Mines (ZM)	Mining & Milling	Zinc concentrate, Lead concentrate
Chanderiya Smelting Complex (CSC)	Smelting & Casting	Zinc cathode and Zinc Ingot (SHGZ)
Dariba Smelting Complex (DSC)	Smelting	Zinc cathode
Zinc Smelter Debari (ZSD)	Smelting & Casting	Zinc cathode and Zinc Ingot (SHGZ)
Pantnagar Metal Plant (PMP)	Melting & Casting	Zinc Ingot (SHGZ)

Product Function and Functional Unit

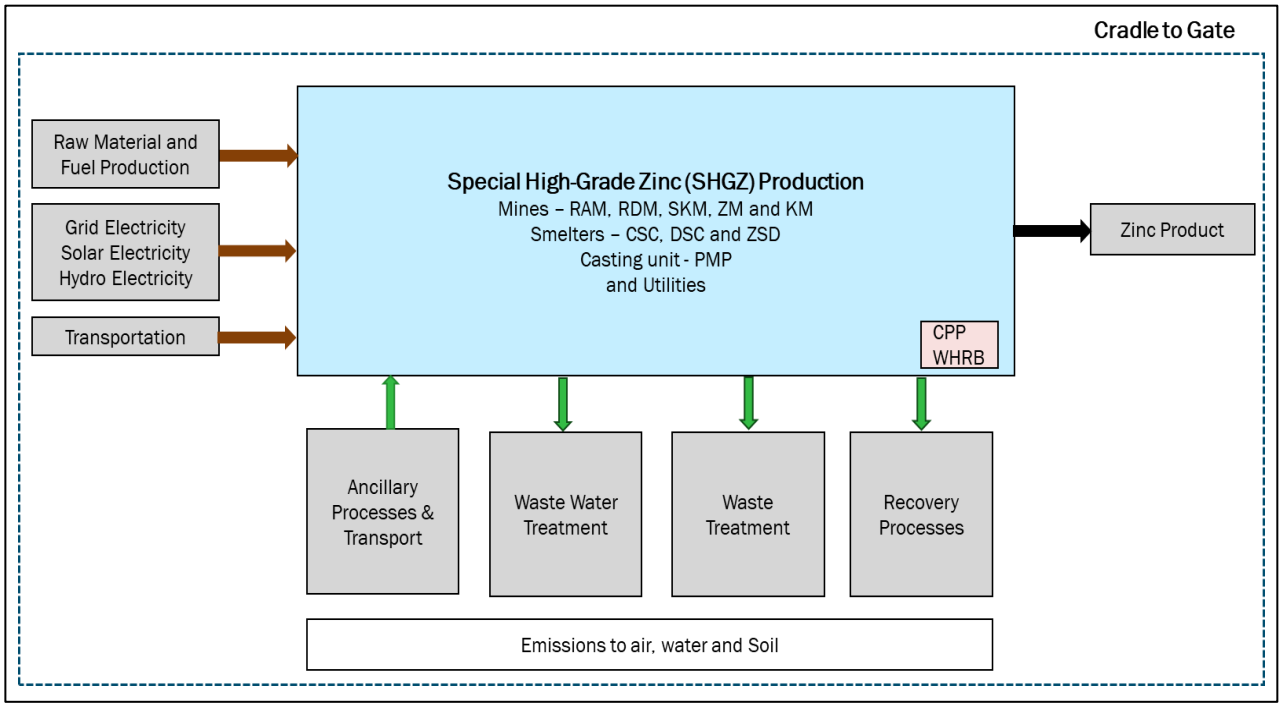
SHG Zinc product is used as raw material in various industries such as construction, steel, alloys, pharmaceutical, fertilizers etc. With each application the functional unit may differ depending on the actual function of the product.

The functional unit is 1 tonne (1000 kg) of Average Special High-Grade Zinc (SHGZ) product.

The functional unit is 1 tonne (1000 kg) of Average Low Carbon Special High-Grade Zinc (SHGZ) product.

System Boundary

Cradle-to-Gate approach includes production of raw materials, upstream transportation, manufacturing process, electricity and steam generation within HZL's manufacturing sites for special high-grade zinc (SHGZ) production. Figure below shows the system boundary for the study.



System Boundary for Special High-Grade Zinc (SHGZ) Production

Allocation

Multi-output Allocation

The GHG Protocol Standard recommends that companies consider various techniques, such as process subdivision, to minimize the use of allocation in the product inventory. When allocation becomes unavoidable, the GHG Protocol Standard recommends that companies allocate emissions based on the underlying physical relationships between the product and co-products. Multi-output allocation applied follows the requirements of ISO 14044, section 4.3.4.2. Allocation is applied to arrive at impacts of Special High Grade Zinc Production in this study. The allocation of zinc and lead in the concentrates is calculated using percentage metal content in concentrate. The allocation of zinc sulphate and purification cake in the smelting process, Lead bullion and furnace zinc produced from Imperial Smelting Furnace, zinc ingot and hard zinc produced in the zinc refining process is calculated using percentage metal content. While price allocation is applied amongst zinc calcined and sulphuric acid produced from roasting plant.

Allocation of background data (energy and materials) taken from the Sphera 2024 databases (Managed LCA Content – 2024) is documented online (Sphera Solutions Inc., 2024) https://sphera.com/life-cycle-assessment-lca-database/.

Data Quality Assessment

Precision and Completeness

- ✓ **Precision:** As most of the the relevant foreground data are measured data or calculated based on primary information sources of the owner of the technology, precision **is considered to be high**. Seasonal variations/variations across different manufacturing sites were balanced out by using yearly averages/weighted averages. All background data are sourced from Sphera databases with the documented precision.
- ✓ **Completeness:** Each foreground process was checked for mass balance and completeness of the emission inventory. No data were knowingly omitted. Completeness of foreground unit process data is high. All background data are sourced from Sphera databases with the documented completeness.

Consistency and Reproducibility

- ✓ **Consistency:** To ensure data consistency, all primary data were collected with the same level of detail, while all background data were sourced from the Sphera databases.
- ✓ **Reproducibility:** Reproducibility is supported as much as possible through the disclosure of input-output data, dataset choices, and modelling approaches in this report. Based on this information, any third party should be able to approximate the results of this study using the same data and modelling approaches.

Representativeness

- ✓ **Temporal:** All data were collected for the year 2023-24 (FY2024) and is believed to be representative of Average Special High Grade Zinc production at HZL, India during this time frame. All secondary data come from the Sphera 2024.1 databases. As the study intended to compare the product systems for the reference year 2023-24, temporal representativeness **is considered to be high**.
- ✓ **Geographical:** All primary and secondary data were collected specific to the countries or regions under study. Where country-specific or region-specific data were unavailable, proxy data were used. Geographical representativeness **is considered to be high**.
- ✓ **Technological:** All primary and secondary data were modelled to be specific to the technologies or technology mixes under study. Where technology-specific data were unavailable, proxy data were used. Technological representativeness **is considered to be high**.

Software and Database

The PCF model was created using the LCA FE 10.7 Software (formerly known as GaBi) system for life cycle engineering, developed by Sphera Solutions Inc. The Sphera Managed LCA Content (MLC) 2024.1 LCI database provides the life cycle inventory data for several of the raw and process materials obtained from the background system. The LCI datasets from the Sphera's MLC 2024.1 database are widely distributed and used with the LCA FE 10.7 Software. The datasets have been used in LCA/PCF models worldwide in industrial and scientific applications in internal as well as in many critically reviewed and published studies.

Assumptions, Limitations and Uncertainty

- Price based allocation is applied amongst Zinc calcined and Sulphuric acid**,** thereby not taking the credit of sulphuric acid production.
- Special high-grade zinc produced using 100% renewable electricity at HZL has significantly lower GHG emissions as per mass balance approach than the global average (3818 kg CO_2 eq./t of SHG Zinc) presented by the International Zinc Association (IZA)[1]. As per the international practices followed by leading organization (e.g., Boliden,

[1] *https://www.zinc.org/wp-content/uploads/sites/30/2023/12/IZA_LCA_Update_Reportv1.3_FINAL.pdf*

Teck etc.), zinc product with GHG intensity lower than 1 t-CO_2 eq./t of SHGZ can be considered as Low carbon Special High-Grade Zinc[23].

- For the Global Warming Potential (GWP) factors, the Intergovernmental Panel on Climate Change (IPCC) Sixth Assessment Report: Climate Change (AR6) GWP100 factors have been used. Changes to the GWP factors could add uncertainty to the CH_4 and N_2O emissions.

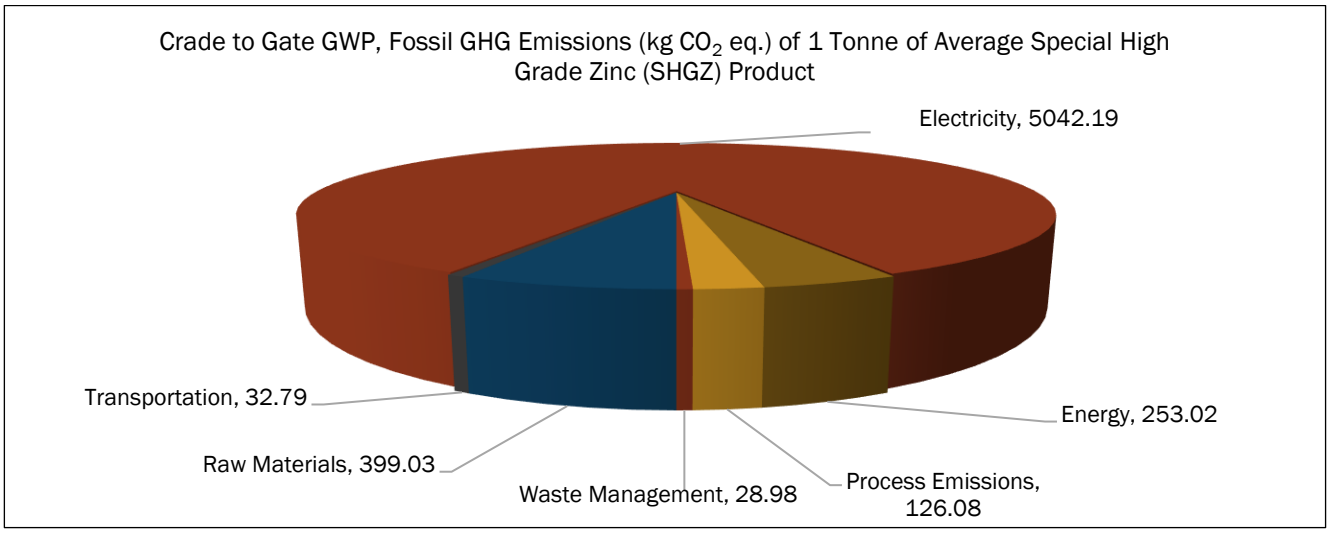
PCF of Average Special High-Grade Zinc (SHGZ) Product

The Cradle to Gate Product Carbon Footprint (PCF) of 1 tonne of Average Special High Zinc (SHGZ) Product (HZL) is given in Table below:

Product Carbon Footprint of 1 Tonne of Average Special High-Grade Zinc (SHGZ) Product

Product Carbon Footprint Indicator	Unit	Average Special High-Grade Zinc (SHGZ) Product
ISO14067 GWP100, Fossil GHG emissions	kg CO_2 eq.	5882.10

Figure below shows source-wise break-up of GWP100, fossil GHG emissions with major contribution from electricity (~86%), followed by raw materials (~7%), and energy (~4%).



PCF of Average Low Carbon Special High-Grade Zinc (SHGZ) Product

Average Low Carbon Special high-grade zinc is produced by using **100% renewable electricity**. Cradle to Gate Product Carbon Footprint (PCF) of 1 tonne of Average Low Carbon Special High Zinc (SHGZ) Product is given in Table below:

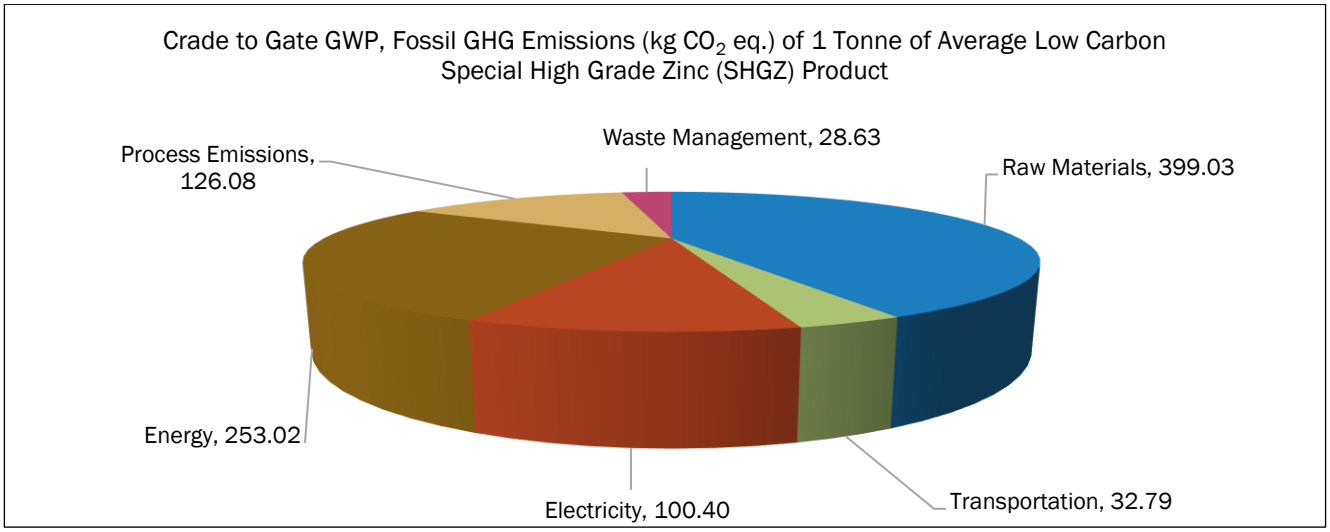
Product Carbon Footprint of 1 Tonne of Average Low Carbon Special High-Grade Zinc (SHGZ) Product

Product Carbon Footprint Indicator	Unit	Average Low Carbon Special High-Grade Zinc (SHGZ) Product
ISO14067 GWP100, Fossil GHG emissions	kg CO_2 eq.	939.95

Figure below shows source-wise break-up of GWP100, fossil GHG emissions with major contribution from raw materials (~42%), followed by energy (~27%), and process emissions (~13%).

[2] *low-carbon-shg-zinc2.pdf (boliden.com)*

[3] *Carbon-Footprint-of-Teck-Special-High-Grade-Zinc.pdf*



Mass Balance Approach – Average Low Carbon Special High-Grade Zinc (SHGZ)

Mass Balance Approach for Average Low Carbon SHGZ for FY 2023-24

Mass balance approach is a method of assigning specified characteristics of input materials to outputs/products when mixing raw materials of different characteristics, in general. HZL utilizes the mass balance approach in the form of pooling GHG or CO_2 emission reductions from reduction projects within the organization and allocating the reductions to low carbon SHG zinc product to be supplied along with certificate. This is a method of pooling greenhouse gas (GHG) emission reductions or CO_2 emission reductions from emission reduction projects implemented by companies, allocating the reductions to any product, and supplying products with certificates that are capable of reducing customers' Scope 3 emissions.

The mass balance system is a central element of this low carbon zinc product certification process for HZL. It establishes a connection between carbon footprint related to raw materials, intermediate and final products and its relation to the renewable electricity mix application to the product under consideration. HZL has applied mass balance approach (MBA) with the allocation of the gradual increase of renewable electricity projects implemented to source electricity in the total electricity mix of HZL over the next two financial years by pooling GHG or CO_2 emission reductions from reduction projects within the organization and allocating the reductions to Average Low Carbon SHGZ product along with certificate.

The calculation of carbon footprint of low carbon SHGZ reflects the actual emissions generated from the electricity source that a company has purposefully chosen, such as renewable electricity with Guarantees of Origin (GoO) certificates and supplier certificate. Firstly, inventory of baseline data 2023-24 has been prepared along with the actual electricity mix with details of sourcing of renewable electricity and captive electricity mix. Then based on the baseline data, GHG emission intensity (product carbon footprint) for 1 tonne of Special High-Grade Zinc has been calculated for a cradle to gate system boundary applying ISO 14067 standard. The percentage (%) of average low carbon special high-grade zinc (SHGZ) production has been calculated based on percentage (%) renewable electricity in total electricity mix based mass balance approach for baseline year 2023-24.

Production of Average Low Carbon SHGZ for baseline Year (FY 2024) based on mass balance approach is given in the Table below:

Production of Average Low Carbon Special High-Grade Zinc (SHGZ) Product for FY 2023-24 Based on Mass Balance Approach	
Total Production of Special High-Grade Zinc (SHGZ) Product (tonne)	750,752
Average Low Carbon SHGZ Production based on mass balance approach (%)	**8.37%**
Average Low Carbon SHGZ Production based on mass balance approach (tonne)	62,862

Therefore, HZL have **~8.37%** of Low Carbon SHGZ product of total SHGZ production for baseline year 2023-24 (FY 2024).

Projection of Average Low Carbon SHGZ product Based Mass Balance Approach for FY 2025 and FY 2026

Production projection of Average Low Carbon Special High Grade Zinc Product is calculated based on based mass balance approach of renewable electricity and total electricity consumption mix and shown in Table below.

Production Projection of Average Low Carbon Special High-Grade Zinc (SHGZ) for FY 2025 and FY 2026 based on Mass Balance Approach								
Production Projection	**(FY 2024)**	**Apr'2024 (FYTD)**	**May'2024 (FYTD)**	**Jun'2024 (FYTD)**	**Oct'2024 (FYTD)**	**Dec'2024 (FYTD)**	**(FY 2025)**	**(FY 2026)**
Total Production of (SHGZ) Product (tonne)	750,752	76,000	152,000	228,000	532,000	684,000	912,000	912,000
Average Low Carbon SHGZ Product – Share (%)	**8.37%**	**8.29%**	**8.77%**	**11.05%**	**14.75%**	**15.64%**	**16.89%**	**30.30%**
Average Low Carbon SHGZ Product (tonne)	62,862	6,303	13,325	25,190	78,462	106,961	154,028	276,324

**Note – FY: 12-month period between April-March*

Therefore, as per mass balance approach HZL have **~8.37%** of Average Low Carbon SHG Zinc product of total SHG Zinc production for baseline year 2023-24 (FY 2024), will reach **~16.89%** of Low Carbon SHG Zinc production at end of FY 2025 and **~30.30%** of Low Carbon SHG Zinc production at end of FY 2026.

Disclaimer

The findings presented in this report reflect only the analysis performed by Hindustan Zinc Limited in respect of Average Special High-Grade Zinc (SHGZ) and Average Low Carbon Special High-Grade Zinc produced at their various manufacturing sites during the FY 2023-24 based on the methodologies set out in this Report. All of the assumptions and uncertainties mentioned in this report apply to the data gathered in compliance with it as well as its conclusions. The conclusions drawn herein could be significantly impacted by modifications to the methodology or data sources. The results should not be used as a comparative tool directly against other products as the differences in assumptions and practices may produce incomparable results.

Additional Information

HZL is ensuring the complete details about renewable electricity supply. Renewable electricity supply is ensured by the grid. The scheduling mechanism implemented by the Grid ensures that the energy that is injected at the generating end is drawn at the consumer end. The power will be injected only from the renewable energy projects set up on captive SPV arrangement. The power transaction documentation is maintained according to the t-gna document. Below are the details of projects under execution by Serentica for HZL under captive special purpose vehicle scheme.

Serentica Global	SRI4PL	Solar	180MW	Bikaner
		wind	325MW	Kallamb
	SRI5PL	solar	220MW	Bikaner
		solar	40MW	Fatehgarh
		wind	250MW	Solapur
		wind	120MW	Kallamb

For any questions about this report, please contact:
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Head HSE & Sustainability
Email: pradeep.singh2@vedanta.co.in

Annex A: Third Party Review

PRODUCT CARBON FOOTPRINT

REVIEW STATEMENT

This is to certify that

The GHG inventory of

Average Special High-Grade Zinc (SHGZ) Product & Average Low Carbon Special High-Grade Zinc (SHGZ) Product

Manufactured by

"Hindustan Zinc Limited (HZL)"

has been verified based on ISO 14067:2018 Greenhouse gases - Carbon footprint of products – Requirements and guidelines for quantification standard and GHG Protocol - Product life cycle accounting and reporting standard (the GHG Protocol Standard).

Quantification Standard: ISO 14067:2018 Greenhouse gases - Carbon footprint of products – Requirements and guidelines for quantification standard and GHG Protocol – Product life cycle accounting and reporting standard (the GHG Protocol Standard).

Product producer (manufacturer): Hindustan Zinc Limited

Production Location: Mines (RAM, RDM, SKM, ZM & KM), Smelters (CSC, DSC & ZSD) and Casting unit (PMP), India.

Average Special High-Grade Zinc (SHGZ) Product

System Boundary: Cradle to gate
Functional unit: 1 tonne (1000 kg)
Product Carbon Footprint Result (CO_2-eq): 5882.10 kg CO_2-eq

Average Low Carbon Special High-Grade Zinc (SHGZ)[1] Product

System Boundary: Cradle to gate
Functional unit: 1 tonne (1000 kg)
Product Carbon Footprint Result (CO_2-eq): 939.95 kg CO_2-eq

Review Details

Statement No: MET-2024013

Issue date: 2024.06.01

Expiration date: 2026.05.31

Reviewer Name: Dr Hüdai Kara

Reviewer Signature:

Designation: Founder & CEO

Review Company: Metsims Sustainability Consulting

Company Address: 4 Clear Water Place, Oxford OX2 7NL United Kingdom
www.metsims.com

Carbon Footprint Consultant:
Dr. Rajesh Kumar Singh
Sphera Solutions, India

Production Projection of Average Low Carbon Special High-Grade Zinc (SHGZ) for FY 2025 and FY 2026 at HZL based on MBA [1]

Production Projection	FY 2024	April 2024	May 2024 (FYTD)	June 2024 (FYTD)	Oct. 2024 (FYTD)	Dec. 2024 (FYTD)	FY 2025	FY 2026
Total Production of Average SHGZ Product (tonne)	750,752	76,000	152,000	228,000	532,000	684,000	912,000	912,000
Average Low Carbon SHGZ Product - Share (%)	8.37%	8.29%	8.77%	11.05%	14.75%	15.64%	16.89%	30.30%
Average Low Carbon SHGZ Product (tonne)	62,862	6,303	13,325	25,190	78,462	106,961	154,028	276,324

Note: FY: 12-month period between April- March

[1] This result is based on mass balance approach (MBA) with the allocation of the gradual increase of renewable electricity projects implemented to source electricity in the total electricity mix of HZL over the next two financial years by pooling GHG or CO2 emission reductions from reduction projects within the organization and allocating the reductions to Average Low Carbon SHGZ product to be supplied along with certificate.

PRODUCT CARBON FOOTPRINT

THIRD PARTY REVIEW STATEMENT

Metsims Sustainability Consulting was commissioned by Hindustan Zinc Limited to provide independent thirdparty review/verification on the carbon footprint (greenhouse gas emissions) for Average Special High-Grade Zinc and Average Low Carbon Special High Grade Zinc over a cradle to gate system boundary.

The review exercise was performed against the general principles of ISO 14067:2018 Greenhouse gases - Carbon footprint of products – Requirements and guidelines for quantification standard and GHG Protocol – Product life cycle accounting and reporting standard (the GHG Protocol Standard).

The objective of the study is to assess and allocate the quantity of low carbon special high-grade Zinc (SHGZ) product to the actual production of conventional special high-grade Zinc (SHGZ) produced at HZL. This evaluation is based on mass balance approach with the allocation of the gradual increase of renewable electricity projects implemented to source electricity in the energy mix of HZL the next two financial years. Mass balance approach is a method of assigning specified characteristics of input materials to outputs/products when mixing raw materials of different characteristics, in general. HZL utilizes the mass balance approach in the form of pooling GHG or CO_2 emission reductions from reduction projects within the organization and allocating the reductions to low carbon special high grade zinc product to be supplied along with certificate.

The study has been performed in a professional manner using engineering expertise, state-of-the-art PCF methods, adequate PCF models and suitable background data, The data quality of the foreground processes using primary data sources are found to be very high. As a result, the report is closer to representative for the production processes at HZL.

Description of the studied product

The following HZL metal products were included within the scope of this work:

Average Special High-Grade Zinc (Zn – 99.99%)

Average Low Carbon Special High-Grade Zinc (Zn – 99.99%)

The study covers the cradle to gate system boundary which includes production of raw materials, upstream transportation, and manufacturing processes at HZL's different sites.

HZL has produced average special high-grade zinc their mines (RAM, RDM, SKM, KM, and ZM), smelters (CSC, DSC and ZSD) and melting & casting plant (PMP). HZL has also produced average low carbon special high-grade zinc by using allocation of 100% renewable electricity at their mines (RAM, RDM, SKM, KM, and ZM), smelters (CSC, DSC and ZSD) and melting & casting plant (PMP) to the apportioned production of SHG zinc product.

Data collection period – FY 2023-24

Details of manufacturing processes at HZL:

Site Name	Processes	Product(s)
Rampura Agucha Mines (RAM) + Kayad Mines (KM)	*Mining & Milling*	*Zinc concentrate, Lead concentrate*
Rajpura Dariba Mines (RDM)	*Mining & Milling*	*Zinc concentrate, Lead concentrate*
Sindesar Khurd Mines (SKM)	*Mining & Milling*	*Zinc concentrate, Lead concentrate*
Zawar Mines (ZM)	*Mining & Milling*	*Zinc concentrate, Lead concentrate*
Chanderiya Smelting Complex (CSC)	*Smelting & Casting*	*Zinc cathode and Zinc Ingot (SHGZ)*
Dariba Smelting Complex (DSC)	*Smelting*	*Zinc cathode*
Zinc Smelting Debari (ZSD)	*Smelting & Casting*	*Zinc cathode and Zinc Ingot (SHGZ)*
Pantnagar Metal Plant (PMP)	*Melting & Casting*	*Zinc Ingot (SHGZ)*

The intended audience for this study includes HZL management, operational and marketing departments, and other internal stakeholders. HZL will use the information from this study in an aggregated manner for public communications, to develop marketing materials for potential customers.

Roles and Responsibilities

The calculation and determination of the carbon footprints for the Zinc products of HZL are the sole responsibility of HZL. Metsims's responsibility is to express an independent review opinion as to whether the carbon footprints calculated for HZL's Zinc products have been prepared in accordance with the relevant standard.

Description of Third Party Review Process and Criteria

Metsim's review process was carried out to ensure that:

- *Methods used to carry out the product inventory are transparent and consistent with the relevant Standard*
- *Methods used to carry out the product inventory are scientifically and technically valid.*
- *Information and Data used are appropriate and reasonable in relation to the goal of the study.*
- *The inventory report, mass allocation for low carbon SHG zinc and any conclusions based on the results are appropriate for GHG-only inventories.*
- *The inventory report and mass allocation for low carbon SHG zinc is transparent and consistent.*
- *The interpretations reflect the limitations identified and the goal of the study.*
- *The report is intended to support public disclosure.*

The review process entailed review of the carbon footprint report prepared by Hindustan Zinc Limited with support by Sphera Solutions. The reviewer used a review checklist to log all pertinent remarks that were then internally reviewed to ensure rigorous and transparent approach before sharing and discussing with HZL all comments in detail. Outcomes were addressed within an updated version of the carbon footprint report which was subsequently checked by the re-viewer. A materiality check was applied for cut-off criteria. Furthermore, an examination of the process models within the LCA software (LCA FE) was an integral part of this review.

The reviewer acknowledges the unrestricted access to all requested information as well as the open and constructive dialogue during the review process. Various assumptions were addressed and backed by sensitivity analyses of data and methodological choices. The system under study was very carefully defined and modelled. The assumptions are transparently described and are found to be suitable and acceptable concerning the conclusions.

Conclusion and Review Opinion

The reviewer found the overall quality of the methodology and its execution to be adequate. The study is reported in a very comprehensive manner including a transparent documentation of its scope. The used secondary data sources, the used software and background data, the transparent documentation, as well as the discreet and careful interpretation make this report and its results very consistent, applicable and valuable.

Based on the review activities undertaken, nothing has come to our attention that would cause us to believe that HZL have not disclosed accurate and reliable carbon footprint data and production projection of Low Carbon Special High Grade Zinc based on Mass Balance Approach and in conformance with the requirements ISO 14067:2018, GHG Protocol Life Cycle Accounting and Reporting Standard (the GHG Protocol Standard).

Hudai Kara BSc MSc DPhil IMMM

1st of June 2024

Oxford, United Kingdom