

Think Zinc! The Zinc Battery Initiative

Dr. Josef Daniel-Ivad

NAATBATT Annual Meeting & Conference

Feb. 17 - 20, 2025

Orlando, FL



International Zinc Association (IZA)

- 42 full members
- >200 affiliate and associate members
- Offices in North Carolina, Brussels, Delhi, Shanghai

IZA represents the global zinc industry in mining, production, first use production and recycling



IZA Full Members

BEFESA



GRUPO MEXICO



CHELYABINSK
ZINC PLANT



mitsui
KINZOKU



rezinal

Trafigura

NEW
BOLIDEN



ANTAMINA



GRUPO



KIM 2000 PPH



MMG



RHEINZINK®



VM
BUILDING
SOLUTIONS



Korea Zinc



NEW CENTURY
RESOURCES



Silox



ZN
ZINC NACIONAL

everZINC+



Hecla
MINING COMPANY



Brüggemann



NEWMONT®



SOUTH32

GLENCORE



vedanta
transforming elements



Hindustan Zinc Limited

lundin mining

nexa



SUMITOMO METAL
MINING CO., LTD.



Zinc
Resources LLC



Global Steel Dust



HCM SA



ZGM
BOLESŁAW



METAENTERPRISES



NORZINC
A PREMIUM MINE DEVELOPER

Teck



ZinCol Ossidi
S.p.A.



GRILLO



IEQSA



PEÑOLES®



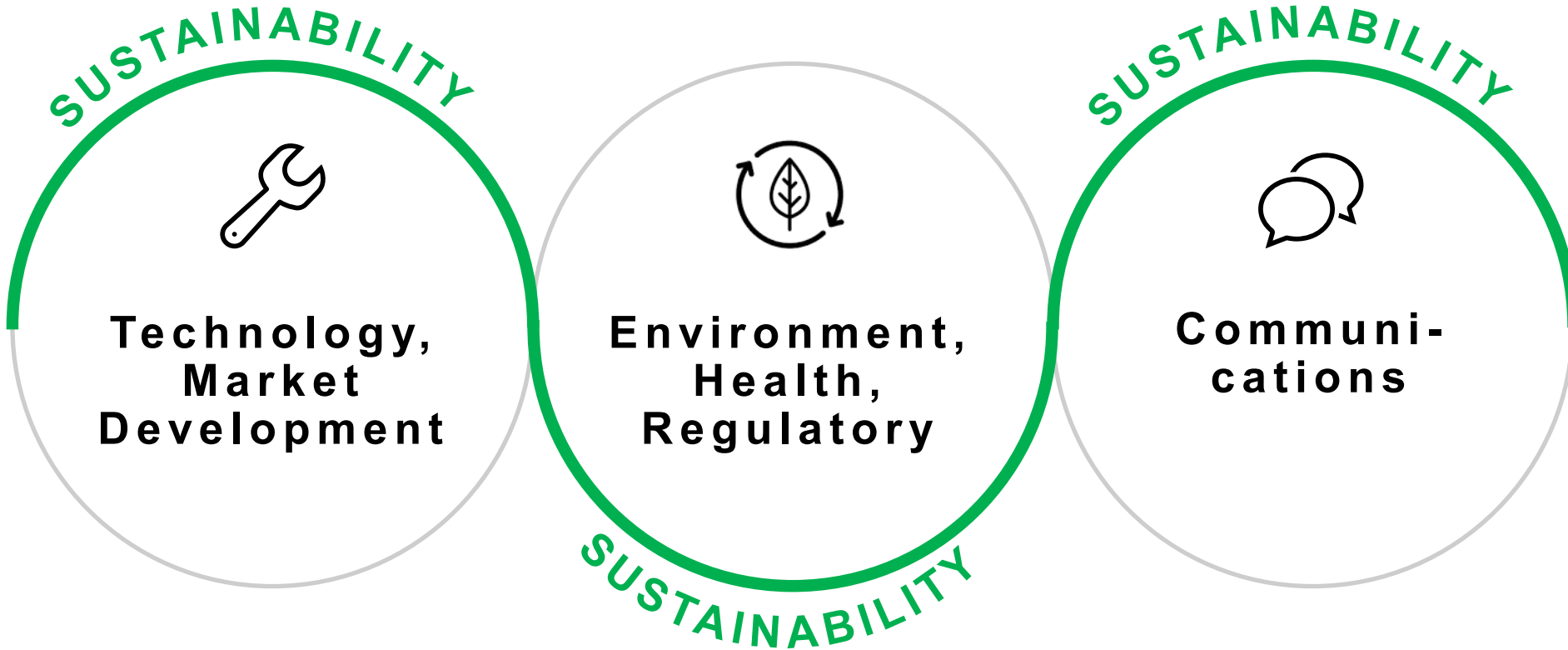
nyrstar

Terrafame



Zochem

IZA's Core Program Areas



Responsible



Essential



Life Saving



Durable



Sustainable

Why Zinc ? – Essential for Modern Life

- ✓ Sustains Life , Strengthens Immune System
- ✓ Helps Plants Grow
- ✓ Protects Infrastructure
- ✓ Enables Lower Cost Autobody Parts
- ✓ Provides Shelters, Building Material
- ✓ Die Castings for Fixtures & Faucets etc.
- ✓ Helps Power Our World → Batteries
- ✓ Recyclable, Sustainable
- ✓ Low Carbon Footprint



ZBI - Zinc Battery Initiative

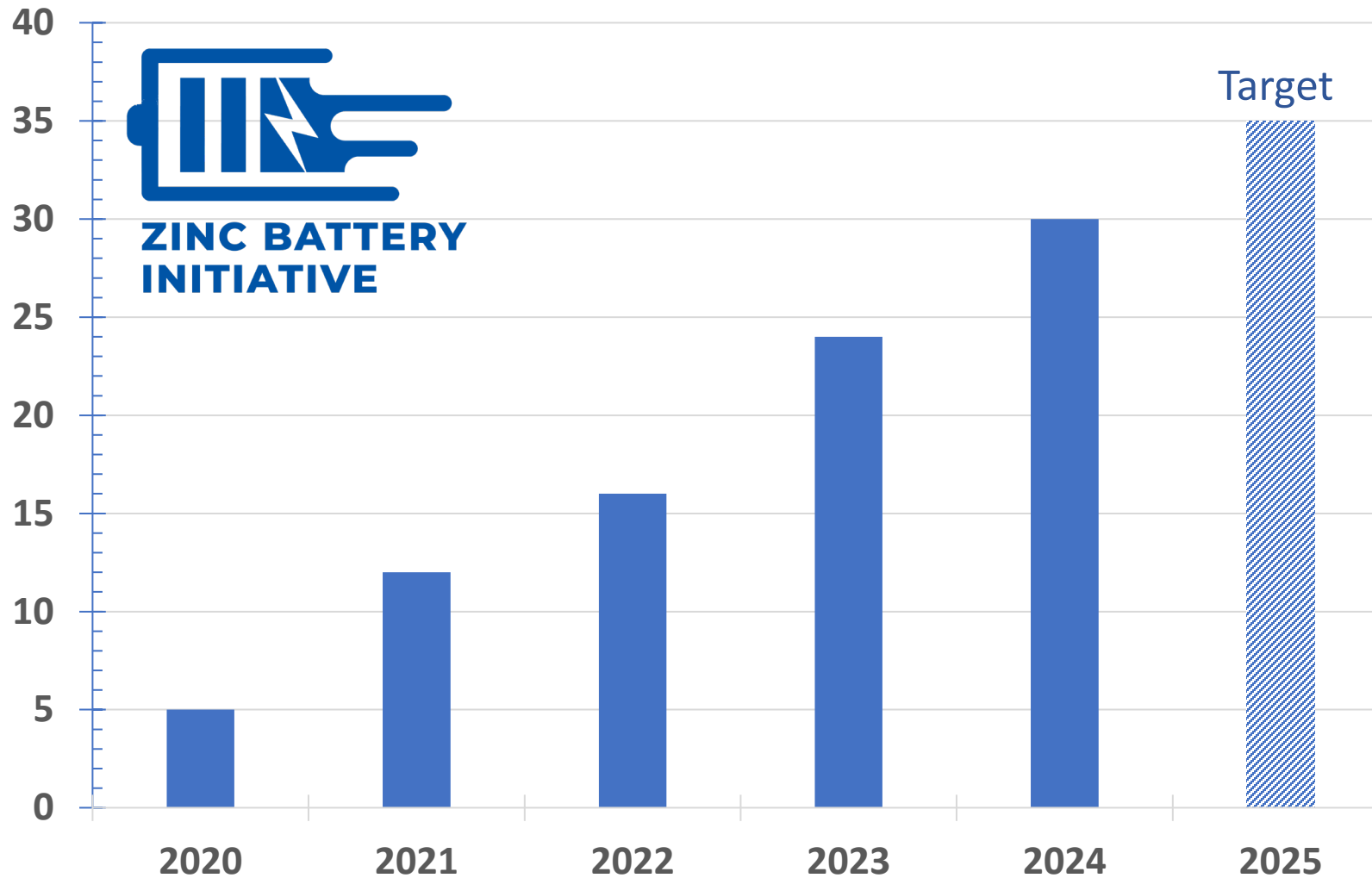
A Partnership to Advance Zinc-based Battery Technologies

The ZBI serves to champion zinc batteries and ensures that all potential customers and other stakeholders understand the value and advantages of zinc-based power and energy storage products.



ZINC | international
zinc association

ZBI Members



Starting with 5 members in 2020, the ZBI grew to 30 members in the span of 4 years.





Zinc Battery Workshop at West Virginia University

- ✓ Seven Zinc battery developers & manufacturers
- ✓ Six zinc producers & suppliers
- ✓ International Zinc Association & ZBI
- ✓ West Virginia University
- ✓ DOE Office of Electricity
- ✓ DOE Office of Energy Efficiency & Renewable Energy
- ✓ DOE Pacific Northwest National Lab
- ✓ DOE Sandia National Lab



U.S. DEPARTMENT OF
ENERGY



**ZINC BATTERY
INITIATIVE**

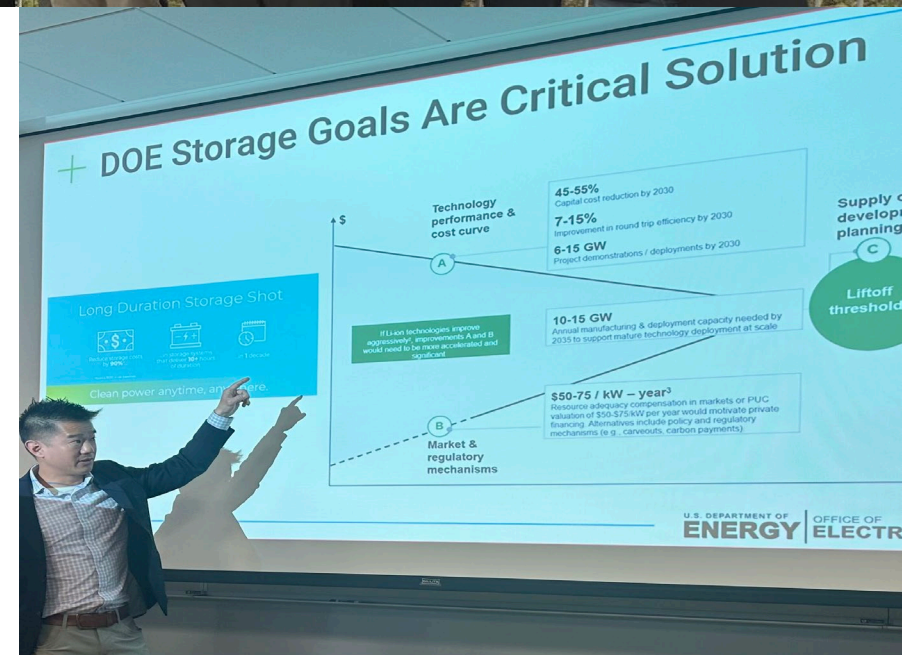


West Virginia University

BENJAMIN M. STATLER COLLEGE OF
ENGINEERING AND MINERAL RESOURCES



Pacific Northwest
NATIONAL LABORATORY



“What if the DOE offered to be the first customer? How many cells would we need to buy?” Eric Hsieh, DOE Deputy Assistant Secretary for Energy Storage

Workshop Outcomes: Challenges and Opportunities



1. High cost for investments in pilot production lines

- * Shared pilot production lines would be valuable for zinc battery developers

2. Derisking first business with batteries produced with a pilot production line (PPL) or full-size line (FSL)

- * Off-take agreements for supply of batteries

3. Industrial awareness and adoption

- * Look beyond utilities: The EV charging industry, energy intensive industry (e.g. steel), and potential other industries, are good targets for adoption of non-Lithium battery chemistries
- * Re-designed charging-discharging strategies offer new opportunities for batteries, such as the addition of (high cycling) grid stabilization functionality to (low cycling) UPS batteries.



Workshop Outcomes: Challenges and Opportunities



4. Safety standards for battery transportation and applications

- * Application standards to include zinc-based batteries
- * Work with insurance companies to derisk zinc batteries for indoor use and in critical applications (datacenters)
- * Work with other battery associations to get zinc batteries specified as unique category in UN battery transportation standards.

5. Supply bottlenecks in battery raw materials and components



Action Plan

- ✓ **Promote and raise awareness about the benefits of zinc batteries to a wider audience of stakeholders**
- ✓ **Collaborate with the federal government and other key stakeholders to bolster the supply chain and offer cost-effective energy storage solutions**
- ✓ **Advocate for the inclusion of zinc batteries in both safety and application standards**



www.zincbatteryinitiative.com



In-Kind Support for DOE Funded Projects

❖ DOE Grant - Newlab and Sandia's HiDEZ consortium

❖ FOA3020 – Newlab and Sandia's HiDEZ consortium (short for “High-capacity long Duration Energy storage Zinc battery consortium”).
IZA/ZBI in-kind support.

❖ LDES National Consortium Teaming Partner

❖ IZA/ZBI in-kind support
❖ Participation in ‘Tiger Teams’

❖ Oak Ridges Nat'l Lab project Aqueous Zn-Ion Batteries

❖ Pledged IZA/ZBI in-kind support



U.S. DEPARTMENT OF
ENERGY



**ZINC BATTERY
INITIATIVE**



Sandia
National
Laboratories



International Zinc Association



Zinc batteries charged for another banner year

Energy Storage

Emerging Technology

TOP STORIES

Buzz

Wednesday, 07 February 2024



Zinc is advancing to deliver as a top battery chemistry for energy storage in 2024, following a breakthrough in both funding and demonstration projects last year, writes *Dr. Josef Daniel-Ivad** of the Zinc Battery Initiative (ZBI).



Zinc battery people feeling confident

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Dr. Josef Daniel-Ivad, manager of the [Zinc Battery Initiative](#) industry body, provides an upbeat assessment for zinc batteries.

Zinc batteries are generating confidence in 2024. This follows promising market outlooks announced at the 2024 annual International Zinc & Zinc Oxide Conferences, the forming of key commercialisation partnerships and a full slate of upcoming demonstration projects designed to prove the value of this sustainable, safe, and scalable technology.



POWER



Jul 24, 2024
by Josef Daniel-Ivad

Energy Storage

Zinc Battery Manufacturers Partner to Speed Commercialization

The Zinc Battery Initiative (ZBI) and its members have collaborated with experts from the U.S. Department of Energy (DOE) and West Virginia University (WVU) to develop an effective path to

ALSO IN THIS ISSUE

July 24, 2024

2024 Media Accomplishments

- ✓ 187 articles mention Zinc Battery Initiative
- ✓ Three editorials by Dr. Josef Daniel-Ivad
- ✓ S&P Global profiles the zinc battery market

2025 Goals

- ✓ Top-tier publication coverage
- ✓ European media coverage
- ✓ Opportunities to feature ZBI members

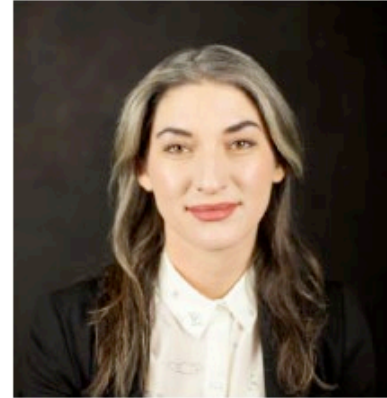
International Zinc Association



Joint Webinars



Think Zinc for Sustainable, Safe,
Long-Duration Energy Storage



Ann-Marie Augustus



Lukas Fuchshofen



Mark Higgins



Balki Iyer

Virtual Webinar

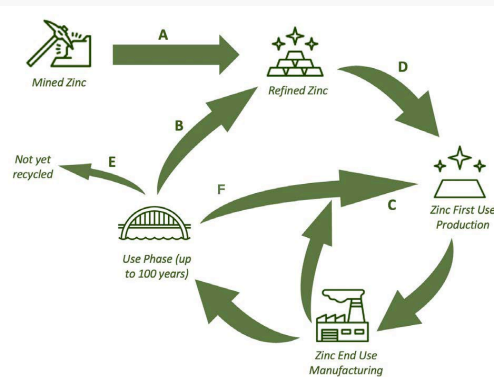
Join the LDES Council and ZBI in our webinar featuring four prominent names in the long-duration energy storage game, highlighting roadblocks and solutions for LDES.





Why Use Zinc for Batteries ?

- ✓ High specific capacity at 820 Ah/kg, 5820 Ah/L
 - ✓ Better volumetric capacity than Li at 2060 Ah/L
- ✓ Versatile, powerful anode material, can be combined with several cathodes
 - ✓ Silver
 - ✓ Nickel
 - ✓ Manganese
 - ✓ Intercalation cathodes, MnO_x , VO_x , PBA, etc...
 - ✓ Bromine, Iodine
 - ✓ Air
- ✓ Fire-safe, water-based electrolytes
- ✓ Low-cost, abundant, sustainable commodity raw material available around the world





ZBI – Members 2-2025

ZINC BATTERY INITIATIVE



Suppliers

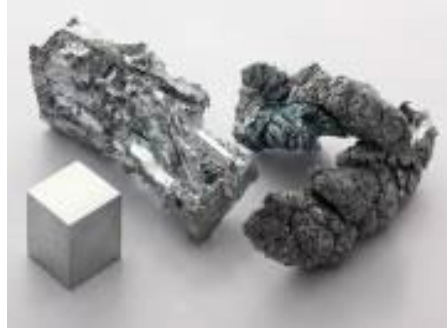


Versatility of Zinc Batteries

	Zinc-Nickel	Zinc-Manganese	Zinc-Ion	Zinc-Halide	Zinc-Air
Chemistry	Aesir Technologies	Urban Electric Power	Enerpoly	EOS Energy	Abound Energy
	Enzinc	Zelos	Salient Energy		AZA Battery
	ZincFive		Hilabs GmbH		E-Zinc
			Coulomb Tech.		Hilabs GmbH
	Zinc-Nickel	Zinc-Manganese	Zinc-Ion	Zinc-Halide	Zinc-Air
Application	UPS Data Center	Backup Power	Residential ESS	Grid Services	Long Duration Energy Storage
	Intelligent Transportation	C & I Energy Storage	C & I Energy Storage	Microgrids	C & I Energy Storage
	Defense	Residential ESS	Backup Power	Remote and Off-Grid Energy Storage	Remote and Off-Grid Energy Storage
	e-mobility		Internet of Things	C & I Energy Storage	

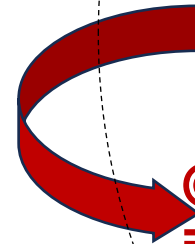


Availability of Zinc



Mt = million tons

1. "Zinc resources – a state of knowledge" by Eric Pirard, 2021 (5 km mineable depth scenario)
2. IZA and Fraunhofer ISI 2021 zinc stocks and flows update (based on 2019 data)
3. U.S. Geological Survey, 2021
4. International Lead Zinc Study Group. 2019
5. IZA and Fraunhofer ISI 2021 update, post- and pre-consumer scrap
6. IZA and Fraunhofer ISI 2021, zinc entering first use stage



**@12.5Mt/yr
= 5,040 yrs.**

Accessible crustal content
198,000,000 Mt¹

Zinc currently in use
247 Mt²

Extractable global resources
63,000 Mt¹

Proven and Probable reserves
250 Mt³

World zinc use/y ● 20 Mt⁶

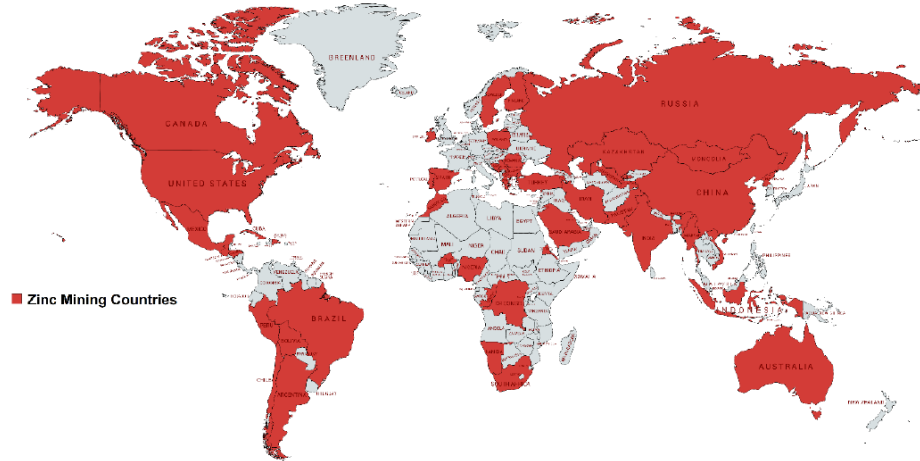
Mined zinc/y ● 12.8 Mt⁴

Zinc recycled/y ● 7.6 Mt⁵



Zinc can be sourced **LOCALLY**

ZINC MINING COUNTRIES IN 2023



- Since 1960 over 60 countries have mined zinc ore
- In 2023, 50 countries were actively mining zinc
- Top 5 mining countries are China, Peru, Australia, USA and India
- Top 10 mining companies contributed to 84% of the world concentrate production capacity

ZINC PRODUCING COUNTRIES IN 2023



- In 2023, 30 countries had zinc metal smelting and/or refining activities
- Top 10 refined zinc metal producing countries contributed 83% of world total output

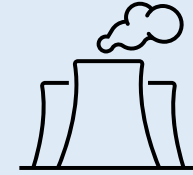


IZA Sustainable Development



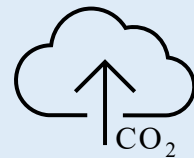
1. Responsible Sourcing

LME Requirements – Joint DD Standard, passport
Full ESG and Assurance - Zinc Mark
Harmonizing Frameworks



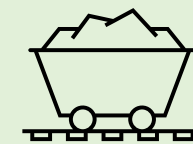
2. LCA and Carbon Footprint

Sector - LMEpassport CF Guidance for SHG Zinc
Material – Profiles at site and global level



3. Climate Action and Energy

Coordination – IZA Climate Change Task Force
Strategy – Decarbonization Roadmap



4. Circular Economy and Availability

Demand – 2050 scenarios
Supply – Material Flow Analyses

ZINC RECYCLING Stocks + Flows

As a material, zinc follows a complex life cycle from one extraction, through refinement and use in society, to eventual collection and recycling of products at the end of life. This life cycle can be characterized by collecting information at various stages of production, manufacturing, use, and waste management. Information on these "stocks and flows" of material can be used to calculate recycling rates, identify recycling gaps, and impact opportunities for increasing zinc circularity.

Material Flow Analysis

A tool called Material Flow Analysis (MFA) is used to characterize the zinc life cycle, which is based on the mass balance principle. In MFA, a material life cycle is described by identifying the main stages (processes) of a material, the main flows connecting these processes, the stocks in which material accumulates over time, and its release from these stocks. These processes are interconnected through the generation and use of scrap in different forms and at different life stages. Flows are quantified by using a variety of data sources, estimates, and mass balance. Five main processes characterize the life cycle for zinc (Figure 1): mining & smelting (production), first use production, fabrication & manufacturing (products), use (service), and management and recycling of scrap and waste (end of life).

Figure 1: Anthropogenic cycle of zinc (Fraunhofer ISI 2022)

The Dynamic Model of Zinc Global Stocks + Flows

The broad variety of zinc uses and zinc recycling pathways require a wealth of data to credibly describe the global zinc cycle. Zinc production, use, and recycling are closely interconnected with the material cycles of steel, brass, and lead, which adds to the complexity. The dynamic nature of the zinc cycle not only requires current input data, but also on historical flows to account for the durability of zinc which can offer a functional lifetime of 100 years for some applications. The International Zinc Association (IZA) partnered with Fraunhofer ISI Institute, Karlsruhe, Germany to develop a comprehensive dynamic model describing global zinc stocks and flows.

Zinc Circularity

The zinc global stocks and flows model helps quantifying the current zinc circularity

- In 2019, 247 Mt of zinc were bound in the use phase, the so-called anthropogenic stock, about twenty times the amount of zinc that was mined in the same year (Figure 2). At the end of useful life, zinc will become available for recycling from the urban mine.

ZINC RECYCLING Material Supply

The world is naturally abundant in zinc. Its unique metallurgical and chemical properties make it the material of choice for an extensive range of applications in a modern and growing society. At the end of their useful life, the zinc recovered from these products can be recycled without loss of its metallurgical characteristics or value. Further, while the attributes of zinc contribute significantly to sustainability during use, zinc recycling also plays a role in reducing mined zinc demand, energy use, emissions, and minimizing waste disposal.

Zinc is Available from Geological, Mined Sources

There is an estimated 198,000 billion metric tons of zinc contained in the earth's crust in such form and amount that economic extraction is currently feasible or will become feasible by 2050 (accessible crustal content Figure 1). However, not all of this zinc is immediately available for extraction. The complex interaction of economic, political, and environmental considerations dictates whether a particular ore body can or should be developed. Due to these factors, 63 billion tons of zinc are estimated as extractable global zinc resources. Of this, about 250 billion tons (Mt) are proven and probable reserves that meet specified criteria for production to achieve current market demands.

Figure 1: Global estimate of zinc resources, reserves, production, and use 2019. (Fraunhofer ISI 2022)

1. Fraunhofer ISI 2022
2. US Geological Survey (USGS)
3. US Geological Survey 2020
4. International Lead Zinc Study Group, 2022

Since exploration and mine development are ongoing processes, the amount of zinc reserves is not a fixed number and sustainability of zinc ore supplies cannot be judged by simply extrapolating the combined mine life of today's zinc mines. This concept is well supported by data from the United States Geological Survey (USGS), which illustrates that although refined zinc production increased 80% between 1990 and 2019, the reserve lifetime for zinc has remained unchanged.

ZINC RECYCLING Closing the Loop

Zinc is an essential element for all living organisms. Its unique metallurgical and chemical properties have also made it the material of choice for an extensive range of applications in modern society. At the end of their useful life, the zinc recovered from these products can be recycled without loss of its characteristics or value.

Current Uses of Zinc

Refined zinc is used in a variety of applications. Galvanizing represents the largest first use of zinc – coating steel to provide corrosion protection (about 60% of total consumption; Figure 1). Other markets for zinc include alloying with copper (brass) or aluminum (die casting), rolled zinc sheet compounds such as zinc oxide (used in fertilizers, paint, rubber, and pharmaceuticals) and many other applications. While uses have not significantly changed over time, zinc consumption has more than doubled in the last 40 years. Most of this growth has occurred in applications with long effective lifetimes, such as galvanizing, alloys, and rolled zinc, where the products may stay in service up to 100 years. Primary end use markets for these products include building and construction, transportation, industrial, electronic, and agricultural applications.

Figure 1: Global refined zinc consumption by first use

Sources for Zinc Recycling

A systematic life cycle for zinc is illustrated in Figure 2. Zinc-containing products such as galvanized steel become a source of recycling feedstock at the end of their useful life ("old scrap"). These products are collected and processed based on scrap availability, metal composition (e.g., purity, alloy, etc.) and ease of processing. Additionally, due to potential losses during manufacturing and fabrication (e.g., dross, residues, off-cuts, etc.), zinc becomes available for recycling during the processing phase ("new scrap"). Depending on the composition of the recycling source being available, it can either be re-melted or returned to the refining process.

Figure 2: 2050 zinc recycling loop (Fraunhofer ISI 2022)

Recycling Rates

Approaches commonly used to assess recycling rates for zinc are Recycled Content (RC), Recycling Input Rate (RIR).

ZINC RECYCLING 2050 Demand + Supply

Metal demand at global level is expected to increase over the next decades. The development is driven by the growing world population and increasing living standards in developing regions, as well as changing use patterns in a growing economy. Zinc contributes to both improved living standards and changing use patterns from its uses in the building sector, infrastructure projects, and renewable energy production and storage. To ensure long-term zinc availability, the International Zinc Association has asked renowned experts to analyze 2050 zinc demand and supply scenarios.

Zinc in Modern Society

About 60% of all zinc produced is used to protect steel from corrosion by galvanizing. Steel is the main metal needed for all projects linked to building, construction, and infrastructure. Prolonging the lifetime of steel saves valuable natural resources and energy, while at the same time increasing and preserving the living standard of societies worldwide.

Figure 1: Zinc coating makes offshore wind energy substitution more than 20x more design-efficient

Renewable energy production is at the core of climate friendly economies. Zinc not only is involved in galvanizing steel structures that support wind and solar power generation, but zinc batteries also support long-duration grid/backstop storage, transforming intermittent energy generation (wind and solar) into constant energy supply.

Figure 2: Zinc coating makes offshore wind energy substitution more than 20x more design-efficient

Zinc 2050 Demand Scenario

Using the zinc global stocks and flows model, Fraunhofer ISI, Karlsruhe, Germany developed a 2050 demand scenario based on population growth and global GDP developments as described by OECD (Global Material Resources Outlook to 2050). As a result, the total amount of zinc used to produce first use goods is expected to increase from 17.5 Mt in 2019 to 28 Mt in 2050. The energy storage market is forecast to consume an additional 2.8 Mt of zinc by 2050 (Figure 3). Demand expectations estimated by Fraunhofer ISI are well in line with those described elsewhere in published literature over the past ten years and for various time horizons. Unforeseen changes in societal use patterns to support carbon neutrality and unknown new uses for zinc will also modify scenarios in the coming years.

Figure 3: 2050 Zinc demand scenario (Fraunhofer ISI 2022)

Maximizing Zinc Circularity

Fact Sheets

- Zinc Stocks and Flows ([link](#))
- 2050 Supply and Demand ([link](#))
- Material Supply ([link](#))
- Closing the Loop ([link](#))

CALL FOR MEMBERSHIP!

Join IZA's ZBI – the voice of the zinc battery industry

Thank You!

PLEASE VISIT OUR WEBSITES

www.ZincBatteryInitiative.com

www.zinc.org

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