IMPACT REPORT 2023

PREVIOUS IMPACT REPORTS

Contents

2023 Sustainability Highlights 2

Who We Are 3
Letter from the CEO 4
Our Vision, Challenge, Plan 5
Our Responsibility 6
Our Key Milestones 7

Why We Exist 8
Metal Intensive Future 9
Availability 10
Security 11
Price 12
ESG Impacts 13
A Circular Metal Economy Future 14
Limitations and Trade-offs of Mining More Metals 15
Doughnut-Shaped Solution Space 15
Complications 16
Our Hypothesis 17
Why We Focus Only on Nodules 18
The CCZ and Abyssal Plains 19
Comparative Life Cycle Studies 20

How We Do It 21
TMC Governance 22
TMC's Governance Structure 22
Business Ethics & Transparency 23
Sustainability Approach 24
TCFD & TNFD 25
Other Initiatives We Support 26
Stakeholders Engagement 27
CCZ Governance 28
International Treaty for High Seas 28
Sponsoring States - State Profiles 29
ISA Mining Code 30
Environmental Impact Statement 31

What We Do 32
Our Operations 33
Our Offshore Operations 34
Resource Definition 35
Collection System 36
Collection System Trials 37
Environmental Program 38
Regulations and Contracts 40
Our Onshore Operations 41
Processing System: Flowsheet Development 42
Plant Site Selection: Choosing the Right Site 43
Environmental, Social and Governance (ESG) Footprint 44
Scope of Our Activities - Pre-Commercial 44
Energy and Emissions 45
Water 46
Waste 47
Our People 48
Environment, Health and Safety (EHS) 49
Sponsoring States 50

About this Report 51
Scope and Boundary 52
Abbreviations 53
ESG Framework Indexes 54
GRI 54
SASB Metals & Mining 55
SASB Marine Transportation 56
Ocean Stewardship Coalition 57

This document is a copy of The Metals Company's (TMC) Impact Report 2023, originally available online at https://metals.metrio.net/. We have made minor adjustments from the web-based report to accommodate its format. To access all features and contents, please refer to the online version.

2023 Sustainability Highlights

ENVIRONMENT

Data collection and sharing for the NORI-D Project offshore environmental impact assessment (EIA):

we spent **28 research days at the NORI-D site in 2023** with world-leading scientists to evaluate seafloor ecosystem function one year after our 2022 nodule-collection system test.

Peer-reviewed research:

data collected from the NORI-D site has served as the basis for **6 peer-reviewed papers published in 2023**[1].

Publication of ocean biodiversity data:

we became the **largest single contributor of biological occurrence data to the UNESCO's Ocean Biodiversity Information System (OBIS) ISA-node**, providing almost 60% of the records and increasing biodiversity records available for the CCZ by about 150%.

Operational visibility for stakeholders:

new agreement with Kongsberg Digital will bring AI and machine learning capabilities to enhance Kognitwin, a digital twin that replicates the **offshore operating environment and nodule-collection operations in 3D.** Kognitwin gives stakeholders a view into the operations and operators a tool to anticipate and manage the impact that future operations could have on the environment.

Carbon sink study:

we commissioned Benchmark to **quantify the magnitude of carbon stocks and carbon sequestration services loss due to mining of cobalt in the region of Katanga, DRC and nickel in Sulawesi, Indonesia.** The study found that 1 kg of nickel mined in Sulawesi removes forests containing carbon stock equivalent to 7.0-9.4 kg of CO_2e, and 1 kg of cobalt mined in Katanga removes 3.6 kg of CO_2e. In contrast, Benchmark estimated that collecting 1 kg of nickel and 1 kg of cobalt from polymetallic nodules could cause the loss of carbon stored in the deep-seabed that would be orders of magnitude smaller: potentially only 0.00011 kg and 0.00014 kg of CO_2e, respectively.

SOCIAL

The world's first social impact assessment (SIA) for a polymetallic nodule project in international waters:

NORI presented on the **SIA scoping and consultation process** for the NORI-D Nodule Project and sought stakeholder input during the International Seabed Authority's 28th Session.

Our contribution to sponsoring state communities:

our subsidiaries NORI and TOML awarded **43 grants for community-led initiatives in Nauru and Tonga** focused on ocean health and the environment, women empowerment, youth and healthy living, sanitation and water, education, and agriculture and food security.

Capacity building:

NORI and TOML sponsored **37 scholarships and training opportunities** through our community program.

Engagement with ocean conservation community:

In an open letter, our Executive Chairman and CEO Gerard Barron invited organizations to sit with us and have honest and constructive conversations on real world data and trade-offs to supply critical minerals for the energy transition.

GOVERNANCE

Our path to deliver net positive impacts:

we published our **sustainability approach and goals.**

The first environmental, social, and governance (ESG) handbook for marine minerals:

we joined an international consortium to develop an ESG disclosure guidance to advance **consistent and transparent industry disclosure** of material topics related to marine minerals projects in the deep-sea environment.

Gender diversity in the boardroom:

3 out of 8 TMC board members were women in 2023, a 38% representation above the 32%average for S&P 500 companies.

[1] Montenegro et al. "Heterogeneity in diagnostic characters across ecoregions: A case study with Botrynema (Hydrozoa: Trachylina: Halicreatidae)", 17 Jan. 2023; Perelman et al. "Eddies and fronts influence pelagic communities across the eastern Pacific ocean", Feb. 2023; Eichsteller et al. "Ophiotholia (Echinodermata: Ophiuroidea): A little-known deep-sea genus present in polymetallic nodule fields with the description of a new species", 1 Mar. 2023; Bergman et al. "Face-Down, Tail-Up: Unusual In Situ Behavior of the Blackchins Neoscopelus macrolepidotus, Neoscopelus microchir, and Scopelengys tristis (Myctophiformes: Neoscopelidae)", 6 Jul. 2023; Simon-Lledó et al., "Carbonate compensation depth drives abyssal biogeography in the northeast Pacific", 24 Jul. 2023; Neal et al. "Taxonomy, phylogeny, and biodiversity of Lumbrineridae (Annelida, Polychaeta) from the Central Pacific Clarion-Clipperton Zone", 25 Jul. 2023.

Next section : Who We Are >

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Who We Are

- Letter From the CEO
- Our Vision - Our Challenge
- Our Responsibility
- Our Key Milestones

Forward-Looking Statements

The Impact Report contains “forward-looking statements” within the meaning of Section 27A of the Securities Act of 1933, as amended, and Section 21E of the Securities Exchange Act of 1934, as amended, that relate to future events, TMC the metals company Inc.’s (the “Company”) future operations or financial performance, or the Company’s plans, strategies and prospects. These statements involve risks, uncertainties and assumptions and are based on the current estimates and assumptions of the management of the Company as of the date of this report and are subject to uncertainty and changes. Given these uncertainties, you should not place undue reliance on these forward-looking statements. Important factors that could cause actual results to differ materially from those indicated by such forward-looking statements include, among others, those set forth under the heading “Risk Factors” contained in the Company’s Form 10-K for the year ended December 31, 2023, which was filed with the Securities and Exchange Commission on March 25, 2024, as well as any updates to those risk factors filed from time to time in our periodic and current reports.

Next: Letter From the CEO >

We're building a carefully managed metal commons that will be used, recovered, and reused again and again.

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Letter From the CEO

Gerard Barron
Chairman & CEO

Dear stakeholders,

After completing two more offshore campaigns in 2023, we have reached an important milestone for our NORI Project: after more than 12 years of offshore research, we believe we have collected sufficient marine environmental baseline and impact data to develop an Environmental Impact Statement (EIS) and Environmental Mitigation and Management Plan (EMMP) for the world's first deep-seafloor nodule collection project.

Once completed, both the NORI Project EIS and EMMP will be subject to public consultation. We look forward to engaging with our stakeholders on the expected environmental and social impacts of our proposed operations. In the meantime, several developments from the last twelve months merit highlighting:

– **World's most comprehensive deep-sea dataset:** The dataset collected by NORI is now approaching 900 terabytes in size and includes data gathered across multiple disciplines including Oceanographic, Biological, GIS, Geological, Geochemical, eDNA, as well as operational metadata collected and tracked across environmental campaigns, different vessels and equipment. With no off-the-shelf solutions available to manage and share such a diverse and large dataset, we had to build our own platform that integrates solutions from dozens of providers. In 2023, NORI began the process of submitting all environmental baseline data collected in NORI Area D to the DeepData platform, an open database of contractor data managed by the International Seabed Authority (ISA). The first batch of this data was also published by the ISA to UNESCO's Ocean Biodiversity Information System (OBIS). Just the first batch of NORI-D data already represents almost 60% of all records for the ISA node. OBIS shows that as of July 23, 2024, the NORI-D dataset has already been downloaded over 4,000 times and interrogations of specific taxa contained within the holdings have seen NORI-D occurrences downloaded over 200 million times.

– **Encouraging images of sessile seafloor fauna 12 months after pilot collector system test:** In 2023, about twelve months after the completion of our 2022 integrated nodule collection system test in NORI-D area, we returned for two more offshore campaigns to collect data on the recovery and functioning of the abyssal ecosystem a year after the disturbance. While marine scientists are still collating and making sense of all the data collected from diverse measurements, we did report anecdotal evidence of recovery. Images gathered using Remotely Operated Vehicles (ROV) showed that sessile megafauna living inside the collector test area that were visibly impacted by the seafloor sediment plume when we photographed them within weeks of the test, were alive and free of sediment, including organisms identified right next to the collector tracks.

– **Adapting our collector system design based on environmental baseline data:** In line with best practice, NORI has applied the findings from its Environmental Impact Assessment (EIA) and pilot collection system test to inform the design of our first commercial-scale collection system. Based on the results from plume modelling, the return pipe has been extended from a depth of 1,200 m to 2,000 m, ensuring that sediment and seawater discharged back into the ocean avoids the sensitive oxygen minimum zone and the more productive surface layers of the water column. Modifying project specifications in response to environmental findings embeds mitigation measures in to the project design. This is considered the gold standard for impact mitigation as embedded measures are typically more effective than reactive mitigation.

– **NORI-D SIA and Cultural Heritage study:** Significant progress was made on our Social Impact Assessment for the NORI-D project in 2023, which is the first such assessment of its kind for a deep-sea minerals project in international waters. Prizma LLC have conducted stakeholder consultations and engagements, and are now finalizing the baseline descriptions for the assessment, which has now begun in earnest. We are also committed to conducting a Cultural Heritage Impact Assessment to understand the potential impacts of our operations on tangible (Ex. Ship wrecks, downed planes) and intangible (ex. Cultural connections, knowledge, skills) cultural heritage. SEARCH Inc. has been engaged to deliver this workstream, which is currently underway. From this, culturally sensitive and appropriate measures will be developed to ensure the responsible development of the NORI-D project which ensures the safeguarding of cultural heritage resources.

– **Comparative impacts on carbon sinks during mining phase:** In our continued quest to understand lifecycle impacts of our future production and how they compare to the current alternatives on land, we commissioned Benchmark Mineral Intelligence to study the impacts of land-based mining on carbon sinks and sequestration services in the top nickel and cobalt producing regions of Sulawesi, Indonesia and Katanga, Democratic Republic of Congo. Forest ecosystems play a critical role in the carbon cycle, yet mining's impacts on their carbon sequestration services often goes unaccounted for in studies. This study addressed this gap and showed that when accounting for the removal of forests, the lifecycle global warming potential (GWP) per kilogram of nickel mined in Indonesia would increase by 7-49% per kilogram (depending on production routes) and by 35% per kilogram of cobalt mined in the DRC. By comparison, peer reviewed research published in *Limnography and Oceanography* and our own analysis show that nodule collection from the seafloor results in negligible impacts on carbon sinks and carbon sequestration services.

In 2024, our team is laser focused on finalizing the NORI Project EIS and EMMP alongside a broad group of subject matter experts. With no precedents to draw on, it's a formidable task our environmental team often likens to writing multiple PhDs at the same time. But that's what it takes to ensure that the regulator and all stakeholders have a rigorous science-based overview of the impacts of our planned operations!

I look forward to sharing the highlights of how it goes in the next year's Impact Report.

Gerard Barron
Chairman & CEO

^ Back to the section page Next: Our Vision - Our Challenge >

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Our Vision

"We envision a carefully managed metal commons that will be used, recovered, and reused again and again – for millennia."

Imagine if, a hundred years from now, our great-grandchildren could use the exact same metal atoms inside our phones, cars and homes. These metal atoms could continue to serve humankind through countless cycles of technological ingenuity. No more metal lost to landfills. No more damage to the planet and the people on it. A society built with a metal metabolism, similar to how many biological systems have evolved over time.

Our Challenge

Getting there is not a straight path because today we do not have sufficient metal stocks to meet our growing needs (for more information, see pages "Metal-Intensive Future" and "Availability"). We face the challenge of building up a metal commons in a way that has the lowest possible adverse impact on people and the planet.

The fight against climate change—or, present-day climate crisis for many Pacific Island nations—requires an accelerated transition to renewables and electric transportation. Such a transition comes with an exponential growth in demand for the critical metals that these technologies require. It will take decades to get to a place where humanity has enough metal stock in circulation to meet its needs without having to take significantly more metal from the planet.

We see two trends that we expect to continue to drive growth in metal demand:

- The world has embarked on a massive, multi-generational project to decarbonize global energy and transportation.
- At the same time, the world's population continues to grow (the United Nations has predicted that it will grow by 2 billion net by 2050[1]), urbanize, and develop.

Given these developments, it is likely that in the next 30 years we will have to mine more nickel, cobalt and copper than we have mined in all of human history[2]. Remaining land-based metal reserves reside in locations with multi-dimensional challenges. For instance, Indonesia, the world's largest nickel producer and reserve holder, and the Democratic Republic of the Congo (DRC), the world's largest cobalt producer and reserve holder, have significant human populations (over 278 million and 104 million, respectively[3]) and possess large carbon sinks, high biomass, and mega-biodiversity—all of which are impacted by metal production.

[1] United Nations Department of Economic and Social Affairs, "World Population Prospects 2022: Summary of Results", 2022

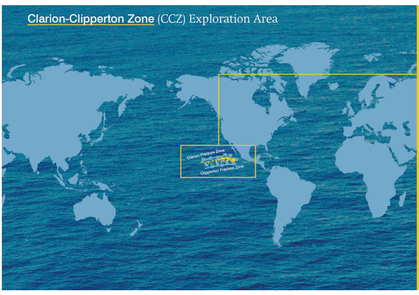
[2] IEA, "The Role of Critical Minerals in Clean Energy Transitions", May 2021

[3] Worldometer, "Indonesia Population" and "DR Congo Population", Updated on July 16, 2023 with the latest July 2023-July 2024 estimates from the United Nations, Department of Economic and Social Affairs, Population Division

Our Plan

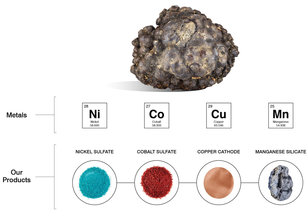
We have a three-step plan. First, we focus on addressing the immediate challenge: How do we produce more metal required for the global energy transition and development with the lowest possible cost to people and the planet? If extracted responsibly, we believe polymetallic nodules found on the deep seafloor in the Clarion-Clipperton Zone (CCZ) could be a good complementary answer for energy transition and development metals like nickel, copper, cobalt, and manganese.

Clarion-Clipperton Zone (CCZ) Exploration Area



The Earth's oceans cover 361 million km² or 71% of our planet's surface. The nodule exploration area in East Pacific known as the CCZ covers 4.6 million km² or 1.3% of the global oceans. The seafloor in the CCZ is deep (3,500-6,500m) and relatively flat, characteristic of an abyssal plain. Abyssal plains and hills are the most common habitat on Earth, covering 70% of the ocean's floor.

Key Battery Metals Contained in Nodules



Second, every new ton of metal we extract from deep seafloor nodules and add into the system today is a ton of metal that can be recovered and recycled in the future. We plan to track, recover and recycle the metals that we have added into circulation to help build up recyclable metal stocks to reduce future demand for mined metals. In a few decades, we expect to exit metal extraction from seafloor resources altogether as we expect most of global demand will be met with recycled metals. Finally, with metal recycling as our key focus, we will expand our scope to recover a broader set of metals.

We envision a carefully managed metal commons that will be used, recovered, and reused again and again – for millennia.

Chapter 1	Chapter 2	Chapter 3
Supply required primary critical metals with the east negative impact on people and the planet	Recycle the metals we produce	Recycle the rest

↓

Exit primary production

^ Back to the section page Next: Our Responsibility >

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Our Responsibility

We consider it our responsibility to (1) account for the full stack of impacts we may have on planetary boundaries and social foundations, (2) aim to create a net positive impact on people and the planet, and (3) change course if the path we choose does not deliver on our net positive impact goal.

Full stack of impacts: Failing to account for negative externalities of human activities on people and the planet is what got our civilization in trouble. Taking metal from the planet inevitably damages nature and can have significant human costs as well. Minimizing these costs is why we decided to focus on developing a polymetallic nodule resource found far offshore, away from human communities, and at great depths of the abyssal plains that host lower biomass and biodiversity than most other biomes on Earth. But are we right? Will our operations deliver a better set of trade-offs compared to the alternatives? We believe that a careful inventory of all material impacts of our choices is a prerequisite for making informed decisions. It is therefore our responsibility to invest in understanding the environment, anticipating potential impacts of our future commercial operations on people and the planet, and improving before we begin.

Net positive impact: We have a rare opportunity to develop a resource deemed to be a common heritage of humankind. We believe it is our responsibility to develop such a resource in a manner that has a significant, lasting, and net positive impact on people and the planet.

Course correction: We believe it is our responsibility to change course if our chosen path does not deliver on our net positive impact goal. We cannot afford path dependencies.

OUR RESPONSIBILITIES

#1: Full Stack of Impacts

No "externalities" – accounting for the full stack of our impacts on planetary boundaries and social foundations

#2: Net Positive Impact

Create a significant, lasting, net positive impact on people and planet using a common heritage of humankind resource.

#3: Course Correction

Change course if our chosen path does not deliver on our net positive impact goal: we cannot afford path dependencies.

For over a decade, in partnership with and support from three Pacific island nations as our sponsoring states, we have explored the seafloor of the Clarion-Clipperton Zone (CCZ) in the Pacific Ocean where the planet's largest-known deposits of undeveloped energy transition metals reside. Together with our offshore engineering partner, Allseas, we have developed and successfully piloted an offshore nodule-collection system that lifted over 3,000 tonnes of nodules to the surface. And our onshore processing team has developed and successfully piloted a nodule-processing flowsheet to produce energy transition metals from the nodules while generating near-zero solid processing waste. We have also invested in comparative lifecycle assessments to determine the impacts associated with producing metals from nodules compared to key land-based routes of producing the same metals. And to determine the offshore environmental impacts associated with nodule-collection operations in the CCZ, we have invested in a multi-year, comprehensive assessment program with leading scientific and academic institutions across the world. Today, we remain in the exploration phase and are working on a comprehensive application for an exploitation permit. To date, our impacts on people and nature are limited to our offshore exploration expeditions and the technology-development work that our partners predominantly conduct in their own facilities.

With this impact report, which we have published since 2021, we share our motivation, approach, expected impacts and how they compare to key-land based metal-production routes, and current work to eliminate or reduce our future impacts. We do so to uphold our responsibilities as we look to account for the full stack of possible impacts that we may have on planetary boundaries and social foundations, aim to create a net positive impact on people and the planet, and change course if the path we choose does not deliver on our impact goal.

We share these analyses and plans for another reason as well: to invite the many brilliant people in the world who do not work in TMC to keep reading and to respond to our plans. If you see questionable assumptions or if you have better ideas for solving our complex impact puzzle, please share them via impact@metals.co. We welcome a science-driven dialogue with a focus on solutions that consider the interconnectedness and complexities of planetary and social systems.

^ Back to the section page Next: Our Key Milestones >

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Our Key Milestones

2011 — DeepGreen[1] is founded — Nauru Ocean Resources Inc. (NORI, fully owned subsidiary) in the Clarion-Clipperton Zone is granted an exploration contract, sponsored by Nauru

2012 — TOML (Tonga Offshore Mining Limited, a fully owned subsidiary since 2020) exploration contract granted, sponsored by Tonga

2015 — Marawa, sponsored by Kiribati, enters into an exclusive commercial agreement with DeepGreen (now TMC)

2017 — Maersk Supply Service becomes a strategic partner and investor

2019 — Allseas becomes a strategic partner and investor

2020 — Allseas acquires first ship for nodule collection

2021 — Sustainable Opportunities Acquisition Corp. (SOAC) + DeepGreen = the metals company

2022 — NORI and Allseas Lift Over 3,000 Tonnes of Polymetallic Nodules to Surface (first integrated system trial in the CCZ since the 1970s)

2023 — Binding MOU with PAMCO to complete feasibility study to process polymetallic nodules into battery metal feedstocks

2025 — ISA roadmap for finalization of Mining Code

2026 — Projected to start small-scale commercial production

2030 — Expected steady-state commercial production

[1]DeepGreen Resources predecessor of DeepGreen Metals

^ Our Responsibility Next section: Why We Exist >

We're building a carefully managed metal commons that will be used, recovered, and reused again and again.

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Why We Exist

Metal-Intensive Future

- Metal-Intensive Future
- Availability
- Security
- Price
- ESG Impacts

A Circular Metal Economy Future

- A Circular Metal Economy Future

Limitations and Trade-Offs of Mining More Metals

- Doughtnut-Shaped Solution Space
- Complications

Our Hypothesis

- Our Hypothesis
- Why We Focus Only on Nodules
- The CCZ and Abyssal Plains
- Comparative Life Cycle Studies

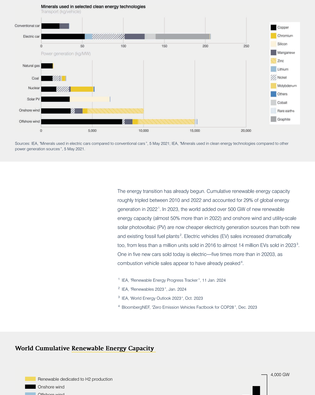
Metal-Intensive Future

Introduction
Availability
Security
Price
ESG Impacts

The global energy transition requires significant quantities of metal. An offshore wind farm requires eight times more critical metals to build than a coal-fired plant[1], while an electric car requires six times more compared to a conventional one[2].

[1] IEA, 'Minerals used in clean energy technologies compared to other power generation sources', 5 May 2021

[2] IEA, 'Minerals used in electric cars compared to conventional cars', 5 May 2021



Sources: IEA, 'Minerals used in electric cars compared to conventional cars', 5 May 2021; IEA, 'Minerals used in clean energy technologies compared to other power generation sources', 5 May 2021.

The energy transition has already begun. Cumulative renewable energy capacity roughly tripled between 2010 and 2022 and accounted for 29% of global energy generation in 2022[1]. In 2023, the world added over 500 GW of new renewable energy capacity (almost 50% more than in 2022) and onshore wind and utility-scale solar photovoltaic (PV) are now cheaper electricity generation sources than both new and existing fossil fuel plants[2]. Electric vehicles (EV) sales increased dramatically too, from less than a million units sold in 2016 to almost 14 million EVs sold in 2023[3]. One in five new cars sold today is electric—five times more than in 2003, as combustion vehicle sales appear to have already peaked[4].

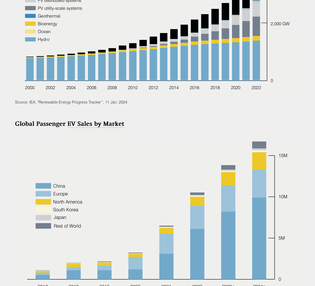
[1] IEA, 'Renewable Energy Progress Tracker', 11 Jan. 2024

[2] IEA, 'Renewables 2023', Jan. 2024

[3] IEA, 'World Energy Outlook 2023', Oct. 2023

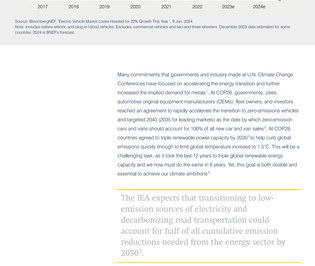
[4] BloombergNEF, 'Zero Emission Vehicles Factbook for COP28', Dec. 2023

World Cumulative Renewable Energy Capacity



Source: IEA, 'Renewable Energy Progress Tracker', 11 Jan. 2024

Global Passenger EV Sales by Market



Source: BloombergNEF, 'Electric Vehicle Market Looks Headed to 22% Growth This Year', 8 Jan. 2024
Note: Includes battery-electric and plug-in hybrid vehicles. Excludes commercial vehicles and two-and-three wheelers. December 2023 data estimated for some countries. 2024 is BNEF's forecast.

Many commitments that governments and industry made at U.N. Climate Change Conferences have focused on accelerating the energy transition and further increased the implied demand for metals.[1] At COP26, governments, cities, automotive original equipment manufacturers (OEMs), fleet owners, and investors reached an agreement to rapidly accelerate the transition to zero-emissions vehicles and targeted 2040 (2035 for leading markets) as the date by which zero-emission cars and vans should account for 100% of all new car and van sales.[2] At COP28, countries agreed to triple renewable power capacity by 2030[3] to help curb global emissions quickly enough to limit global temperature increase to 1.5°C. This will be a challenging task, as it took the last 12 years to triple global renewable energy capacity and we now must do the same in 8 years. Yet, this goal is both doable and essential to achieve our climate ambitions[4].

> The IEA expects that transitioning to low-emission sources of electricity and decarbonizing road transportation could account for half of all cumulative emission reductions needed from the energy sector by 2050[5].

[1] U.N. Climate Change Conference (COP26) at the SEC Glasgow, "COP26 Outcomes", 20 Dec. 2021

[2] COP26, "COP26 Declaration on Accelerating the Transition to 100% Zero Emission Cars and Vans", 9 Apr. 2022

[3] UNFCCC, "COP28 Agreement Signals "Beginning of the End" of the Fossil Fuel Era", 13 Dec. 2023

[4] IEA, 'Net Zero Roadmap - A Global Pathway to Keep the 1.5 °C Goal in Reach', Sep. 2023; BloombergNEF, "Tripling Global Renewables by 2030", 21 Nov. 2023

[5] IEA, 'Net Zero Roadmap - A Global Pathway to Keep the 1.5 °C Goal in Reach', Sep. 2023

An electric car with a 75 kWh battery using NMC811 (nickel-manganese-cobalt) cathode chemistry would need 122 kg of metals contained in nodules:

56 kg	7.1 kg	6.6 kg	53 kg
of nickel in nickel sulfate ($NiSO_4$)	of cobalt in cobalt sulfate ($CoSO_4$)	of manganese in manganese sulfate ($MnSO_4$)	of copper cathode for the harness and connectors
28 Ni Nickel	27 Co Cobalt	25 Mn Manganese	29 Cu Copper

Source: Elias Oliveira et al., "Lithium-Ion Battery Supply Chain Considerations: Analysis of Potential Bottlenecks in Critical Metals," 11 Oct. 2021, BMO Markets Capital, Aug. 2023.
Note: In 2022, lithium nickel manganese cobalt oxide (NMC) remained the dominant battery chemistry with a market share of 86% (IEA, Global EV Outlook 2023", Apr. 2023).

Our decarbonized, metal-intensive future attracts considerable analytical effort from organizations such as the World Bank[1], the International Energy Agency (IEA)[2], and the International Monetary Fund (IMF)[3]. The IEA found that the record deployment of energy transition technologies has already underpinned considerable demand growth for critical minerals. Between 2017 and 2022, demand for lithium tripled while demand for nickel and cobalt grew by 40 and 70%, respectively. It expects this trend will continue and when compared to 2022, by 2030 the overall energy-transition-driven demand for metals would grow up to 3.5 times. As a result, by 2030 the demand growth is projected to increase 7.6 times for nickel, 4.7 times for manganese, 3 times for cobalt and 2.7 times for copper[4].

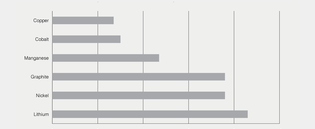
[1] World Bank, "The Mineral Intensity of the Clean Energy Transition", Apr. 2020

[2] IEA, "The Role of Critical Minerals in Clean Energy Transitions", May 2021

[3] Lukas Boer, et al., "Energy Transition Metals" 12 Oct. 2021

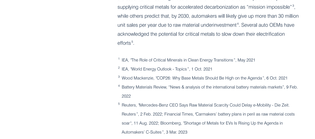
[4] IEA, "Critical Minerals Market Review 2023", Jul. 2023; IEA, "Critical Minerals Data Explorer", 11 Jul. 2023

Mineral Requirements for Clean Energy Technologies by Scenario



Notes: STEPS = Stated Policies Scenario; APS = Announced Pledges Scenario; NZE = Net Zero Emissions by 2050 Scenario. Includes most of the minerals used in various clean energy technologies but does not include steel and aluminum.
Source: IEA, "Critical Minerals Market Review 2023", Jul. 2023

Demand Growth for Selected Minerals by 2030 Driven by Energy Transition Technologies Under the Net Zero Emissions by 2050 Scenario, 2020 Compared to 2022



Source: IEA, 'Critical Minerals Market Review 2023', Jul. 2023

> To contain climate change, we will need to mine more critical metals in the next 30 years than we have mined in all of human history[1].

The IEA acknowledges that current data shows a "looming mismatch between the world's strengthened climate ambitions and the availability of critical minerals that are essential for realizing those ambitions".[1] Some market analysts already view supplying critical metals for accelerated decarbonization as "mission impossible"[2], while others predict that, by 2030, automakers will likely give up more than 30 million unit sales per year due to raw material underinvestment[3]. Several auto OEMs have acknowledged the potential for critical metals to slow down their electrification efforts[4].

[1] IEA, 'The Role of Critical Minerals in Clean Energy Transitions', May 2021

[2] IEA, 'World Energy Outlook - Tables', 1 Oct. 2021

[3] Wood Mackenzie, "COP26: Why Base Metals Should Be High on the Agenda", 6 Oct. 2021

[4] Battery Materials Review, "News & analysis of the international battery materials markets", 8 Feb. 2022

[5] Reuters, 'Mercedes-Benz CEO Says Raw Material Scarcity Could Delay e-Mobility - Die Zeit', Reuters', 2 Feb. 2022; Financial Times, 'Carmakers' battery plans in peril as raw material costs soar', 11 Aug. 2022; Bloomberg, "Shortage of Metals for EVs Is Rising Up the Agenda in Automakers' C-Suites", 3 Mar. 2023

Growing stakeholder awareness about the key role of critical minerals in the energy transition and their supply mismatch has led to several notable developments in 2023. In April, G7 Ministers of Climate, Energy and the Environment created a Five-Point Plan for Critical Minerals Security and governments around the world tasked the IEA to make recommendations on options to diversify supplies of critical minerals and clean energy technology manufacturing[1]. As a response, the IEA created a new Energy Security and Critical Minerals Division within its Secretariat dedicated to these issues. In September, the organization held the first ever Critical Minerals and Clean Energy Summit and delivered six key actions for secure, sustainable and responsible supply chains[2]. In December, at COP28, UN Secretary-General António Guterres announced the establishment of a Panel on Critical Energy Transition Minerals to provide guidance on the extraction of critical metals in a "sustainable, fair and just way"[3].

[1] IEA, 'IEA Critical Minerals and Clean Energy Summit delivers six key actions for secure, sustainable and responsible supply chains', 28 Sep. 2023

[2] IEA, 'IEA Critical Minerals and Clean Energy Summit delivers six key actions for secure, sustainable and responsible supply chains', 28 Sep. 2023

[3] UN News, "COP28: Extraction of minerals needed for green energy must be 'sustainable and just', says Guterres", 3 Dec. 2023

At TMC, we believe we could play a role in supporting these ambitions and the ongoing efforts to accelerate progress towards diversified and sustainable supplies of critical minerals. We see polymetallic nodules found far offshore in the international waters of the CCZ as a promising pathway to responsibly bring to market significant amounts of nickel, cobalt, copper and manganese. The volume of critical minerals needed for the energy transition is one part of the challenge, and their production comes with its own risks. We can identify four main risks presented by the supply of critical metals needed for the energy transition: availability, security, price and ESG impacts.

^ Back to the section page Next: Availability >

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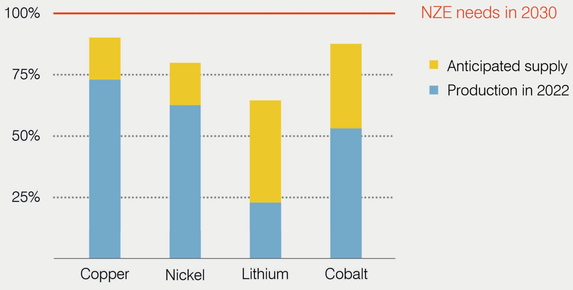
Availability

The world will need to mine unprecedented quantities of critical minerals in the coming decades to achieve its climate ambitions. For critical metals like lithium, nickel, cobalt and copper, around 500 new mines need to be brought online in the next 5-10 years to meet the necessary speed and scale of the energy transition alone[1]. The IEA anticipates that primary supply from the current pipeline of announced project for these minerals could fall short of the net zero emissions (NZE) scenario requirements by up to 35%[2].

[1] IEA, "IEA Summit on Critical Minerals and Clean Energy", 28 Sep. 2023. Comments from 4m00s-4m40s; The World Bank, "Minerals for Climate Action: The Mineral Intensity of the Clean Energy Transition", Apr. 2020.

[2] IEA, "Net Zero Roadmap - A Global Pathway to Keep the 1.5 °C Goal in Reach", Sep. 2023.

Production from Existing and Announced Extraction Projects for Key Critical Minerals Relative to NZE Scenario Requirements



Notes: Anticipated supply from the current pipeline of announced projects for key critical minerals would provide at least 65% of 2030's NZE Scenario requirements. This figure shows primary demand and supply of critical minerals, excluding secondary production. 'Anticipated supply' is expected future production based on expert judgement from third-party data providers. Expectations in commodity prices can have a large impact on the expected supply; a higher price might lead to more supply coming online. At the same time, unexpected delays in financing, permitting or construction could delay projects and yield lower supply. The value is therefore lower than the sum of all announced projects.
Source: IEA, "Net Zero Roadmap - A Global Pathway to Keep the 1.5 °C Goal in Reach", Sep. 2023.

The world faces potential shortages for metals such as nickel[1], copper[2], and cobalt[3] as early as 2025 to 2028 depending on the metal[4]. Exploration pipelines currently look thin and, if major new discoveries arise, it will take a long time to assess them and plan, develop, and start production. Between 2020-2023, it took, on average, 17.9 years for major mining projects to move from discovery to first production—5 years longer than mines starting up 15 years ago[5]. It remains to be seen what share of anticipated projects will materialize on time—delays have been common in the past[6]. Besides, not all metal supply is equal. Batteries for instance, need battery-grade metals which generally require high-quality inputs, whereas technology-grade metals can be produced from lower quality inputs. This means that the availability of battery-grade metals could still be constrained even if the overall market balance is positive[7]. This is an important distinction to note since the EV market is just starting to scale up[8].

[1] Marcelo Azevedo et al., "How clean can the nickel industry become?", 11 Sep. 2020

[2] Wood Mackenzie, Q4 2020 Copper Long Term Outlook, Dec. 2020

[3] Pratima Desai and Mai Nguyen, "Shortages flagged for EV materials lithium and cobalt", 1 Jul. 2021

[4] Benchmark Raw Material Forecast, 2023

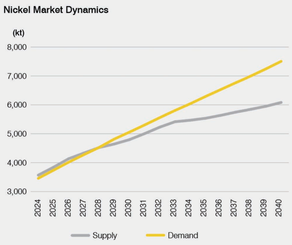
[5] S&P Global, S&P Commodity Insights, Mar. 2024

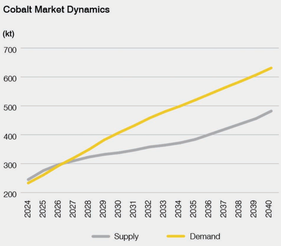
[6] IEA, "Critical Minerals Market Review 2023", Jul. 2023

[7] IEA, "Critical Minerals Market Review 2023", Jul. 2023

[8] Benchmark, Benchmark Week 2023, "The Race to Secure Sustainable and Compliant Nickel and Cobalt", 14 Nov. 2023

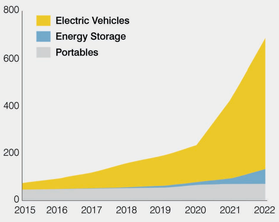
Nickel and Cobalt Long-Term Market Balance Suggest Potential Market Deficit from 2028 Onward

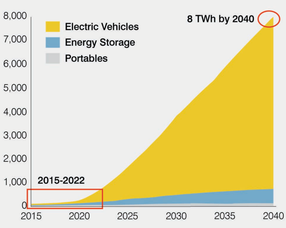




Source: Benchmark, Nickel and Cobalt Balance Q1 2024

Battery Demand by Market Segments





Source: Benchmark Minerals Forecast, Benchmark Week 2023, "The Race to Secure Sustainable and Compliant Nickel and Cobalt", 14 Nov. 2023

^ Back to the section page Next: Security >

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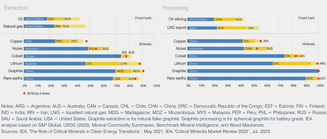
Security

After decades of strategic investment, strategic investment and industrial policy codified in its governing five-year plans, China ("dubbed the "Saudi Arabia of clean technology[1]") dominates the energy materials supply chain and has effectively secured its role as the world's primary economic beneficiary of the energy transition. Fatih Birol, the International Energy Agency (IEA's) Executive Director warned that "the level of over-concentration that we see in critical minerals markets today is unlike that for any other major commodity we have come to rely on in the modern world. History has shown us that failing to properly diversify supplies and trade routes of essential resources comes with profound risks[2].

[1] Peter Sopher, "How a Minerals Shortage is Halting our Energy Transition", 16 Feb. 2022

[2] IEA, "IEA Critical Minerals and Clean Energy Summit delivers six key actions for secure, sustainable and responsible supply chains", 28 Sep. 2023

Share of Top Three Producing Countries in Total Production of Fossil Fuels and Selected Resources and Minerals



Notes: ARG = Argentina; AUS = Australia; CAN = Canada; CHL = Chile; CHN = China; DRC = Democratic Republic of the Congo; EST = Estonia; FIN = Finland; IND = India; IRN = Iran; LNG = liquefied natural gas; MDG = Madagascar; MOZ = Mozambique; MYS = Malaysia; PER = Peru; PHL = Philippines; RUS = Russia; SAU = Saudi Arabia; USA = United States. Graphite extraction is for natural flake graphite. Graphite processing is for spherical graphite for battery grade. IEA analysis based on S&P Global, USGS (2023), Mineral Commodity Summaries, Benchmark Mineral Intelligence, and Wood Mackenzie.
Source: IEA, "The Role of Critical Minerals in Clean Energy Transitions", May 2021; IEA, "Critical Minerals Market Review 2023", Jul. 2023

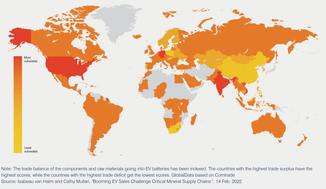
Electric vehicle (EV) sales soared by 60% in 2022 and, although their sales increased only 30% in 2023 —*likely due to challenging economic conditions*— they attained for the first time a 20% global market share led by China and the European Union[1] with over 13 million new EVs sold during the new record-breaking year[2]. *China aside*, in a supply chain vulnerability assessment for battery EVs, GlobalData concluded that countries with the biggest EV sales have among the biggest supply chain vulnerabilities[3].

[1] IEA, "World Energy Outlook 2023", Oct. 2023

[2] David Wallace-Wells, "Electric Vehicles Keep Defying Almost Everyone's Predictions", Jan 11, 2023

[3] Isabeau van Halm and Cathy Mullan, "Booming EV Sales Challenge Critical Mineral Supply Chains", 14 Feb. 2022

EV Battery Materials: 2022 Supply Chain Vulnerability Index



Note: The trade balance of the components and raw materials going into EV batteries has been indexed. The countries with the highest trade surplus have the highest scores, while the countries with the highest trade deficit get the lowest scores. GlobalData based on Comtrade
Source: Isabeau van Halm and Cathy Mullan, "Booming EV Sales Challenge Critical Mineral Supply Chains", 14 Feb. 2022

Mineral dependence has now become a critical geopolitical issue in many countries around the world. In the United States, the White House has disclosed ambitious plans to achieve net *zero greenhouse* gas (GHG) emissions by 2050, decarbonize the national electrical grid entirely by 2035, and ensure that *zero-emission* vehicles account for at least 50% of all new vehicle sales by 2030[1]. Encouraged by the tax credits incentives from the Inflation Reduction Act (IRA)[2], investments in EV battery plants in the US have skyrocketed—more than in any other country[3]. Yet, today, China produces three out of every four batteries, and we can expect the country to continue to dominate the global energy metals supply chain and battery manufacturing capacity, the latter of which looks set to increase almost fourfold by 2030[4]. The Chinese province of Jiangsu alone produces more batteries than Europe and North America combined, and it may remain so until 2028[5].

[1] US Department of Energy, "Biden-Harris Administration Releases First-Ever Blueprint to Decarbonize America's Transportation Sector", 16 Jan. 2023

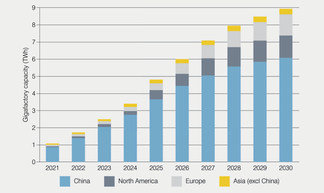
[2] M. Hoar Uddin, "Understanding the Inflation Reduction Act's Electric Vehicle Tax Credits", 7 Nov. 2022

[3] Atlas EV Hub, "$210 Billion of Announced Investments in Electric Vehicle Manufacturing Headed for the U.S.", 12 Jan. 2023

[4] Benchmark, "Over 400 gigafactories in 2030 pipeline, but overcapacity fears loom", 18 Aug. 2023

[5] Benchmark, "The Chinese province producing more batteries than the rest of the world", 8 Dec. 2023

401 Gigafactories in 2023 Pipeline



Source: Benchmark Gigafactory Assessment; Benchmark, "Over 400 gigafactories in 2030 pipeline, but overcapacity fears loom", 18 Aug. 2023

Notwithstanding these ambitions, the US relies heavily on critical mineral imports and midstream products that gigafactories require (i.e., cathodes, anodes, and precursor cathode active materials (pCAM), supply which is also dominated by China)[1]. In 2021, the White House's battery supply chain assessment report raised nickel as a critical mineral, and the United States Geological Survey (USGS) formally added nickel to the critical minerals list along with cobalt, manganese and lithium. The report also highlighted steps the US needs to take to start building mineral independence while taking a more prominent role in the energy transition.

Yet, the IRA's sourcing requirements[2] might restrict the country's options to get the critical minerals it needs for its EV battery manufacturing industry. EV supply chain specialist firm Benchmark anticipates that less than 20% of nickel and cobalt raw materials and processed products will be IRA compliant by 2030[3]. Thus, while the country strives to build mineral independence, critical mineral supply chain shortages could delay its decarbonization efforts.

[1] Benchmark, "Three key battery takeaways from Benchmark Week", 21 Nov. 2023

[2] Green Car Congress, "Inflation Reduction Act mandates escalating battery critical mineral requirements to qualify for EV tax credit", 9 Aug. 2022

[3] Benchmark, "The race to secure sustainable and compliant nickel and cobalt", 23 Nov. 2023

Reliance on Imports for Battery Metals in the U.S. in 2023

Source: U.S. Department of Interior, U.S. Geological Survey, "Mineral Commodity Summaries 2024", 31 Jan. 2024

The Wilson Center in its Mosaic Approach report states it clearly: *"Nearly all of U.S. produced nickel is exported abroad for further processing and refinement. Polymetallic nodules on the ocean floor represent a significant domestic opportunity for increasing U.S. supplies of nickel, with the added bonus that they also contain cobalt and manganese"*[1].

In another recent study, it argues that *"Locating processing capabilities offers the greatest opportunity to build a resilient supply chain for critical minerals domestically, and several jurisdictions across North America can offer the necessary benefits and synergies to enable the development of smelting and refining facilities necessary to achieve this goal"*[2].

We can see the same concerns in the European Union (EU). The EU meets only 1% of its own critical metal demand, and European politicians have stated that they cannot allow a dependency on critical raw materials to replace Europe's current reliance on fossil fuels[1]. The European Commission presented its Green Deal Industrial Plan in response to the U.S. IRA that aims to provide EU countries with more financial support to compete as a hub for electric vehicles manufacturing[2]. In addition to the Critical Raw Materials (CRM) Act that aims to ensure the EU's access to a secure, diversified, affordable and sustainable supply of critical raw materials[3].

> Announced new EV battery gigafactyories and solar panels plants approach the capacity the worlds needs according to the IEA's Net Zero Emissions (NZE) Scenario[4], but the progress on the raw material supply side is not following suit[5].

[1] The Wilson Center, "The Mosaic Approach: A Multidimensional Strategy for Strengthening America's Critical Minerals Supply Chain", 23 Sep. 2023

[2] The Wilson Center, "Polymetallic Nodules and the Critical Minerals Supply Chain: A North American Approach", Feb. 2024.

[1] European Commission, "Keynote speech by Vice-President Maroš Šefčovič at the Raw Materials Security of Europe Conference", 12 Sep. 2022

[2] Reuters, "Explainer: Why the U.S. Inflation Reduction Act Has Rattled Europe", Feb. 1, 2023.

[3] European Commission, "Critical Raw Materials: ensuring secure and sustainable supply chains for EU's green and digital future", 16 Mar. 2023.

[4] IEA, "Critical Minerals Market Review 2023", Jul. 2023

[5] Simon Moores, "Gigafactories are all well and good, but supplying them with lithium is the key", 14 Aug. 2023; IEA, "Critical Minerals Market Review 2023", Jul. 2023.

^ Back to the section page
Next: Price >

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Price

Mass electric vehicle (EV adoption depends on price parity with conventional, internal combustion engine (ICE) cars. We can generally expect that price parity to occur when a battery reaches approximately US$100 per kilowatt-hour (kWh)[1]. Since 2010, when lithium-ion battery pack prices exceeded US$1,200/kWh, prices have dropped 90% due to better technology and economies of scale[2]. However, they increased for the first time in 2022 due to soaring inflation and the rising battery component costs, reversing momentarily the historical downward trend[3]. In 2023, factors such as higher manufacturing capacity combined with lower-than-expected demand led prices back on their declining trajectory, dropping 14% from 2022 to a record low of $139/kWh[4].

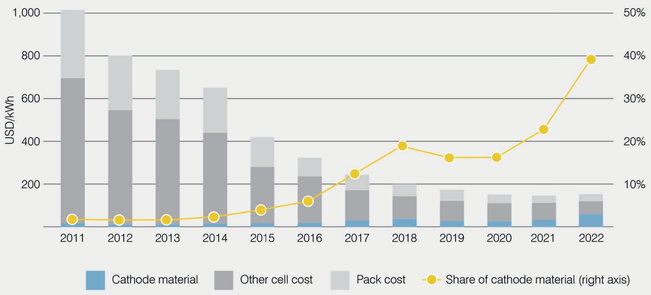
EV research firm BloombergNEF expects EVs to reach price parity with comparable ICE models, without subsidies, by the end of the decade, although it will vary by segment and country. Large and SUV models could start achieving parity in Europe in 2025 or before, whereas the same segment in India would not reach it before 2030 due to low average cost of this segment in the country[5]. In all cases, the costs of lithium, nickel, cobalt and manganese account for an increasingly large share of the overall battery pack price: they rose from well below 5% in 2010 to 40% in 2022. Given their correlation with EV batteries affordability, higher or more volatile critical metals prices could potentially delay price parity of EVs with ICEs and put the immediate mass EV adoption at risk[6].

Rising or volatile metal prices could threaten the affordability and speed of the energy transition, at the same time, lower-than-expected demand and prices could threaten the economic viability and development pace of some mining projects—and the delivery of the new additional critical minerals supplies the market needs.

[1] BloombergNEF, "Battery Pack Prices Cited Below $100/kWh for the First Time in 2020, While Market Average Sits at $137/kWh", Dec. 16, 2020, BloombergNEF, "Battery Pack Prices Fall to an Average of $132/kWh, But Rising Commodity Prices Start to Bite", Nov. 30, 2021.
[2] BloombergNEF, "Zero Emission Vehicles Factbook for COP28", Dec. 2023
[3] BloombergNEF, "Lithium-ion Battery Pack Prices Rise for First Time to an Average of $151/kWh", Dec. 6, 2022
[4] BloombergNEF, "Zero Emission Vehicles Factbook for COP28", Dec. 2023
[5] BloombergNEF, "Electric Vehicle Outlook 2023", 2023
[6] IEA, "Critical Minerals Market Review 2023", Jul. 2023

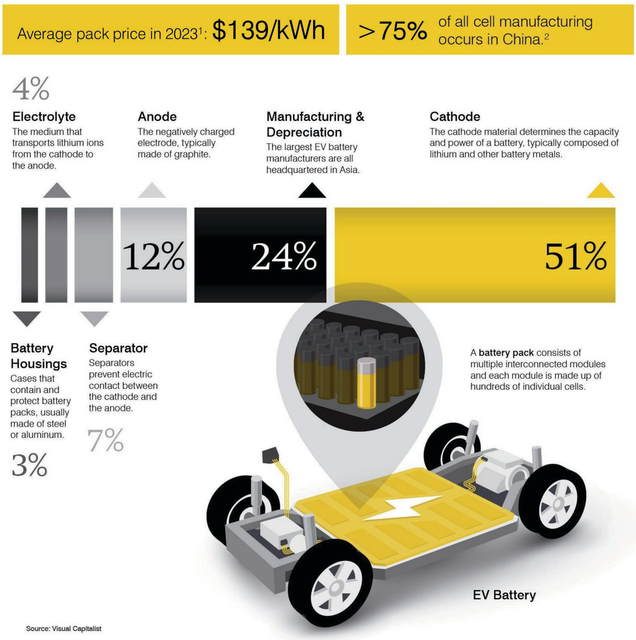
With Elevated Commodity Prices, Raw Material Costs Loom Larger in the Total Cost of Key Clean Energy Technologies

Average pack price of lithium-ion batteries and share of cathode material cost



Notes: Cathode material costs include lithium, nickel, cobalt and manganese. Other cell costs include costs for anode, electrolytes, separator and other components as well as costs associated with labour, manufacturing and capital depreciation.
Source: IEA analysis based on BNEF (2022).

Breaking Down the Cost of an EV Battery Cell



Source: Visual Capitalist. The contribution of each EV battery cell component is based on 2021 costs from BloombergNEF.
1 BloombergNEF, "Zero Emission Vehicle Factbook", Dec. 2023.
2 BloombergNEF, "Zero Emission Vehicle Factbook", Dec. 2023.

^ Back to the section page Next: ESG Impacts >

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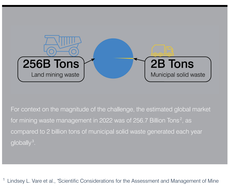
ESG Impacts

A long history of severe environmental and social impacts makes increased land-based mining for metals an uncomfortable fit with the ethos behind the energy transition. By its nature, extracting resources constitutes a destructive process that often starts with the need to displace or change the land that local communities and Indigenous people use. Depending on an operation's nature, it may involve deforestation and associated loss of carbon sinks and biodiversity due to flattened mountains, giant holes from blasting, and other events that disfigure the landscape at a large scale. Factors such as location, ore type, ore grade, and processing technique create different environmental, social and governance (ESG) impacts. For example, low ore grades often result in operations that produce rock waste and tailings in large amounts that an operator must isolate from the environment and manage almost indefinitely in engineered structures, place underground, or dump into the deep sea[1].



For context on the magnitude of the challenge, the estimated global market for mining waste management in 2022 was of 256.7 Billion Tons[2], as compared to 2 billion tons of municipal solid waste generated each year globally[3].

[1] Lindsey L. Vare et al., "Scientific Considerations for the Assessment and Management of Mine Tailings Disposal in the Deep Sea", Feb. 5, 2018.

[2] Research and Markets, "Mining Waste Management – Global Market Trajectory & Analytics", Mar. 2023.

[3] World Bank, "What a Waste 2.0: A Global Snapshot of Solid Waste Management to 2050", Sept. 20, 2018.

The tailings storage facilities that are used to contain these mountains of waste on land are among the world's largest engineered structures – they can be well over 150 meters tall and store more volume than 750,000 Olympic swimming pools. If they are not managed appropriately, tailings storage facilities can pose a threat to the surrounding environment and communities.

Brumadinho dam disaster, 2019, Brazil

At its worst, metal extraction can involve child labor[1] (with up to 40,000 children working in dangerous conditions in cobalt mines in the Democratic Republic of the Congo[2]), human rights abuses, shortened miner lifespans, and even loss of life. Land-based mining also frequently generates conflicts with surrounding communities, especially when it poses a risk to their livelihood and traditional ways of life. In a report, MSCI found that the majority of U.S. reserves for critical minerals reside within 35 miles of Native American reservations: 68% of cobalt, 89% of copper, 79% of lithium, and 93% of nickel reserves[3]. Metal extraction is usually an energy and water-intensive business and generates significant carbon emissions, noise, and dust, and it also puts additional stress on a region's freshwater resources. Copper mines, in particular, often coincide with water stressed regions that will likely face increased aridity in the coming decades[4].

As a result, new mining projects tend to face strong opposition on social and environmental grounds[5]. As IEA's executive director has said, "left unaddressed, these potential vulnerabilities could make global progress towards a clean energy future slower and more costly—and therefore hamper international efforts to tackle climate change"[6]. Global scrutiny over ESG performances of critical minerals' supply chains is growing, and mismanaged ESG risks can discourage investment—or lead to divestment—and cause supply disruptions that impact energy metal prices[7].

The International Energy Agency (IEA) analyzed the ESG impacts of 20 major mining companies with strong presence in energy transition minerals and found that their progress over a 4-year period shows a mixed picture. They made some notable headways on social and governance dimensions such as health and safety, gender balance and community investments, but failed to demonstrate industry-wide progress on many other areas. For instance, water withdrawals almost doubled between 2018 and 2021 while mining waste and GHG emissions per ton of output remained the same. The IEA also noted that the information these public reports include has limitations and varies in quality and scope, which makes it difficult for someone to track and compare progress across companies or at a regional level[8]. If we wanted to get a higher-resolution picture that includes activities from all player sizes, the challenge would be even harder: many smaller players and artisanal or illegal operations do not disclose this information at all—e.g., only 4% of Indonesian nickel operators prepare public reports[9] and in 2023, two-thirds of global mined nickel supply has come from companies operating with moderate or limited ESG transparency[10].

[1] Dailymail, "The Shaming Images That Show Where Our iPhones, Laptops and Tesla Cars REALLY Come From: The Truth About the Congolese Mines Where Kids are Paid $2-a-day to Dig for Cobalt", 30 Jan. 2023.

[2] International Labour Organization, "ILO – Child Labour in Mining and Global Supply Chains", May, 2019.

[3] Samuel Block, "Mining Energy Transition Metals: National Aims, Local Conflicts", 3 Jun. 2021.

[4] McKinsey, "Climate Risk and Decarbonization: What Every Mining CEO Needs to Know", Jan. 2020.

[5] Henry Fountain, "Alaska's Controversial Pebble Mine Fails to Win Critical Permit, Likely Killing It", 25 Nov. 2020; Ernest Scheyder, "Rio Tinto's 26-year Struggle to Develop a Massive Arizona Copper Mine", 19 Apr. 2021; U.S Department of Interior, "Interior Department Takes Action on Mineral Leases Improperly Renewed in the Watershed of the Boundary Waters Wilderness", 26 Jan. 2022.

[6] IEA, "Clean Energy Demand for Critical Minerals Set to Soar as the World Pursues Net Zero Goals", 5 May 2021.

[7] IEA, "Why is ESG so important to critical mineral supplies, and what can we do about it?", 9 Sep. 2022.

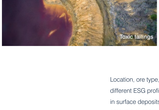
[8] IEA, "Critical Minerals Market Review 2023", Jul. 2023

[9] Steven Brown, "Nickel Powerhouse", Feb. 2023

[10] Benchmark, "What did COP28 mean for critical minerals?", 27 Dec. 2023

Child labor

Deforestation, loss of biodiversity and carbon sinks



Toxic tailings

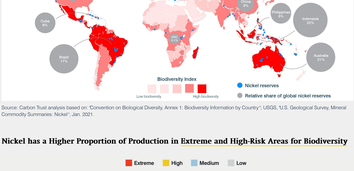
CO_2, SO_2 and NO_x emissions

Location, ore type, ore grade and processing techniques result in significantly different ESG profiles. For example, nickel laterite ores appear in greater abundance in surface deposits in the tropics. They come with more impurities, require large amounts of energy and water to process, and generally impact the environment and the climate more significantly than nickel sulfide ores[1] (see the pages "Comparative Lifecycle Studies" and "TCFD & TNFD" for more information). Driven by demand growth, nickel production from laterite ores continues to rise and now represents about 76% of production globally[2]. Due to where these deposits reside, this tendency also comes with greater risks for biodiversity.

[1] USGS, 2011; Michelle Michot Foss et al., "Need Nickel? How Electrifying Transport and Chinese Investment Are Playing Out In The Indonesian Archipelago", Apr. 2022.

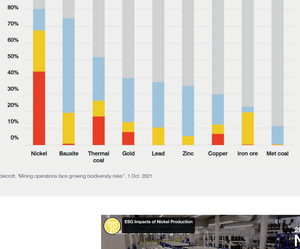
[2] Benchmark, "US and Indonesia pave way for critical minerals agreement", 14 Nov. 2023

75% of Nickel Reserves on Land Reside in High Biodiversity Countries



Source: Carbon Trust analysis based on: "Convention on Biological Diversity, Annex 1: Biodiversity Information by Country"; USGS, "U.S. Geological Survey, Mineral Commodity Summaries: Nickel", Jan. 2021.

Nickel has a Higher Proportion of Production in Extreme and High-Risk Areas for Biodiversity



Source: Maplecroft, "Mining operations face growing biodiversity risks", 1 Oct. 2021

^ Back to the section page
Next: A Circular Metal Economy Future >

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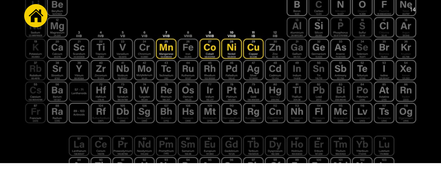


A Circular Metal Economy Future

Metals are recyclable—the silver lining to our metal-intensive future. Our increasing reliance on metals makes it easier to reimagine how we can keep making and remaking our "technosphere" through iterative technological innovation cycles while relying on a shared metal stock (cradle-to-cradle). To a limited extent, we will need to continue to mine for more metals. However, as long as we take care of our metal stocks, we can ensure to significantly reduce mining activities and, thus, its potential harm to people and the environment.

We have yet to achieve this vision. Take copper—a metal we have arguably mined for the longest period (in fact, archaeologists have found copper artifacts that date far back as 8,000 years)[1]. Our predicted copper needs for the next 30 years far outstrip estimations for the total copper amount that humans have taken from the planet to date and, with declining ore grades, the projected tailings generation dwarfs those generated in the last century[2]. What's more, we cannot rely on using existing copper stock in the near future since long-term applications, such as building wire, copper pipes, and telecommunication and power cables, tie it up[3].

[1] Robert J. Braidwood et al., "Beginnings of Village-Farming Communities in Southeastern Turkey", 1971.

[2] Ayman Elshkaki et al, "Copper Demand, Supply, and Associated Energy Use to 2050", 2016.

[3] UNEP, "Metal Stocks in Society: A Scientific Synthesis", 2010.

Societies have practiced metal recycling for decades. Estimates for current global end-of-life recycling rates range between 68% for cobalt, 59% for nickel, 53% for manganese[1], and 45% for copper[2]. Given the dynamic nature of metal flows, durable consumer goods can tie up metals for decades. Product lifespans differ and can even grow. For example, an EV battery may enter second-life applications in home or grid energy storage[3]. As a result, it might take a good part of the 21st century to get to a place where we have enough metal stock in circulation to meet our needs without having to dig up much more. According to analysis by the World Bank, if we currently recycled all copper, nickel, and cobalt at the end of a product's life, by 2050, we would have reduced demand for mining by only 26%, 23% and 15%, respectively[4]. In September 2023, the International Energy Agency (IEA) published an updated version of its net zero emissions (NZE) roadmap for the energy sector to contribute to the Paris Agreement's objective to limit global warming to 1.5°C above pre-industrial levels. It found that secondary supply from recycling could meet 10-20% of the total demand for key energy transition metals by 2030 and that total anticipated supply will fall well below the requirements for the NZE scenario. Benchmark found similar results and expects 11% of nickel demand and 4% of cobalt demand will be met by recycling in 2030[5]. The IEA warns that "further increases in investment are urgently needed in the near term, as are government efforts to diversify supply chains, reduce lead times and reduce material demand by promoting recycling and innovation"[6]. As long as the overall metal demand remains larger than the amount of end-of-life metals available for recycling, our reliance on mined metal will persist.

[1] UNCTAD, "Commodities at a Glance", May 2020.

[2] M.L.C.M. Henckens and E.Worrell, "Reviewing the Availability of Copper and Nickel For Future Generations. The Balance Between Production Growth, Sustainability and Recycling Rates", 10 Aug. 2020.

[3] Jerad Ford and Jim West, "Known Unknowns: the Devil in the Details of Energy Metals Demand", 3 Nov. 2021.

[4] The World Bank, "Minerals for Climate Action: The Mineral Intensity of the Clean Energy Transition", Apr. 2020.

[5] Benchmark, "The race to secure sustainable and compliant nickel and cobalt", 23 Nov. 2023

[6] IEA, "Net Zero Roadmap - A Global Pathway to Keep the 1.5 °C Goal in Reach", Sep. 2023

[1] Ayman Elshkaki et al, "Copper Demand, Supply, and Associated Energy Use to 2050", Jul. 2016.

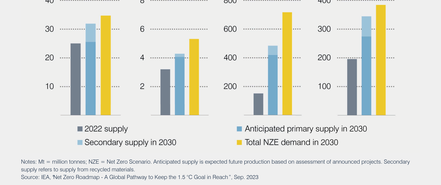
[2] Takuma Watari et al, "Review of Critical Metal Dynamics to 2050 for 48 Elements", Apr. 2020.

[3] Harald Ulrik Sverdrup et al, "Adaptation to a New Economic Reality", 30 Nov. 2019.

[4] Takuma Watari et al, "Review of Critical Metal Dynamics to 2050 for 48 Elements", Apr. 2020.

[5] Harald Ulrik Sverdrup et al, "Adaptation to a New Economic Reality", 30 Nov. 2019.

Anticipated Supply and Projected Demand for Selected Minerals in the NZE Scenario, 2030



Notes: Mt = million tonnes; NZE = Net Zero Scenario. Anticipated supply is expected future production based on assessment of announced projects. Secondary supply refers to supply from recycled materials.
Source: IEA, 'Net Zero Roadmap - A Global Pathway to Keep the 1.5 °C Goal in Reach', Sep. 2023

Fortunately, we have seen real progress across the world: China already requires its EV battery manufacturers to assign individual batteries a unique ID that one can track from production to end-of-life recycling[1]. The European Union (EU)'s new battery regulations establish requirements for achieving transparency, accountability, and circularity throughout an EV battery's entire lifecycle. The regulations introduce a digital "battery passport" that will improve traceability and will provide relevant information about the battery's environmental impact, origin, and lifecycle. This level of transparency will enable safer and easier removal and replacement of batteries to build a stronger battery recycling industry[2]. In addition, the EU's Critical Raw Material Act (CRMA) targets 25% of EU's annual critical material demand (including metals such as lithium, cobalt, nickel, copper and manganese) to be from recycled sources by 2030[3]. Various organizations have also begun piloting blockchain solutions for supply-chain tracking throughout the lifecycle (e.g., Everledger, Circular, ReSource), and dozens of established and new battery recycling companies (e.g., Umicore, Northvolt, Redwood Materials, Duesenfeld, Li-Cycle) have begun recovering metal from production scrap.

All these developments notwithstanding, we must face the fact that recycling alone cannot meet our current transitional metal needs for the next 30-50 years[4].

We can also expect other factors beyond the energy transition to drive the demand: projections expect the world's population to grow by almost another 2 billion people by 2050[5] and living standards to improve in the developing world. In the short to medium term, we cannot avoid extracting significantly more metal. We will need to mine more critical metals in the next 30 years than we have mined in all of human history. But that does not mean we cannot do it in a better way.

Global Metal Stocks and Future Demand

[1] Lukas Merkle, "Automotive Battery Tracking in China", Nov. 2019

[2] News European Parliament, "Batteries: Deal on New EU Rules for Design, Production and Waste Treatment", 9 Dec. 2022; Colltech; "New EU Battery Regulation – What Does it Mean in Practice?", 7 Feb. 2023

[3] Benchmark, "EU increases critical mineral recycling targets in bid to increase self-reliance", 22 Nov. 2023

[4] Daniele La Porta Arrobas et al, "The Growing Role of Minerals and Metals for a Low Carbon Future", Jun. 2017

[5] United Nations Department of Economic and Social Affairs, "World Population Prospects 2022: Summary of Results", 2022

^ Back to the section page Next: Doughnut-Shaped Solution Space >

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Doughnut-Shaped Solution Space

Extracting and using our planet's resources without proper regard and accounting for environmental and human consequences has resulted in our current predicament. As a global community, we are moving toward taking responsibility for negative externalities and rethinking what it takes for humans and nature to thrive on our planet. In the last two decades, a new industry has emerged that focuses on producing sustainability principles, frameworks, standards, rankings and certifications. And, while we have finally attained increased awareness about the urgent challenges facing the world, we often see only commitments that fail to achieve the magnitude and speed of the change needed to ensure we do not surpass planetary boundaries while providing prosperity for all.

Today, carbon emissions continue to rise, and ecosystems continue to lose biodiversity. According to the 2019 Intergovernmental Science-Policy Platform on Biodiversity and Ecosystems Services (IPBES) Global Assessment Report, approximately 25% of species in most animal and plant groups studied face extinction[1], and local domesticated plant varieties and animal breeds have begun disappearing, which poses a serious risk to global food security. As for why, since 1970, the largest negative impact on nature has come from changes in land use (e.g., mainly for producing crops and livestock), which have significantly altered 75% of the world's land surface and directly impacted terrestrial and freshwater ecosystems. As a result, we have lost forests, grasslands, and wetlands (e.g., 85% of wetlands area). While agriculture drives around 73% of deforestation and forest degradation, urban expansion drives 10%, infrastructure drives another 10%, and mining drives 7%. For the latter in particular, developing roads, rail, and port infrastructure to transport and explore minerals can have more indirect and cumulative impacts than actual mine sites[2].

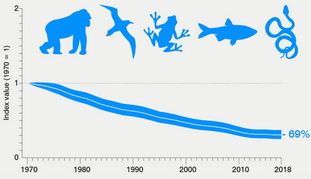
[1] IPBES, "Summary for Policymakers of the Global Assessment Report on Biodiversity and Ecosystem Services", Nov. 25, 2019.

[2] Siân Bradley, "Mining's Impacts on Forests", Oct. 14, 2020.

The Global Living Planet Index (1970 to 2018)

The average change in relative abundance of 31,821 populations, representing 5,230 species monitored across the globe, was a decline of 69%.

The white line shows the index values and the shaded areas represent the statistical certainty surrounding the trend (95% statistical certainty, range 63% to 75%).



Key

Global Living Planet Index

Confidence limits

Source: WWF/ZSL, "The Living Planet Index database", 2022

On average, the populations of terrestrial, freshwater, and marine vertebrate populations that the Global Living Planet Index (LPI) tracks have declined in abundance by 69% in less than 50 years[1]. LPI only monitors populations that represent 5,230 species. In a 2021 study, Yale researchers estimated that we have yet to discover 80 to 90% of all terrestrial species in the world and that Indonesia, Brazil, Madagascar, and Colombia (all nickel mining countries) provide the greatest opportunity for new discoveries overall (i.e., about a quarter of all potential discoveries)[2].

Since 1992, urban area across the world has doubled in size, which has resulted in a corresponding expansion in infrastructure linked to growing populations and consumption. Furthermore, soil erosion (e.g., from deforestation, agriculture, increases in urban areas, and mining) decreases soil fertility, and, today, soil erodes quicker than it forms, which reduces its ability to store carbon dioxide[3]. After oceans, soil constitutes the second largest natural carbon sink[4]. Oceans absorb 30% of the carbon dioxide released in the atmosphere. As the amount of carbon dioxide increases in the atmosphere, so will ocean acidification. As the ocean acidifies, it will impact many ocean species, "especially organisms like oysters and corals that make hard shells and skeletons by combining calcium and carbonate from seawater"[5]. The ocean faces other challenges as well: currently one-third of the global fish stocks experience overfishing and, in the last century, large ocean fish have decreased in abundance by 90%[6].

To meet everybody's needs while maintaining a healthy, living planet, we must subject solutions for resource extraction to two constraints: ecological limits and social needs. Known as "doughnut economics", this construct, which English economist Kate Raworth first proposed in 2012, refers to an economic model with two concentric rings: an ecological ceiling and a social foundation. Between these two boundaries lies an ecologically safe and socially just doughnut-shaped space in which humanity can thrive. In Raworth's words, she developed the construct "to ensure that no one falls short on life's essentials (from food and housing to healthcare and political voice), while ensuring that collectively we do not overshoot our pressure on Earth's life-supporting systems on which we fundamentally depend—such as a stable climate, fertile soils and a protective ozone layer"[7].

Doughnut economics offers a helpful conceptual framework to define the solution space for ramping up the rate at which we will need to extract metal to meet demand, but it only becomes meaningful when one updates it to reflect the world as it currently stands. Raworth uses nine planetary boundaries, which a group of earth systems and environmental scientists led by Swedish scientist Johan Rockström and American chemist Will Steffen introduced in 2009[8], as the ecological ceiling, and she derives the social foundation from internationally agreed-on minimum social standards that the U.N. Sustainable Development Goals identify. Humanity has already overshot six planetary boundaries, and millions of people still fall short on all 12 social dimensions.

[1] WWF/ZSL, "The Living Planet Index", 2022.

[2] Mario R. Moura et al., "Shortfalls and Opportunities in Terrestrial Vertebrate Species Discovery", 22 Mar. 2021.

[3] Dede Sulaeman and Thomas Westhoff, "The Causes and Effects of Soil Erosion, and How to Prevent It", 7 Feb. 2020.

[4] European Environment Agency, "Soil, Land and Climate Change", 11 May 2021.

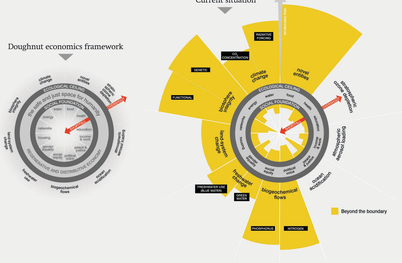
[5] NOAA, "Ocean Acidification", 1 Apr. 2020.

[6] Campaign for Nature, "Why 30?".

[7] Kate Raworth, "Exploring Doughnut Economics".

[8] Johan Rockström et al, "A Safe Operating Space for Humanity", 23 Sep. 2009.

The Doughnut of Social and Planetary Boundaries



Source: Image based on the Doughnut economics framework. Planetary boundaries updated with 2023 information from "Azote for Stockholm Resilience Centre, based on analysis in Richardson et al 2023".

As a global civilization, we have much work to do to rein in the ecological overshoots while improving social shortfalls. A significant increase in net new land-based mining poses a serious challenge to achieving this goal. On the one hand, we cannot rein in the climate change overshoot without extracting more metal. On the other hand, metal extraction often modifies the environment at a large scale, which will push humanity further towards breaching our ecological limits. It also has mixed social impacts.

Looking ahead, several factors will make these impacts even harder to deal with.

^ Back to the section page Next: Complications >

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Complications

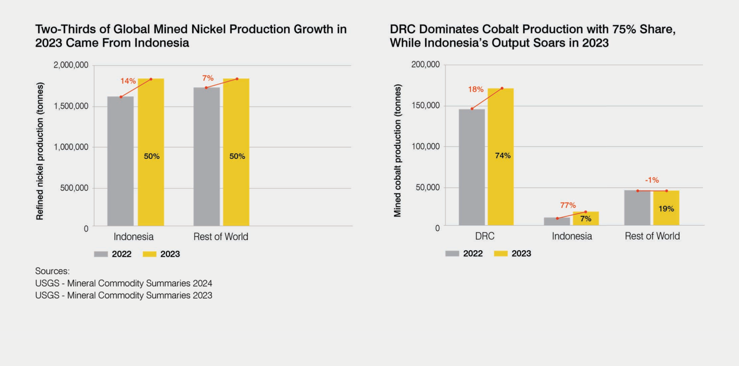
Looking ahead, several factors, such as deposit locations, falling ore grades, and increasing capital intensity will make land-based mining's impacts even harder to deal with.

Deposit Locations

If we map our remaining known battery metal deposits, we can expect mining to expand into places with higher geopolitical risk, higher biodiversity, and greater carbon sinks and carbon-sequestration services. Most known nickel and cobalt reserves (and current production) appear in equatorial regions[1] such as Indonesia and the Democratic Republic of the Congo (DRC), respectively, which have forests with rich biodiversity and large carbon sinks.

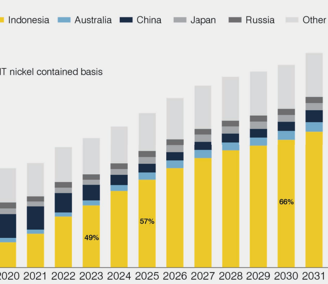
As a country, the DRC faces an ongoing battle with corruption[2] and political instability while its valuable cobalt industry has had to deal with issues such as child labor, safety risks, and environmental degradation[3]. For example, 20% of cobalt in the DRC comes from artisanal mines where some estimates have found that up to 40,000 children work in dangerous conditions with inadequate safety equipment and for low compensation[4]. In Indonesia, the government has implemented policies to rapidly grow its domestic nickel production capacity and become the top nickel producer[5]. By holding more than 20% of the world's nickel reserves in a market hungry for it, Indonesian output jumped 14 times between 2014 and 2022[6]. In 2023, it further increased by about 38% and accounted for roughly half of the global refined nickel supply[7]. As the country represents 88% of planned nickel refining facilities by 2030[8], Benchmark expects this trend will continue and anticipates Indonesia will account for nearly two-thirds of global refined nickel production by 2030[9].

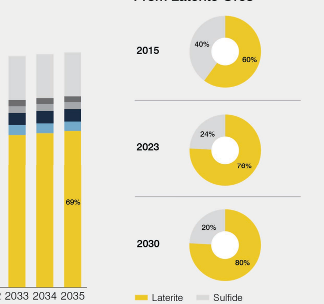
[1] Nickel Institute, "Is There Enough Nickel? Reserves, Resources and Recycling", 6 Jan. 2020.
[2] Transparency International, "Corruption Perceptions Index".
[3] UNCTAD, "Commodities at a Glance", May 2020.
[4] Michele Fabiola Lawson, "The DRC Mining Industry: Child Labor and Formalization of Small-Scale Mining", 1 Sep 2021.
[5] ASEAN Briefing, "Unleashing Nickel's Potential: Indonesia's Journey to Global Prominence", 30 May 2023.
[6] Steven Brown, "Nickel Powerhouse", Feb. 2023
[7] Benchmark, "Indonesian nickel at centre of battery geopolitics – 2023 in review", 19 Dec. 2023
[8] IEA, "Critical Minerals Market Review 2023", Jul. 2023
[9] Benchmark, "US and Indonesia pave way for critical minerals agreement", 14 Nov. 2023



*Overseas Territory of France.

Source: USGS Mineral Commodity Summaries 2024





Sources:
USGS - Mineral Commodity Summaries 2024
USGS - Mineral Commodity Summaries 2023

Source: Benchmark Mineral Intelligence 2023

Notes: (1) Although China's refined nickel production is expected to decrease in the coming years, its control over the production will likely not fall. The change in nickel production output per country is a result of the Indonesian Government's ban of nickel ore exports to boost its economy to make value-added refined and manufactured nickel products domestically. Chinese companies have adapted by investing over US$3.2 billion in 2022 into Indonesian islands such as Sulawesi and Halmahera to secure their nickel supply into the next decade[1]. (2) The growing share of laterite-based production in the overall supply is relevant because producing battery-grade Class 1 nickel from laterite resources consumes multiple times more energy than sulphide-based production routes[2] and Indonesia's nickel industry is particularly carbon intensive due to the widespread use of coal-fired power[3]. In addition to the rapidly growing number of coal-fired power plants that the country is building to support its booming nickel industry, producing battery-grade nickel with laterite resources also raises other environmental concerns, such as waste generation and management, deforestation, pollution, soil erosion, and biodiversity loss[4].

Sources:
[1] Bloomberg, "Chinese Companies Are Flocking to Indonesia for Its Nickel", Dec. 15, 2022
[2] IEA, "Critical Minerals Market Review 2023", Jul 2023
[3] Bloomberg, "Indonesia Nickel Heartland Wants to Be Greener Link in EV Chain", 23 Jul. 2023; The Financial Times, "Indonesia's high-carbon nickel key challenge in global EV uptake", 31 Aug. 2022; The Japan Times, "Indonesian nickel mine takes green steps as environmental concerns mount", 24 Jul. 2023
[4] IEA, "Critical Minerals Market Review 2023", Jul. 2023

> Most new mined nickel and cobalt will likely come from Indonesia and DRC, respectively.

Given that Indonesian nickel deposits reside under rainforests in a "megadiverse" country, a conservation hotspot with a high endemism level[1], they demand strongly enforced adequate environmental and social standards. The recent explosion in an Indonesian nickel smelter that caused 21 fatalities and injured dozens of others[2] reminds us that exponential capacity growth can be challenging. Awareness around the fact that some cobalt mining involves child labor has attracted many initiatives to tackle the issue. In contrast, the public seems to appreciate to a more limited degree the fact that most nickel and cobalt come from clearing rainforests and woodlands, which destroys the carbon sinks and biodiversity they contain.

A recent study established a strong correlation between nickel production and deforestation in Indonesia. It found that nickel production has led to the loss of over 300 km2 of rainforests between 2000 and 2020 and each tonne of nickel produced caused the net loss of approximately 45 m2 of tropical rainforest[3]. The region most impacted coincides with the Wallacea, which is one of the most significant biodiversity hotspots in the world. Indonesia does not currently mandate the implementation of the mitigation hierarchy nor "no net loss" of biodiversity[4].

[1] UNEP WCMC, 'Megadiverse Countries", 2020.
[2] apNEWS, "Indonesia police to charge 2 Chinese nationals in furnace explosion at Chinese-owned nickel plant", 12 Feb. 2024.
[3] Heijlen and Duhayon, "An empirical estimate of the land footprint of nickel from laterite mining in Indonesia", 1 Feb. 2024.
[4] Steven Brown, "Nickel Powerhouse", Feb. 2023.

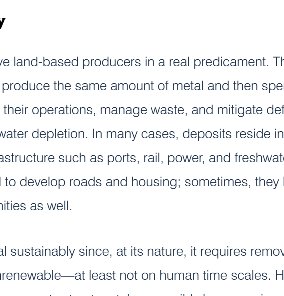
Deforestation and Nickel Mining Correlation

Source: Heijlen and Duhayon, "An empirical estimate of the land footprint of nickel from laterite mining in Indonesia", 1 Feb 2024

Falling Grades

Resource extraction follows a simple logic: focus on the easy and high-grade resources first. As a result, the amount of metal per ton of mined ore for nickel and copper has decreased over time. In 1900, one ton of ore would generate 30 kilograms of copper. Today, to get that same amount of copper, one needs up to five times more ore[1], which means a mining operation needs to use more land, more energy, and more water. It also means that each kilogram of metal now comes with more waste (over 99.5% of ore ends up in mined waste and processing tailings in addition to the waste rock that one needs to mine to reach the target deposit), and this waste needs to be managed and contained[2].

[1] Calvo et al., "Decreasing Ore Grades in Global Metallic Mining: A Theoretical Issue or a Global Reality?", 7 Nov. 2017
[2] Global Tailings Review, "Towards Zero Harm", Aug. 2020



Sources: S&P Global, 2023

Capital Intensity

Falling ore grades leave land-based producers in a real predicament. They need to spend more capital to produce the same amount of metal and then spend more capital to decarbonize their operations, manage waste, and mitigate deforestation, biodiversity loss, and water depletion. In many cases, deposits reside in remote locations that lack infrastructure such as ports, rail, power, and freshwater. Mining companies often need to develop roads and housing; sometimes, they have to relocate local communities as well.

One cannot mine metal sustainably since, at its nature, it requires removing resources that are nonrenewable—at least not on human time scales. However, it does not mean that one cannot extract metal responsibly by managing and being accountable for all negative externalities that extraction has on people and the planet. In principle, one can resettle impacted communities and Indigenous people with their consent and through an equitable value exchange, provide mine workers with fair compensation and care, and keep children in classrooms rather than mine sites. In addition, one can replace diesel-powered dump trucks with electric ones, replace coal-fired plants with renewable energy, capture and manage waste streams, regenerate stripped soils, and replant cleared forests. Given that actual metal products account for a tiny fraction of the mass that any mining company manages, it would be fair to say that a responsible mining company's real core activity involves managing environmental and human impacts with metal extraction on the side. However, each new mining project comes with its own jurisdictional, geological, ecological, social, and economic challenges. Ensuring that every new mining project over the coming decades operates at the highest possible standard seems implausible.

To understand the scale of the challenge in quantitative terms, we commissioned a life cycle assessment (LCA) to look at the impacts of producing energy-transition metals via key land-based production routes. The assessment found that producing 1kg of nickel in nickel sulfate through key land-based production routes results in varying degrees of environmental impacts as a result of location, ore type, ore grade and processing routes as shown below.

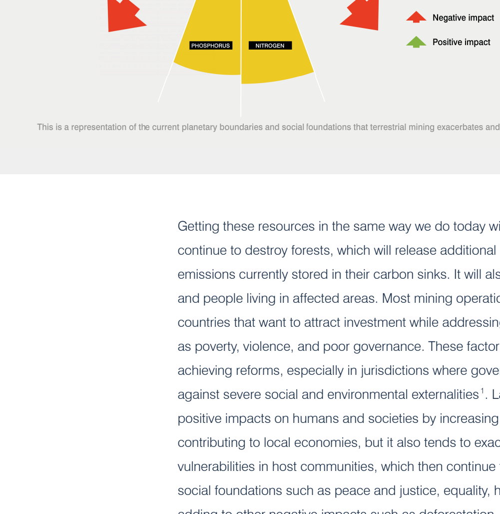
		=93% of global refined nickel production for 2022					Lowest value
Impact category	Unit	INDONESIA Laterite RKEF route	AUSTRALIA Sulfide Conventional	INDONESIA Laterite HPAL (MHP)	PHILIPPINES Laterite HPAL (MSP)	CANADA Sulfide POX route	CCZ Nodules RKEF route
Global warming potential	kg CO_2 eq	102.0	28.5	19.2	13.9	8.0	6.2
Stratospheric ozone depletion	mg CFC11 eq	14.1	27.1	3.1	3.1	3.4	0.7
Fine particulate matter formation	g PM2.5 eq	1,187.6	42.9	262.0	160.0	39.5	9.2
Terrestrial acidification	kg SO_2 eq	0.96	0.13	0.69	0.53	0.13	0.03
Freshwater eutrophication	g P eq	91.0	76.4	9.1	5.2	2.9	1.0
Marine eutrophication	g N eq	5.5	2.3	-1.8	-1.3	0.2	-2.1
Water consumption	m^3	0.31	0.13	0.25	0.24	0.15	0.05
Land-based waste generation*	kg	244	545	337	337	82	0
Marine waste generation*	kg	N/A	-	N/A	N/A	-	137

Source: Benchmark, 'Life Cycle Assessment of NORI-D Polymetallic Nodule Project and Comparison to Key Land-based Routes for Producing Nickel, Cobalt and Copper", Mar. 2023.
Note: Global warming potential includes the direct emissions from metal mining, processing & refining, but does not account for the release of carbon stored in vegetation, detritus & soil; nor the emissions from land use change.

The LCA compared the key land-based routes results to those obtained for producing the same metals from NORI-D polymetallic nodules. A summary of the findings of this ISO-standards-compliant analysis completed by Benchmark Mineral Intelligence and reviewed by an independent third-party expert is also available here, and the complete study here. More can also be found on the Comparative Lifecycle Studies and TCFD & TNFD pages of this report.

The world faces a catch-22 situation: to mitigate the impacts of climate change and support the infrastructure that a growing population requires, we need to promptly transition to lower-carbon technologies. However, implementing these technologies involves large amounts of mineral resources that put additional pressure on the Earth's life-support systems and can lead to negative social consequences.

Land Mining



This is a representation of the current planetary boundaries and social foundations that terrestrial mining exacerbates and/or alleviates.

Getting these resources in the same way we do today will require the world to continue to destroy forests, which will release additional greenhouse gas (GHG) emissions currently stored in their carbon sinks. It will also severely impact wildlife and people living in affected areas. Most mining operations happen in developing countries that want to attract investment while addressing their own challenges such as poverty, violence, and poor governance. These factors add complexity in achieving reforms, especially in jurisdictions where governments cannot safeguard against severe social and environmental externalities[1]. Land mining can have positive impacts on humans and societies by increasing employment and contributing to local economies, but it also tends to exacerbate pre-existing vulnerabilities in host communities, which then continue to fall short on fundamental social foundations such as peace and justice, equality, health, and education while adding to other negative impacts such as deforestation, erosion, pollution, human rights violations, displaced communities and practices, and conflicts over land and water allocation[2].

[1] Éléonore Lèbre et al., "The Social and Environmental Complexities of Extracting Energy Transition Metals", Sept. 24, 2020.
[2] Ibid.

^ Back to the section page   Next: Our Hypothesis >

We're building a carefully managed metal commons that will be used, recovered, and reused again and again.

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Our Hypothesis

Finding a way to obtain the metal that humanity needs without further exceeding the planetary boundaries and worsening social shortfalls is what TMC is working on. As a team, we started with a premise that, if humanity has largely exhausted high-grade (and, as a result, often lower-impact) metal deposits on land, it might be preferable to look at the seafloor.

Some people with justifiable concerns about the health of our oceans might find this premise counterintuitive. Indeed, our oceans face enormous pressure from overfishing, marine pollution, and ocean acidification, and the ecosystem services they provide face more serious threats than ever before. Climate change drives acidification and contributes to warmer seas, which have begun to cause widespread damage to coral reefs. These reefs occupy less than 1% of the ocean floor but house more than 25% of marine life[1]. According to the Food and Agriculture Organization of the United Nations (FAO), over one third of fish stocks have been fished beyond sustainable limits[2]. Overfishing and illegal and unreported fishing continue to pose a major challenge. With over 3 billion people in the world depending on marine and coastal biodiversity for their livelihood, addressing oceans threats is of vital importance[3].

The ocean also plays a prominent role in shaping Pacific Islanders' cultural and spiritual identity, home, and common heritage. As Pacific scholar Epeli Hau'ofa explains, "the sea is our pathway to each other and to everyone else, the sea is our endless saga, the sea is our most powerful metaphor, the ocean is in us"[4]. Through our partnerships with our sponsoring states, we have come to better understand the ocean's special significance to Pacific Islanders. Rather than perceiving the ocean as an endless physical barrier that seemingly separates them from outlanders, they perceive it as a path to the world.

The global community has begun to focus on protecting our oceans. At the COP15 UN Biodiversity Conference in Montreal in December 2022, 188 governments from around the world agreed on a landmark new Global Biodiversity Framework (GBF) to address biodiversity loss, restore ecosystems, and protect indigenous rights. The plan, known as the Kunming-Montreal Global Biodiversity Framework, comprises 23 targets that aim to halt and reverse nature loss, such as protecting 30% of the planet's land, coastal areas and oceans by 2030 (also known as the 30x30 target)[5].

The UN subsequently wrote the 30x30 target into the UN High Seas Treaty on March 2023 to protect the oceans and biodiversity in international waters. After talks over nearly two decades, delegates attending the Intergovernmental Conference on Marine Biodiversity of Areas Beyond National Jurisdiction (BBNJ) agreed in June 2023—subject to member state ratification—on an international legally binding instrument under the United Nations Convention on the Law of the Sea (UNCLOS) on the conservation and sustainable use of marine biological diversity of areas beyond national jurisdiction. This agreement is a major tool to support the protection of 30% of the world's oceans by 2030, put more money into marine conservation, and provide a framework to share marine genetic resources and deep-sea scientific knowledge[6].

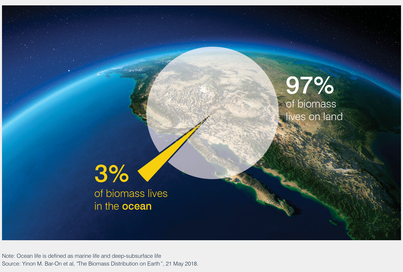
As UN Secretary General António Guterres has said, this "breakthrough is vital for achieving ocean-related goals and targets of the 2030 Agenda for Sustainable Development, and the Kunming-Montreal Global Biodiversity Framework". The High Seas Treaty is one of the three implementation instruments for the UNCLOS adopted in 1982 to establish a single set of rules to protect the world's oceans and govern efforts to use their resources[7]. The ISA, established pursuant to another UNCLOS implementation instrument (1994 Implementation Agreement), has already placed 1.97 million km^2 of the Clarion-Clipperton Zone under protection. Note that the High Seas Treaty neither impacts the ISA's mandate as regulator nor sponsoring states and contractors' rights and responsibilities.

Given these efforts to protect the world's oceans and given land-based mining's destructive legacy, one might find it odd to even consider introducing a new extractive activity on the seafloor. However, we believe that the deep seafloor on the abyssal plain is worth exploring as a potential source of energy transition metals with a lower impact mainly due to advantages offered by the location of polymetallic nodules and its characteristics.

Even though life likely originated in the ocean which accounts for 70% of the Earth's surface, most life lives on land. Only 3% of living biomass resides in the oceans while 97% resides on land[8]. While vast, oceans largely lack the structure that vegetation on land offers and, as a result, feature less abundant ecological niches for life to evolve. The ocean represents an expanse of similar habitats, while land features a much wider variety of smaller habitats and ecological niches mainly due to plant and tree diversity[9]. This diversity translates into greater biodiversity overall on land than in the oceans[10].

[1] UNEP, "Life Below Water", 2020.
[2] UN SDGs, "Goal 14: Conserve and Sustainably Use the Oceans, Seas and Marine Resources", Accessed in Jul. 2023.
[3] United Nations Sustainable Development Goals, "Goal 14: Life Below Water", Accessed in Feb. 2024
[4] Epeli Hau'ofa, "The Ocean in Us", Fall 1998.
[5] CDB, "COP15: Nations Adopt Four Goals, 23 Targets for 2030 in Landmark UN Biodiversity Agreement", 19 Dec. 2022.
[6] United Nations, "Intergovernmental Conference on Marine Biodiversity of Areas Beyond National Jurisdiction", 16 Mar. 2022.
[7] United Nations, "UN Delegates Reach Historic Agreement on Protecting Marine Biodiversity in International Waters", 5 Mar. 2023.
[8] Yinon M. Bar-On et al, "The Biomass Distribution on Earth", 21 May 2018.
[9] Yinon M. Bar-On and Ron Milo, "The Biomass Composition of the Oceans: A Blueprint of Our Blue Planet", 12 Dec. 2019.
[10] Katona et al, "Land and Deep-Sea Mining: the Challenges of Comparing Biodiversity Impacts", 18 Mar. 2023.

Life in the Ocean: Despite the Large Area of the Ocean, Most Life is Found on Land



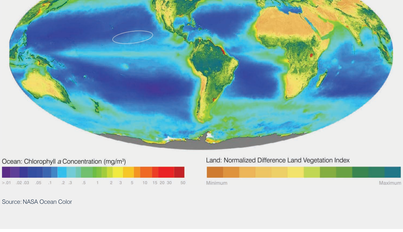
Note: Ocean life is defined as marine life and deep-subsurface life.
Source: Yinon M. Bar-On et al, "The Biomass Distribution on Earth", 21 May 2018.

Not unlike different biomes on land (e.g., deserts vs. tropical rainforests), the ocean comprises areas that vary in productivity. Coral reefs possess the most biodiversity in the ocean (e.g., the Coral Triangle in the Indo-Pacific region), whereas abyssal plains are among the lowest biomass habitats on the planet (akin to deserts on land).

> We decided to focus on areas with the lowest ocean productivity, far away from human coastal communities, coral reefs and fisheries.

Global Surface Ocean Primary Productivity

As measured by chlorophyll concentration average 1997-2000, combined with the SeaWiFS-derived Normalized Difference Vegetation Index over land



Source: NASA Ocean Color

We decided to look at areas with the lowest ocean productivity, and this decision took us to the deep sea in international waters where three types of metal deposits can be found: polymetallic nodules found on the abyssal plains, cobalt crusts found on seamount slopes (underwater mountains), and seafloor massive sulfides found around hydrothermal vents.

^ Back to the section page Next: Why We Focus Only on Nodules >

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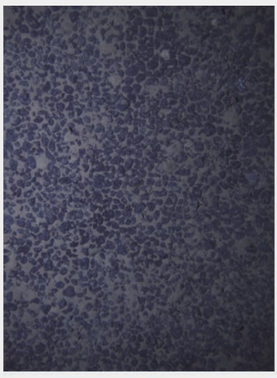
Why We Focus Only on Nodules

Deepsea Minerals



The Abyssal Plain

Polymetallic nodules

3,800-5,500 m depth

Discrete rocks, 2-30 cm in diameter, formed by dissolved metal compounds precipitating around a nucleus.

- **Growth: 10-20 mm per million years.**
- Unattached to the seafloor. Can be collected using gentle water jets directed at nodules in parallel with the seafloor.
- Low-food, low-energy environment.
- **13 grams of biomass/m²**

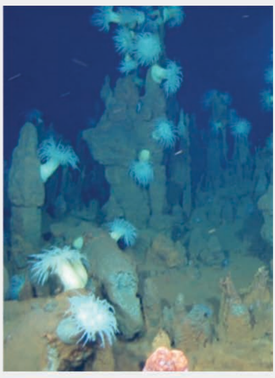
Seamounts

Cobalt crusts

800-2,500 m depth

Rock-hard metallic layers that are 2-26 cm thick and precipitate on the flanks of submarine volcanoes.

- **Growth: 1-5 mm per million years.**
- Integral part of the seafloor that requires hard-rock cutting to break the ore from the substrate.
- Abundant food supply due to nutrient-rich water upwelling from near-bottom currents. High-frequency destination for tuna and sharks.
- **10-100x biomass vs. abyssal plain**



Hydrothermal Vents

Seafloor massive sulfides

1,000-4,000 m depth

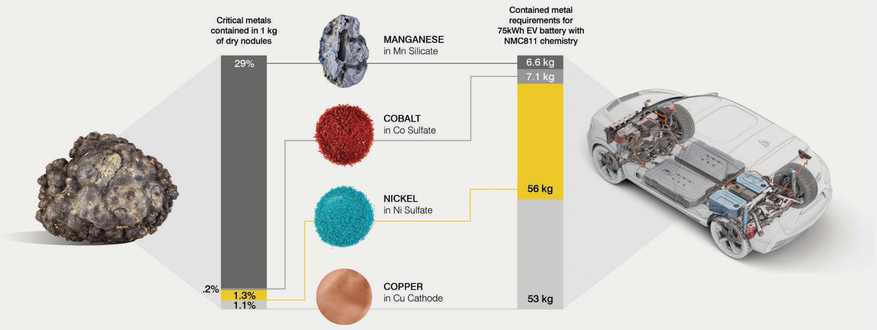
Tall chimney-like structures that form at hot vents where sulfide-enriched water flows out of the seabed, causing dissolved metals to bind into minute sulfide particles and sink as fine precipitants to the bottom.

- Integral part of the seafloor that requires hard-rock cutting to break the ore from the substrate.
- Abundant food supplied by chemoautotrophic bacteria that exploit energy-rich chemical compounds from the vents.
- **100x biomass vs. abyssal plain**

Sources: Skowronek et al, "Chemostratigraphic and Textural Indicators of Nucleation and Growth of Polymetallic Nodules from the Clarion-Clipperton Fracture Zone (IOM Claim Area)", 11 Aug. 2021; Yinon M. Bar-On et al, "The Biomass Distribution on Earth", 21 May 2018.

Polymetallic nodules stand out because each one contains high grades of four critical metals that the energy transition requires. In addition, since they sit unattached on the abyssal plain seafloor, one does not need to cut, dig, or blast into the seafloor to collect them. This fact explains why we use the term "nodule collection" rather than "nodule mining" when referring to our future operations. In contrast, cobalt crusts and seafloor massive sulfides represent integral seafloor structures and one would have to mine them via conventional means (i.e., by breaking and cutting hard rock).

Nodule Composition vs. Battery Metal Needs



These factors landed us in the abyss at 4-6-kilometer depths.

^ Back to the section page Next: The CCZ and Abyssal Plains >

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The CCZ and Abyssal Plains

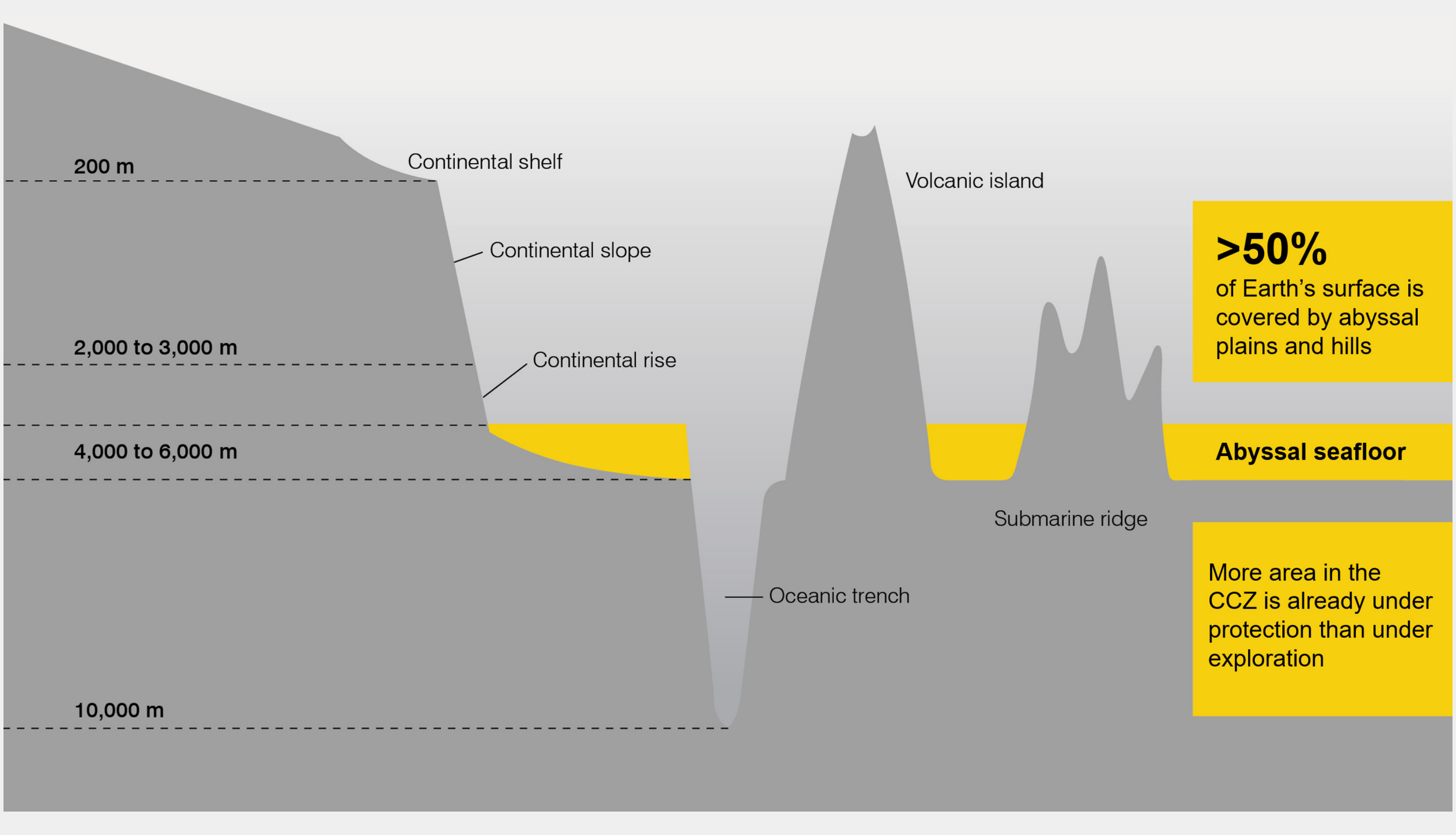
While operating far offshore at depths that exceed 4km involves many challenges, collecting polymetallic nodules from the abyssal plains has several advantages. For instance, abyssal seafloor (i.e., abyssal plains and hills) covers more than 50%[1] of the Earth's surface and 70% of the global seafloor. Abyssal plains alone cover 40% of the global seafloor, which makes it easier to set aside vast areas for protection[2].

[1] Harris et al., "Geomorphology of the Oceans", Jun. 2014

[2] NOAA, "Ocean Floor Features", 1 May 2020

The Abyssal Seafloor: the Most Common Biogeographical Area on the Planet

Abyssal plains and hills, where polymetallic nodules are found, are the most abundant habitat type on the surface of the Earth, accounting for >50% of the Earth's surface and 70% of the global seafloor.



Visual representation not to scale.
Source: Harris et al., "Geomorphology of the Oceans", Jun. 2014

The seafloor sediments of the abyssal plains contain up to 15 times less carbon than all vegetation and soil on land—a much better starting point compared to land-based mining. Although nodule-collection operations can disturb the upper layer of the seafloor sediment (disturbance at around 5-10cm), we are finding that most of the sediment resettles relatively quickly and within a short distance from origin. Furthermore, there are no known pathways for the disturbed seafloor sediment (and carbon contained in it) to travel 4 kilometers upwards through the water column to reach the atmosphere. In a 2022 study based on actual field trials that the ISA contractor GSR conducted in the Clarion-Clipperton Zone (CCZ), the Massachusetts Institute of Technology (MIT) and Scripps Institute of Oceanography, found that the seafloor plumes from the nodule-collector vehicle on flat terrain remained relatively low. Between 92% and 98% of the plumes remained in suspension within 2 meters of the sea floor as opposed to traveling higher into the water column as some had speculated[1]. As a result, we do not expect nodule-collection activities to release significant amounts of carbon sequestered in seafloor sediments. We collected more in field data during our pilot collection test in 2022 and we now have multiple lines of evidence that indicate that the seafloor plume forms a gravity-driven turbidity current that hugs the seafloor and does not loft into the water column to be transported long distances by ocean currents (see the "Environmental Program" section for more information).

[1] Carlos Muñoz-Royo et al., "An In Situ Study of Abyssal Turbidity-Current Sediment Plumes Generated by a Deep Seabed Polymetallic Nodule Mining Preprototype Collector Vehicle", 21 Sep. 2022.

Actual Footage from the Autonomous Underwater Vehicle Following the Collector Vehicle Showing Plume Does Not Rise Above the Collector Lights

Less than 10% of all marine life lives below 4,000 meters[1] due to the enormous pressure, low temperatures, lack of light (which means no plants), and poor food availability at these depths. If one lines up all terrestrial and marine biomes on a scale from poorest to richest in terms of life, the scale runs from a few grams to about 30 kilograms of contained carbon per square meter. Rainforests such as the ones in Indonesia sit on the rich end of the scale at 15-30 kilograms. The abyssal plain sits on the opposite, lowest end of the scale at about 10 grams. For clarity, these values mean the abyssal CCZ has 300 times less biomass than an average biome on land and up to 3,000 times less biomass compared to rainforest regions where most of nickel mining occurs[2]. The abyssal plain sits on the opposite, lowest end of the scale at about 10 grams.

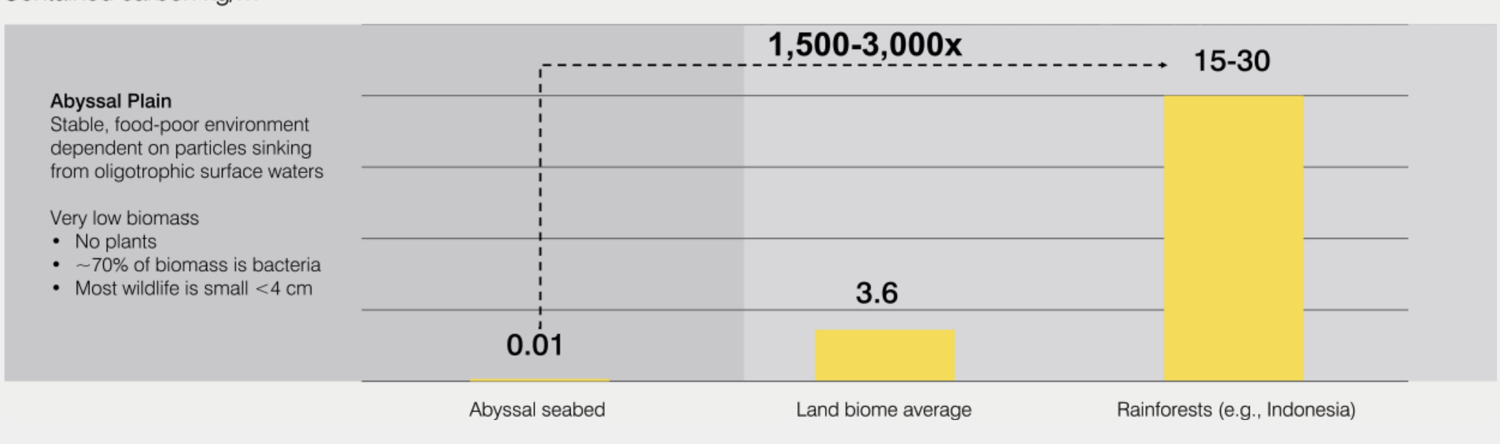
[1] Yinon M. Bar-On et al, "The Biomass Distribution on Earth", 21 May 2018.

[2] Ibid.

The Abyssal Plain: Home to Less Than 10% of Ocean Life

The abyssal plain is a vast sedimentary seabed, oxic to 2 m. It has gentle depressions, troughs and ridges. There is intense pressure (5,700-8,500 psi) and no sound or light except the ones made by animals. This environment is food-poor and stable.

The Abyssal Plain Advantage: One of the Lowest Biomass and Carbon Sequestration Environments on the Planet



Note: The seafloor-biomass value incorporates an estimate of seamounts and hydrothermal vents attributed to Wei, et al., 2010. It is also an overestimate because it includes all fish in the water column, rather than focusing only on the seafloor and mid-water column. The overall biomass of Earth's ice-free terrestrial area was 472.7 gigatonnes of carbon, compared to 2.49 gigatonnes of carbon for the global abyssal seabed.
Sources: Yinon M. Bar-On et al., "The Biomass Distribution on Earth", 21 May 2018; Wei, et al., "Global Patterns and Predictions of Seafloor Biomass Using Random Forests", 30 Dec. 2010.

Bacteria account for approximately 70% of the life in the abyssal plain based on biomass. Many creatures in the abyssal CCZ include invertebrates that filter organic matter from the sediments or overlying water. The main food source comes from the marine snow, organic particles that fall from the productive photic zone throughout the water column as they get metabolized along the way. Given the limited amount of food that reaches the bottom, most animals on the abyssal plain do not exceed 4 centimeters in size; in fact, most have microscopic dimensions. Some large mobile species such as ratfish and shrimp do live on the abyssal plain and can swim, so they will be able to move away from the areas that nodule collection disturbs. We have built a library of deep-sea biological samples to preserve and better understand them. To learn more, please view the "Marine Genetics Resource" and "Environmental Impact Statement" sections.

Life on the Abyssal Plain

Megafauna photo credit: Amon et al., 2016.
Meiofauna photo credit: C.R. McClain, "An empire without food," Amer. Sci. 98(6), 2010.

As a precautionary environmental management and protection measure, the International Seabed Authority (ISA), which regulates efforts to explore and exploit seabed resources in international waters, has already set aside 1.97 million square kilometers of the CCZ as protected areas or Areas of Particular Environmental Interest (APEIs) — 42% more than all contracted areas in the CCZ combined. These areas go beyond the Global Biodiversity Framework's objective to protect 30% of the ocean by 20301, which the High Seas Treaty will help achieve by establishing additional marine protected areas in international waters[1].

[1] CBD, 'COP15: Nations Adopt Four Goals, 23 Targets for 2030 in Landmark UN Biodiversity Agreement", 19 Dec. 2022; BBC, "What Is the UN High Seas Treaty and Why Is it Needed?", 8 Mar. 2023.

Earth:
510 million km²

Global ocean:
362 million km² (71% of Earth's surface)[1]

Pacific Ocean:
162 million km² (45% of the global ocean)

Deep sea (>200m depth):
360 million km² (70% of the Earth's surface)

International waters/high seas (generally >200 nautical miles or 370 km from a country's shoreline):
230 million km² (>60% of the ocean)

Abyssal plains and hills (>2,000 meters in depth):
253 million km² (70% of the ocean floor and one of the largest habitat on earth)[2]

Clarion-Clipperton Zone (CCZ):
4.56 million km² (1.2% of total ocean area, 1.7% of the abyssal plains and 3% of Pacific Ocean)

CCZ currently under exploration contract:
1.24 million km² (27% of CCZ)[3]

CCZ Areas of Particular Environmental Interest (APEI):
1.97 million km² never to be mined (an area 42% larger than all contracted areas within the CCZ combined)

TMC's exploration area:
224,000 km² (5% of CCZ)

Source: Report of the Chair of the Legal and Technical Commission on the work of the Commission at its twenty-sixth session: Decision of the Council of the International Seabed Authority relating to the review of the environmental management plan for the Clarion-Clipperton Zone, 10 Dec. 2021, SBA/26/C/58
1. NOAA, ETOPO1
2. NOAA Ocean Floor Features
3. ISA, Polymetallic nodules contractors, Accessed on 27 Feb. 2024

^ Back to the section page   Next: Comparative Life Cycle Studies >

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Comparative Life Cycle Studies

We have commissioned several research assessments to quantitatively understand the lifecycle impacts associated with TMC's future operations and how they compare to key land-based routes for producing the same metals.

In March 2023, Benchmark Mineral Intelligence (Benchmark) completed an independent LCA that compared the NORI-D Project's lifecycle environmental impacts with key land-based routes for producing intermediate (NiCuCo matte) and end-products (nickel sulfate, cobalt sulfate, and copper cathode). A third-party expert reviewed the LCA in compliance with ISO standards. TMC's flowsheet will also produce a pre-reduced manganese silicate expected to deliver cost and emission savings to downstream users.

The land-based routes Benchmark analyzed represent 93% of global refined nickel output and 86% of global mined cobalt output for 2022. This cradle-to-gate LCA analyzed seven environmental impact categories critical for the metal industry: global warming potential, stratospheric ozone depletion, terrestrial acidification, freshwater and marine eutrophication, particulate matter formation, and water consumption. Benchmark also conducted supplementary research into waste generation.

Impact Category (ReCiPe 2016)	Details
Global Warming Potential	Emissions included: carbon dioxide, carbon monoxide, methane, nitrous oxide, chlorofluorocarbons and hydrochlorofluorocarbons **(in kg CO_2 equivalent to air)**.
Stratospheric Ozone Depletion	Chemicals that cause the depletion of the ozone layer have chlorine or bromine groups in their molecules that interact with ozone (mainly) in the stratosphere. Ultimately, they cause human health issues because of the resultant increase in UVB radiation **(in mg CFC-11 equivalent to air)**.
Terrestrial Acidification	Atmospheric deposition of inorganic substances, such as sulfates, nitrates and phosphates, cause a change in the acidity of the soil. Major acidifying emissions include nitrogen dioxide (NO_x), ammonia (NH_3) or sulfur dioxide (SO_2). This can cause extinction of species, leading to damage to the terrestrial ecosystem **(in kg SO_2 equivalent to air)**.
Freshwater Eutrophication	Occurs due to the discharge of nutrients into soil or into freshwater bodies and hence in the subsequent rise in nutrient levels, e.g., phosphorus and nitrogen linked to algae blooms, tainted drinking water supplies, degradation of recreational opportunities, and hypoxia 'dead zone' lacking sufficient oxygen to support most organisms **(in g P equivalent to freshwater)**.
Marine Eutrophication	Occurs due to the discharge of nutrients into marine environments and hence in the subsequent rise in nutrient levels, e.g., phosphorus and nitrogen, setting off a chain reaction in the ecosystem that leads to acidification and the reduction of marine life **(in g N equivalent to marine water)**.
Particulate Matter Formation	Represents a complex mixture of organic and inorganic substances. PM2.5 can cause human health problems as it can deposit to the upper part of the airways and lungs when inhaled. Secondary PM2.5 aerosols are formed in air from emissions of SO_2, NH_3 and NO_x, among other elements **(in g PM2.5 equivalent to air)**.
Water Consumption	Attributed to the availability reduction of freshwater, which leads to impacts on human health and ecosystem quality **(in m³ water consumed)**.

Supplementary Research	Details
Waste Generation	Waste stream analysis does not form part of the third-party LCA but Benchmark included it as supplementary research to this study. Includes mine waste, mine and processing tailings,tailings bleed, slag and mobilized sediments (in kg of waste).

> Benchmark found that NORI-D Project model performed better for nickel and copper in every impact category analyzed and the vast majority of impact categories analyzed for cobalt on all the routes chosen for comparison.

The study found that TMC's nickel sulfate product would outperform not just Indonesian nickel sourced from beneath biodiverse rainforests and carbon sinks but all other key land-based production routes, with more than 70% lower emissions on average, including GWP.

Summary: Environmental Impacts of NORI-D Project By Product

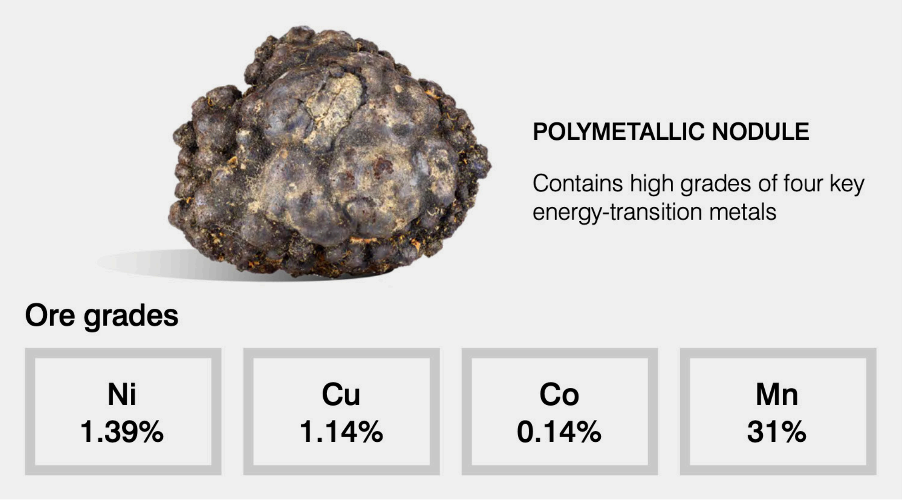
NORI-D Project products	NiCuCo matte	Nickel in nickel sulfate	Copper cathode	Cobalt in cobalt sulfate
Environmental Performance	**Best environmental performance** in all **7 impact categories** among the 3 processing routes analyzed	**Best environmental performance** in all **7 impact categories** among the 8 processing routes analyzed	**Best environmental performance** in all **7 impact categories** among the 4 processing routes analyzed	**Best environmental performance** in **5 of 7 impact categories** among the 8 processing routes analyzed
Overall Impact	On average **>90% lower emissions** than the conventional and DON processing routes in 4 of 7 impact categories, namely stratospheric ozone depletion, freshwater eutrophication, marine eutrophication and water consumption. And on average **lower emissions by >63% in GWP, >36% in terrestrial acidification and >44% in fine particulate formation**	On average **>80% lower emissions** than other routes in 5 of 7 impact categories, namely stratospheric ozone depletion, terrestrial acidification, freshwater eutrophication, marine eutrophication and fine particulate matter formation. And on average **>70% lower emissions in GWP and water consumption**	On average **>90% lower emissions** in 3 of 7 impact categories for stratospheric ozone depletion, freshwater eutrophication and marine eutrophication. And on average **lower emissions by >55% in GWP, 64% in terrestrial acidification and 43% in water consumption**	On average **>70% lower emissions** in 5 of 7 impact categories, namely stratospheric ozone depletion, terrestrial acidification, freshwater eutrophication, marine eutrophication and fine particulate matter formation. And on average **>44% lower emissions in GWP and water consumption**
Global Warming Potential (GWP)	**60% and 64% lower GWP** than conventional and DON processing routes respectively	Between **23-94% lower GWP** than other 7 processing routes analyzed	Between **11-78% lower GWP** than other 3 processing routes analyzed	Between **11-92% lower GWP** than other 7 processing routes and **58% higher GWP** than the RLE route
Notes	Lower electricity demand, use of renewable energy and differences in the mining process contributed to better performance. Since nodules are unattached to the seafloor, obtaining metal ores by collecting nodules avoided emissions from blasting in traditional terrestrial mining, one of the chief environmental hotspots in stratospheric ozone depletion, fine particulate matter formation and terrestrial acidification in conventional and DON processing routes. Sulfidic tailings are also avoided, leading to 97% lower freshwater eutrophication emissions.	In addition to renewable electricity and higher recovery rates, the main reason for NORI-D Project's lower emissions in most impact categories is because use of sulfuric acid in the MHP and MSP routes is respectively 5-6 times higher than that in the NORI-D Project. Another critical contributor to the better performance is the absence of blasting in the mining stage. TMC NORI-D's absence of sulfidic tailings has proved significant in lowering the freshwater eutrophication emissions and the absence of blasting in the mining stage is another critical contributor to the better performance.	NORI-D Project's emissions from electricity contributed to only 0-7% in six impact categories, thanks to an energy efficient process and the use of renewable electricity. Another factor is the emissions from blasting in Conventional and DON technologies make NORI-D Project perform better in ozone depletion, fine particulate matter formation and terrestrial acidification. Similar to the previous products, the absence of sulfidic tailings helps differentiate the NORI-D Project from other routes in terms of eutrophication emissions.	Although the Indonesian RKEF route is similar to NORI-D in terms of the pyrometallurgical process for converting ore to matte, emissions from the NORI-D Project are between 76-149% lower in all impact categories. This is due to an 18% higher cobalt recovery rate, an 81% lower energy consumption rate, the use of renewable electricity and an 87% lower coal consumption. As compared to the RLE route, TMC NORI-D Project has higher GWP due to emissions from coal combustion and 10% higher water consumption.

Source: Benchmark Mineral Intelligence, 'Life Cycle Assessment of NORI-D Polymetallic Nodule Project and Comparison to Key Land-based Routes for Producing Nickel, Cobalt and Copper – Report Summary", March 2023.

While nodules on the abyssal seafloor reside far beyond any countries and communities, it does not mean that they do not have social benefits, such as economic royalties and fees, capacity building and training through education, jobs, and knowledge sharing with the people in our sponsoring states. It means that instead of focusing on mitigating adverse impacts to nearby communities, we can focus on creating positive impact. You can find more information about these benefits in our social impact section.

LIFE CYCLE STUDIES COMMISSIONED BY THE METALS COMPANY:

Other studies that TMC has commissioned include a 2020 white paper looking at 19 ESG indicators, a 2020 peer-reviewed paper looking at climate change impacts, a 2022 peer- reviewed paper looking at waste streams, a 2023 paper looking at biodiversity impacts, and an assessment of the impact of nickel and cobalt mining on terrestrial carbon sinks.



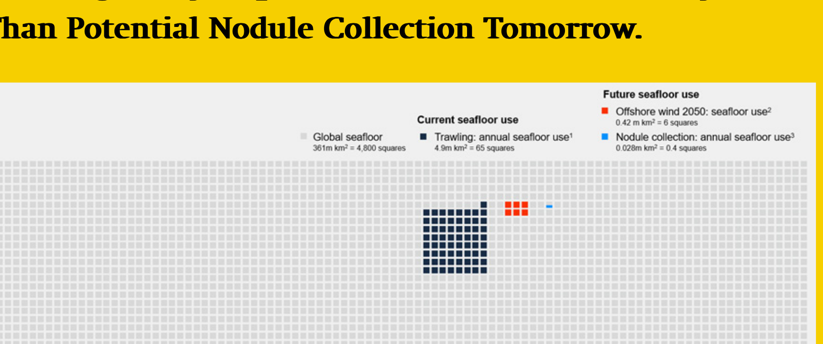
> These life cycle studies suggest that using nodules to produce energy-transition metals provides an opportunity to significantly compress most lifecycle ESG impacts associated with conventional metal production from land-based ores.

Nodule collection also avoids various ESG impacts associated with conventional metal-production from land-based ores, such as child labor, displaced local communities, deforestation, destroyed carbon sinks, large amounts of mine waste generation and toxic processing tailings. In addition, nodule collection can significantly reduce several impacts as compared to metal-production from land-based ores, such as greenhouse gas emissions freshwater use, and land competition. Given that these benefits stem from the polymetallic nodules' intrinsic properties, their location, and technology developments and tests that TMC has conducted for over a decade, we have a reasonably high confidence about our ability to deliver them.

With that said, uncertainties remain around the impact that commercial-scale nodule-collection operations may have on the biodiversity and ecosystem function of the CCZ abyssal seafloor and overlying water column. Unlike biomass, one cannot easily measure and compare biodiversity (defined as species richness). Some uncertainty about the full inventory of local and regional biodiversity will always remain. Measuring biodiversity on land faces a similar situation in that many species remain undescribed despite 250 years of taxonomic classification. More than 150,000 published papers have discussed polymetallic nodules in general and over 40,000 papers focused on CCZ nodules in particular. Still, research continues. TMC has conducted research fo1r over 11 years, and several academic institutions have contributed to our environmental impact assessment (EIA) program that comprises over 100 studies throughout the water column from the seafloor to ocean surface. We will continue conducting this research and expanding on the world's collective deep-sea knowledge.

It is also worth noting that in the highly unlikely scenario where the entire CCZ area currently under exploration (1.24 million square kilometers) were to be exploited over a 30-year period, these nodule collection operations would impact an estimated 42,000 square kilometers of the abyssal seafloor per year in one of the least productive areas of the ocean. This is less than 1% of the estimated 4,900,000 square kilometers of the seafloor currently impacted every year by trawling operations that take place primarily in highly productive coastal waters[1].

Trawling Today Impacts 175x More Seafloor Every Year Than Potential Nodule Collection Tomorrow.



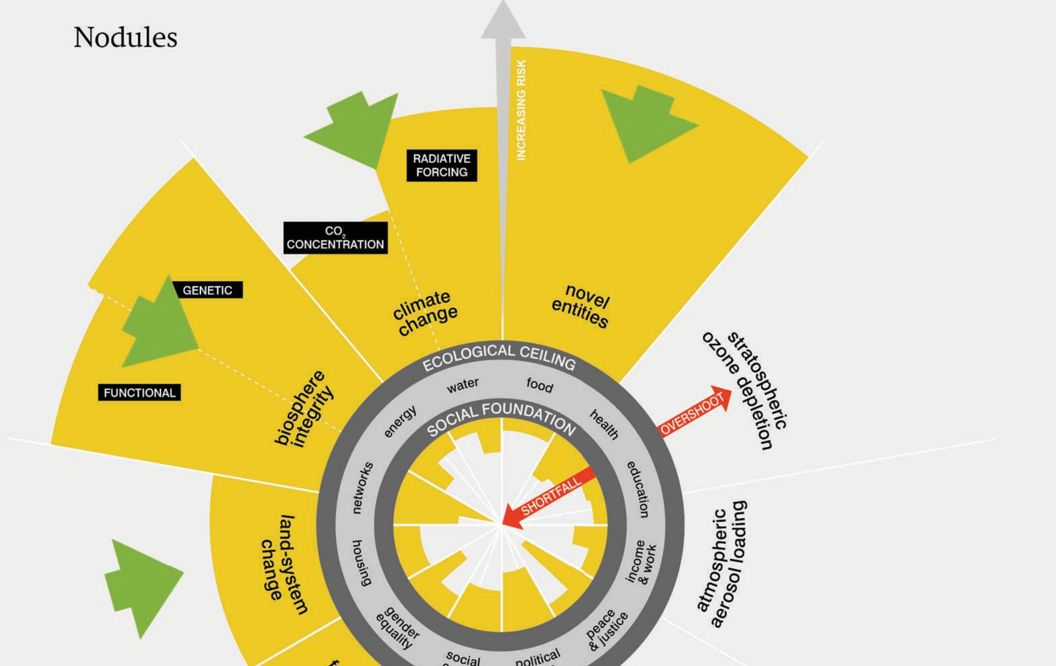
[1] Estimate provided in Enric Sala et al., "Protecting the Global Ocean for Biodiversity, Food and Climate", 17 Mar. 2021.

[2] Estimate based on IEA, "Net Zero by 2050", May 2021.

[3] Assuming a scenario where 50% of the 1.68 million km2 of nodule exploration area globally (international waters + EEZs) is exploited over a 30-year period, starting on the same day.

The above reasoning forms the basis for our hypothesis that nodules represent a viable lower impact source from which to obtain critical metals for the energy transition—a source that could allow humanity to move forward while helping to prevent it from overshooting most planetary boundaries and falling short on most social foundations.

Impact From Nodules Collection on Planetary Boundaries and Social Foundations Relative to Most Current Land-Based Production Routes of Battery Metals



This is a representation of the current planetary boundaries and social foundations that nodule collection presents.

Even if this hypothesis proves correct, collecting polymetallic nodules would only reduce rather than eliminate negative externalities. While it may constitute a responsible and the best option we have, it cannot be sustainable. It still involves taking resources from the planet. That explains why, in our plan, we have a goal to recycle the metals we produce as we help build up sufficient metal stocks. Over time, we will be able to sunset our nodule-collection activities and transform into a recycling business. From there, we intend to expand our scope to possibly recover a broader set of metals to build a carefully managed metal commons that will be used, recovered, and reused again and again.

^ Back to the section page   Next section: How We Do It >

We're building a carefully managed metal commons that will be used, recovered, and reused again and again.

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How We Do It

The Metals Company has a fundamental vision: to build up and maintain a global metal commons with the least possible environmental and social impact.

Whether we design with our partners an offshore nodule collection system or an onshore processing flowsheet, engage with our sponsoring states, or develop a decarbonization strategy prior to production, we focus on addressing key ESG risks and opportunities as we work toward commercial production. Developing a resource deemed a common heritage of humankind (CHH) means we must embrace the responsibility that comes with it.

The CHH principle represents the notion that certain globally important resources should not be unilaterally exploited but rather managed and developed for the benefit of humanity as a whole. We believe the spirit of the CHH principle calls for transparency, strong partnerships, and broad stakeholder engagement.

TMC Governance

- TMC's Governance Structure
- Business Ethics and Transparency
- Sustainability Approach
- TCFD & TNFD
- Other Initiatives We Support
- Stakeholders Engagement

CCZ Governance

- International Treaty for the High Seas
- Sponsoring States: States Profiles
- ISA Mining Code
- Environmental Impact Statement (EIS)

A CLOSER LOOK AT THE COMMON HERITAGE OF HUMANKIND

While there is no concise fully agreed-on definition for the CHH, it has several core elements:

- **The non-appropriation principle**: no state or other entity (e.g., corporations and people) can own or claim sovereignty/sovereignty rights over certain global heritage spaces or resources that belong to humanity as a whole.
- **Cooperative management:** one can use the CHH only in accordance with a cooperative management system for all humankind's benefit (i.e., for the common good).
- **Sharing of benefits:** benefits (including financial, technological, and scientific) derived from activities in an area deemed the CHH must be actively and equitably shared.
- **Peaceful purposes:** one can use the CHH only for peaceful (and not military) purposes.
- **Preservation:** one must protect ecological integrity and intergenerational equity between present and future generations.

These elements in the United Nations Convention on the Law of the Sea (UNCLOS), which governs the Area (the seabed and ocean floor and the subsoil thereof beyond the limits of national jurisdiction) and embraces the goal to contribute to realizing a just and equitable international economic order that considers all humankind's (but, in particular, developing countries') interests and needs[1].

[1] David Bollier and Silke Helfrich, "The Wealth of The Commons: A World Beyond Market & State", 2012.

Next: TMC's Governance Structure >

We're building a carefully managed metal commons that will be used, recovered, and reused again and again.

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TMC's Governance Structure

We have developed a governance structure to ensure that we actively embed environmental, social, and governance (ESG) topics into our business. Accountability for ESG-related performance is an open and iterative exercise across all levels in the company. Ultimately, TMC's Chief Executive Officer (CEO) is responsible for our overall sustainability performance, while the board of directors is responsible for our sustainability strategy, which our chief sustainability officer proposes and the board's sustainability and innovation committee vets.

Sustainability and Innovation External Advisory Council
Independent members will serve as the company's sounding board to challenge us to do better. They bring their expertise and diverse perspectives to enrich TMC's approach.

Board of Directors
Responsible for ESG strategy and governance.

Sustainability & Innovation (S&I) Committee
In-depth review of strategy and performance. First stop to discuss ESG risks and opportunities.

CEO
Responsible for the company's ESG management, compliance and performance.

Chief Sustainability Officer
Identifies TMC's most material sustainability issues and sets the sustainability strategy framework, with oversight by the S&I Committee and input from external and internal stakeholders. Works with TMC leadership and department heads on strategy, goals development and implementation. Works closely with the **chief strategy officer** to ensure sustainability and business strategy are fully aligned.

Leadership Team
Responsible for TMC's sustainability performance, monitoring progress and addressing challenges. Provides relevant information to identify ESG-related risks and opportunities, develops strategy and defines targets.

Department Heads
Responsible for implementing sustainability strategy, tracking progress on goals and mitigating material risks. Provide regular updates to peer leadership and the board.

TMC's Board of Directors

TMC's board of directors recognizes that strong corporate governance, which involves actively engaging with and seeking input from stakeholders, promotes accountability, transparency, and sound decision-making that fosters sustainable business growth over the long term. At TMC, we see strong corporate governance as particularly relevant given that we operate in an emerging industry to collect a mineral resource declared a common heritage of humankind. Our board of directors sets high standards for the company's employees, officers, and directors and oversees key risks, which includes strategic, financial, operational, safety, environmental, social, and legal compliance matters. See TMC's Proxy Statement 2023 for detailed information and metrics about our board of directors for the reporting year 2023, and TMC's Corporate Governance webpage for up-to-date information about our current board of directors and committee composition.

Board Composition, Responsibilities and Commitments

TMC's strategic plan includes first expanding metal stocks through primary metal production before transitioning to a business model that tracks, recovers and recycles secondary metals. This plan requires a board willing to commit to a long-term strategy while balancing many different stakeholders' interests.

The board (together with management) focuses on getting the polymetallic nodule resource into commercial production, scaling to meet demand with the lowest ESG footprint, and setting the company up for long-term growth and profitability, which includes decisions to:

- Set a new bar for a metals business that aligns with the common heritage of humankind (CHH) principle.
- Secure the world's first International Seabed Authority (ISA) exploitation contract.
- Develop the world's first commercial nodule project.
- Expand upon our existing relationships with our sponsoring states to create shared lasting value.
- Develop strategic partnerships with offshore and onshore companies to enable capital-efficient and ESG-focused paths to start and scale metal production capacity in response to demand driven by the energy transition and development.

The board directly and regularly engages with management on these topics. Furthermore, board members have significant experience as top-level executives at public companies or as entrepreneurs who founded successful organizations.

As of 31 December 2023, our board comprised five males and three females who come from Australia, South Africa, Botswana, Denmark, the Kingdom of Tonga, and the United States.

Board Committees

The board has four standing committees:

1. Audit committee
2. Nominating and governance committee
3. Compensation committee
4. Sustainability and innovation committee

Committee Composition (as of 31 Dec. 2023)

Name	Function	Audit Committee	Compensation Committee	Nominating & Governance Committee	Sustainability & Innovation Committee
Andrew C Greig	Lead independent director		●		
Andrew Hall	Director	●			
Andrei Karkar	Director		◆	●	
Sheila Khama	Director	●		●	◆
Christian Madsbjerg	Director			◆	●
Kathleen McAllister	Director	◆			
Amelia Kinahoi Siamomua	Director				●

◆ Chairperson ● Member

Each committee member qualifies as an independent director under NASDAQ's listing standards. In addition, as part of our governance review and succession planning, the board (which the nominating and governance committee leads) evaluates our leadership structure to ensure that it remains the optimal structure for TMC; reviews the board's and its committees' composition, size, and performance; evaluates individual board members; and identifies and evaluates candidates for election or re-election to the board. See TMC's Corporate Governance webpage for updated board and committees composition.

The committees have the following responsibilities:

Sustainability and Innovation Committee

- Oversee sustainability and innovation initiatives with significant business, financial, environmental, and reputational impact
- Oversee sustainability- and innovation-related risks and opportunities
- Review and advise on TMC's sustainability performance

Audit Committee

- Oversee auditors
- Review financial reporting policies and processes
- Manage risk (e.g., enterprise risk management), related party transactions, legal compliance, and ethics
- Oversee regulatory and other financial matters
- Administer whistleblower policy

Nominating and Governance Committee

- Nominate directors
- Oversee corporate governance and review policy
- Oversee code of business conduct and ethics

Compensation Committee

- Establish corporate performance scorecard
- Review CEO performance
- Oversee executive compensation and administer the equity-incentive plan

^ How We Do It Next: Business Ethics & Transparency >

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Business Ethics & Transparency

TMC aspires to act in ways that benefit the planet and people for generations to come. Our Code of Business Conduct and Ethics (the "Code") sets out basic principles that guide all individuals who work at or for TMC to prevent any improper behavior. The company also requires collaborators and business partners to abide by the requirements and guidelines set forth in other applicable TMC policies, such as its Anti-Corruption and Anti-Bribery Compliance Policy.

TMC requires any employee, partner or contractor who learns about anyone who may have violated the code to report the violation to our ethics hotline, the board chairman, or our general counsel. A third-party service provider operates the hotline, and reports can be made in a completely anonymous and confidential manner. TMC encourages any person who, in good faith, suspects that someone has violated the code to report it without fear that they will face negative repercussions (e.g., termination, demotion, reprimand, or other harm). We logged no reported incidents in 2023.

^ How We Do It Next: Sustainability Approach >

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Sustainability Approach

The energy transition and global development are metal intensive and require unprecedented quantities of mined metals in the coming decades. Metal extraction comes with its own set of human and planetary costs, and while there are no perfect solutions, we see the collection of polymetallic nodules from the seafloor of the Clarion Clipperton Zone (CCZ) of the Pacific Ocean as an opportunity to provide an abundant supply of battery metals for the energy transition with the least social and environmental impact.

Our destination is a carefully managed metals commons that is used, recovered, and reused for generations to come. Getting there will be challenging and as long as the world's metal demand keeps growing, existing metal stocks will not be enough to meet it. At TMC, it is our mission to find a workable path to this future. In our sustainability approach, we share the thought processes and principles that will guide our decisions as we work towards realizing this vision.

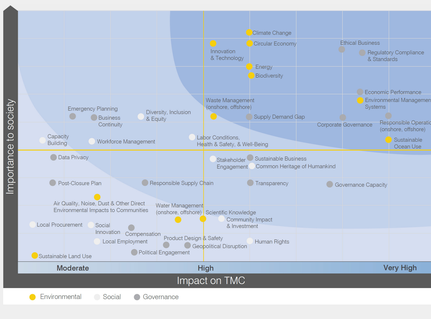
Vision	**We envision a carefully managed metal commons that will be used, recovered, and reused again and again – for millennia.**		
Our Plan	**CHAPTER ONE** Supply required primary critical metals with the least negative impact on people and the planet	**CHAPTER TWO** Recycle the metals we produce	**CHAPTER THREE** Recycle the rest
	We see polymetallic nodules found far offshore in the international waters of the CCZ as a promising pathway to supply critical metals with the least negative impact on people and the planet.		
Why Nodules	**Location:** - Far offshore – no human settlements, no child labor, no human displacement - Deep on the abyssal zone – 4-6 km beneath the ocean surface; no forests, no plants, 70% of life found in the form of bacteria - International waters –regulations developed by the International Seabed Authority's 168 member states plus the EU	**Resource Characteristics:** - Unattached to the seafloor – no drilling, digging or blasting needed - Four metals in a single ore, high ore grades – much less ore mass to process - Very low traces of hazardous elements such as arsenic, cadmium and mercury – no toxic processing tailings - CCZ holds much larger resources of nickel, cobalt and manganese than known reserves of these metals on land – addressing supply availability	**Our choices:** - Near-zero processing waste - Onshore plants can be located on any continent – addressing supply chain diversification - Onshore processing powered with low carbon electricity - Enable traceability and recovery of the metals produced – circular economy
Our Responsibilities	**#1: Full stack of impacts** No "externalities" –accounting for the full stack of our impacts on planetary boundaries and social foundations	**#2: Net positive impact** Create a significant, lasting, net positive impact on people and the planet using a common heritage of humankind resource	**#3: Course correction** Change course if our chosen path does not deliver on our net positive impact goal; we cannot afford path dependencies

Our Methodology

We are taking a methodical approach to bringing our vision to reality. In 2022, we carried out a materiality assessment to identify the areas that matter most to internal and external stakeholders, and to our business. The results of this exercise form the foundation of our sustainability goals and reporting, and periodic materiality assessments will continue to take place to ensure alignment with the evolving global landscape. The four-step process included:

1. **IDENTIFICATION**: Topics were identified via a materiality horizon, where we developed an initial list of more than 500 topics based on a desktop review of related legislation, standards, frameworks, industry trends, global megatrends, media, peers, value chain and TMC's strategy.
2. **PRIORITIZATION**: Topics were grouped into 40 key topic areas. Two sets of criteria were developed to help prioritize them – one for the level of importance to stakeholders and another to measure the level of impact to the company, including factors such as stakeholder relations, business strategy and purpose, among others.
3. **STAKEHOLDER ENGAGEMENT**: Via interviews and surveys using the two sets of criteria developed, the topics were ranked. Participants of this exercise included external stakeholders, TMC's Board of Directors, TMC's leadership team and department heads.
4. **VALIDATION AND REVIEW**: The process and the results of the exercise were shared and discussed internally with TMC's leadership team and with the Board's Sustainability & Innovation Committee. Discussion around continuous improvement of this process and topics where communication needs to increase were an additional valuable part of this exercise.

Materiality Matrix



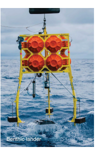
Our Goals

The results of the materiality process gave us key insights into what the focus of our 2030 sustainability goals should be and, via an iterative feedback process with all TMC employees, the Board and its Sustainability & Innovation Committee, we have identified 12 key goals for the company.

Driver	**The energy transition should not come with the destruction of our planet or the suffering of people. At TMC, we look to help supply the minerals needed to accelerate this transition with the least negative planetary and social impacts while intentionally building a circular economy for these metals.**		
Ambitions	**ENVIRONMENTAL** We will account for the full stack of our impacts, through a science-driven approach, we will address our emissions, waste and impacts to ecosystems, and share our knowledge of the deep sea.	**SOCIAL** We acknowledge the responsibility that comes with developing a resource deemed common heritage of humankind, and as such we commit to consult and communicate openly and transparently with global stakeholders and invest to deliver positive impact.	**GOVERNANCE** We understand the responsibility that comes with starting a new extractive industry in a new environment – we will proceed with caution, transparency and openness.
Goals	1. Continue to build and share knowledge of deep-sea ocean ecosystems 2. Protect and manage ecosystems we impact using a science-driven approach 3. Systematically implement path toward net-zero emissions 4. Drive circularity of critical minerals through materials tracking partnerships, investment and innovation	5. Build trusted relationships by engaging with stakeholders and providing visibility into our operations 6. Protect people by ensuring the right policies and programs are in place to support their well-being 7. Invest in capacity building to develop the next generation of deep-sea scientists and, with our sponsoring states, help close the skills gaps needed by them 8. Fund solutions that benefit people and the planet such as community-led initiatives and conservation projects	9. Report transparently on our progress and impacts 10. Build strong environmental, social and governance (ESG) oversight into our daily business activities 11. Drive industry-leading ESG performance and disclosure 12. Course-correct if chosen path does not deliver on our impact goals
Targets	The targets that will drive us to achieve these goals and that will allow us to track our progress are under development. We want your feedback and that is why we are sharing where we are now to give you a clear idea of the areas that we are working on and that will take us where we want to be. Insights from your feedback will be reviewed to help us finalize them.		
Highlights	1. TMC makes extensive Deep-sea Submission of Environmental Data to UNESCO's Ocean Biodiversity Information System 2. TMC and Kongsberg Digital Announce Next Phase of Agreement to Bring AI and Hybrid Machine Learning to Future Deep-sea Nodule Collection Operations 3. TMC identified ways to reduce metcoal consumption by at least 10% 4. TMC's offshore partner Allseas retrofitted a 228-meter-long former drill ship into first subsea mining vessel	5. Open Letter to Ocean Conservation Community: Engage with us on real-world data and trade-offs 6. All contractors conducting our operations have third-party verified health and safety management systems 7. Since 2020, we have provided 100 training opportunities and scholarships 8. In 2023, we have funded 43 grants for community-led projects in Nauru and Tonga	9. TMC Subsidiary NORI Shares Preliminary Findings on Environmental Impacts of Pilot Nodule Collection System Test 10. TMC Has a Sustainability & Innovation Committee at the Board, a Chief Sustainability Officer and Clear Sustainability Goals Developed 11. TMC joins International Consortium to Develop the First ESG Handbook for Marine Minerals 12. Lifecycle Assessment by Benchmark Shows TMC's NORI-D Nodule Project Could Outperform Land-Based Routes of Producing Nickel, Copper and Cobalt in Almost Every Impact Category Analyzed
UN SDGs alignment	13 CLIMATE ACTION 14 LIFE BELOW WATER	8 DECENT WORK AND ECONOMIC GROWTH	12 RESPONSIBLE CONSUMPTION AND PRODUCTION 17 PARTNERSHIPS FOR THE GOALS

A set of key performance indicators is being finalized per goal, and as we implement them, we will provide a scorecard on our progress toward meeting them. We welcome feedback and look forward to hearing from you. Write us at impact@metals.co.

TCFD & TNFD



Getting to net zero emissions by 2050 requires an accelerated transition to renewable energy sources and electric vehicles, which amplifies demand for the critical metals that these technologies use. The production of vast amounts of these metals will further exacerbate impacts on nature; therefore, reconciling global needs for metals while tackling the climate and biodiversity crises is a challenge. TMC seeks to address the need for critical minerals with the lowest environmental and social impacts to support the transition to a low-carbon economy. We have committed to adopting the recommendations of the Task Force on Climate-Related Financial Disclosures (TCFD) and the Task Force on Nature-Related Financial Disclosures (TNFD).

We welcome the launch of the TNFD framework as a much-needed guidance for reporting complex and interconnected nature-related impacts. We believe in shifting financial flows away from nature-negative outcomes and toward nature-positive outcomes—something that the Global Diversity Framework and High Seas Treaty also support. The TNFD framework provides a structured approach and common language that underpins our efforts to quantify the nature-related trade-offs and opportunities associated with producing energy-transition metals from polymetallic nodules as compared to producing them via key land-based routes. We look forward to continuing to strengthen our disclosures and risk management process in line with the recommendations that the TNFD and TCFD provide.

Governance

TMC's board of directors is ultimately responsible for overseeing risks and opportunities related to climate change and nature. Management informs the Sustainability & Innovation (S&I) Committee of the Board of environmental, social, and reputational issues that could potentially have an impact on the business, and the S&I committee, reviews and advises on them. Such issues include climate change, nature- and stakeholder-related impacts, and innovation matters.

The S&I committee meets at least once per quarter to address these and other issues and works with TMC's leadership team and, in particular, with the chief sustainability officer to guide the company's sustainability strategy. The S&I committee reviews and makes recommendations to management on the company's progress towards establishing ESG goals and delivering at a minimum an annual public report on the company's progress towards them and other non-financial initiatives, strategies, and targets. The S&I committee currently focuses on discussing governance, business plans and budgets for implementing TMC's ESG goals. At the management level, the chief sustainability officer monitors climate- and nature-related issues and brings them to the S&I committee. For more information, refer to TMC's Governance Structure page and the S&I Committee Charter.

Risk and Impact Management

The process we use to manage nature-related risks is derived from TMC's enterprise risk management (ERM) policy, which incorporates a consistent approach to risk management into the culture and strategic planning of TMC, and our ERM framework which describes the roles, responsibilities and strategy that we use to manage risks. Together, they offer a systematic methodology applicable to all activities and projects that establishes the context to make decisions and respond timely to risks and opportunities as they arise. This constitutes the first of our seven-stage process for managing risks.

We seek to identify risks on an on-going basis and as required when significant changes occur and / or for new processes, programs, or initiatives. Following a risk assessment that considers likelihood and impact, we evaluate them against pre-established risk appetite criteria in order to prioritize them for treatment using TMC's risk matrix. We list, describe and categorize risks in a risk register, and assign risk owners who are responsible for managing the risk and those involved in each related key mitigating procedure and control. We manage risks by identifying, assessing and implementing treatment options that not only seek to minimize potential downside but also maximize the potential upside of opportunities. The monitoring and review process seeks to continuously evaluate and refine the effectiveness and relevance of TMC's ERM program.

Sustainability and innovation-related risks and opportunities are identified and shared across the organization by management, with the board holding ultimate oversight responsibility. To help us identify, assess, evaluate, manage and monitor risks and to ensure we achieve our plan, we continuously acquire insights through research and third-party engagement. For example:

- We continuously scan for key risks and opportunities. We use reports such as those from the International Energy Agency (IEA), World Economic Forum, and Benchmark Mineral Intelligence (Benchmark) in addition to industry reports, research, and other sources to acquire more insights. The leadership team reviews and escalates potential significant insights to the S&I committee as needed.
- We adopt a science-driven approach to better understand and mitigate the potential impacts of our operations in the Clarion-Clipperton Zone (CCZ). To that end, we have implemented a robust science program and begun developing an environmental management system (EMS) with aid from technology such as an adaptive management system (AMS).
- We analyze the impact that our future operations will have on the climate and nature, test our hypotheses, and identify opportunities to further reduce our footprint. To that end, we have invested in several lifecycle studies, such as a recent third-party verified, ISO standards-compliant analysis that Benchmark conducted to assess the impact that producing nickel, cobalt, and copper from nodules would have on the environment and to compare the results to key land-based production routes for the same metals.
- We strive to work with sustainability-minded members across the value chain with the skills and resources to ensure we can achieve better performance from before we even begin commercial operations.
- We seek consistent engagement with external stakeholders to keep up to date in the most concerning areas for them. From engagement with our sponsoring states to NGOs, we connect with key stakeholders who help us identify climate- and nature-related risks and opportunities. You can learn about our policies and our engagement activities that relate to nature impacts, risks, and opportunities, by visiting the following pages: Corporate Governance, Stakeholder Engagement, Environmental Impact Statement, and Sponsoring States.

Strategy

TMC seeks to build a carefully managed metal commons with the lowest environmental and social impacts to help close the rapidly growing supply gap in energy transition metals. With a strong alignment to sustainable development and the transition to a lower-carbon society, we see many opportunities to build economic, environmental, and societal value, which includes supplying lower-impact energy transition metals and contributing to track, recover, and recycle metals. Producing these metals from polymetallic nodules also offers the potential opportunity to help mitigate current land-based mining's impacts on nature while meeting the projected demand for critical metals since it involves no drilling, digging, or blasting activities; does not involve removing overburden as nodules sit unattached on the seafloor; does not produce tailings; and does not remove carbon-rich habitats (e.g., forests) since the abyssal plains lack plant life. Our vision aligns with and supports TCFD and TNFD's intent to protect the climate and nature.

Our immediate business strategy focuses on minimizing and removing execution risks to ensure we achieve commercialization. At the same time, we take an intentional and methodical approach to building a sustainable business, and we consider ways to eliminate or minimize climate- and nature-related risks in the choices we make as we develop our onshore flowsheet and offshore operations. We expect our offshore commercial operations to start with a former drillship that our partner, Allseas. converted into a production vessel. The Environmental Program and Environmental Impact Statement (EIS) pages describe in more detail the resources and efforts we continue to invest in studying the potential impacts of our future nodule collection operations on marine biodiversity and ecosystem function and to develop effective mitigation measures.

For our onshore operations, we intend to start commercial operation by using existing metallurgical facilities, and, as the project scales up, we may partner to build a bespoke refinery facility using our near-zero waste processing flowsheet. We aim to use low-carbon electricity to power our operations and to maximize the extent to which we electrify our processes to minimize the resulting carbon footprint. We also aim to use closed-loop water systems and produce near-zero processing waste. You can learn more about this in the Onshore Operations section of the report.

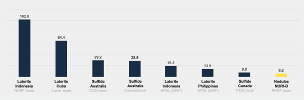
We started centralizing our climate-related risks and opportunities in a register which leverages our ERM framework and aligns with TCFD recommendations. We assess climate-related transition risks and opportunities that could potentially have a material impact on TMC's value proposition and financial prospects in the short term (before 2030), medium term (from 2030 to 2040), and long term (from 2040 to 2070). We selected these horizons based on our project development's expected timeline and offshore vessels and onshore facilities' expected lifetime (which ranges from 30 to 50 years).

In our Sustainability Approach, we stress our responsibilities to #1 account for the full stack of our impacts on planetary boundaries and social foundations; #2 create a significant, lasting, net positive impact on people and the planet; and #3 change course if our chosen path does not deliver on our net positive impact goals. This requires comprehensively studying our potential future environmental impacts and reporting them transparently. To that end, we commissioned a third-party verified, ISO standards-compliant lifecycle assessment (LCA) that Benchmark conducted to determine the environmental impacts associated with producing metals from nodules compared to other key land-based metal-production routes. More detailed information appears in the Comparative Lifecycle Studies page in this report, and below you can find an extract with the results from the LCA.

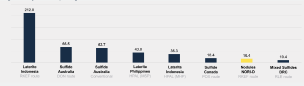
Climate-Related Impacts for Producing Nickel and Cobalt from NORI-D Nodules and Key Land-based Routes

Global Warming Potential (GWP)

Kilogram of CO_2e emissions per kilogram of **nickel in nickel sulfate**



Kilogram of CO_2e emissions per kilogram of **cobalt**



Note: Benchmark found that the land-based routes it analyzed had a direct association with 93% of global refined nickel output and 86% of global mined cobalt output for 2022

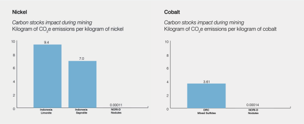
The assessment confirmed that the majority of NORI-D's emissions will come from the pyrometallurgical step. Knowing that our onshore nodule processing will consume the most carbon makes the energy sources available a top consideration when reviewing potential sites of existing and potential future plant(s). Other considerations include a site's vulnerability to physical climate-related risks (e.g., extreme weather events, water scarcity, and sea-level rises), proximity to market, supplier base, and transportation availability. For our offshore operations, we expect the vast majority of lifecycle carbon emissions to result from offshore vessels' fuel use. Therefore, we have also begun exploring approaches for maritime decarbonization with our vessel provider and our offshore system designer, such as by improving system efficiency and using alternative fuels.

We continuously look for ways to reduce our climate impact. In 2021, we completed the pyrometallurgical phase of our onshore pilot plant program. While testing our near-zero waste process flowsheet, we found a way to reduce metallurgical coal consumption by at least 10%. We also tested potential replacements for metallurgical coal to further improve the carbon footprint of our future onshore operations.

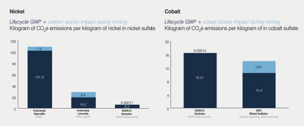
In 2022, SINTEF, one of Europe's largest independent research institutions, conducted a study to compare TMC's manganese silicate product with four other typical manganese feedstocks used for producing silico-manganese (SiMn)—an alloy primarily used in the steel-making industry. The study found that TMC's high-grade nodule-derived manganese silicate product appears to offer significant advantages to the SiMn producer on both cost and carbon footprint. As a pre-reduced product, TMC's manganese silicate effectively offers downstream clients the opportunity to decrease how much energy the process to produce silico-manganese alloy requires and how much carbon it produces. At TMC we consider our manganese silicate product—which could account for almost 30% of our future revenues—to offer an opportunity to help support decarbonization efforts in the hard-to-abate steelmaking industry value chain.

In another independent third-party study, we commissioned Benchmark to quantify the magnitude of carbon stocks and carbon sequestration services loss due to mining — which often goes unaccounted for in other studies — in the top nickel and cobalt producing regions of Sulawesi, Indonesia and Katanga, in the Democratic Republic of the Congo (DRC). In both megadiverse countries, which accounted for half of the world's nickel and 75% of the world's cobalt production in 2022, the extraction of metal ores through open pit mines requires the complete removal of overlying ecosystems and contained carbon sinks, in turn eliminating the carbon sequestration services they provide. The study finds that 1 kg of nickel mined from saprolite and limonite ore in Sulawesi removes forests containing carbon stock equivalent to 7.0 and 9.4 kg of CO_2e, and 1 kg of cobalt mined in Katanga removes 3.6 kg of CO_2e. Resulting vegetation change also causes carbon sequestration services loss of 4.8g and 6.5g of CO_2e respectively for nickel, and 9.3g of CO_2e for cobalt per year.

Summary Results of the Terrestrial Carbon Stock Study



When combining the findings of this latest study on carbon stock loss with the GHG emissions (Global Warming Potential) quantified in Benchmark's earlier LCA study, the total carbon impacts of Indonesian nickel production from laterites via RKEF and HPAL routes increase by between 7-49% respectively, and by 35% in the case of cobalt production from mixed sulfides in the DRC.



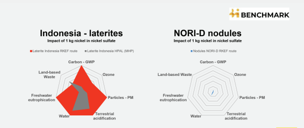
Source: "Summary Report Nickel and Cobalt Mining Impact on Terrestrial Carbon Sinks in Sulawesi, Indonesia and Katanga, DRC", Oct. 2023

Together, the lifecycle global warming potential (GWP) and carbon stocks and sequestration services studies provide insights that help us understand the relative climate-related benefits of developing the nodule resource in a region devoid of trees or plants, and with orders of magnitude less life than would be found in biodiverse forest ecosystems being impacted by mining today.

Other Nature-Related Impacts

Benchmark's lifecycle study assessed other environmental impact categories and suggests that producing energy-transition metals from nodules rather than via land-based routes could have significantly less impacts on nature. For example, the figure below compares the potential impact that producing nickel from NORI-D polymetallic nodules would have on the environment compared to producing it from Indonesian laterites via RKEF and HPAL processing routes.

Nickel From NORI-D Could Have Dramatically Lower Lifecycle Impacts than Indonesia



		≈93% of global refined nickel production for 2022					Lowest value
Impact category	Unit	INDONESIA Laterite RKEF route	AUSTRALIA Sulfide Conventional	INDONESIA Laterite HPAL (MHP)	PHILIPPINES Laterite HPAL (MSP)	CANADA Sulfide POX route	CCZ Nodules RKEF route
Global warming potential	kg CO_2 eq	102.0	28.5	19.2	13.9	8.0	6.2
Stratospheric ozone depletion	mg CFC11 eq	14.1	27.1	3.1	3.1	3.4	0.7
Fine particulate matter formation	g PM2.5 eq	1,187.6	42.9	262.0	160.0	39.5	9.2
Terrestrial acidification	kg SO_2 eq	0.96	0.13	0.69	0.53	0.13	0.03
Freshwater eutrophication	g P eq	91.0	76.4	9.1	5.2	2.9	1.0
Marine eutrophication	g N eq	5.5	2.3	-1.8	-1.3	0.2	-2.1
Water consumption	m^3	0.31	0.13	0.25	0.24	0.15	0.05
Land-based waste generation*	kg	244	545	337	337	82	0
Marine waste generation*	kg	N/A	-	N/A	N/A	-	137

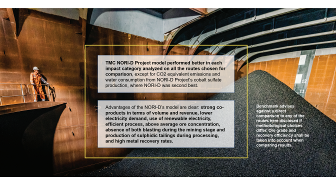
* Nodule collection operations entrain underlying sediment, separate it from nodules and return to the seafloor within meters of its origin. For the purposes of the LCA, this entrained sediment has been defined as a marine waste stream.
Nodules from NORI-D (RKEF route) also found to be the lowest impact option for copper. Cobalt from the DRC is lowest impact in GWP and water consumption; cobalt from NORI-D is lowest in all other assessed impact categories.
Source: Independent lifecycle assessment (LCA) completed by Benchmark March 2023. Lifecycle from mine to end-product format (battery-grade nickel sulfate, cobalt sulfate, copper cathode and manganese silicate).

Typically, three different mines would have to be developed on land to produce the four energy-transition metals contained in polymetallic nodules (i.e., nickel, cobalt, copper, and manganese). As we describe in the ESG Impacts page, these land-based mines generally produce mining waste and toxic tailings in large volumes and often require the removal of biodiverse- and carbon-rich habitats such as the Indonesian rainforests and the Democratic Republic of the Congo's (DRC) woodlands where most nickel and cobalt production occurs today[1]. Examples of climate- and nature-related opportunities that nodules-based metals production could provide include:

- Mitigating climate change (due to lower global warming potential (GWP) and avoiding destruction of significant natural carbon sinks)
- Avoiding destruction and/or degradation of high biodiversity habitats.
- Consuming less water
- Avoiding impacts from waste on nature (no mining waste, no toxic tailings, near-zero process waste)

[1] Source: Benchmark nickel and cobalt forecast Q4 2022 (weighted)

Key Findings from Benchmark's Comparative LCA



Benchmark's LCA quantitatively explains how producing energy-transition metals from the NORI-D project could come with lower climate- and nature-related impacts as compared to key land-based production routes.

We next plan to continue strengthening our strategy by:

- Setting targets and metrics to mitigate our risks and seize opportunities.
- Exploring the viability to use key levers to continue to reduce the potential impact our future operations will have on society and the environment (e.g., find a replacement for coal as a reductant in the pyrometallurgical processes and use lower carbon energy sources to collect, transport, and process nodules).

Metrics and Targets

Since we remain in an exploration phase, we disclose emissions from our offshore exploration campaigns (both our own direct emissions and emissions that our subsidiaries produce) since we started conducting them in 2012. We take full responsibility for our impacts and work with our partners to identify the most value-added ways to eventually offset part of our emissions, which includes emissions from entities that we have acquired along the way (i.e., TOML). In particular, we prioritize offsets that would directly and tangibly benefit our sponsoring states. While this approach will take longer compared to purchasing offsets from the market, we see more value in working with our sponsoring states and the Pacific region to develop offset programs and local capacity and focus on issues that they find the most important.

Ultimately, in line with the Paris Agreement, we want to achieve net-zero emissions as soon as feasible and have begun reviewing technologies, targets and pathways that could help us achieve this goal. Powering our onshore processing plants with renewable electricity and replacing metallurgical coal with lower carbon alternatives will play a key role in these efforts.

^ How We Do It   Next: Other Initiatives We Support >

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Other Initiatives We Support

OCEAN STEWARDSHIP COALITION

We share a vision for a thriving world for all with the U.N. Sustainable Development Goals (SDGs), and we believe we have a role to play in contributing to a more sustainable planet. Given that deep-sea mining has attracted intense ideological debates and strong opposition from several environmental non-governmental organizations (NGOs), we have committed to making science-driven decisions and engaging in open dialogue with stakeholders. We continue to partner with experts, share what we learn, and correct our course accordingly because we believe that the energy transition must not compromise the health and safety of people and the planet.

We developed our sustainability goals based on a materiality assessment that involved internal and external consultation, and they reflect our commitment to advance the U.N. SDGs and to embrace the principles that the U.N. Global Compact and the Ocean Stewardship Coalition (initiatives TMC has formally supported since 2019 and 2022, respectively) have set forth. Below, we discuss U.N. SDGs that are most relevant to our business and for which we have the greatest opportunity to make a positive impact.

Direct Contribution to SDGs

Goal 8: Decent Work and Economic Growth

We already provide training and employment opportunities to nationals of developing states including from our sponsoring states and see the potential to provide even more once we begin commercial production. In addition, our operations could result in new metallurgical plants and could support further growth of the battery manufacturing industry, thus we see an opportunity to generate more work and economic growth. We have also committed to equal pay for equal work, continue to have a strong health and safety record, and have progressively improved resource efficiency in consumption and production to help decouple economic growth from environmental degradation.

Goal 12: Responsible Production and Consumption

To create a carefully managed metal commons to be used, recovered, and reused again and again in perpetuity, we have already invested in developing onshore processing flowsheets that will generate near-zero solid waste and will work with partners to track, recover, and recycle the metals we supply. We look to help supply the minerals needed to accelerate the energy transition with the least negative environmental and social impacts in a way that actively contributes to responsible production and consumption practices, and plan to intentionally participate in the circular economy for these metals.

Goal 13: Climate Action

How we build a metal commons also matters. In focusing on protecting the climate, we have committed to ensuring that we monitor our operations as we look to achieve near-zero waste and net-zero emissions. We have already begun building a path to decarbonize our operations via optimizing our processes and assessing renewable energy sources, fuel alternatives, and new technologies. Given that we seek to supply metals that electric vehicle (EV) batteries and renewable energy storage need, we will directly contribute to enabling the energy transition. Considering power generation and transport together account for more than two-thirds of total global greenhouse gas (GHG) emissions and have caused almost all global GHG growth since 2010[1], the energy transition will play a crucial role in addressing climate change. For additional context, fuel combustion for vehicles accounts for about 30% of all direct CO2 emissions, which EVs powered with renewables could mitigate.

[1] IEA. "CO_2 Emissions in 2022", Mar. 2023

Goal 14: Life Below Water

Currently, the International Seabed Authority (ISA) has allocated 1.97 million km^2 of the CCZ as protected area — 42% more than all contracted areas in the CCZ combined. In addition, TMC is setting aside areas for protection and monitoring in our contracted areas. In this way, we can contribute to conserving and responsibly using the ocean and its marine resources. To learn more about how TMC focuses on conserving the ocean through the nine principles that the Ocean Stewardship Coalition has set forth, refer to the corresponding index table.

Goal 17: Partnership for Goals

Since TMC has a small workforce, partnerships play an important role in helping the company leveraging expertise and amplifying impact. For instance, we have many partnerships with the scientific community. For the last 11 years, we have completed research with several academic institutions that have contributed to our offshore environmental and social impact assessment program, which comprises more than 100 studies throughout the water column from the seafloor to the surface. This research has increased the world's scientific deep-sea knowledge, and it will help us develop technology to manage and mitigate our negative impacts to the marine environment (Goal 14).

Given deep-sea mining's international nature, we engage in multi-stakeholder partnerships with a particular focus on SIDS. Through our partnerships, we seek to mobilize and share knowledge, expertise, technology, and financial resources as we look to meet the SDGs.

Equator Principles and IFC Performance Standards

We will manage environmental, social and governance (ESG) risks effectively and transparently by using best practice guidance suitable for our future multi-jurisdictional and multi-industry operations. Our offshore activities will occur in international waters governed by the ISA. Our onshore operations are expected to start in Japan (see details about TMC's memorandum of understanding with Pacific Metals Co Ltd) and could be governed by additional authorities as they potentially expand to other jurisdictions in the future. When looking at risk management, our project presents both unique risks that pertain to the novel nature of deep-sea activities and well-known ones that occur in industrial activities (e.g., onshore metallurgical processes). For both onshore and offshore operations, TMC has begun developing and will implement robust environmental and social risk-management systems based on relevant international frameworks.

The Equator Principles and IFC Performance Standards offer strong guidance for managing environmental and social risks, which we look to incorporate in our management systems. For example, to develop our stakeholder engagement approach, we built on IFC's principles for engagement[1], which we plan to use throughout our projects' entire lifetime (e.g., provide meaningful information in a format and language that target stakeholder group(s) can readily understand, provide information before consultation activities and decision-making occurs, and so on. For more information, refer to the Stakeholder Engagement page). An example of our stakeholder engagement approach is the offshore environmental impact statement (EIS) that we submitted to the ISA for the collection system trials that we performed in the CCZ in 2022. This EIS includes the feedback that we received from a broad audience through a formal stakeholder-consultation process. Similarly, the social impact assessment (SIA) that we have begun preparing for the NORI-D exploitation contract application to the ISA includes a scoping process to engage and consult stakeholders. We used the feedback received to design the terms of reference (TOR) for the SIA study.

[1] See Stakeholder Engagement: 'A Good Practice Handbook for Companies, Doing Business in Emerging Markets, International Finance Corporation', 2007.

TMC commissioned Prizma LLC, third-party SIA expert, to develop the NORI-D SIA—the first ever conducted for a deep-sea nodule collection project in international waters. After a preliminary screening of potential social impacts, Prizma recommended that TMC manage the NORI-D Project's potential impacts in a manner consistent with the following IFC Performance Standards:

- PS 1: Assessment and management of environmental and social risks and impacts
- PS 2: Labor and working conditions
- PS 3: Resource efficiency and pollution prevention
- PS 4: Community health, safety, and security (mainly for onshore facilities)
- PS 6: Biodiversity conservation and sustainable management of living natural resources

These standards help us shape our commitments and actions. For example, our environmental impact statement for the collector test study which will be part of the application we intend to submit in 2024 for an exploitation contract for NORI-D, presents a risk-assessment method based on the ISO 31000 Standard, which, in the ISA's words, demonstrates "rigorous implementation of environmental management systems". For our offshore campaigns, we work with partners who have third-party certified environment and health and safety management systems aligned with ISO 45001 and ISO 14001, and follow International Maritime Organization (IMO) Standards to prevent marine pollution (e.g., all vessels systematically use water ballast treatment systems). Our onshore partner Pacific Metals Co Ltd (PAMCO)'s metallurgical plant where we intend to toll treat polymetallic nodules to produce lithium-ion battery and steel making feedstocks as part of the NORI-D Project Zero development also has registered certifications for ISO 45001, ISO 14001, and ISO 9001. Any potential future metallurgical plant would undergo a rigorous environmental and social impact assessment that we will use to strengthen our onshore environmental and social risk-management systems.

We have begun developing corporate policies to formalize TMC's commitment to implement best international practices for managing ESG risks alongside several actions to provide clarity and certainty to our stakeholders about the performance standards we set for ourselves and our business partners for operating in safe, responsible, and more sustainable ways for people and the planet. Look for our upcoming policies, including our Environmental Policy and Human Rights Policy (based on the United Nations Guiding Principles on Business and Human Rights, or UNGPs), in TMC's Corporate Governance webpage. In addition, we have begun developing indicators and mechanisms to achieve these performance standards. TMC joined an international consortium to develop the first ESG handbook for marine minerals that will provide disclosure guidance on material ESG topics specific to developing marine minerals projects in the deep-sea environment. The guidance in this handbook will enable companies in the industry to report performance in a standardized manner consistent with the rapidly evolving global ESG disclosure landscape. This approach intends to promote ESG thinking and improvements before any commercial activity begins

^ How We Do It Next: Stakeholder Engagement >

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Stakeholder Engagement

As we advance toward our vision to affect systems change across the metals value chain, we have focused on building a safe, diverse, and inclusive culture for our workforce, partners, contractors, independent researchers, sponsoring states communities, and other stakeholders.

Several environmental non-governmental organizations (NGOs) have voiced concerns about the impacts any future extraction of deep-sea minerals would have on the marine environment. Some of them passionately campaign to stop the exploration of potential deep-sea resources of critical minerals altogether. At the same time, a different set of concerns is being voiced within communities focused on climate change, development and national security – limited access to a secure supply of critical minerals will rule out the energy transition and continued development at the currently planned scale and timeline. We believe these concerns are reconcilable. Agreeing on what matters most is possible. Honest conversations about real-world trade-offs are hard but, again, possible. The first step is simple: we all need to show up with an open mind and sincere commitment to engage with the problem and each other. For that reason, we have invited the ocean conversation community to engage with us on real-world data and trade-offs, and we have committed to working openly and collaboratively with all our stakeholders.

Currently, we engage proactively and transparently with our regulators—the ISA and our sponsoring states' governments. We work with leading scientific research institutions and universities to increase deep-sea knowledge by collecting environmental baseline data during our exploration campaigns, monitoring environmental impacts during collector tests, studying post-collection test data, and supporting independent peer-reviewed research by providing the scientists who partner with us with the freedom to publish. We also engage with NGOs and civil society to make our activities and plans transparent and to receive feedback. For example, we addressed comments collected during an open stakeholder consultation in the offshore environmental impact statement (EIS) for the 2022 collector test in the NORI-D area in the CCZ. We also released a social impact assessment (SIA) scoping document for the NORI-D Project for public stakeholder comment in late 2022, which provided stakeholders with the opportunity to comment on and contribute to terms of reference for the SIA report. We also regularly host public webinars and side events at ISA meetings to provide updates on issues of interest to stakeholders.

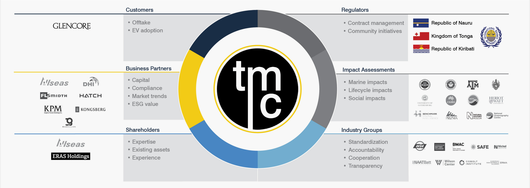
To ensure that we operate in a socially and environmentally responsible manner, we use the following principles to inform TMC's wholly-owned subsidiary Nauru Ocean Resources Inc. (NORI)'s stakeholder engagement:

- **Proactive engagement and listening:** We seek and welcome diverse thoughts, opinions, and experiences to help us make better decisions and outcomes.
- **Accessibility:** We are committed to reducing barriers to participation and will offer a variety of channels and methods to encourage equitable engagement.
- **Responsiveness:** We will consider, respond to, and incorporate stakeholder feedback where we can and if not possible, explain why. We will be clear about how we incorporate feedback into our planning and decision making.
- **Transparency:** We are transparent – we are open, true, and direct with stakeholders about our company, operations, and decisions and provide accurate information. We are committed to providing opportunities for external monitoring.
- **Grievances:** We ensure that there is an accessible and responsive means for stakeholders to raise concerns and grievances about the project through its life.
- **Reporting:** We track, measure and report on our stakeholder performance to learn, adapt and improve our approaches.

Developing a common heritage resource in the Pacific Ocean under a regulatory regime that an intergovernmental organization governs and under sponsorship from Pacific Island nations represents an unprecedented endeavor. To do it right, we need the best and the brightest, which explains why we draw on a broad network of professionals from various organizations to leverage our collective expertise, knowledge, and strengths. Through meaningful dialogue, we seek to drive change by focusing the conversation around sustainability and shared value creation.

Below, we present the (non-exhaustive) stakeholder network that we currently work with.

Building Networks to Create Shared Value



Given that the polymetallic nodule resource in international waters constitutes a common heritage of humankind (CHH), we define our stakeholders as any interested individual or organization. This global view means we need to engage and partner with many different stakeholders across the world. Stakeholder engagement creates a feedback loop that enhances the way we develop this resource. By openly communicating, engaging in meaningful dialogue, and building relationships, we aspire to be and do better from the very start. The table below broadly shows the main stakeholder groups with whom we engage and the key topics we discuss with them.

TMC Governance – Stakeholder Engagement Table

Stakeholder	Engagement Method	Key Topics	Objectives
Employees	Townhalls, in-person team meetings, company chat 'AllHandsOnDeck', emails, internal committees for topics such as the ESIA program, ESG, Pacific Islands engagement	Vision, plan, strategy, company values, projects performance and updates, climate change, ESG performance expectations and progress	· Communicate strategy and progress · Gain feedback and insights · Maintain an engaged purpose-driven workforce
Strategic Partners and Contractors	Meetings, emails, website, reports, contracts, exploration campaigns, technology development and testing	Project updates, opportunities, megatrends, vision, projects timeline and forecast, our policies, sustainability approach and goals, ESG performance expectations and due diligence process, scope of work, sustainability initiatives.	· Create shared value · Leverage expertise · Mitigate risk · Deliver science-based solutions · Foster innovation to decarbonize value chain
Scientific Community	Meetings, emails, reports, webinars	Project updates, environmental impact assessments, management and monitoring, deep sea knowledge, conservation, innovation, climate change, carbon offsets, blue economy, transparency.	· Promote open and healthy debate and understanding that drive science-based decisions · Advance deep-sea research and understanding of impacts · Support conservation and advance solutions from the blue economy
Value Chain (Suppliers, Potential Customers)	Meetings, emails, reports, conferences	Project updates, critical metals demand trends: availability/security/ price/ ESG impacts of critical metals supply; climate change and energy transition; our value proposition; ESG performance expectations and due diligence process.	· Develop opportunities · Foster collaboration · Build ESG focus and transparency · Leverage expertise · Decarbonize value chain · Deliver science-based solutions
NGOs and Global Community	Meetings, website, social media, press releases, reports, consultation	Project updates, transparency, accountability, climate change and energy transition, real-world data and trade-offs, shared value, best practices, our sustainability approach, goals and impact.	· Promote transparency, inclusivity · Foster conversation and collaboration · Drive science-based understanding of impacts and receive feedback to understand and address concerns
Communities of Sponsoring States	Meetings, townhalls, website, social media, information videos, local newsletter, local events, community programs, consultation, press releases	Project and industry updates, our vision, responsibilities and sustainability approach and goals, deep-sea mining regulations, shared value creation, local capacity building, education, local initiatives, grants, climate change	· Be a good partner · Engage transparently · Support local training and capacity building initiatives · Understand community priorities · Create shared value
Investors and Shareholders	Annual general meeting, meetings, emails, website, reports, webinars, conferences, press releases	Project updates, financial and ESG reporting, our sustainability approach and goals, climate change, energy transition, energy metals supply and market trends, governance, strategy, risks and opportunities	· Communicate strategy, updates and progress, including risks and opportunities · Understand market trends and expectations · Build transparency and drive value by sharing financial and ESG performance
Industry Groups	Meetings, emails, website, reports, webinars, press releases	Project updates, best practices, standards development, climate change, transparency, ESG, environmental and social impacts	· Go beyond compliance and support the development of transparent ESG standards and certification that drive continuous improvement for the industry
Governments, ISA, Regulators, Sponsoring States	Meetings, emails, reports, industry events, webinars,	Project updates, governance, transparency, accountability, compliance, permitting, standardization, ESG strategy, climate change, ESG certification development	· Support and implement best-in-class regulations and standards that build in a high level of transparency and accountability · Support training and capacity building

^ How We Do It Next: International Treaty for the High Seas >

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International Treaty for the High Seas

Common Heritage of Humankind: International Treaty for Waters Outside National Jurisdictions

For the first time in human history, we seek to develop a resource deemed a common heritage of humankind (CHH) rather than an endowment of any nation state. While we have no precedent to follow, we believe the spirit of the CHH principle calls for radical transparency, strong partnerships, and broad stakeholder engagement. We realize the CHH means that we must do more and be better compared to traditional resource-exploitation operations. Therefore, TMC has committed to exploring new ways to conduct business in collaboration with its stakeholders.

The following paragraphs summarize the CHH principle, its governance, and its relevance to developing deep-sea minerals.

In 1967, Arvid Pardo, the Maltese ambassador to the United Nations, delivered a speech at the United Nations General Assembly in which he called for the deep seabed beyond national jurisdictions and the resources contained therein to be declared the common heritage of humankind. His speech provided the most comprehensive proposal of the concept, and he gave it due to reports about rich resources in this part of the sea and concerns that wealthy, technologically advanced nations would unilaterally exploit the resources and, thus, exclude poorer nations.

The freedom-of-the-seas doctrine—a principle that proclaimed the sea beyond a narrow belt surrounding a nation's coastline as free to all and belonging to none—prevailed into the 20th century. During his speech in 1967, Pardo spoke about the superpower rivalry that had begun spiraling to the oceans, about the pollution that poisoned the seas, about the conflicting legal claims and their implications for a stable order, and about the rich resource potential that lay on the seabed[1]. Pardo asked the world's nations to look around them and open their eyes to a looming conflict that could devastate the oceans.

Pardo urged the nations to develop an international regime over the seabed to avoid escalating tensions. His call-to-action came at the right time as many recognized the need to update the freedom-of-the-seas doctrine to consider the technological changes that had altered humankind's relationship with the oceans. As a result, the General Assembly created an ad hoc committee in the same year, which became the United Nations Seabed Committee[2]. In 1970, the General Assembly declared the seabed, ocean floor, and subsoil thereof beyond the limits of national jurisdiction (i.e., "the Area" and the resources in the Area the Common Heritage of Humankind)[3].

Initially, the CHH concept had a sole association with the United Nations Convention on the Law of the Sea (UNCLOS), but it has since expanded to other domains, such as outer space, the Moon, Antarctica, human rights, human genomes, and plant genetic resources[4].

International Seabed Authority (ISA)

Historical Background

The realization that the problems that concern the ocean relate to one another and, thus, that they should be considered as a whole led to heightened interest in establishing a legal-economic regime to govern efforts to explore and exploit the non-living resources in the Area.

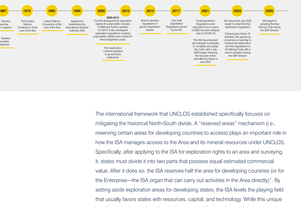
Based on its 1970 declaration and provisions surrounding the CCH principle, the General Assembly mandated the Seabed Committee to produce a draft convention for a seabed regime and an agenda for the Third United Nations Conference on the Law of the Seas in New York in 1973. The conference, which 160 sovereign states participated in, held 11 sessions between 1973 and 1982. During these years, sovereign state representatives discussed, negotiated, and prepared a draft convention on the law of the sea. In the final year (1982), the conference adopted the convention at which point it contained 320 articles and nine annexes governing all aspects of ocean space, such as environmental control, marine scientific research, economic and commercial activities, technology transfers, and the process to settle disputes relating to maritime[5]. UNCLOS focuses on ensuring that efforts to develop seabed mineral resources beyond national jurisdiction will benefit developing states and not just wealthy countries.

UNCLOS included provisions for establishing four institutions to bring it to life: the International Seabed Authority (ISA), the International Tribunal for the Law of the Sea, the Commission on the Limits of the Continental Shelf, and the Meeting of the States Parties to the Convention[6]. The ISA was established with the 1994 Implementation Agreement relating to implementing Part XI of UNCLOS and it is entrusted to supervise and regulate exploration and exploitation of the resources derived from the established complete regime.

Today, the ISA comprises 169 members, including 168 member states and the European Union. It has a mandate under UNCLOS to organize, regulate, and control all mineral-related activities in the Area while ensuring the effective protection of the marine environment on behalf of humankind[7].

[1] UNCLOS, "A Historical Perspective, Originally Prepared for the International Year of the Ocean", 1998.
[2] UNCLOS, "United Nations Convention on the Law of the Sea", Dec. 10, 1982.
[3] United Nations General Assembly Resolution 2749 (XXV).
[4] Oxford Bibliographies, "Common Heritage of Mankind", May 12, 2017.
[5] U.N. "UNCLOS Overview".
[6] Ibid.
[7] ISA, "About ISA". Accessed on 24 Jan. 2024.

ISA Member States



Source: ISA, "Member States", as of 18 May 2023. Accessed on 24 Jan. 2024.

CCZ Governance

Deep-sea mining is the first extractive industry in history to adopt regulations before any extraction begins. The ISA provides an international and transparent forum to regulate and manage all mineral resources related activities and ensure protection of the marine environment in the "Area", the deep seabed and subsoil beyond national jurisdiction, for the benefit of all humanity. In the 30 years it has operated, the ISA has proven its stability and ability to develop contemporary regulations through transparent and inclusive negotiations.

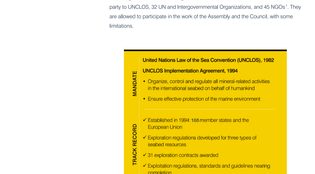
A Timeline of Important Milestones

The international framework that UNCLOS established specifically focuses on mitigating the historical North-South divide. A "reserved areas" mechanism (i.e., reserving certain areas for developing countries to access) plays an important role in how the ISA manages access to the Area and its mineral resources under UNCLOS. Specifically, after applying to the ISA for exploration rights to an area and surveying it, states must divide it into two parts that possess equal estimated commercial value. After it does so, the ISA reserves half the area for developing countries (or for the Enterprise—the ISA organ that can carry out activities in the Area directly)[1]. By setting aside exploration areas for developing states, the ISA levels the playing field that usually favors states with resources, capital, and technology. While this unique legal framework provides a foundation to equitably share financial and other economic benefits, it requires strong private-sector partnerships for developing states to take advantage of these benefits.

TMC, through our subsidiaries, operates in international waters under the regulatory jurisdiction of the ISA and our sponsoring states. Nauru Ocean Resources Inc. (NORI) and Tonga Offshore Mining Ltd. (TOML)[2] with sponsorship from the Republic of Nauru and the Kingdom of Tonga, respectively, constitute the first private-sector entities to apply for exploration contracts in the Area. These applications also constitute the first applications for seabed areas based on developing state sponsorship. Since then, several nations have followed in their footsteps, such as Kiribati, the Cook Islands, Singapore, and Jamaica. Recently, Nigeria has expressed an interest in becoming a sponsoring state. We feel great pride in the partnerships that we have developed with our supporting states.

1. ISA, "Reserved Areas"; UNCLOS, "Annex III, Article 8, Reservation of Areas."

ISA Principal Organs: Structure and Functions



Source: ISA, "Secretary-General Annual Report", 2023.

The ISA's "Supreme organ," the Assembly, is empowered to establish the general policies. It is responsible for making decisions on the equitable sharing of financial and other economic benefits derived from activities in the Area, and on compensation or other economic adjustments to developing countries whose export earnings from their land-based mineral extraction are diminished by seabed production.

As of August 2023, the ISA has granted observer status to 29 states that are not party to UNCLOS, 32 UN and Intergovernmental Organizations, and 45 NGOs[1]. They are allowed to participate in the work of the Assembly and the Council, with some limitations.

United Nations Law of the Sea Convention (UNCLOS), 1982

UNCLOS Implementation Agreement, 1994

MANDATE
- Organizes, control and regulate all mineral-related activities in the international seabed on behalf of humankind
- Ensure effective protection of the marine environment

TRACK RECORD
- ✓ Established in 1994: 168-member states and the European Union
- Exploration regulations developed for three types of seabed resources
- 31 exploration contracts awarded
- Exploitation regulations, standards and guidelines nearing completion
- Developing states and marine environment prioritized

The ISA developed the exploration regime for polymetallic nodules in 2000 and further updated it in 2013[2]. Under this regime, contractors receive a 15-year contract divided into five-year work programs with the option to apply for five-year extensions. An exploration contract provides exclusive rights to explore and to apply for an exploitation contract. The ISA has been developing the regulatory code for exploiting seafloor minerals since 2014 and its framework appears in UNCLOS. In December 2021, the ISA Council adopted a roadmap for work during 2022 and 2023 for adopting the draft regulations and associated Phase 1 standards and guidelines by July 2023[3]. After missing its deadline for completion, the Council adopted a revised roadmap and agreed to work towards adoption of the draft regulations at the thirteth Session (2025)[4].

TMC has exploration and commercial rights to three ISA exploration contracts via sponsorship from three Pacific Island developing states through our subsidiaries.

[1] ISA, "Observers". Accessed in May 2024.
[2] ISA, "The Mining Code".
[3] ISA, "ISA Council concludes in-person meetings under the 26th session with agreement on a roadmap for work for coming year", Dec. 21, 2021.
[4] ISA, "ISA Council closes Part II of its 28th session", 24 Jul. 2023

< How We Do It Next: Sponsoring States - State Profiles >

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Sponsoring States - State Profiles

Three Pacific developing states sponsor the two ISA exploration contracts and the commercial agreement to which TMC has rights: the Republic of Nauru, the Kingdom of Tonga, and the Republic of Kiribati. Specifically, TMC subsidiaries NORI and TOML hold the two exploration contracts, which Nauru and Tonga sponsor, respectively. TMC has an exclusive commercial agreement through its subsidiary with Marawa, a Kiribati state-owned entity, to explore and develop its contract area.

Granting of **ISA Contracts**

2011	2012	2015
NORI Area	**TOML Area**	**Marawa Area**
exploration contract granted to NORI, sponsored by Nauru[1]	exploration contract granted to TOML, sponsored by Tonga[2]	commercial rights secured by DGE through agreement with Marawa, sponsored by Kiribati[3]

1 Nauru Ocean Resources Inc (NORI), a wholly owned TMC subsidiary
2 Tonga Offshore Mining Ltd (TOML), a wholly owned TMC subsidiary
3 DGE DeepGreen Engineering, a wholly owned subsidiary of TMC The Metals Company, has secured exclusive exploration and commercial rights through an agreement with Marawa and Kiribati

Nauru and NORI first implemented this model where commercial companies partner with a developing state. It enables our sponsoring states to participate in this industry in a way that minimizes their risk via transferring the capital and technical requirements to their commercial partner.

In 2010, at Nauru and NORI's request, the ISA sought an advisory opinion from the Seabed Disputes Chamber of the International Tribunal for the Law of the Sea (the Chamber) on issues pertaining to sponsoring states' responsibility.

> "… The original purpose was to provide developing States with a practical and realistic means of participating in seabed mining …"
>
> Nii Allotey Odunton, Secretary-General of the ISA, Speech given to the U.N. General Assembly in 2011

The Chamber confirmed that:

1. Sponsoring states do not have strict liability, and
2. For the sponsoring state's liability to arise, a causal link between its failure to meet its responsibilities and damage that its sponsored contractor caused must exist.

With the Chamber's opinion and commercial partners willing to take on the capital and technical requirements, it became possible for developing states to participate in this industry as UNCLOS envisions. NORI and Nauru constitute the first entities to ever access the reserved areas that the ISA sets aside specifically for developing states. Other states such as Tonga (in 2012), Singapore (in 2015), Kiribati (2015), Cook Islands (in 2016), and Jamaica (in 2021) have since replicated this model.

At TMC, we have great pride in the joint leadership role that we have played with our sponsoring states in supporting developing states exercise their rights under UNCLOS. As sponsoring states, Tonga, Nauru, and Kiribati have all implemented legislation that governs their participation in this industry.

Overview of **Sponsoring States**

Republic of Nauru

2015 Nauru Seabed Minerals Act

2017 Sponsorship Agreement

Kingdom of Tonga

2014 Tonga Seabed Minerals Act

2008 Sponsorship Agreement

2021 Tonga and TOML Amended Sponsorship Agreement

Republic of Kiribati

2013 Services Agreement

2017 Kiribati Seabed Minerals Act

Nauru	
Location	Northeast of Australia in southeastern Micronesia
Population	~12,840
Geography	Uplifted limestone island with no harbors. The island is fringed by a coral reef, which acts as the island's main defense from rising sea levels.
Impact of Climate Change	Projected sea-level rise poses risks to Nauru's communities and key infrastructure, concentrated mainly in the coastal areas[1].
Economy	Phosphate, mined on Nauru since 1907, first by Germans, until the British Phosphate Commission, a joint Australian, British and New Zealand enterprise took over the lucrative phosphate industry throughout the 20th century until Nauru became independent in 1968. Phosphate was the island's main export and dominated its economy until the late 20th century, when phosphate deposits became exhausted. In the 1990s, the country was near bankruptcy and struggled to develop other resources or alternative sources of income. In the 2000s, repairs and improvements to mining-related infrastructure allowed the more difficult extraction of secondary phosphate deposits. In 2001, Nauru agreed to house Australia-bound asylum seekers. The sale of commercial fishing licenses in the Nauruan exclusive economic zone (EEZ) that extends 200 miles offshore also brings in steady revenue.
Challenges	Given its size, remote location and narrow production base, Nauru faces many challenges. The lack of agricultural production and high costs of importing fresh, healthy food contribute to the high rates of obesity and diabetes on the island. Colonial exploitation of Nauru's rich phosphate reserves created a legacy of environmental degradation that left more than 80% of the island uninhabitable and unsuitable for agriculture. The economy is affected by the high cost of goods and services, inadequate infrastructure and the impact of climate change. Natural freshwater resources are limited. Roof storage tanks collect rainwater, but most people are dependent on the desalination plant for freshwater resources[2].
Other	As a result of its history and challenges, Nauru is dedicated to ensuring that future extractive activities are done responsibly. Nauru is a party to UNCLOS and recognizes the important role of the ISA to put in place strict guidelines and protection measures before any extraction activities take place. Nauru is the first sponsoring state to access the developing state land bank and views polymetallic nodules as an opportunity to diversify its economy and contribute to the transition to clean energy.

1 Nauru, "Voluntary National Review on the Implementation of the 2030 Agenda", 2019.
2 Ibid.
3 Worldometer, "Nauru", accessed on 29 Jan. 2024.

Tonga	
Location	East of Fiji, south of Samoa and north of New Zealand
Population	~108,300 people, with 70% of residents living on the main island of Tongatapu
Geography	Archipelago of 172 South Pacific islands, of which 36 are inhabited
Impact of Climate Change	Tonga's groundwater supplies are tainted by salt-water intrusion from rising seas, threatening domestic agriculture.
Economy	Unlike many of its Pacific Island neighbors, Tonga never experienced the impacts of colonial resource extraction. Its economy is reliant on tourism and climate-sensitive sectors such as agriculture and fisheries. It also has a heavy dependence on remittances from the half of the country's population that lives abroad, chiefly in Australia, New Zealand and the United States, as well as foreign aid.
Challenges	As a small island state with limited natural resources and vulnerability to climate change and natural disasters, Tonga faces several development challenges. High unemployment (especially among the young), a continuing upturn in inflation and rising civil service expenditures are issues that face government[1]. On January 15, 2022, an undersea volcano, located about 40 miles north of Nuku'alofa, erupted, covering Tonga in thick volcanic ash. The eruption generated a devastating tsunami and significant flooding.
Other	The Kingdom of Tonga, the only remaining monarchy in the Pacific, is under a constitutional monarchy where the king acts as the head of state and chief commander of the armed forces, and the prime minister runs the government.

1 New World Encyclopedia, "Tonga".
2 Worldometer, "Tonga", accessed on 29 Jan. 2024

Kiribati (Pronounced, Kiri-Bass)	
Location	Central Pacific Ocean, west of Hawaii and near the Equator
Population	~134,800
Geography	33 atolls scattered over 3,500,000 square kilometers
Impact of Climate Change	Despite accounting for just 0.0002% of global CO_2 emissions, Kiribati is heavily impacted by climate change and already two of its islands have disappeared into the sea. Climate change is a serious challenge from acute water shortages, tidal inundation, seawater intrusion, and heat and storm events.
Economy	Until 1979, Kiribati's economy depended heavily on the export of phosphate from their Banaba island's deposit. The country now depends on foreign assistance and revenues from license fees from foreign fishing fleets, including a special tuna-fishing agreement with the European Union; the export of copra from coconuts, mostly produced in the village economy; work remittances; and tourism[1].
Challenges	In addition to being one of the countries most affected by climate change, Kiribati is also constrained by geographic isolation, a highly dispersed population, high transport costs and a low population base. The relative infertility of its coral islands and distance to markets prohibits agricultural or industrial production on a large scale[2].
Other	The nation is renowned for creating the world's first large open-ocean protected area, the Phoenix Islands Protected Area (PIPA), which achieved legal designation in 2008. PIPA is now a UNESCO World Heritage Site, protecting the pristine corals, reef fishes, sharks, manta rays, turtles, tuna stocks and ocean-dependent human communities in an area more than 400,000 square kilometers, approximately the size of California. On November 15, 2021, the Office of the President of Kiribati announced the decision to lift the closure of the PIPA for the sustainable use of marine resources[3]

1 New World Encyclopedia, "Kiribati".
2 Kiribati, "Voluntary National Review and Development Plan Mid-Term Review", 2018.
3 UNESCO World Heritage Convention, "UNESCO Expresses Concern Over the Lifting of Fishing No-Take Zones in Kiribati's Phoenix Islands Protected Area", 2 Dec. 2021.
4 Worldometer, "Kiribati", accessed on 29 Jan. 2024

^ How We Do It Next: ISA Mining Code >

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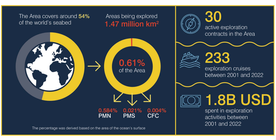
ISA Mining Code

The Mining Code refers to the comprehensive set of rules, regulations, and procedures that the International Seabed Authority (ISA) issues to regulate efforts to prospect, explore, and exploit marine minerals in the international seabed area (the Area). The Mining Code comprises two major components: exploration and exploitation. The ISA adopted three sets of exploration regulations covering prospecting and exploration for polymetallic nodules (2000 and revised 2013), polymetallic sulfides (2010) and cobalt-rich ferromanganese crusts (2012), and, in 2014, began to develop regulations to govern efforts to exploit mineral resources in the Area.

Exploration In The Area



Source: ISA, "Status of exploration activities in the Area", Feb. 2024

To date, the ISA has issued exploration contracts only. The ISA targeted July 2020 as the date that it would complete and adopt its exploitation regulatory regime, but the coronavirus pandemic of 2019 (COVID-19) delayed its efforts. Despite the delay, it has continued to make significant progress on the exploitation regulatory regime's major components. The ISA Council revised its roadmap in July 2023 and reiterated its commitment to work in good faith to complete the regulations. In November, it agreed to consolidate, harmonize, and clean up the draft text into one document, making it easier to negotiate[1]—which signals the transition to the final phase of negotiations. On 16 February 2024, it released the consolidated text which will be negotiated in the next Council sessions.

The Mining Code's exploitation component has **three major parts:**

1. Exploitation regulations
2. Standards and guidelines
3. Benefit sharing

The work to develop regulations for exploitation of mineral resources in the Area started with preliminary work in expert workshops and involved various expert studies and discussion papers, which culminated in draft regulations prepared by the ISA Legal and Technical Commission (LTC) for the Council to consider. Stakeholders continue to participate in drafting the regulations through a transparent process[2].

The draft regulations on exploitation of mineral resources in the Area require that various ISA organs develop certain standards and guidelines to help the ISA implement the regulations. The standards will be legally binding on contractors and the ISA, whereas the guidelines will be recommendatory in nature. The LTC recommended a three-phase approach for their development:

- **Phase 1:** Standards and guidelines deemed necessary to be in place by the time of adoption of the draft regulations on exploitation.
- **Phase 2:** Standards and guidelines deemed necessary to be in place prior to the receipt of an application of a plan of work for exploitation.
- **Phase 3:** Standards and guidelines deemed necessary to be in place before commercial mining activities commence in the Area[3].

Phase 1 generated 10 standards and guidelines, which remain with Council for final discussion and approval after undergoing revision based on stakeholder consultation.

The financial regime that the ISA will establish will require contractors to make royalty payments to the ISA, which the ISA will share according to "equitable sharing criteria". The ISA has conducted research and consultation to consider mechanisms to share the financial benefits.

[1] ISA, "ISA Council closes Part III of the 28th session with the agreement to deliver the consolidated text of the draft exploitation regulations to pursue negotiations in March 2024", 9 Nov. 2023

[2] ISA, "The Mining Code: Draft Exploitation Regulations"

[3] ISA, "The Mining Code: Standards and Guidelines"

Overview of Status of Preparation of the Exploitation Code

Mining Code - Exploitation	Under Development by the LTC	Stakeholder Consultation	Under Consideration for Approval by the LTC	Under Consideration by the Council
Exploitation Regulations				underway
Standards & Guidelines				
Phase 1				underway
Phase 2				
Phase 3	To be completed prior to commercial mining commence			
Benefit Sharing				underway

Copyright: International Seabed Authority

Two-Year Notice: Section 1, Paragraph 15 of the 1994 Agreement

Section 1, paragraph 15 of the 1994 Agreement relating to the Implementation of Part XI of the UNCLOS allows a member state whose national intends to submit a plan of work for exploitation for approval to notify the ISA about its intention to do so. This notice obliges the ISA to complete the process to adopt the exploitation regulations within two years since the member state made the request.

On 25 June 2021, the Republic of Nauru submitted its notice to the ISA to request that, by 9 July 2023, the ISA complete the process to adopt regulations necessary to allow it to approve plans of work to commercially exploit polymetallic nodules. At the 28th ISA Session in July 2023, it became clear the Parties needed more time to fulfil their obligation of delivering the Mining Code, and the Council decided on a new roadmap to deliver final rules, regulations and procedures. TMC's wholly-owned subsidiary, NORI, now intends to submit an application following the July 2024 ISA session, which gives us more time to strengthen our environmental dataset while providing time for three additional Council sessions and intersessional work. It is NORI's strong preference to submit an application for a plan of work for exploitation once the Mining Code has been adopted, but NORI reserves its right to submit an application for a plan of work in the absence of the adoption of a Mining Code pursuant to Section 1, Paragraph 15 of the Annex to the Agreement. This provision requires the ISA to consider and provisionally approve such a plan of work based on: (1) the provisions in UNCLOS; (2) any rules, regulations, and procedures that the ISA may have adopted provisionally at the time; (3) the basis of the norms in UNCLOS; and (4) the principle of non-discrimination among contractors. TMC appreciates the continued commitment from ISA Council members to negotiate and adopt the regulations which will ensure the protection of the marine environment while setting out requirements for responsibly accessing seafloor resources. Together with the Republic of Nauru, NORI commits to only submitting an application for exploitation after we complete a comprehensive, science-driven environmental and social impact assessment.

APPLICATION

- ✓ Certificate of Sponsorship
- ✓ Mining Plan
- ✓ Test Mining Report
- ✓ Financing Plan
- ✓ Environmental Impact Statement
- ✓ Emergency Response and Contingency Plan
- ✓ Health and Safety Plan & Maritime Security Plan
- ✓ Training Plan
- ✓ Environmental Management and Monitoring Plan
- ✓ Closure Plan

While the ISA has developed a work plan and roadmap to complete the final regulations, and while the draft regulations and several supporting standards and guidelines have reached an advanced stage, they have not yet been adopted, which may impact our ability to meet our objectives.

Learn more: Government of the Republic of Nauru, "Nauru FAQ on two-year notice" Accessed in January 2024.

^ How We Do It Next: Environmental Impact Statement >

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Environmental Impact Statement

ESIA PROCESS

- ESIA Process
- Scoping
- Impact Assessment
- Mitigation
- Reporting
- Review
- Decision Making
- Monitoring
- EIA Audit

The International Seabed Authority (ISA) requires all exploitation contract applications to include an offshore environmental impact statement (EIS). The EIS documents and reports result from an environmental and social impact assessment (ESIA), which refers to "the process of identifying, predicting, evaluating and mitigating the physicochemical, biological, socioeconomic, and other relevant effects of development proposals prior to major decisions being taken and commitments made". Thus, an ESIA covers all potential positive, negative, and neutral effects and encompasses both natural and anthropogenic receptors[1]. The respective environmental and social components of the ESIA are described below.

[1] ISA, "Draft Standard and Guidelines for the Environmental Impact Assessment Process", 31 Jan. 2022.

Offshore Environmental Impact Assessment (EIA)

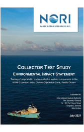
The ISA requires an application to seek approval for a plan of work for exploitation to assess the potential impact that the proposed activities may have on the environment and to describe a program for oceanographic and baseline environmental studies in accordance with ISA rules, regulations, and procedures. Environmental baseline studies characterize an area's biophysical components before developing a project. This understanding makes it possible to find ways to minimize impacts and establish measures for protection.

For NORI-D's offshore EIA, we have designed a comprehensive seabed-to-surface research program to understand the effects our operations may have on the biota throughout the water column and its various zones and how such biota will respond to the impacts that potential future operations would generate. The information we are gaining from the program adds to the knowledge in this area that various entities have contributed since the 1960s. Indeed, since that time, over 150,000 published papers have discussed manganese or polymetallic nodules in general and almost 50,000 have discussed nodules in the Eastern Pacific Ocean (CCZ) in particular.

> TMC has commissioned some of the world's leading ocean scientists to conduct over 100 individual studies to characterize the baseline of the biophysical components throughout the water column and its various zones

We have collected biophysical data from the NORI areas since 2012. Since 2018, NORI has focused its efforts on NORI-D to better understand the resource and, since 2020, we have focused on collecting environmental baseline and impact data to inform the offshore EIA. In 2021, we completed the campaigns related to our environmental baseline assessment, while, in 2022, we conducted four additional environmental research campaigns representing the first in-situ integrated polymetallic nodule-collection system test conducted in the Clarion-Clipperton Zone since the 1970s. During this trial, NORI and our partner Allseas lifted over 3,000 tonnes of nodules from a small test area in NORI-D up a 4.3km riser system to the surface production vessel, the Hidden Gem. During our 2022 campaigns we completed our objective to survey the pre-, during- and post-collection test environment and monitor the impacts during the trials. In 2023, NORI completed another offshore campaign evaluating seafloor ecosystem recovery and functioning a year after the collection system test.

During the NORI-D collector system test campaigns, we collected impact data to compare against the baseline assessment. We operated and monitored a fully functional prototype collector vehicle (PCV) that measured nominally 12 meters in length, 6 meters in width, and 5 meters in height at NORI-D to test our impact models and gather additional data to gain more insights on the potential impacts of our operations. With the knowledge that we continue to acquire from analyzing the terabytes of environmental data that we gathered before, during, and after the collection test, we have also begun developing a framework for our environmental management and monitoring plan (EMMP), designing a mitigation plan, making improvements in our equipment design, and adjusting our collection operations plans accordingly. This knowledge will form the backbone of the NORI-D offshore EIA.

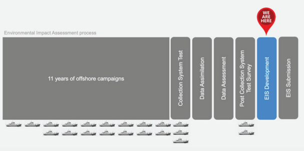


The ISA required a comprehensive offshore EIA for these tests, and, accordingly, we submitted both an environmental impact statement (EIS) and an environmental monitoring and management plan (EMMP) for approval. NORI's sponsoring state, Nauru, facilitated a public stakeholder consultation process to solicit comments and feedback on the offshore EIS for the NORI-D collector test. In contrast to equipment tests on land, which usually do not require an EIS and where stakeholders tend to be local and limited in number, we exhibited our NORI collector test offshore EIS submission publicly to all interested global stakeholders. Following the open stakeholder consultation period, we responded to over 600 comments and updated the EIS to address the most important issues. Subsequently, we held a public information session to present the feedback that we received and how we incorporated it into the updated offshore EIS that we submitted to the ISA in March 2022.

> We responded to over 600 stakeholder comments on the offshore EIS for the NORI-D collector test.

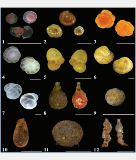
We submitted an environmental management and monitoring plan for the collector test study to the ISA in May 2022 and, in September, NORI received ISA's recommendation to commence pilot nodule collection trials in the CCZ. In December 2023, NORI and independent researchers completed another campaign to collect key environmental data requested by the ISA's Legal and Technical Commission to assess seafloor impacts and recovery rates twelve months after the pilot nodule collection system test. The data gathered will further support NORI's application to the ISA for a commercial exploitation contract, which we expect to submit following the July 2024 meeting of the ISA.

Our Offshore Environmental Impact Statement Will Be Informed by Data Collected Before, During and After our Collection System Test



> Building on the rich data gathered from 20 offshore campaigns over the last 11 years, with cumulative ESIA spending of more than $150 million, the results from the latest campaign will inform NORI's application to the ISA for a commercial exploitation contract.

In all of these campaigns we collected data from the marine habitats represented in NORI-D including tens of thousands of samples, specimens, and data points. We have dedicated significant effort to developing our EIA—from offshore data sample collection to analysis and publication— and the magnitude of this research will continue to grow as we get closer to submitting the NORI-D offshore EIS to the ISA. In early 2023, we commenced uploading the environmental data (hundreds of terabytes) that we have collected since 2011 to DeepData, an open database that the ISA manages.



Foraminifera from the NORI-D Area

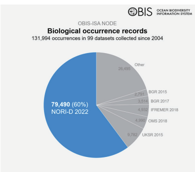
Examples of the top 50 ranked foraminifera species from the NORI-D area by abundance. Foraminifera are single-celled protists (very simple micro-organisms) often called 'armoured amoebae' because they secrete a tiny shell (or 'test') of about 0.5millimeter - 1millimeter long. The scale bar for each example is 100 micrometers and all these individuals would fit on the tip of a pencil.

Macrofauna from NORI-D Area

A selection of typical macrofaunal species found on the NORI-D area during NORI's recent environmental baseline work. These species were retained on a 300 micrometer mesh [half the size of a pencil tip] sieve aboard NORI's vessel. Note: not all images are to scale.

The ISA is the first UN body to become a member of the UNESCO's Ocean Biodiversity Information System (OBIS) network — the world's largest depository of marine biodiversity data for science, conservation and sustainable development, which it uses to publish the data collected by contractors and submitted to its DeepData platform. The OBIS ISA-node provides access to a wealth of information on the deep-sea and biological resources in the global commons for all society to use.

On 22 June 2023, the ISA published the environmental data we collected through two benthic baseline campaigns, and NORI became the single largest contributor of biological occurrence data to the OBIS ISA-node, providing almost 60% of the records and increasing biodiversity records available for the Clarion Clipperton Zone (CCZ) by about 150%.



The publication of this initial batch of data follows NORI's decade-long research efforts to define the polymetallic nodule resource and develop an environmental baseline for the NORI-D exploration area. Biological occurrence records from NORI-D to the OBIS ISA-node will continue to grow considerably as we submit to the ISA the remaining environmental baseline and collector test data. NORI will continue working with research teams to fully collate and categorize the hundreds of terabytes of data and thousands of biological samples that have been collected to date.

100+ studies: Seabed-to-surface ocean research program

Contributions from two of NORI's benthic baseline campaigns have already led to the publication of eight peer-reviewed scientific papers and yielded novel insights about deep-sea biodiversity. NORI expects numerous further papers to be published in peer-reviewed journals in the coming months and years, adding significantly to society's understanding of the deep sea. Once completed, the NORI-D dataset will be one of the most comprehensive datasets ever gathered in the CCZ.

> Research in the Area increases our knowledge about marine biodiversity and ecological processes and will play a critical role in realizing the blue economy.

With the wealth of knowledge that we have and continue to acquire, we can design our nodule collection operations in innovative ways that minimize environmental impacts. Examples include:

- Identifying areas within the contract area that should be preserved as habitat.
- Designing a height-adjustable collector head that picks up nodules using a water jet parallel to the seafloor to minimize sediment disturbance.
- Separating as much sediment as possible from the nodules at the seabed to minimise the amount of sediment lifted to the surface.
- Optimizing the air lift system to minimize acoustic disturbance to the water column.

Social Impact Assessment (SIA)

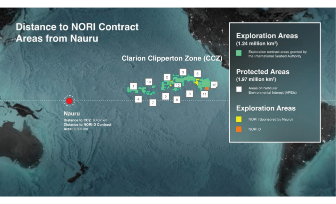
While the environmental component in the ESIA has attracted the most attention, the ISA also requires contractors to evaluate potential social impacts. Assessing the impacts that our future operations may have on people and communities represents a challenging and unique task given polymetallic nodules reside far from human communities in international waters and their designation as a common heritage of humankind (CHH). Still, polymetallic nodules from NORI-D could offer an important and abundant source of energy transition metals that would come with social impacts that differ to those associated with land-based mining. On the one hand, land-based mining operations (and the large multi-year infrastructure projects that support them) generally create local social and economic development opportunities, which deep-sea nodule collection operations would likely not deliver on a comparable level. On the other hand, land-based mining operations also frequently entail tensions with local communities due to various factors such as the need to relocate human settlements, pollution generation, increased competition for water or other local resources, disruption to traditional ways and customs, and so on, which would not exist under a metals-production scenario based on deep-sea nodules. This latter scenario could create fewer but safer jobs and to have significantly lower social impact in terms of fatalities, injuries, illnesses, impacts to vulnerable populations, and toxicity potential[1]. However, given NORI-D's remoteness, we need to rethink how we assess social impact, which explains why we have taken a broad and inclusive approach to understand what social impact means for this emerging industry.

[1] Daina Paulikas et al, "Where Should Metals for the Green Transition Come From?", April 2020.

To undertake our SIA, we have engaged Prizma, an independent ESG, impact assessment, and sustainability advisory practice with demonstrated experience in natural resource projects. The SIA will examine the project's potential positive and negative impacts, engage with external stakeholders, and provide a management and monitoring plan that NORI will incorporate into its future operational and social performance-management plans. On 5 May 2022, NORI and Prizma co-hosted a scoping workshop open to the public in Vancouver, BC, to explore the challenges of conducting a social impact assessment for NORI-D. We developed and released a scoping document for stakeholder comments in December 2022. In March 2023, NORI and Prizma published the Scoping Report and Engagement Record for the NORI-D SIA, which summarized the process and comments received as well as responses provided, in addition to the Terms of Reference for the NORI-D SIA which incorporates stakeholder feedback. In October, we began assessing the potential impacts from the NORI-D Project on intangible cultural heritage (ICH) and establishing a cultural heritage management plan based on good international practice (i.e., aligned with the World Bank's Environmental and Social Standard 1 (ESS1) and the International Finance Corporation's (IFC) Performance Standard 8 (PS8) for Cultural Heritage).

SEVERAL FACTORS MAKE THIS SIA UNIQUE:

- **World first:** Our SIA represents the first SIA for a polymetallic nodule collection project in international waters.
- **Location:** NORI-D resides in the Pacific Ocean over 1,500km from the nearest populated landmass, which means that our nodule collection operations are not anticipated to directly impact any local communities.
- **Regulatory context:** NORI falls under ISA jurisdiction and the resource constitutes a common heritage of humankind.
- **Social impacts:** The NORI-D Project has different direct social impacts as compared to land-based mining projects on in national contexts.



For more information on the ESIA, please refer to the NORI-D Project – Nauru Ocean Resources Inc. webpage.

^ How We Do It   Next section: What We Do >

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What We Do

Our operations

- Our Operations

Offshore Operations

- Our Offshore Operations
- Resource Definition
- Collection System
- Collection System Trials
- Environmental Program
- Regulations and Contracts

Onshore Operations

- Our Onshore Operations
- Processing System
- Plant Site Selection

ESG Footprint

- Scope of Our Activities

Environmental Footprint

- Energy and Emissions
- Water
- Waste

Social Footprint

- Our People
- Health & Safety
- Sponsoring States

Next: Our Operations >

We're building a carefully managed metal commons that will be used, recovered, and reused again and again.

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Our Operations

From collecting nodules to producing battery metals, we have focused on developing **two main operation segments**: offshore operations and onshore operations.

Offshore Operations

Involves all the activities required to collect nodules from the seafloor, lift them to surface, and transfer them to transport vessels for shipping to shore.

From technology development to environmental baseline studies and impact assessments, our offshore activities focus on **four main workstreams:**

Resource Definition | **Collection System** | **Environmental Program** | **Regulations & Contracts**

In 2022, we focused on completing the environmental baseline for NORI Area D (NORI-D), testing the integrated collection system and adaptive management system, monitoring and testing environmental impact data during in situ trials, and developing a social impact assessment for the NORI-D project. In 2023, we returned to the site to collect further environmental data to assess seafloor ecosystem functioning a year after the pilot collection system trials. We expect the results will further improve the quality of our offshore environmental impact statement (EIS) and environmental management & monitoring plan (EMMP) for NORI's application for an exploitation contract to the ISA.

Onshore Operations

Our onshore operations involve developing and testing a near-zero waste flowsheet for nodule processing and refining, and potentially constructing a refining facility.

Our onshore activities focus on **two main workstreams**:

Processing System | **Plant Site Selection**

In 2022, onshore activities focused on testing the hydrometallurgical refinery portion of the flowsheet, characterizing the properties of our manganese silicate product, and identifying the best potential partners for Project Zero and Project One. In 2023, we have entered into a binding memorandum of understanding (MOU) with Pacific Metals Co Ltd (PAMCO) for processing polymetallic nodules (PMN) in Japan, and generated the first sulfates from nodule derived intermediates.

TMC has an **experienced core team**, **and we work with our partners to deliver on our targets.** With our partnerships, we bring the required expertise to develop and implement nodule collection and processing in an effective and environmentally sound manner. Our work with our partners extends across the value chain from resource assessment to nodule processing.

We have **built strong partnerships** that allow us to move fast

OFFSHORE → ONSHORE

Resource → **Collect** → **Ship** → **Process & Refine** → **Product**

RESOURCE ESTIMATION

MAERSK

Partner from 2017-2021

Invested US$25 million in TMC 2017. Maersk provided project management services, such as vessel operations and supplier management, on all resource definition and environmental offshore campaigns until December 2021.

AMC CONSULTANTS MINE SMARTER

Has independently estimated resources for both the NORI and TOML contract areas and conducted an independent economic analysis on the NORI Area D Project.

DECHEL

Manages techno-economic studies.

NODULE COLLECTION TECHNOLOGY DEVELOPMENT

Allseas

Allseas developed and tested a pilot nodule collection system, which is now being upgraded to the first commercial system.

ENVIRONMENTAL IMPACT ASSESSMENT

Several leading deep-sea research institutions around the world have contributed and continue to contribute to the offshore environmental and social impact assessment (ESIA) program that includes over 100 studies. These research institutions can freely publish their research in peer-reviewed journals.

ENVIRONMENTAL MONITORING AND MANAGEMENT / ADAPTIVE MANAGMENT SYSTEM (AMS)

CSIRO **NIWA** **SONGRUNG**

A group of leading organizations is also contributing to developing our ecosystem-based environmental monitoring and management framework and adaptive management system (AMS).

FLOWSHEET DEVELOPMENT

HATCH

TMC engaged Hatch, a Canadian engineering consultancy, to conduct concept engineering for its near-zero solid waste flowsheet and to provide pilot plant technical support.

PILOT PLANT PROGRAM

Calcining	PYROTEK
Smelting Sulfidation	XPS
Converting	
Hydromet refining	SGS

COMMERCIAL PRODUCTION

PACIFIC METALS CO., LTD.

Binding MoU to toll treat 1.3 mtpa of nodules in Japan

OFFTAKES

GLENCORE

the Anglo-Swiss commodity trading and mining company invested in TMC in 2012.

Glencore has an offtake agreement with TMC for:

- Ni (Nickel Sulfate): 50% of nickel production
- Cu (Copper Sulfate): 50% of copper production

Our partnerships make us stronger, because through them we can achieve a lot more than we could alone.

Please refer to the online version of this page for additional context about our workstreams and partnerships.

Our First Project: NORI Area D

While TMC holds exploration rights to several areas in the Clarion-Clipperton Zone (CZZ), we have initially focused on NORI Area D (NORI-D), a 25,160 km^2 area that accounts for 11% of our contracted areas. The area, which resides on the CCZ's southeast margins, possesses an optimal combination of proximity to shore (1,500km from the coast of Mexico), water depth (4.3km), and high and consistent nodule abundance (15-20kg/m^2).

The NORI-D Project has significant optionality not available to terrestrial deposits. Once nodules come to the surface, they can be shipped to a location with an existing port and industrial sites with natural gas, renewable power, and an existing skilled and specialized labor force.

Visual representation of sub-areas within TMC's CCZ permitted areas

The NORI and TOML contract areas constitute the two largest undeveloped nickel projects on the planet[1].

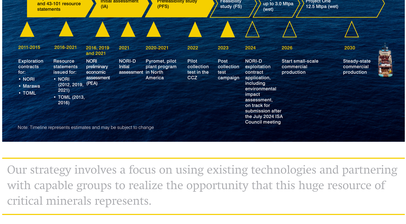
[1] Mining.com, "RANKED: World's biggest nickel projects.", May 1, 2023

Project Development: NORI-D Scheduled for Expected Commercial Production in 2026

We currently expect to commence commercial operations in NORI Area D at the end of the first quarter of 2026. We refer to this operation as Project Zero. In **Project Zero**, we plan to collect a sufficient and continuous quantity of nodules to support commercial operation commencing at 1.3 Mtpa increasing in staged increments to 3.0 Mtpa of wet nodules delivered to a shore-based facility. We plan to process the nodules through existing third-party facilities on a tolling basis, in line with our stated capital-light strategy to get into initial commercial production swiftly and with lower upfront capital.

In November 2023, we entered into a binding memorandum of understanding (MoU) with Pacific Metals Co Ltd (PAMCO) of Japan where PAMCO will complete a feasibility study to toll treat 1.3 million tonnes of wet polymetallic nodules per year at its Hachinohe smelting facility expected to start in Q1 2026. The toll treatment is expected to take place on a dedicated rotary kiln-electric arc furnace (RKEF) processing line and produce two products: **nickel-copper-cobalt (NiCuCo) alloy** — an intermediate product used as feedstock to produce Li-ion battery cathodes — and a **manganese silicate product** used to make silico-manganese alloy, a critical input into steel manufacturing.

Once in production, we plan to focus on scaling and increasing production in a manner that manages development and environmental risks as we build operational knowledge and experience. We refer to this operation as **Project One**. As the NORI Initial Assessment Technical Report Summary outlines, we expect to expand production with an additional converted drillship (Drill Ship 2), and a newly constructed bespoke production vessel (Collector Ship 1).



Our strategy involves a focus on using existing technologies and partnering with capable groups to realize the opportunity that this huge resource of critical minerals represents.

^ What We Do Next: Our Offshore Operations >

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Our Offshore Operations

Our offshore activities include making sure that we can collect nodules in an efficient and environmentally sound manner in the Clarion-Clipperton Zone (CCZ). From technology development to environmental baseline and impact assessment, our offshore activities focus on four main workstreams.

Resource Definition and Resource Economics

Understanding nodule abundance, composition, and metal content to define resource size and quality and demonstrate project economic viability. Workstream features:

- Exploration campaigns
- Indicated and measured resources

Collection System

Designing, developing, and testing a collection system that includes subsea collector robots on the seafloor, an airlift riser system to transport nodules from seafloor collectors to the surface, a production vessel on the surface to dewater nodules and offload them to bulk cargo vessels to transport them to shore. Main components of our collection system:

- Integrated system design
- Allseas partnership
- Pilot system design, fabrication and testing
- Production vessel

Environmental Program

Gaining knowledge about the ecosystem, potential operational impacts, and mitigation strategies and developing an adaptive management system to monitor and ensure that we continuously meet established acceptable parameters. Key elements of our environmental program:

- Science advisory board
- Environmental baseline sampling
- Lifecycle assessments (LCAs), climate change, waste and biodiversity impacts studies
- Offshore environmental impact statement (EIS) for collector test and production
- Adaptive management system (AMS)

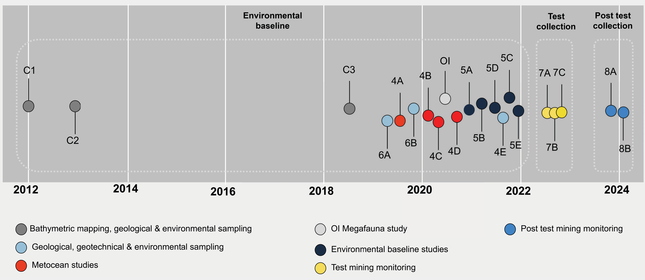
Regulation and Contracts

International Seabed Authority (ISA) permitting requirements include broad engagement with stakeholders and experts as we are developing a resource deemed a common heritage of humankind (CHH) via sponsorship from developing states. Key regulatory requirements:

- 15-year contract
- Five-year work programs and review cycle
- Annual reports cycle

To support all these workstreams, NORI has been collecting samples from NORI contract area in the Clarion-Clipperton Zone (CCZ) and analyzing them since 2012. The picture below shows the timeline and focus for the campaigns that NORI has conducted to date.

NORI-D Environmental Impact Assessment is Based on 20 Offshore Campaigns Over 12 Years



For more information about the NORI exploration campaigns in 2012, 2013, 2018, 2019 and 2020, see Section 7 in the NORI Technical Report Summary.

In addition to these NORI campaigns, before TMC acquired TOML in 2020, TOML conducted two bathymetric mapping, geological, and environmental sampling campaigns in the TOML contract area in the CCZ in 2013 and 2015. In its offshore exploration campaigns, TOML conducted sampling to support environmental studies, collected high-resolution imagery, and conducted environmental baseline studies. TOML also plans to conduct several future campaigns to collect data on ocean currents and water quality to assist plume modeling and environmental baseline studies and to conduct box core and multi-corer sampling focused on benthic ecology and sediment characteristics.

For more information about the TOML exploration campaigns in 2013 and 2015, see Section 7 in the TOML Technical Report Summary.

To date, only limited offshore mineral resource definition activities in the Marawa contract area have occurred. We expect to collaborate with Marawa to assess the viability of any potential project in the Marawa Contract Area, although the timing of such assessment is uncertain.

^ What We Do Next: Resource Definition >

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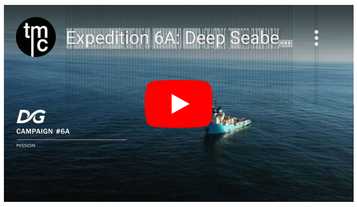
Resource Definition

- 5 campaigns
- Inferred, indicated & measured methodology
- NI 43-101 and SEC S-K 1300 resource statement
- NORI and TOML ranked the two largest undeveloped nickel projects on the planet[1]



Among their many attractive attributes, nodules sit unattached on the seafloor with no overburden to remove and nothing to obstructs them from above. This same attribute makes resource assessment very efficient. We have carried out five campaigns to define the resource in the NORI contract area. By collecting samples and scanning the seafloor using an autonomous underwater vehicle (AUV) with geophysical instruments and cameras, we defined the resource's composition and quantity in the surveyed areas with a high level of confidence.

We commissioned AMC, a world-leading resource consultancy, to estimate the resource in the NORI and TOML contract areas and evaluate the NORI Area D Project from a techno-economic perspective. This evaluation brought together contractors for the offshore shipping and processing work scopes as follows:

- AMC conducted the resource evaluation independently in compliance with U.S. Securities and Exchange Commission (SEC) S-K 1300 standards
- Deep Reach Technology (DRT), an ocean engineering services consultancy, designed and performed costing for the offshore collection system and with inputs from Cellula Robotics and Herbert Marine Engineering
- Canadian Engineering Associates designed and performed costing for the onshore metallurgical plan
- CRU Group, expert in metals and mining intelligence, developed projections for metal product pricess
- Pareto JGO Shipbrokers developed projections for shipping rates

TMC issued technical report summaries for NORI-D and for TOML in March 2021.

1. Mining.com, "RANKED: World's biggest nickel projects", May 1, 2023

Resource Definition: 2D Nature of the Resource Allows Effective Definition

BOX CORE SAMPLING[1]

250
box cores collected[2]

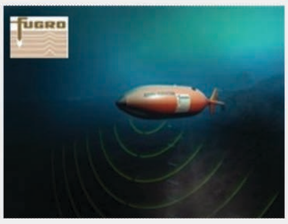
82,000
kg (wet) nodules collected[2]

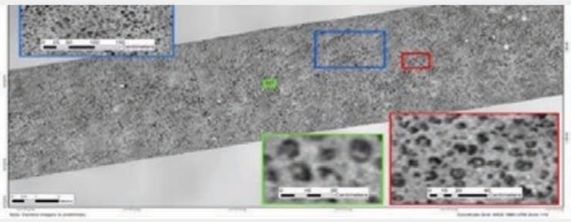
13,950
biological samples collected[2]

AUV CAMERA IMAGERY[1]

178,591
km² of high-res bathymetric survey[2]

5,439
km² detailed seafloor imagery[2]





1 Images from DeepGreen's resource survey offshore campaigns in NORI contract area
2 Boxcores, nodules collected, high-res bathymetry, detailed bathymetry - compiled by DeepGreen from Canadian NI 43-101 and SEC Regulation S-K (Subpart 1300) Compliant NORI Area-D Clarion-Clipperton Zone Mineral Resource Estimate and associated financial model, AMC, March 2021. Canadian NI 43-101 Compliant TOML Clarion-Clipperton-Zone Project Mineral Resource Estimate, AMC, July 2016 and DeepOcean NORI - D Bulk Sampling Report, 2020. Erias Cruise 6a Biological and Physiochemical Co-Sampling Report NORI Area-D post cruise, 2019; Erias Cruise 6b Biological and Physiochemical Co-Sampling Report NORI Area-D post cruise report, 2019.

^ What We Do Next: Collection System >

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Collection System

- Integrated system design
- Allseas partnership
- Production vessel acquired, converted and tested
- Pilot collection-system design, fabrication and testing completed
- System upgrade to collect up to 3.0 Mtpa of nodules

In collaboration with our strategic offshore partner Allseas, we continue to develop a nodule-collection system that includes three main components:

- **Subsea collector vehicles**,
- **A riser and lift system**, and
- **A main production vessel**.

After the collection system collects and brings nodules up to the production vessel, the vessel then offloads them to a bulk carrier that can ship the nodules to any major port.

Did You Know?

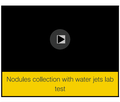
Four different consortia that included leading global companies successfully piloted collector systems in the 1970s. However, as the United Nations Convention on the Law of the Sea (UNCLOS) and the International Seabed Authority (ISA) did not exist then, no legal framework could provide exploration and exploitation rights to the seafloor. While no one has yet exploited nodules in international waters to date, shallow-water mining for sand, tin, and diamonds already occurs in some locations around the world in the exclusive economic zones (EEZs) that belong to national jurisdictions[1]. Some examples include South Africa and Namibia and their offshore mining for diamonds, and the United Kingdom, whose marine-aggregate dredging industry (one of the largest in the world) collects many millions of tons of sand and gravel each year[2].

[1] Woods Hole Oceanographic Institution, "Deep-Sea Mining", 6 Jun. 2019

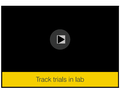
[2] European Dredging Association, "Reasons for Dredging", accessed on 21 Feb. 2024

Subsea Collector Vehicles

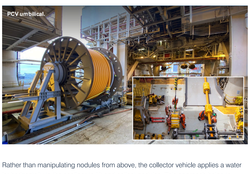
Self-propelled, tracked collector vehicles will collect nodules from the seafloor using seawater jets. The system involves no rock cutting, digging, drilling, blasting, or other breakage at the collection point. Umbilical cables connect the vehicle to the production vessel on the surface via which it receives power and enables personnel to remotely control it.



Nodules collection with water jets lab test

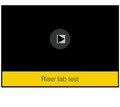


Track trials in lab



Rather than manipulating nodules from above, the collector vehicle applies a water jet horizontally to the seafloor to lift and collect nodules. This approach helps to minimize disturbance to seabed sediments. Laboratory testing confirmed our technical assumptions about the system's efficiency and productivity before we conducted our collection system trial in the CCZ. A simulated analog of the seabed and the world's largest floating test tank was built, and Allseas was able to test the nozzle pickup to achieve a high nodule-pickup efficiency and apply this knowledge to improve the collector vehicle's design before we tested it in thecollection-system trials in the CCZ.

The nozzles met performance expectations during the collection-system test, and Allseas identified improvement opportunities to further increase pick-up efficiency and minimize seabed disturbance. Building on learnings from the trials, Allseas conducted two additional lab tests in 2023. The first focused on researching the influence of different nozzle design parameters on pick-up capacity and efficiency, and the second evaluated how certain environmental conditions would affect pick-up efficiency. Future work will include simulating what impact (if any) plume deposits will have on the collector efficiency.



Riser lab test

Riser and Lift System

An airlift riser and lift system transports nodules from the abyssal depths to the surface
using ocean water. This 4.3km semi-rigid pipe system, lifts the nodules up from the collector vehicle to the production vessel. After a cyclone separator separates the nodules from the entrained water and sediment on the vessel, the system returns seawater and a small amount of remaining sediment to the ocean through a return pipe.

Converted Hidden Gem that performed the collection system trials

Production Vessel

Through our strategic partnership with Allseas, we acquired the Hidden Gem, a former drillship vessel, in February 2020 and repurposed it into the world's first dedicated polymetallic nodule-production vessel. In 2022, we tested this 228m vessel in addition to a prototype collector, riser and lift system, and other systems in acollection-system trials.

We use insights from environmental research to identify appropriate indicators and tolerance limits to minimize impacts in our deep-sea operating environment. Once we obtain an exploitation contract, we would then expect Project Zero to commence after we have upgraded the Hidden Gem to become a production vessel with a collection capacity of up to 3 million tonnes per annum (Mtpa) of wet nodules.

Offshore Development Milestones: Progress on Track

2016-2019 — In-depth technical and feasibility design studies by DeepGreen

2019 — Technology development for all subsystems for pilotscale production system

2020 — Lab testing and fabrication of pilotscale production system

March 2022 — Successful pilot collector test in the Atlantic Ocean

2022 — **Collection System Test** in the Clarion Clipperton Zone from NORI-D test area in the CCZ

2026 — **Project Zero** Commercial-scale system operational at a capacity of 3.0 wet million tonnes per annum (Mtpa)

2030 — **Project One** Ramp up to commercial production of 12.5 wet Mtpa

When it comes to mitigating impacts to deep-sea ecosystems, we can make many choices as we design our collection systems. For example, we can optimize the depth at which the return pipe returns water to the ocean, the nozzle head's design, and the collector vehicle to minimize how much subsea sediment the system lifts to the surface and subsequently discharges back into the midwater column.

We continue to explore ways to reduce our impact on the CCZ and to improve the system's footprint. For example, because the airlift system and the dynamic positioning system that matches the vessel's position to the collector robots on the seafloor consume more energy than any other system offshore, we continue to look for ways to optimize their energy efficiency and to research new technologies that can help us move away from fossil fuels.

^ What We Do Next: Collection System Trials >

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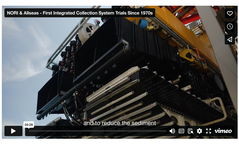
Collection System Trials

In November 2022, TMC's subsidiary NORI and offshore partner Allseas successfully concluded the first integrated collection-system test in the Clarion Clipperton Zone (CCZ) since the 1970s and achieved all significant pilot milestones. In total, the operation collected approximately 4,500 tonnes of (wet) seafloor polymetallic nodules: it transported over 3,000 tonnes (wet) up a 4.3km riser system to the surface production vessel, the *Hidden Gem*, while purposely leaving the additional 1,500 tonnes of nodules behind on the seafloor. Our engineering partner, Allseas, spent three years developing and constructing the prototype polymetallic nodule-collection system for the test. Furthermore, TMC submitted a dedicated offshore environmental impact statement (EIS) and environmental monitoring and management plan (EMMP) for this test. NORI distributed the EIS for stakeholder comments and revised the document based on the feedback before the ISA recommended the company could proceed with the test.

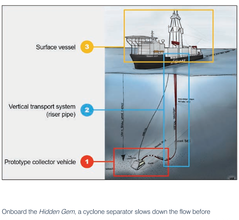


The collection test had four main objectives:

Objective #1 **Demonstrate integrated pilot system capable of collecting and lifting nodules**		✓ First successful integrated-pilot system test in CCZ since 1970s
Objective #2 **Collect ~3,600 wet tonnes of polymetallic nodules**		✓ 4,500 wet tonnes collected ✓ 3,021 wet tonnes lifted
Objective #3 **Test pilot system performance to inform future system optimizations and upgrade**		✓ 86.4t/h production rate Performance data acquired to be used to inform future system optimizations and upgrades with a targeted sustained production rate over 200t/h
Objective #4 **Monitor and survey pre-, during- and post- test environment**		✓ Pre- and during surveys complete ✓ Post-test surveys complete

During the integrated collection-system test, the prototype collector vehicle travelled over 80km across the seafloor in an 8km^2 section of NORI-D allocated for the test. Allseas-engineers put the pilot nodule collector through various tests and achieved a sustained production rate of 86.4 tonnes per hour (roughly equivalent to transporting 40 Tesla Model S vehicles to the surface every 60 minutes).

We used a nozzle design that employs water jets to entrain nodules while minimizing the disturbance of sediment. The nozzle design reduces the benthic plume's size and extent to which it spreads and also minimizes the mid-water plume since it reduces the amount of entrained sediment that the system transported along with the seawater and nodules to the surface. We injected compressed air into a 4.3km riser pipe approximately 2km below the surface to create a partial vacuum that lifted the nodules, seawater, and sediment onto the production vessel. In total, we lifted over 3,000 tonnes of wet nodules to the surface during the test.



Onboard the *Hidden Gem*, a cyclone separator slows down the flow before separating out the nodules from the water and entrained sediment. A conveyor belt then transports the nodules to the vessel's hold for storage. The system returned the separated water, residual sediment, and fine nodule fragments to the water column at 1,200m below the surface.

During the production ramp-up sequence in October 2022, a temporary overflow that comprised seawater mixed with sediment and nodule fragments in small amounts occurred. We notified the ISA about the event, and both the ISA and independent reviewers determined it to have no potential to cause significant harm to the marine environment. Based on an assessment conducted in collaboration with subject matter experts, we made modifications to the cyclone separator, and no further overflows during subsequent test runs occurred. As we outline in the offshore EIS for the NORI-D collector test, we conducted these trials to test an untried system and to identify opportunities to optimize the design of a full-size commercial system. Based on learnings from the test, Allseas is now scaling up the collection system for an increased production capacity for NORI's Project Zero to an estimated 3.0 million wet tonnes per annum (Mtpa), including an additional 15-meter-wide collector vehicle, a wider diameter riser pipe, larger compressor spread, and improvements to the system designed to further mitigate its environmental impacts.

We also conducted the collection test to monitor the impact that the system had on the environment during operations. Specifically, the studies that NORI executed during the system test ranged from above the ocean surface (e.g., avian fauna flying above the water) down approximately 4km through the entire pelagic water column (epi-, meso-, and abyso-) into the abyssal sediments on the seafloor. These studies focused on characterizing the potential environmental impacts associated with the operation.

Production and Monitoring Equipment Deployed During the Collection System Test

We collected near-field data (i.e., <200m from the collector system) from the *Hidden Gem*, whereas we collected far-field data (i.e., > 200m from the collector system) from a 103m research vessel—one among only a handful in the world with the equipment that one needs to perform autonomous underwater vehicle (AUV) surveys, multibeam seabed surveys, and remotely operated vehicles (ROV) surveys at depths greater than 4km.

> We deployed 50 assets and marine sensors to the 4km x 2km test field to collect data on all aspects of plume dynamics, concentration, and dispersal from which DHI have generated a verified plume model.

We conducted the system test and environmental monitoring in three steps:

- We conducted the first aboard a research vessel where scientists gathered critical data to help develop a pre-disturbance environment baseline. We deployed multiple subsea assets at the seafloor and throughout the mid-water column to characterize the ecosystem baseline prior to disturbance.
- The *Hidden Gem* then joined the research vessel at NORI-D. We deployed the collection system and put it through its paces to test its overall performance and how efficiently it picked up and transported nodules. Simultaneously, independent scientists measured the system's environmental performance by monitoring the benthic and mid-water plumes' density, their physical and chemical composition, the extent to which they spread, and the noise that the system generated.
- We conducted the third step aboard the research vessel after we completed the successful collection system test and the *Hidden Gem* departed the area. Scientists repeated all the workstreams from the initial baseline studies to assess the state of the ecosystem after the disturbance. They took low-altitude camera images with an AUV to compare the seabed topography and faunal communities before and after disturbance. They also took box core and multicore samples from the disturbed areas to compare if and how the epifauna, infauna communities, and sediment geochemistry may have changed due to the disturbance. Finally, the scientists visually assessed sedimentation plates to determine the extent to which sedimentation spread from the point of disturbance.

In 2023, we revisited the site to assess the impact one year after the collection system test. Marine scientists conducted an array of studies to collect further environmental data on ecosystem functioning in the area of the pilot nodule collection system test as well as in areas adjacent to and at various distances from the collector tracks. Independent world-leading deep-sea research institutions have contributed to the environmental baseline and impact studies that will form the basis of the NORI-D offshore environmental impact assessment (EIA) in our application for an exploitation contract, which we plan to submit after the ISA Council meeting of July 2024. We expect these institutions to continue to openly publish their research in peer-reviewed journals.

Collaborating with Leading Research Institutions and Industry Experts to Understand Our Offshore Environmental Impacts

^ What We Do Next: Environmental Program >

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Environmental Program

- Environmental Impact Assessment (EIA)
- Adaptive Management System (AMS)
- Contributions to Research

- Science advisory board
- Environmental baseline sampling
- Environmental monitoring of nodule-collection trials
- LCA on NORI-D environmental impacts
- LCA on climate change, waste, and white paper
- EIS for collector test and production
- Adaptive management system

Environmental Baseline Expeditions:
5A ▸ 5B ▸ 5C ▸ 5D ▸ 5E ▸
Resource Definition:
6A ▸ 6B ▸
Collector Test Environmental Surveys:
7A1 ▸ 7A2 ▸ 7B2 ▸
Collector Test Monitoring:
7B1 ▸
Post-Disturbance Survey:
8A ▸

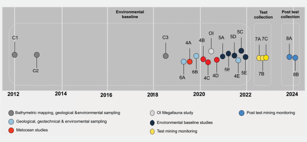
The environmental program forms the foundation of our offshore environmental impact assessment (EIA), itself the largest component of our application for a commercial nodule-collection contract. We have conducted the program to ensure we sufficiently understand the deep-sea ecosystem to mitigate the harm that our operations could cause to the environment. With help from experts, which includes an external science advisory board, we have been able to answer many questions and more clearly understand our contract areas in the CCZ. We have already begun using this knowledge to inform the EIA and the design of the commercial collector system and adaptive management system (AMS).

Scientists have established that the sedimented abyssal seafloor where polymetallic nodules reside constitutes the most common habitat type on Earth and covers approximately 70% of the ocean floor[1]. They have also established that less than 10% of all marine organisms live below 4km[2]. Through the work being done in our environmental program, we have developed baseline knowledge about the marine organisms that live in the water column and on the seabed and we've begun analyzing how our activities might impact them.

We have designed the most comprehensive seabed-to-surface research program that anyone has ever conducted in the region to date. We have commissioned the world's leading ocean scientists to conduct more than 100 individual studies to characterize the biota throughout the zones in the water column and on the seabed. Since 2012, we have conducted over 20 offshore campaigns as part of Nauru Ocean Resources Inc. Area D (NORI-D)'s Environmental and Social Impact Assessment (ESIA).

[1] NOAA, "Ocean Floor Features"
[2] Yinon M. Bar-On et al., "The Biomass Distribution on Earth", May 21, 2018

Data to Inform NORI-D's EIS Has Been Collected Over 20 Offshore Campaigns Spanning 12 Years



100+ Studies: Seabed-to-Surface Ocean Research Program

SURFACE BIOLOGY
Surface fauna logbook (PelagOS)
Remote sensing, hydrophone acoustics

PELAGIC BIOLOGY
Microbial community characterization
Phytoplankton community characterization
Zooplankton community characterization
Gelatinous zooplankton characterization
Micronekton characterization
Trophic analysis (stable isotopes)
Temporal variability of pelagic communities
Trace element profiles in water column
Particulate profiles in water column
Discharge plume characterization (physical)
Discharge plume characterization (biological)
Midwater discharge (food webs particle composition)

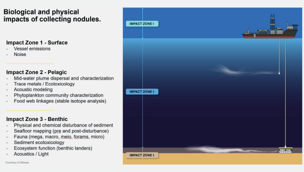
BENTHIC BIOLOGY
Megafauna characterization (photo transects)
Megafauna characterization (time lapse)
Macrofauna characterization
Microfauna characterization
Mesofauna characterization

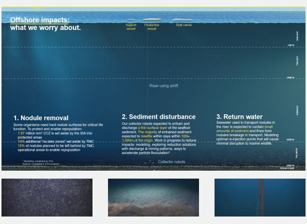
SEDIMENT ANALYSIS
Baited camera and traps
Benthic respiration and nutrient cycling
Seafloor metabolic activities
Bioturbation, sediment characteristics
Porewater sampling
Exposure toxicology studies
Metals determination by ICP analysis
Induction of gene transcripts (metals)

COLLECTOR IMPACT STUDIES
Metocean studies
Bathymetry (seabed mapping)
Habitat mapping
Database development
Digital twin development
Collector test near-field studies
Collector test far-field modeling
Plume modeling
Existing resource utilization study
Noise & light study
Meteorology & air quality study
Hazard & risk assessment
Emergency response planning
Cultural & historical resources
Waste management
Cumulative impacts

Offshore Environmental Impact Assessment

We have identified three main impact zones from which there are three key ways our operations will have an impact on the environment: nodule removal, the benthic plume, and the mid-water plume. Through our offshore campaigns, we have been studying the environmental conditions before, during and after the nodule collection process to better understand the implications and define appropriate mitigation measures.



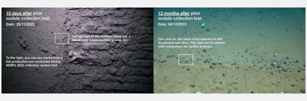


1 Nodule removal

Nodules serve as a hard-surface habitat to which some sessile invertebrates attach. Nodule collection will permanently remove most nodules and the organisms attached to them.

Mitigation action: we continue researching the distribution of organisms that live in the seabed sediment and on nodules to understand the overall impact that nodule removal will have in the Clarion-Clipperton Zone (CCZ). Some organisms need hard nodule surfaces to sustain their critical life functions, but many others live in the sediment itself.

Qualitative data shows individual organisms are present and alive one year following collection test, even right next to the vehicle tracks.



To protect and enable repopulation:

- The ISA has set aside 1.97 million km^2 of the CCZ as areas of particular environmental interest (APEI) that nodule collection will never touch[1].
- We will set aside approximately 10% of TMC's contracted areas as additional "no-take zones" or preservation reference zones (PRZs).
- We also expect to leave behind approximately 15% of nodules in our operational areas.

For comparison, protected areas safeguard only 8.2% of global oceans today[2], though the Global Biodiversity Framework that the international community adopted in December 2022 set 30% as a target to reach by 2030[3].

[1] ISA, Environmental Management Plan for the CCZ ISBA/26/C/58
[2] Protected Planet, "Discover the world's protected and conserved areas", Mar. 2024
[3] Convention on Biological Diversity, "COP15: Nations adopt four goals, 23 targets for 2030 in landmark UN Biodiversity Agreement", 19 Dec. 2022

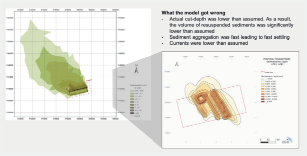
2 Benthic plume

As the collector vehicle moves across the seafloor, it will disturb and entrain a thin surface layer of the seafloor sediment. The collector vehicle will separate the majority of the sediment that it entrains and discharge it back to the seafloor within meters from its origin, which will generate a plume. This plume may spread to other areas, and the fine sediment may clog filter feeding organisms' feeding and respiratory structures. Sedimentation may also bury nodules and, thus, make it hard or impossible for animal larvae to attach to them. Several studies have begun to model how the benthic plume behaves, and, to date, initial findings suggest that the plume may not have as widespread impacts as previously thought. Peer-reviewed research based on field studies on seafloor and mid-water plumes that MIT and Scripps published in 2022 found that 92-98% of the plume from pilot nodule-collector vehicle rose only 2 meters above the seafloor[1]. Study co-author Thomas Peacock from MIT commented: "It's quite a different picture of what these plumes look like, compared to some of the conjecture"[2].

[1] Carlos Muñoz-Royo et al., "An in situ study of abyssal turbidity-current sediment plumes generated by a deep seabed polymetallic nodule mining preprototype collector vehicle", 21 Sep. 2022
[2] Science Daily, "Ocean scientists measure sediment plume stirred up by deep-sea-mining vehicle", Sep. 21, 2022

Mitigation action: During the 2022 nodule collection system trials, we worked with DHI Water and Environment — leading experts on sedimentation modelling — to implement a plume monitoring study. The team deployed over 50 assets and marine sensors to the 4km x 2km test field to collect data on all aspects of plume dynamics, concentration, and dispersal from which DHI have generated a verified plume model. Initial plume models predicted that plume would resettle within days in a 100-1,000m radius from the origin, but preliminary results from in-field pilot measurements show that the actual plume footprint was smaller than expected and did not spread beyond the operating area.

Actual Plume Footprint Was Smaller Even Compared to the Initial Model Built by DHI



From the pilot collection test, we have learned that there is heavy local plume deposition in the vicinity of the collector tracks, but most sediment resettles within hours-to-days within 500 meters from origin.

Understanding the Scale: The Actual Footprint Did not Spread Beyond the Operational Area

Actual Pilot Test Footage Showing Plume Stays Low

With in field knowledge of plume behavior, we continue to explore reduction solutions via discharge parameters and mining patterns, and to find ways to accelerate particle flocculation, which will speed up sediment resettlement on the seabed[1]. The dredging industry has developed significant knowledge on plume dynamics over the years, which we also use to design and establish the best parameters to mitigate the benthic plume that the collector vehicle generates.

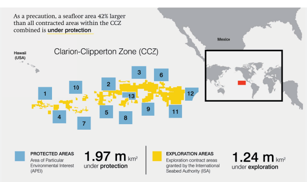
[1] Modeling completed by DHI. Source: Company's ESIA program

3 Return water plume

Nodules, seawater, and any residual sediment that eludes separation inside the collector vehicle will enter the riser pipe and travel to the surface vessel. Once aboard the vessel, a cyclone separator will dewater the nodules and the seawater that the riser system used to transport nodules along with any residual sediment and nodule fines (from nodules breakage in transport) will return to the water column at depth below the measured oxygen minimum zones where it will form a highly dilute plume (the "mid-water plume"). Key risks to the biotic environment from the mid-water plume include clogging pelagic nekton's respiratory and filter-feeding structures and remobilizing heavy metals and toxins that the sediment previously sequestered and possibly making them available for bioaccumulation in the food chain.

Mitigation action: We continue to research optimal reinjection points that will cause minimal disruption to marine wildlife. In a study on the mid-water plume, MIT found that modeling can reliably predict a mid-water plume's properties in the vicinity of its discharge[1]. In the coming months, NORI will release data on midwater sediment plumes collected during the 2022 pilot collection-system test which will further address concerns as to the scope and scale of their distribution.

[1] Carlos Muñoz-Royo et al, "Extent of impact of deep-sea nodule mining midwater plumes is influenced by sediment loading, turbulence and thresholds", July 27, 2021

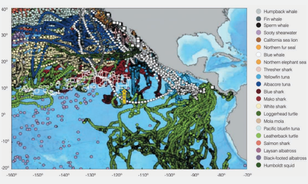


Source: ISA, "Decision of the Council of the International Seabed Authority relating to the review of the environmental management plan for the Clarion-Clipperton Zone", Dec. 10, 2021

We expect to be able to avoid or minimize many impacts that our operations may have on the marine environment by designing the collection system with environmental goals in mind. For example:

- Increasing the depth at which the return pipe returns water to the ocean can minimize the impacts on the more productive mesopelagic layer. Since most marine life lives in the upper layers, placing the discharge in bathypelagic zone contributes significantly to minimizing impacts. Also, an adjustable collector head can adapt the water jet that the collector vehicle uses to pick up nodules to minimize sediment disturbance and, with it, the size of the benthic and mid-water plumes.
- We also aim to design a system that minimizes acoustic disturbance to the water column since the cetaceans such as whales and dolphins that occasionally traverse the CCZ rely on sound for many activities, such as communicating, navigating and feeding. Fortunately, tracking data for key migratory species in the eastern Pacific exists. It shows that NORI Area D falls outside the known migratory routes for many shark, whale, turtle, bird, and commercially important fish species found in the eastern tropical Pacific.

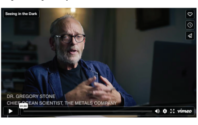
Tracking Data for Migratory Species in the Eastern Tropical Pacific[1]



[1] Fathom Pacific (2020b) adapted from Block et al., Tracking apex marine predator movements in dynamic ocean, June 22, 2011

Importantly, our operations in the CCZ will disturb each area we collect nodules from only once. After nodule collection, we will leave the area alone to recover. The CCZ resides in such a remote location that we expect there would be few, if any, cumulative impacts from other activities. We have begun studying the in-field data successfully gathered on ecosystem functioning a year after the pilot nodule collection system test. While we have yet to complete research, we expect to report on recovery rates at a species level. We expect mobile species such as fish to return soon after nodule collection, whereas we expect some microbes and larger organisms that live in the sediments to potentially take longer to recover (anywhere from tens to hundreds of years). We do not expect the organisms that rely on the nodules for habitat to recolonize areas where we have removed them. Anticipating this outcome, the ISA has established an APEI network in the CCZ to create a reservoir with protected species that could re-colonize mined areas if and when conditions become favorable. Beyond effective design, we will also be able to fine-tune our operations using an adaptive management system (AMS) that will allow us to monitor the precise conditions in the deep sea.

Adaptive Management System



To support deep-sea operations, we have begun developing and testing an AMS with leading organizations around the world. This state-of-the-art predictive system will use environmental and operational data and will enable TMC to mitigate operational impacts in the deep-sea environment as much as possible. It has **three main objectives:**

Transparency
Provide eyes and ears to a secluded & extreme environment

Regulations
Meet UN-ISA draft regulations on exploitation of mineral resources in the Area

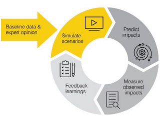
Env Impact
Minimize, mitigate, and avoid environmental impacts where possible.

A structured, iterative, and robust decision-making system, the AMS will allow TMC to simulate planned operational scenarios and predict their environmental impact with an increasing level of certainty over time via continuous system monitoring and adjustments. In particular, the system will connect key incoming data (e.g., research, expert opinion, data from sensors) with a simulation and prediction platform. This data will continually update a digital twin (i.e., a virtual representation) of the collector system and deep-sea operational environment, which will enable TMC to make near real-time and informed environmental management decisions[1].

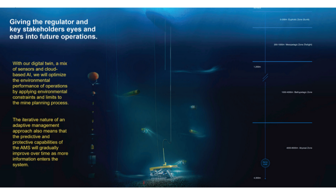
[1] Buckley et al, "Use of an Adaptive Management System to Minimize Impacts of Deep-Sea Nodule Collection", 30 Dec. 2021

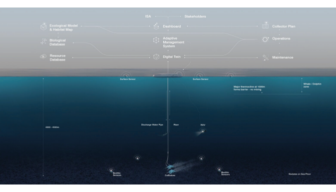
> Like guardrails on a highway, the AMS will help ensure that operations comply with regulations and remain within environmental impact thresholds

AMS Loop



The digital twin will enable us to track underwater robots and vehicles with data coming in from many different deep-sea sensors. As it ingests data, it will rely on models that environmental and data scientists have developed using state-of-the-art methods to simulate the future and generate plans or make contingencies. It will allow us to optimize our operations' environmental performance by applying environmental constraints and limits to the mine-planning process. We have partnered with Kongsberg Digital, a world-class provider of high-technology systems and solutions for the oil and gas, merchant marine, defense, and aerospace industries, to power this core element of the AMS technology stack. Together, the AMS and digital twin will form key components of an integrated environmental management system (EMS).



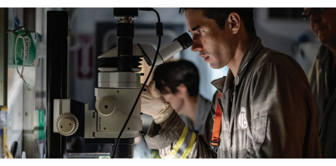


We tested a first iteration of the AMS during the 2022 collection system trials. It performed as designed and tracked equipment's location in near real time (e.g., vessel, collector, remotely operated vehicles, and riser), monitored operational parameters (e.g., nodule pickup rate by the collector, flow rate inside the riser, nodule conveyor rate, total tonnage collected), and tracked the actual collector vehicle's trajectory compared to the planned path.

The next phase of the agreement with Kongsberg Digital will bring artificial intelligence (AI) and hybrid machine learning to build upon the system's capabilities. It will integrate multiple data streams from TMC's future production system (e.g., between environmental monitoring vessels and operations vessels), add simulation capacity to model plume, and add more playback features for historical data (e.g., collector vehicle and ROVs footage and trajectory). This is important to our future deep-sea operations and environmental monitoring as it provides us with the proven accuracy and reliability of physics-based modelling combined with data-driven models for near real-time predictions and optimizations. This AI-driven approach will enable continuous learning and adaptation and enable us to test 'what-if' scenarios, allowing NORI to optimize for efficient operations while minimizing environmental impacts.

> The digital twin and AMS will bring unprecedented visibility to our NORI-D nodule project, enabling the regulator and stakeholders to see exactly what we are doing, and when and where we're doing it.

The digital twin and AMS will enable 3D visualization of deep-sea operations in a dynamic interactive dashboard for review by stakeholders, which we believe will enable one of the most transparent natural resource projects in history—a system with potential applications for resource operations at sea and on land. For example, it might show a mine plan of the collector vehicle on the seafloor, in conjunction with the production vessel and a Remotely Operated Vehicle (ROV) all moving synchronously along the same paths over time. Hovering the cursor over the collector vehicle can callout its speed, direction, depth, efficiency metrics at any point in time. The regulator will also be able to monitor the plume attributes in near-real time, and operators can make adjustments based on this data and conduct simulations to maintain plume dispersal within predetermined thresholds. As part of TMC's commitment to transparency and accountability in this new industry, we will share data from the AMS with researchers and academic institutions to improve humanity's knowledge about the world's oceans and aid efforts to conserve deep-sea and connected ecosystems.



Contributions to Research

Ocean Research: Partnering to Increase Human Knowledge

We contribute to society's knowledge about the deep ocean through our comprehensive environmental program. We have invested more than US$150 million in ESIA spending over the last 11 years to gather research data to understand the CCZ from the surface down through the water column to the abyssal plain. For instance, we have focused on better understanding habitat connectivity and how it relates to the distribution and function of deep-sea organisms and the overall structure of their communities.

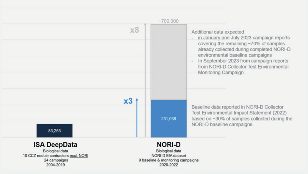
Overall, we also see untapped potential for ocean science, which includes our own research, to make significant contributions to science, medicine, and technology more widely and, thus, humanity in general. Indeed, in recent years, new ocean discoveries have had unimagined implications—from compounds found in marine microbes with antiviral properties to ocean bacteria with the potential to clean polluted soil and water[1]. We view this potential as motivation to continue funding such an extensive scientific program and to conduct it in a transparent and collaborative way.

Accordingly, we continue to develop active partnerships with leading researchers, share our vast catalog of deep-sea biological and sediment samples with labs for study, and share the data we collect with the ISA and the international community. The ISA has developed an open-source database called DeepData to house all scientific and environmental data that companies collect to benefit the scientific community. Scientists who derive work from these samples can freely publish their findings.

On 22 June 2023, the ISA published the environmental data we collected through two benthic baseline campaigns, and NORI became the single largest contributor of biological occurrence data to the UNESCO's Ocean Biodiversity Information System (OBIS) network ISA-node, providing almost 60% of the records and increasing biodiversity records available for the Clarion Clipperton Zone (CCZ) by about 150%[2]. Yet, these records represent less than half of the total dataset collected, which means that our contribution to DeepData will continue to grow considerably.

[1] Ameen, et. al., "Marine microorganisms as an untapped source of bioactive compounds", Jan. 2021
[2] See the page "Environmental Impact Statement" for more information

Number of Biological Specimen



Source: NORI, "NORI-D Collector Test EIS", 2022; NORI-D EIA Campaign reports
Note: The number of biological specimens in the ISA DeepData related to CCZ nodules estimated based on 52,222 records containing the total of 111,004 individuals, less 25% "duplicates" estimated in Rabone et al, 2022 Source: ISA, "DeepData Database" downloaded on 12 July 2021; Rabone et al., "A Review of the International Seabed Authority database DeepData: Challenges and Opportunities in the UN Ocean Decade" (manuscript submitted to Oxford University Press Database Journal on 18 October 2022)

With the help of research institutions around the world, we have supported over 100 original studies across several primary work packages:

- Sediment analysis
- Surface biology
- Benthic biology
- Pelagic biology
- Collector impact studies

Ongoing support studies that contribute to these work packages include:

- Metocean studies
- Collector test near-field studies
- Collector test far-field modeling
- Plume modeling
- Habitat mapping
- Collector test ESIA
- Ecosystem functioning
- Database development
- Digital twin development

> Since the late 1960s, governments and contractors like NORI have spent over 9,000 days – the equivalent of almost 25 years – at sea, researching the deep-sea environment.

Marine Genetic Resources: Contributing to Human Knowledge

We have built a library of deep-sea biological samples and preserved them for the day when the ISA establishes the final regulatory framework. Deep-sea organisms represent a wealth of genetic material from which we could source new drug and treatment ideas for humans. The U.S. Food and Drug Administration has approved thirteen deep-sea-derived drugs to date, the majority of which are used for different cancer treatments[1]. While most marine genetic research has focused on creatures that dwell in shallow and tropical ocean water, attention has increasingly shifted to the deep sea where organisms have adapted over thousands of years to survive in cold, dark, and highly pressurized environments. Ziconotide, a synthetic form of peptide extracted from the venom of predatory tropical cone snails Conus magus that live 2km deep in the sea, represents a particularly successful example. Under the brand name PrialtTM, the European Medicines Agency licensed ziconotide as a non-narcotic anti-pain drug[2].

[1] Saide et al., "A Treasure of Bioactive Compounds from the Deep Sea", 28 Oct. 2021
[2] Patrizia Russo, "Deep sea as a source of novel-anticancer drugs: update on discovery and preclinical/clinical evaluation in a systems medicine perspective", Feb. 20, 2015

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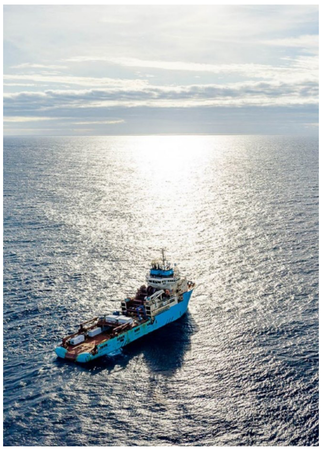
Regulations and Contracts

– 15-year contract
– Five-year work programs and review cycle
– Annual reports cycle



The ISA grants exploration contracts for a 15-year period with the option to apply for five-year extensions. However, a private contractor can only apply with sponsorship from an ISA member state. In our case, the Republic of Nauru sponsors NORI and the Kingdom of Tonga sponsors TOML. All contractors need to provide information to enable the ISA Council to determine their financial and technical capabilities to carry out proposed activities. Contractors must submit a five-year program of work and report annually to the ISA. Every five years, the contractor must then review its program and propose a subsequent five-year program to the ISA.

The regulations on prospecting and exploration set out the ISA's and contractors' duties and obligations regarding the seabed activities under contract and follow a standard formula that requires signatories to abide by the provisions in the 1982 UNCLOS and the 1994 Agreement relating to the Implementation of Part XI of the Convention. The Legal and Technical Commission (LTC) also issues and periodically updates various recommendations as a supplement to the regulations as guidance for contractors and sponsoring states.

After signing a contract with the ISA, **contractors commit to several requirements:**

– Providing an annual report to the ISA on the activities in the Area. The ISA monitors these reports through the LTC, and evaluations cover exploration work, environmental studies, work on developing mining technology, and legal and financial issues.

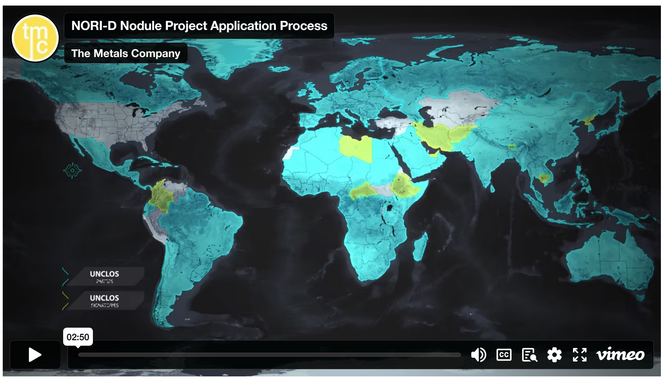
– Preventing, reducing, and controlling pollution and other hazards to the marine environment arising from exploration activities. This requirement means that contractors must not only monitor their activities but also collect baseline data to establish the local environment's natural conditions before any human intervention occurs.

– Proposing a program for training developing state nationals. The contract incorporates the agreed training program once the ISA approves it.

– Submitting a contingency plan to respond effectively to incidents arising from activities in the exploration area, prior to beginning activities under the contract.

As the Mining Code section in this report notes, the ISA developed the regulations on exploration and prospecting in 2000 and updated them in 2013, while it has been developing the regulations on exploitation since 2014. The ISA has made solid progress on these regulations thus far, and the process remains open to stakeholder consultation. While the coronavirus disease of 2019 (COVID-19) pandemic delayed efforts to complete the regulations, more certainty around when the ISA will complete this work has emerged since the Republic of Nauru submitted a two-year notice in accordance with the 1994 implementation Agreement. In 2023, the ISA expressed its intention to continue the work on the exploitation regulations with a view to adopting them during the 30th session in 2025[1].

We currently focus on applying for our first exploitation contract from the ISA on the NORI Area D with a goal to begin commercial production in 2026. To that end, we have a particular focus on completing our ESIA.



[1] ISA, "ISA Council closes Part II of its 28th session", 24 Jul. 2023

^ What We Do
Next: Our Onshore Operations >

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Our Onshore Operations

Our onshore activities include all activities related to converting nodules into products once shipped to a port from the CCZ. Our onshore activities focus on **two major workstreams:** developing our processing system and constructing/selecting sites for plants.

Processing System Development

Concept development and engineering: metallurgical concept development, mass and energy balances, equipment selection and sizing, developing capital and operating cost estimates.

- Flowsheet design with Hatch
- Near-zero waste, renewable energy

Test work and piloting: metallurgical test work and equipment pilot demonstration of the flowsheet processing steps.

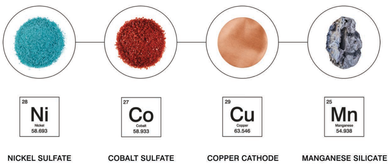
- Lab tests with Kingston Process Metallurgy (KPM)
- Pilot plant program with FLSmidth, XPS/Glencore, and SGS

Plant Site Selection and Construction

Our approach to selecting plant sites depends on the NORI Area D Project's development phase. For Project Zero, we seek to leverage existing facilities. In November 2023, we entered into a binding memorandum of understanding ("MoU") with Pacific Metals Co Ltd (PAMCO) in Japan where PAMCO will complete a feasibility study to toll treat 1.3 million tonnes per annum (Mtpa) of wet nodules at its Hachinohe smelting facility expected to start in Q1 2026. In parallel, we have begun to assess locations and partners for potentially constructing a refining facility for Project One, which involves projects such as:

- Conducting a global location study
- Creating a shortlist to determine appropriate jurisdictions
- Assessing site requirements (e.g., market proximity, port, renewables)
- Selecting partners
- Assessing constructability

TMC intends to supply high-value products (i.e., nickel sulfate, cobalt sulfate, and/or NiCuCo matte) to the rapidly growing electric vehicle battery market along with copper cathode for which demand continues to grow. We also intend to sell manganese silicate with which one can make silico-manganese alloy, a critical input for manufacturing steel.



Achieving Timeline: Focus on High-Value Intermediates

2011-2018
Hydromet flowsheet developed and lab-tested by DeepGreen

2019
20 kg
New lower-cost, lower-risk flowsheet developed (based on conventional nickel processing), modeled and lab-tested

2020-2021
70 tonnes
Pilot plant program with FLSmidth in Whitehall, PA, and XPS (Glencore) in Sudbury, Canada

2026
3.0 Mtpa (wet)
Project Zero – small-scale commercial production using existing or partner facilities

2030 onwards
11.3-54.5 Mt (wet)[1]
Tolling through existing RKEF plants and possibly constructing new refineries

1. 11.3 Mtpa (wet) for NORI-D and 54.5 Mtpa (wet) in full field development scenario for NORI+TOML.

^ What We Do Next: Processing System >

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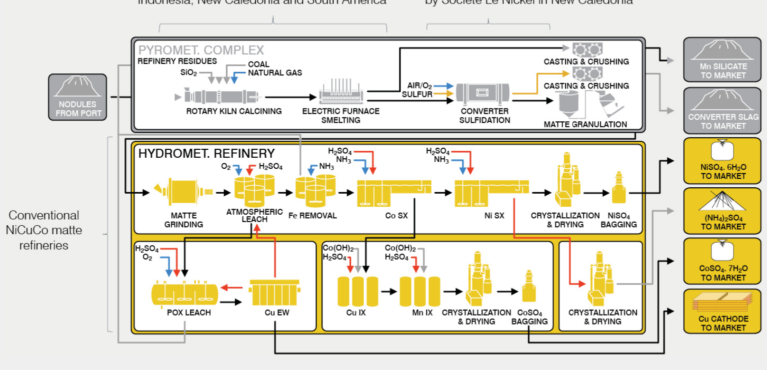
Processing System: Flowsheet Development

- Product definition
- Near-zero-waste metallurgical process flowsheet development
- Concept engineering by Hatch
- Lab test with KPM
- Pilot plant program with FLS, XPS/Glencore and SGS
- Product development test work
- Marketing strategy

To process and refine collected nodules into critical metals, we have developed a near-zero solid-waste flowsheet together with our consultants Hatch, a metallurgical process design firm, and Kingston Process Metallurgy (KPM). We selected our flowsheet because it met the project objectives for near-zero solid-waste, high-pay metal recovery, the ability to produce high-value products, and low costs compared to alternative technologies. This flowsheet uses conventional equipment with modifications to account for the polymetallic nodule resource, which means we can leverage existing rotary kiln electric furnace (RKEF) operations.

This process flowsheet generates nickel sulfate, cobalt sulfate, copper cathode, manganese silicate, and fertilizer-grade ammonium sulfate as key products. The processing flowsheet also provides the potential to generate intermediate product, a nickel-copper-cobalt alloy or nickel-copper-cobalt matte. We expect nickel to account for almost half of our future production revenue.

Low-Risk flowsheet: Using Conventional Equipment and Generating Near-Zero Solid Waste



By using a conventional flowsheet, we can streamline the development costs and timeline, and, since each technology component has substantial commercial precedence, we can be reasonably confident in our capital estimates. Based on this approach, we expect to generate cash flow with a low capital requirement—a key component in TMC's strategy.

We believe we have designed an onshore system with the lowest possible solid metals waste stream, leveraging the benefits that the nodules themselves provide (i.e., they contain useful high-grade metals with very low amounts of undesirable elements toxic to human health and/or the environment). For instance, our flowsheet design means we can recycle the relatively small stream of residue from the refinery process into the smelting process, which will increase our recoveries (i.e., how much metal we extract from nodules as a percentage of their actual metal content). Similarly, we have intentionally made decisions to ensure we produce byproducts rather than waste. An example includes the inert converter slag that we will produce, which the construction industry can use to, for example, pave local roads. Overall, we have deliberately decided to embrace strong ESG standards as we believe that the benefits outweigh the costs.

Key Process Inputs

Pyrometallurgical Plant
- Nodules
- Electricity
- Natural gas
- Coal

Hydrometallurgical Refinery
- Air
- Natural gas
- Sulfuric acid
- Ammonia
- Water

Key Process Outputs

Pyrometallurgical Plant
- Manganese Silicate
- NiCuCo alloy or NiCuCo matte
- Byproduct – converter slag/aggregate

Hydrometallurgical Refinery
- Nickel sulfate
- Cobalt sulfate
- Copper cathode
- Byproduct – ammonium sulfate

Near-Zero Solid Waste: How We Achieve It

We start with nodules that have remarkably low levels of harmful elements

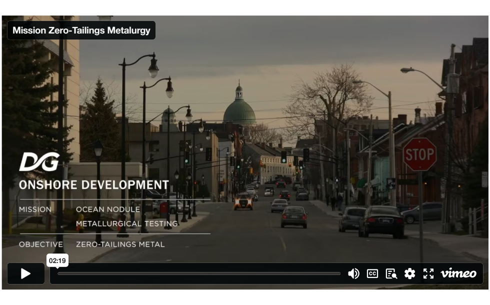
Dual pyro/hydro process allows for residues to be recycled to smelter

We select plant sites based on proximity to markets for byproducts and access to renewable energy

We select reagents that produce products instead of waste

Key Developments

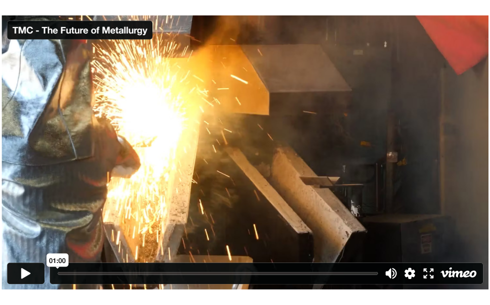
We have completed lab-scale test work and pilot-scale pyrometallurgical testing with assistance from our world-class partners Kingston Process Metallurgy (KPM), FLSmidth, SGS Canada, and Expert Processing Solutions (XPS) (a Glencore subsidiary). As we advance our onshore program, we continue to validate that we can scale the custom-designed flowsheet relatively easily while maintaining suitable recoveries of products consistent with those observed during testing.



In 2021, we completed our **pyrometallurgical pilot testing** on the polymetallic nodules with FLSmidth and XPS. The smelting, sulfidation, and converting pilot-scale campaigns successfully created two distinct products:

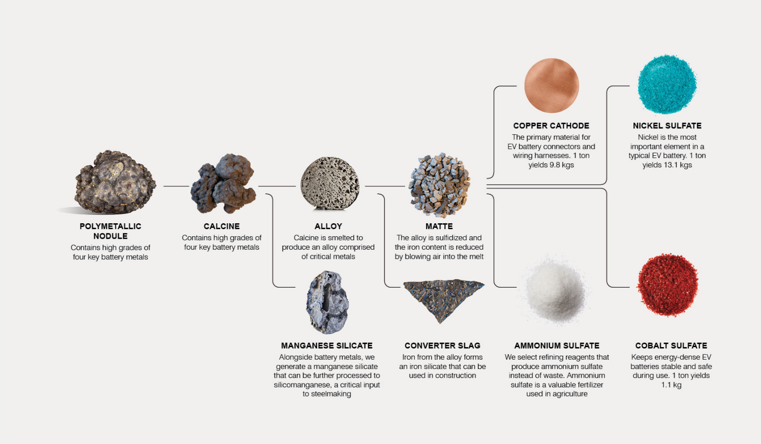
- **A nickel, copper, and cobalt (NiCuCo) matte product** via sulfidizing an intermediate NiCuCo alloy. We expect the matte product to serve as feedstock for producing critical metals that EV batteries and wiring require.
- **A manganese silicate product** that we can sell directly to market and that can undergo further processing to become a manganese alloy, a critical input for producing steel.

In 2022, one of Europe's largest independent research institutions, SINTEF, studied TMC's manganese silicate product and found that it behaves similarly to traditional manganese sources. TMC's high-grade nodule-derived manganese silicate product appears to offer significant advantages over conventional manganese ores both in cost and carbon footprint. As a pre-reduced product, TMC's manganese silicate product effectively offers downstream clients the opportunity to decrease the energy that the carbon-intensive reduction step requires for producing manganese alloy and, thus, yield significant emissions savings.

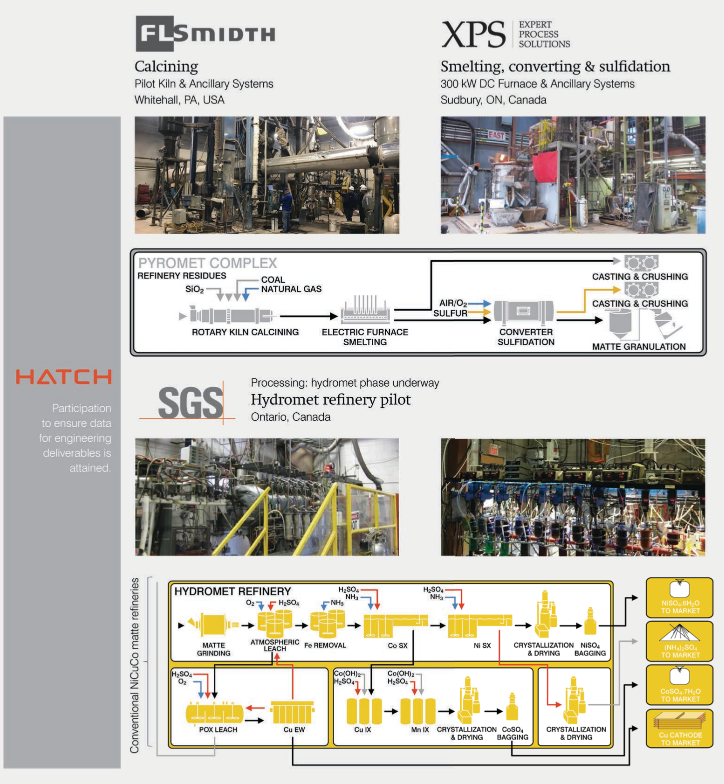


We transported the matte that XPS generated to Lakefield, Ontario, Canada, where SGS Canada Inc used it as a feed for a hydrometallurgical refinery bench-scale test work program designed to produce nickel sulfate, cobalt sulfate, copper cathode and fertilizer-grade ammonium sulfate. All tests conducted to date have yielded zero solid waste, and we anticipate that we will fully demonstrate the proposed flowsheet by end of 2Q2024.

Zero Toxic Tailing, Near-Zero-Waste Metallurgical Process that Uses Entire Nodule Mass



Flowsheet Development: Working With Best-in-Class Service Providers



For **Project Zero**, our strategy focuses on getting into a business scenario that leverages existing operations to create high-value intermediate products. This strategy will create a capital-light path to production.

In November 2022, we entered into a non-binding memorandum of understanding (MoU) with Pacific Metals Co Ltd (PAMCO) in Japan to evaluate the processing of wet nodules at PAMCO's Hachinohe smelting facility expected to start in 2026. In November 2023, following successful completion of the pre-feasibility exercise, TMC and PAMCO have entered into a binding MOU where PAMCO will complete a feasibility study to toll treat 1.3 million tonnes of wet nodules per year to produce lithium-ion battery and steel making feedstocks.

Binding MOU with PAMCO

Upon completion of the feasibility study, PAMCO and TMC will work towards finalizing definitive processing agreements in Q3 2024.

The toll treatment is expected to take place on a dedicated rotary kiln-electric arc furnace (RKEF) processing line and produce two products: NiCuCo alloy — an intermediate product used as feedstock to produce lithium-ion battery cathodes — and a manganese silicate product used to make silico-manganese alloy, a critical input into steel manufacturing. PAMCO's Hachinohe facility is located on the coast in northern Japan and is equipped with port and processing infrastructure required to receive and process polymetallic nodules and to ship products to customers. Work to date has confirmed that the plant is well-suited to process nodules with near-zero solid waste, with little modification.

Under the new binding MoU:

- PAMCO, with TMC support, expects to complete the feasibility study by Q3, 2024.
- TMC provides PAMCO with the exclusive right to the first 1.3 Mtpa of the expected 3 Mtpa of wet nodule collection capacity of the company's first nodule collection system until completion of the feasibility study.
- The parties will enter into good faith negotiations to finalize definitive processing agreements on completion of the feasibility study.

The feasibility study is expected to confirm operating parameters and product specifications for PAMCO's dedicated production line and define the scope and execution plan for any additional equipment requirements, which are currently expected to be minor. An extended pilot demonstration program utilizing existing kilns and furnaces at PAMCO's Hachinohe facility is expected to treat a 2,000 tonne sample of polymetallic nodules collected during the successful pilot nodule collector test completed by Allseas in November 2022 on the NORI-D area, with the goal of optimizing the furnace refractory selection and confirm commercial scale operating parameters such as tapping temperatures and dusting rates when treating nodules through the Hachinohe facility. The cost of processing polymetallic nodules will be estimated to inform finalization of the definitive processing agreements.

In parallel, PAMCO is continuing to study the addition of a converting facility to process the intermediate alloy to nickel-copper-cobalt matte, which is an upgraded intermediate battery supply chain feedstock. It is expected that the additional facility would be constructed once commercial processing of polymetallic nodules to alloy has been demonstrated.

^ What We Do   Next: Plant Site Selection >

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Plant Site Selection: Choosing the Right Site

Projects for selecting a site for Project One:

- Conducting a global location study
- Creating a shortlist to determine appropriate jurisdictions
- Assessing site requirements (e.g., market proximity, port, renewables)
- Selecting partners
- Assessing constructability

We need to ensure we find the right site for our plant to further mitigate ESG impacts and help diversify the battery metal supply chain. Currently, land-based mining companies primarily extract ore from remote regions, process it on site, and then transport the derived product to a port before shipping it mainly to Asia for processing and battery manufacturing. From there, the end product then proceeds across the world to battery end markets. TMC seeks to help reshore global metal supply chains and reduce our footprint by also utilizing existing infrastructure where possible. TMC intends to transport nodules to an industrial port-side area close to battery and electric vehicle manufacturing to provide a supply alternative while also significantly reducing the carbon footprint of today's complex supply chains.

TMC has a prime opportunity to strategically select where nodules are processed, not limited by proximity to mining operations, enabling inherent ESG benefits. Several third-party global site selection studies adhered to requirements including proximity to material buyers, access to existing or planned large-scale low-carbon electricity, as well as access to natural gas, adequate port capacity, and local, skilled workforce. Focused initially on a combined pyrometallurgical smelting-hydrometallurgical refining facility, the study identified 13 possible jurisdictions; six were shortlisted for further review. In 2021, third-party studies around logistics and jurisdiction-specific capital and operational costs were completed. Quebec and the U.S. Gulf Coast emerged as a front-runner in the siting of the facility[1]. Since, the buildout of primary processing infrastructure suitable for smelting nodules has continued globally — providing an opportunity to utilize existing assets, lowering TMC's direct environmental footprint and significantly lowering capital requirements. The Wilson Center published a report outlining existing suitable operations for both processing stages. The same study prioritized jurisdictions in North America for nodule refining suitability. In line with this strategy, as noted in the Onshore Operations section, TMC has partnered with Pacific Metals. Co in Japan to potentially process first commercial tonnages of nodules at their existing Hachinohe facility. With significant capacity for similar arrangements available globally, TMC has focused its site selection efforts on suitable locations for the hydrometallurgical refinery which requires less land area, port capacity, power and other consumables. A breakdown of Project One (12.5 Mtpa wet) requirements for the combined and refinery-only facilities is below.

	Combined Facility	Refinery Only	Units
Site Features			
Industrial land	350	125	acres
Port capacity (inbound / outbound)	6,400 / 3,800	150 / --	ktpa
Personnel			
Total Direct Personnel	1,170	346	
Estimated Indirect Personnel	9,000	2,600	
Annual consumables			
Low-carbon Electricity	2,660,000	270,000	MWh
Natural Gas	10,930,000	1,760,000	MMBTU
Diesel	940,000	320,000	L
Water	5,850,000	3,300,000	m3
Coal	750,000		(wet) t

Source: AMC, "Technical Report Summary, Initial Assessment of the NORI Property, Clarion-Clipperton Zone", 17 Mar. 2021

We expect our flowsheet design to eliminate waste and be energy efficient. Ultimately, however, low-carbon electricity and alternative metallurgical reductants will enable TMC to get as close to net-zero emissions as possible. Since our onshore metallurgical plant will consume more energy compared to any other aspect in our entire operations (see the TCFD &TNFD page), where we process nodules will play a key role in addressing our future carbon footprint. One alternative to metallurgical coal that we have tested at lab scale is a torrefied spruce chip reductant. We conducted the test smoothly and found no difference compared to other smelting tests. We will continue to test reductant alternatives that can help us decarbonize, and, once we have confirmed a site location, we will be able to better assess viability.

[1] Jim Magill, "Answer to metal supplies for batteries may lie on sea floor — and in Houston", 17 Apr. 2021; James Osborne, "Texas congressmen angling to have deep-sea mined minerals refined on Gulf Coast", 13 Dec. 2023.

^ What We Do Next: Scope of Our Activities >

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Scope of our Activities – Pre-Commercial

Currently, we remain in an exploration phase and do not conduct any commercial activities. Since 2012, our subsidiaries have carried out 24 offshore campaigns, which represent TMC's major resource definition and environmental research activities. In addition, we have completed pilot-scale demonstrations for the first three onshore processing steps: calcination, smelting, and sulfidation/converting. We have primarily relied on leading industry partners and contractors to conduct our activities, and we report their corresponding footprint in this section. We do so to uphold our responsibilities to account for the full stack of our impacts on planetary boundaries and social foundations, and to create a net positive impact on people and the planet.

Offshore Operations

In the table below, we list all exploration campaigns and activities that we have conducted to date. Note that we include the exploration campaigns that TOML conducted before TMC acquired it and one campaign that TMC conducted on Marawa's behalf based on an existing agreement. We also report the impacts associated with our partner Allseas' vessel provided for our exclusive use, the Hidden Gem, including pre-collector test and post-collector test operations.

Year	Area	Campaign	Scope	Length of Campaign (days)	Media
2022	NORI				
		Campaign 7c	Exploration | NORI-D collector campaign (Hidden Gem)	71	
		Campaign 7b1	Exploration | NORI-D collector monitoring campaign	43	
		Campaign 7b2	Exploration | NORI-D post-collector campaign	43	
2023	NORI	Campaign 8a	Exploration | NORI-D post-collector test ecosystem function survey	46	
		Hidden Gem 2023[8]	Vessel standby and nodules transportation	365	

Note: visit the page "Scope of our Activities – Pre-Commercial" to access the complete list.

[1] Campaign shared by NORI (Campaign 2) and TOML (CCZ13)

[2] Campaign shared by NORI (6b) and Marawa

[3] Short campaigns done by third parties traveling through the CCZ

* Note that these testing and transit activities are not technically considered a Campaign

[8] The Hidden Gem was in standby for over 10 months and was then used to ship nodules to our onshore partner PAMCO through South Korea. We report the corresponding impacts throughout 2023.

If we obtain an exploitation contract over the NORI area, we expect that Project Zero commercial production would commence after the upgrading of our partner Allseas's vessel, the Hidden Gem, into a production vessel. Collection of wet polymetallic nodules would start at a rate of 1.3 Mtpa increasing in staged increments to up to 3.0 Mtpa. For Project One, we believe that a fleet of three production vessels, each with multiple dedicated nodule collector vehicles, could be estimated to produce approximately 12.5 Mtpa of wet nodules at steady state (expected 2030-2045).

Onshore Operations

To date, our onshore operations have involved lab and pilot -scale test work which has a small environmental and social footprint. We list them below.

Year	Business Partner	Project	Scope	Media
2016	KPM	Decomposing manganese nitrate concept study	Identify solutions with a strong potential to produce manganese dioxide from manganese nitrate and compare against previously determined success criteria.	-
2019	KPM	Bench-scale pyrometallurgical test work	Perform lab-scale testing to inform a heat and mass balance model, a pilot plant program work plan, and a pre-feasibility study.	
2020	FLSmidth	Rotary kiln calcining pilot program	Process TMC's polymetallic nodules through a pilot scale rotary kiln to prove concept of first stage of TMC's proposed flowsheet, create a calcine intermediate for downstream testing, and compile data to inform pre-feasibility study. Identify potential process issues.	
	Hatch	Onshore processing scoping study	Complete scoping level trade-off studies to validate design and identify improvements for proposed TMC flowsheet.	HATCH
2021	XPS	Smelting, sulfidation, and converting pilot program	Process TMC's calcine intermediate product to create an alloy and matte intermediate products used for downstream testing and to prove concept of TMC's selected flowsheet. Gather data to inform pre-feasibility study and identify potential process issues.	
2022	SINTEF	Manganese product development	Evaluate the feasibility of TMC's manganese silicate product as manganese source for silico-manganese production.	
2023	SGS	Testing hydrometallurgical refinery flowsheet	Perform lab-scale testing on TMC's NiCuCo matte generated at XPS to inform key data for the refinery flowsheet development. Generate final products from TMC's flowsheet — battery grade sulfates, copper cathode and by-products.	
	SINTEF	Kilogram Scale Test Work	Scale up SINTEF's previous work on processing TMC's manganese silicate product into SiMn to further evaluate the feasibility of TMC's product for that purpose.	

If we obtain an exploitation contract, we expect to process nodules on a tolling basis at existing kiln-electric furnace (RKEF) plants for the first phase of commercial production ("Project Zero"), utilizing excess industry capacity. To that end, we have partnered with Pacific Metals Co Ltd (PAMCO) from Japan, whom we expect to toll treat up to 1.3 million tonnes of wet polymetallic nodules per year at its Hachinohe smelting facility starting in Q1 2026. For Project One, we expect to ramp up production in stages either at a new facility to be constructed by us or by potential processing partners, subject to available capital, or at third-party facilities pursuant to a toll treatment model. In the "Plant Site Selection" page, we discuss how the opportunity to select where nodules will be processed offers inherent environmental and social benefits (e.g., sourcing of low carbon energy and feedstock, proximity to market and skilled workforce).

A key driver for why we explore polymetallic nodules is the significant potential that they provide to supply nickel, cobalt, copper, and manganese with a lower environmental and social footprint as compared to land-based mining. To that end, we commit to make science-based decisions and choose paths that will result in a lower environmental and social impact. For example, we research solutions to systematically decarbonize our future operations and we have developed a metallurgical process flowsheet that results in near-zero processing waste. To inform our decisions, we have commissioned several assessments to quantitatively understand the lifecycle impacts associated with TMC's future operations and how they compare to key land-based routes for producing the same metals. These studies show how polymetallic nodules offer a promising pathway to supply critical metals with the least negative impact on people and the planet and they help us identify impact hotspots of our future operations. We invite you to visit the "Comparative Life Cycle Studies" page of the report for more information.

Environmental Footprint

- Energy and Emissions
- Water
- Waste

Social Footprint

- Our People
- Health and Safety
- Sponsoring States

^ What We Do Next: Energy and Emissions >

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Energy and Emissions

To date, our greenhouse gas (GHG) emissions mostly came from marine gas oil used by third-party vessels that supported our offshore campaigns. We report these emissions under our scope 1 emissions using the GHG Protocol's operational control approach. Taking ownership for these emissions is consistent with our sustainability approach and responsibilities to account for the full stack of our impacts. We estimate and report air travel emissions from offshore campaigns participants, whether TMC employees or contractors, as scope 3 emissions. Given our small workforce who mostly work remotely (we employed 46 employees and consultants as of 31 December 2023) and limited activities carried out currently by the company, we estimate other emissions to lack materiality at this stage of our development.

In this report, we share the emissions from all the offshore campaigns we have done since starting in 2012. We decided to collect and report our historical carbon footprint data as we plan to offset these emissions. TMC continues to research and evaluate potential carbon offset initiatives as we advance towards commercial operations.

Our activities have generated relatively few emissions to date. Given that our future commercial operations will have a larger footprint, we are working to identify decarbonization paths that align with the Paris Agreement. To calculate our emissions, we have used emission factors from the United Kingdom's Department for Environment, Food, and Rural Affairs (DEFRA) as they provide the most conservative footprint for marine gas oil. In the table below, we summarize our estimated onshore and offshore emissions.

TMC	2020	2021	2022	2023
TOTAL ENERGY CONSUMPTION (GJ)	**138,845**	**157,123**	**425,991**	**242,877**
Fuels (GJ)	138,845	157,033	425,991	242,877
Coal	188.5	0.0	0.0	0.0
Marine Gas Oil	138,586	157,033	425,991	242,877
Natural Gas	70.2	0.0	0.0	0.0
Electricity (GJ)	0.0	90.0	0.4	0.1
TOTAL GHG EMISSIONS (tCO2e)	**10,909**	**12,378**	**34,823**	**18,964**
Operational Emissions (tCO2e)	**10,548**	**11,925**	**32,347**	**18,416**
Scope 1 Emissions (tCO2e)	10,548	11,924	32,347	18,416
Scope 2 Emissions (tCO2e)[1]	0.0	0.4	0.0	0.0
Value Chain Emissions (tCO2e)	**361**	**453**	**2,476**	**548**
Scope 3 Emissions - Upstream (tCO2te)	361	453	2,476	548
Business Travel (tCO2e)	361	453	2,476	548
AIR POLLUTION (METRIC TONS)				
CO (t)	-	-	-	10.2
NOx[2] (t)	-	-	140.2	54.7
SOx[3] (t)	-	-	27.3	10.4
Volatile Organic Compounds (VOCs) (t)	-	-	15.8	-

[1] Scope 2 emissions are calculated using the location-based method

[2] Includes NO and NO_2, but excludes N_2O

[3] Includes SO_2 and SO_4

[4] Metric applicable only for onshore operations

Offshore

Vessels and all supporting offshore operations use marine gas oil, which currently constitutes our main emissions source. We have decided to include emissions from the three campaigns that TOML conducted before TMC acquired it in 2020. Note that NORI and TOML jointly conducted Campaign 2 in 2013 and TMC conducted shared Campaign 6b for NORI and on Marawa's behalf in 2019. Also, in two instances, TMC has taken advantage of other vessels already traveling through the Clarion-Clipperton Zone (CCZ) and contracted them for several days: once in 2020 to conduct a photographic survey and once in 2017 to deploy moorings. We base emissions for these two instances and for Campaign 1 on fuel-usage estimates.

Offshore	Campaign Name	Vessels		Air Travel		Total Offshore	
		Marine Gas Oil Consumption (tonnes)	GHG Emissions (tCO_2e)	Air Distance Traveled (km)	GHG Emissions (tCO_2e)	Energy Consumption[4] (GJ)	GHG Emissions (tCO_2e)
2021	Campaign 4a	365	1,251	407,448.0	57	16,478	1,308
	Campaign 5b	1,040	3,380	642,918.0	90	44,512	3,470
	Campaign 5c	788	2,561	587,778.0	83	33,726	2,644
	Campaign 5d	616	2,002	813,308.0	114	26,365	2,116
	Campaign 5e	840	2,730	776,614.0	109	35,952	2,839
2022	Pre-Collection Test	6,148	19,981	9,711,000.0	1,587	263,138	21,568
	Campaign 7a1	558	1,814	797,019.0	189	23,894	2,003
	Campaign 7a2	360	1,170	265,097.0	63	15,411	1,233
	Campaign 7c*	2,156	7,006	2,705,354.0	460	92,264	7,466
	Campaign 7b1	367	1,193	213,040.0	50	15,717	1,244
	Campaign 7b2	364	1,182	537,192.0	127	15,566	1,309
2023	Campaign 8a	331	1,077	827,096.0	161	14,184	1,236
	Hidden Gem 2023	5,343	17,366	2,362,000.0	387	228,693	17,727
	Total	26,758	86,962	29,247,930	4,545	1,145,231	91,480

[1] Limited records exist for Campaign 1, fuel usage and air distance traveled are estimates based on Campaign 2

[2] Short campaigns done by third party traveling through the CCZ

[3] Estimated based on marine gas oil consumption

[4] In November, a supply vessel from Allseas that was conducting activities in the region made a detour to deliver equipment to the Hidden Gem.

We conservatively calculated the associated fuel consumption and GHG emissions from these activities and added them to Campaign 7c.

We had more intensive energy consumption and a larger carbon footprint in 2022 than in other years. This is because the activities that we completed throughout the year involved over 250 people and two vessels, amounted to 426 operating days, and involved a travel distance that reached almost 31,000 nautical miles—considerably more than any other year. The Hidden Gem, a 228m former drillship that Allseas converted into a polymetallic nodule-collection vessel, concluded the first integrated system test in the CCZ since the 1970s (Campaign 7c), while a 103m survey vessel performed the four accompanying environmental studies. We also report the footprint of pre-collection test activities (including conversion works for the Hidden Gem, the collector vehicle deep-water test in the Atlantic Ocean, and the Hidden Gem's transit from Europe to the Campaign 7c departure point). In 2023, we returned to the site and completed a research campaign evaluating seafloor ecosystem function one year after the nodule collection test.

Onshore

We have few onshore-related emissions as our pilot testing used a small-scale kiln and furnace. Onshore pilot test work started in 2020.

Onshore	Coal		Natural Gas		Electricity		Total Onshore	
	Consumption (tonnes)	GHG Emissions (tCO_2e)	Consumption (GJ)	GHG Emissions (tCO_2e)	Consumption (MWh)	GHG Emissions (tCO_2e)	Consumption (GJ)	Emissions (tCO_2e)
2020	6.5	20.5	70.2	3.7	0	0.0	256.4	24.2
2021	0.0	0.0	0.0	0.0	25,000	0.4	90.0	0.4
2022	0.0	0.0	0.0	0.0	100	0.0	0.4	0.0
2023	0.0	0.0	0.0	0.0	20	0.0	0.1	0.0
Total	**6.5**	**20.5**	**70.2**	**3.7**	**25,120**	**0.4**	**348.8**	**24.6**

^ What We Do Next: Water >

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Water

Collecting polymetallic nodules from the ocean's deep seafloor has negligible impact on freshwater availability and quality as it does not take place in water stressed regions and uses seawater to help transport nodules to surface. To date, our water use has mainly come from facilities on vessels. These vessels produce most water that they use on board via desalination, though they sometimes do load a small amount when at harbor for longer periods as their freshwater generators do not run at harbor (representing 17% of all water used in 2022, and 0% in 2023).

Most of this water is consumed on the vessel, but some of it is also discharged at sea in compliance with applicable regulations (e.g., treated grey, black, and vessel-operations water). When collecting samples offshore, vessels collect water in small amounts before returning it to the ocean. During the collection test we conducted in 2022, we airlifted nodules with seawater through a riser pipe from the collector vehicle on the seabed to the production vessel on the surface. After dewatering the nodules, we returned residual water with sediment and nodules fines in small amounts to the ocean through a pipe approximately 1.2km deep in the water column. We do not report that data below but will disclose it in the environmental impact assessment (EIA) as part of NORI's application for an exploitation contract that we expect to submit to the International Seabed Authority (ISA) in the second half of 2024.

Our future onshore operations will involve pyrometallurgical processing of polymetallic nodules to produce intermediate metal products, which typically require significant volumes of water for cooling, dust suppression and other industrial uses. They will potentially involve hydrometallurgical refining facilities, which also use significant volumes of water. Yet, in a third-party verified LCA published in 2023, Benchmark concluded that producing nickel-copper-cobalt matte from nodules would have a considerably lower impact on water consumption, freshwater eutrophication and marine eutrophication than all key land-based production routes analyzed for the same metals.

To date, our onshore activities have had a negligible impact on water, as we have focused on pilot-scale demonstrations for the first three metallurgical processing steps: calcination, smelting, and sulfidation/converting. As we approach commercial operations in 2026, we value our partner PAMCO's efforts to reduce water withdrawals through their recycling program, ensure treated discharges meet safe water quality standards, and manage other water-related risks like those from natural disasters (floods due to typhoons, storms, or tsunamis) and accidents (e.g., leaks of water and chemical substances). At TMC, we are committed to responsible water management. We continue to optimize our process flow and aim to use closed loop water systems to minimize freshwater intake.

[1] PAMCO, "Integrated Report 2023", Nov. 2023

Category	2020 (m^3)	2021 (m^3)	2022 (m^3)	2023 (m^3)
Total Water Withdrawals	2,417	3,056	12,780	5,845
Freshwater Withdrawals	1,140	1,172	2,196	0
Other Water Withdrawals[1]	1,277	1,884	10,584	5,845
Total Water Discharges	49	492	8,071	5,296
Total Water Consumed	2,368	2,564	4,709	549

[1] Refers to freshwater produced on vessels via desalination of seawater.

Offshore

Year	Campaign Name	Freshwater Withdrawals (Bunkered at Port) (m^3)	Other Water Withdrawals (Freshwater Produced on Vessel by Desalination of Seawater) (m^3)	Water Discharges[1] (m^3)
2012	Campaign 1	LR	LR	LR
2013	Campaign 2 and CCZ13	LR	LR	LR
2015	CCZ15	LR	LR	LR
2017	CCZ17	NA	NA	NA
2018	Campaign 3	498	336	18
2019	Campaign 4a	109	99	0
	Campaign 6a	533	465	22
	Campaign 6b and Marawa	312	315	4
2020	Campaign 4b	172	233	13
	Campaign 4c	296	336	6
	Campaign 4d	110	102	8
	Campaign 5a	558	606	18
	OI	NA	NA	NA
2021	Campaign 4e	149	126	14
	Campaign 5b	396	449	7
	Campaign 5c	150	370	237
	Campaign 5d	475	457	24
	Campaign 5e	0	482	210
2022	Pre-Collection Test	1,389	5,174	5,009
	Campaign 7a1	0	525	34
	Campaign 7a2	0	598	39
	Campaign 7c	806	3,003	2,906
	Campaign 7b1	0	642	42
	Campaign 7b2	0	642	42
2023	Campaign 8a	0	653	620
	Hidden Gem 2023	0	5,192	4,676
Total		5,957	20,805	13,950

[1] Refers to treated grey, black and vessels-operations water

NA: Not applicable. Vessel was already fully staffed traveling through the CCZ

LR: Limited records

Note: we updated our methodology to estimate water discharges for the Hidden Gem and revised 2022 figures accordingly

Onshore

Onshore	2020 (m^3)	2021 (m^3)	2022 (m^3)	2023 (m^3)
Water Withdrawn[1]	2	0	1	1
Water Discharged[2]	2	0	1	1

[1] Freshwater supplied through third parties.

[2] Treated and discharged through third parties in compliance with applicable regulations.

^ What We Do Next: Waste >

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Waste

To date, the waste we have generated largely comes from crew activities on our vessels during offshore campaigns. In compliance with applicable regulations, vessels incinerate some of this waste via their certified incinerators, while they sent the remaining waste back to shore for an approved disposal processing company to treat it.

We achieved a critical objective for our future metallurgical processes in developing a near-zero solid-waste flowsheet through which we transform nodules in their entirety into usable materials. Nodules have useful high-grade metals with very low amounts of elements toxic to human health or the environment, so we can produce a byproduct aggregate rather than tailings. Additionally, with the designed pyrometallurgical-refinery combination, we could recycle the relatively small stream of residue from the refinery process to the smelter, which would increase our recoveries (i.e., how much metal we extract from nodules as a percentage of their actual metal content). We selected our reagent based on our requirement to produce byproducts rather than waste as the environmental benefits outweigh the costs. Our onshore activities have generated minimal waste thus far.

TMC	2020 (tonnes)	2021 (tonnes)	2022 (tonnes)	2023 (tonnes)
TOTAL WASTE GENERATED	**82**	**105**	**184**	**52**
Non-Hazardous Waste	80	103	162	40
Food Waste Discharged at Sea	0 %	0 %	1 %	0 %
Disposed of Through Third-Party[1]	100 %	100 %	85 %	100 %
Incinerated Onsite[2]	0 %	0 %	14 %	0 %
Hazardous Waste	2	2	23	12
Disposed of Through Third-Party[3]	100 %	100 %	95 %	100 %
Incinerated Onsite[4]	0 %	0 %	5 %	0 %

[1] Mostly includes paper, glass, metals and other types of residual waste

[2] Mostly includes food waste, packaging, and other types of residual waste incinerated on vessels.

[3] Includes waste types such as e-waste, incinerator ashes, batteries, plastic, etc.

[4] Includes operational waste (e.g. oily rags and filters) incinerated on vessel in compliance with MARPOL regulations

Waste Generated Offshore

Year	Campaign Name	Non-Hazardous Waste[2] (tonnes)	Hazardous Waste[1] (tonnes)
2012	Campaign 1	LR	LR
2013	Campaign 2 and CCZ13	LR	LR
2015	CCZ15	LR	LR
2017	CCZ17	NA	NA
2018	Campaign 3	15.0	0.4
2019	Campaign 4a	7.0	0.4
	Campaign 6a	19.0	0.4
	Campaign 6b and Marawa	13.0	0.4
2020	Campaign 4b	25.0	0.4
	Campaign 4c	19.0	0.4
	Campaign 4d	13.0	0.4
	Campaign 5a	20.0	0.4
	OI	NA	NA
2021	Campaign 4e	18.0	0.4
	Campaign 5b	22.0	0.4
	Campaign 5c	18.0	0.4
	Campaign 5d	25.0	0.4
	Campaign 5e	20.0	0.4
2022	Pre-Collection Test	79.9	13.2
	Campaign 7a1	14.2	1.6
	Campaign 7a2	6.9	0.9
	Campaign 7c	46.4	4.7
	Campaign 7b1	6.6	1.1
	Campaign 7b2	7.8	1.2
2023	Campaign 8a	6.4	0.7
	Hidden Gem 2023	33.8	11.3
Total		**436**	**40**

NA: Not applicable. Vessel was already fully staffed traveling through the CCZ

LR: Limited records

1. Hazardous waste mostly includes cooking oil, incinerator ashes, e-waste, and operational waste such as rags, filters, and paint waste. For campaigns completed before 2022, our vessel contractor provided a conservative estimate of a consistent 0.4 tonnes per campaign.

2. Total mass of waste produced before incineration or offload in port

Waste Generated Onshore

Waste Type	2020	2021	2022	2023
Non-Hazardous Waste (tonnes)	3	0	0	0
Hazardous Waste (tonnes)	0	0	0	0

^ What We Do Next: Our People >

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Our People

TMC has purpose-driven team members who, together, focus on creating a hard-working, impact-driven culture with high tolerance for change, uncertainty, and adversity.

As of 31 December 2023, we employed 46 employees and consultants (18% more than in 2022). Collective bargaining agreements do not cover any TMC staff member. Geographically, our staff resides in Tonga, Nauru, the United States, Canada, Australia, the United Kingdom, and the United Arab Emirates. In addition, we work with over 300 partners and contractors. TMC's leadership team and, indeed, all our employees and consultants bring relevant professional backgrounds and diverse perspectives to the company.

Our Team

Experienced leadership team

46 people
Working for
The Metals Company

>300 business partners
Working on the project

Gerard Barron
Chairman & Chief Executive Officier

Craig Shesky
Chief Financial Officer

Anthony O'Sullivan
Chief Development Officer

Ryan Coombes
General Counsel & Corporate Secretary

Erika Ilves
Chief Strategy Officer

Corey McLachlan
Head of Sponsoring State and ISA Relations

Erica Ocampo
Chief Sustainability Officer

Andy Jones
Chief Technology Officer

Claude Plourde
Chief Accounting Officer

Dr Greg Stone
Chief Ocean Scientist

Grant Lindner
NORI Project Director

Dr Mike Clarke
Environmental Program Manager

Dr Jeffrey Donald
Head of Onshore Development

Jon Machin
Head of Offshore Engineering

Dan Porras
Head of Communications and Brand

Executive Management by Gender[1]	Gender Breakdown	
	Male	Female
Number	5	2
Percentage	71 %	29 %

1. As of December 31, 2023. Executive Management is defined as the CEO plus officers.

Scope: TMC plus its wholly owned subsidiaries NORI and TOML

Diversity Metrics[1]	2016	2017	2018	2019	2020	2021	2022	2023
Total Employees & Consultants	9	14	16	18	20	32	39	46
New Hires & Turnover								
New hires	-	-	-	-	-	-	11	9
Turnover	-	-	-	-	-	-	5 %	4 %
Gender Breakdown								
Men	67 %	71 %	81 %	89 %	90 %	69 %	77 %	74 %
Women	33 %	29 %	19 %	11 %	10 %	31 %	23 %	26 %
Generation Breakdown								
1997 – 2012 | Gen Z	-	-	-	-	-	-	2 %	2 %
1981 – 1996 | Millennials	-	-	-	-	-	-	41 %	50 %
1965 – 1980 | Gen X	-	-	-	-	-	-	49 %	42 %
1946 – 1964 | Boomers	-	-	-	-	-	-	7 %	6 %
Education Breakdown								
People with Master's Degree and Above	33 %	29 %	38 %	50 %	60 %	56 %	61 %	56 %
Location Breakdown								
North America	-	-	-	-	-	-	44 %	38 %
Asia	-	-	-	-	-	-	7 %	6 %
Europe	-	-	-	-	-	-	12 %	13 %
Oceania	-	-	-	-	-	-	37 %	44 %
Ethnic Background								
Ethnic Diversity[2]	11 %	7 %	0 %	10 %	25 %	32 %	29 %	29 %

Scope: TMC plus its wholly owned subsidiaries NORI and TOML.

[1] As of December 31, 2023

[2] Refers to people self identifying as being part of an ethnic diversity group (i.e. people connected with or relating to different cultural background or place of origin). For us, includes Middle Eastern, Pacific Islander, Hispanic and Asian.

Diversity and Inclusion

We are committed to attracting, developing, and retaining diverse talent with different backgrounds in terms of age, gender, gender identity, race, sexual orientation, physical capability, ethnicity, beliefs, and perspective. We seek to develop cultural competency by seeking knowledge, increasing awareness, modeling respect, and promoting inclusion. Our team comprises highly skilled individuals among whom 56% hold post-graduate degrees. Moreover, our team comprises 26% women and almost one third of individuals from ethnically diverse backgrounds.

We also aim to contribute to diversity and inclusion through the work we do with our partners and regulators. For example, we seek to build capacity in our sponsoring states and the Pacific region by engaging young professionals and by funding science scholarships that create opportunities for students to develop skills that benefit society. For the second consecutive year, all recipients of our discretionary scholarships and grants program were nationals from developing nations, and in 2023, we achieved gender parity among beneficiaries. Empowering women continues to be a key focus of the community assistance initiatives we support in our sponsoring states. In addition, we requested that females comprise at least half of all trainees that the International Seabed Authority (ISA) provides as part of our contract requirements. The offshore industry today is predominantly male, and we strive to not only foster women to participate in the industry but also provide them with a work environment offshore that makes them feel safe and welcomed. TMC has also partnered with the ISA to support its Promoting Women Empowerment and Leadership in Marine Scientific Research initiative. We share the ISA's vision for women from developing states to play a central role in marine scientific research and for these states to have stronger scientific and technological capabilities.

People Engagement

As a company working to pioneer a new industry and new ways to do things, our success depends on attracting and retaining strong, independent, entrepreneurial and multi-talented team members. Since our team is distributed across several continents and time zones, most staff members work remotely as the norm. Despite physical and temporal separation, we maintain strong cohesion by attracting people with an intrinsic motivation to fulfill our mission. We cultivate a flat organizational structure and a culture built on mutual respect and care for one another. We rely on regular management and company meetings, ongoing communication flows across different technology platforms, frequent ad hoc video communication, and opportunities for in-person gatherings. We offer our people flexible work schedules and autonomy in managing their time while encouraging them to set boundaries between their work and their home lives.

Compensation and Benefits

We strive to compensate our staff competitively. In addition to salaries, our compensation and benefits program includes annual discretionary bonuses, equity awards, an employee stock purchase plan, a 401(k) contribution/superannuation or RRSP benefit contribution (as applicable jurisdictionally), healthcare and insurance benefits, health savings, and flexible spending accounts. Our annual equity compensation focuses on company priorities that we believe create long-term value for our stakeholders.

^ What We Do Next: Health and Safety >

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Environment, Health and Safety (EHS)

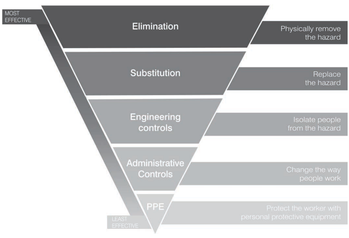
Our EHS culture is built on a zero harm philosophy, meaning we strive to achieve zero incidents and zero injuries. Our safety commitment is simple: everyone returns home safely. We leverage technology and the expertise and capability of our partners, who share our commitment to ensuring the safety and wellbeing of everyone who works for and with us.

The nodule collection and transshipment stages of our operations present inherent advantages to conventional land-based mining operations (which have one of the highest injury and fatality rates of any industry[1]), because the different nature and technologies involved effectively eliminate or mitigate people's exposure to potential hazards. For instance, we use autonomous robots to collect nodules and we bring mining equipment to the surface for all maintenance activities, which eliminates people's exposure to underwater occupational risks. And, since we produce no tailings with polymetallic nodules as we can turn their full mass into usable products with our near-zero processing waste metallurgical flowsheet, we eliminate the risks associated with tailings storage dams, which include the potential for fatalities and environmental catastrophes[2].

[1] US Bureau of Labor Statistics, "National Census of Fatal Occupational Injuries in 2022", 19 Dec. 2023

[2] Warren Cornwall, "A Dam Big Problem", Aug. 2020

In addition to leveraging technology that eliminate or mitigate people's exposure to safety risks, we also work hand in hand with our partners to implement EHS systems that incorporate thorough training, planning, risk assessment, and disciplined control implementation. On average, Allseas, our offshore nodule collection partner, provides 27.5 hours of EHS training for every 1,000 man-hours worked. Toolbox talks and drills form part of Allseas regular EHS routines to reinforce awareness of EHS risks management in the workplace. We also have put in place culturally based safety observation systems such as safe act observations and obligation to stop work if it becomes unsafe for workers to proceed. Allseas' vessel, the Hidden Gem, has third-party certified environmental and health and safety management systems meeting the requirements of International Organization for Standardization (ISO) Standards (14,001 and 45,001, respectively). For our future onshore metallurgical operations, our partner PAMCO's Hachinohe smelting facility also has third-party certified environmental, health and safety, and quality management systems aligned to ISO 14,001, ISO 45,001, and ISO 9,000. With our partners, we actively seek to use the control hierarchy to manage EHS risk for our people and the environment.



We routinely collect safety data from organizations that do work for us. As the table below shows, we have noted no lost-time injury in any offshore exploration campaigns or onshore projects that we have conducted to date. We investigate all incidents and treat them as valuable lessons that we incorporate into future practices. In the table below, we summarize how many work hours TMC personnel (which includes our subsidiaries) and our contractors have performed and provide lagging and behavioral statistics, which relate to contractors and participants in our offshore campaigns.

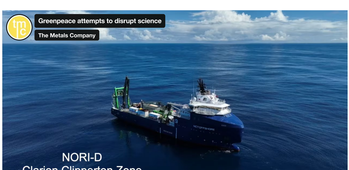
TMC Safety Statistics	2018	2019	2020	2021	2022	2023
TMC Personnel Hours *	27,181	30,561	36,580	50,804	75,152	83,248
Contractor Hours **	26,317	45,814	96,160	663,724	743,294	249,683
Lagging Statistics ***						
Fatalities	0	0	0	0	0	0
Lost-Time Incidents	0	0	0	0	0	0
Medical Treatment Cases	0	0	0	2	2	0
First-Aid Cases	1	1	3	2	4	1
Environmental Incidents	0	0	0	2	1	0
Security Incidents	1	0	0	1	0	1
Lost Time Injury Frequency Rate (LTIFR)	0	0	0	0	0	0
Near Misses	-	-	-	-	-	0
Behavioral Statistics ***						
Hazard Identification and Risk Assessments (HIRAs) Completed	1	3	10	17	753	88
Drills	6	9	8	13	154	144
Inductions	50	73	80	152	215	30
Safety Observations	633	3,136	5,801	16,047	753	121
Stop Work Authority Used	19	0	18	40	1	0
Job Safety Analysis	275	25	22	44	6,635	4

* Includes worked hours by personnel working for DeepGreen Metals, which later became TMC and its subsidiaries NORI and TOML after acquisition in 2020

** Includes the hours worked by our partners and contractors for both onshore and offshore operations

*** All trailing and behavioral statistics relate to partners and contractors

To date, the few incidents that have occurred have been minor first-aid cases. During the 2023 reporting period, one first-aid injury and one security incident took place. In November 2023, Greenpeace actively disrupted the scientific operations NORI was conducting in the CCZ on campaign 8a with the explicit aim of stopping the science by, in their own words, "disrupting [our] attempt at collecting data". Activists illegally boarded our contractor's research vessel, NV Coco, in a manner that put our crew and theirs at serious risk. Greenpeace's unsafe and unlawful activities have also hindered independent scientists in conducting legally-mandated environmental impact assessments requested by the International Seabed Authority (ISA) to assess ecosystem function one year after NORI's pilot nodule collection system test.



^ What We Do Next: Sponsoring States >

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Sponsoring States

To create shared value with developing countries through our business and, in particular with our sponsoring states, we take measures to embrace the intent set out in the United Nations Convention on the Law of the Sea (UNCLOS) — see the page International Treaty for the High Seas for more information. This industry has the potential to provide a large positive impact for our sponsoring states.

> Although we have not yet begun commercial operations, we have started building the foundation for our positive impact.

Currently, to create shared value, we focus on three areas:

- Training Opportunities
- Scholarships
- Community Programs

Training Opportunities

TMC and its subsidiaries have supported training opportunities since 2011, which includes at-sea training, attendance at workshops and conferences and scholarships. Through the International Seabed Authority (ISA)'s Contractor Training Program (CTP), we have a legal obligation to deliver and fund training opportunities through our subsidiaries for ISA personnel and developing state nationals. The legal basis for such training stems from provisions of UNCLOS and the 1994 Agreement. Its purpose is to ensure that personnel from developing states are provided with appropriate operational expertise to enable them to participate in deep seabed mining. Additionally, we also offer traineships to nationals from our sponsoring states on a voluntary basis. We see significant value in these opportunities, which develop highly skilled professionals who will advance our deep-sea knowledge. As TMC grows and expands, so too will our continued support for training and capacity building.

Offshore Traineeships

In 2023, we created opportunities for three offshore trainees, who took part in our post-collector test research campaign 8b to evaluate seafloor ecosystem function one year after the nodule collection test. In addition to our capabilities to complete safety prerequisites in 2023 before going offshore, candidates also gained direct exposure, experience, and training from world-class engineers and scientists working on the campaigns. Trainees came from various countries such as Nigeria, Tonga and Nauru. Their traineeships started in December 2023 and ended in March 2024, hence we will report their achievements in our Impact Report 2024.

In 2023, we witnessed the value of the traineeship opportunities we support. Building on our commitment to capacity building in the deep-sea mining industry and empowering women in marine science research, we selected former ISA trainee Ms. Paola Andrea Quintero from Colombia to join campaign 8a as a scientist. Ms. Folauhola Lata'ifa, who previously took part in a 2022 NOR campaign as an observer for the Tongan government, also joined campaign 8a as a scientist. Paola and Folauhola supported the team in gathering further environmental data on ecosystem functioning one year after the nodule collection test.

Paola Andrea Quintero, Geologist

Ms. Paola Andrea Quintero, a geologist from Colombia, joined the environmental monitoring vessel during the collection-system trials in 2022 to support the work of environmental science teams to quantify the geological, chemical, biological, and oceanographic conditions in NORI-D. In 2023, we hired her on campaign 8a to return to the site.

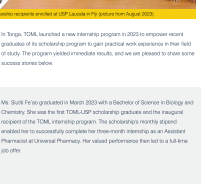
"Being a woman and having been born in Latin America are conditions that hinder professional and personal development in science; however, society has advanced in gender equality and my family has always supported me to get ahead despite the adversity. For myself, for my family and for a better society, I want to take the most of this opportunity and show that you can do it too!"

Folauhola Lata'ifa, Geologist

Ms. Folauhola Lata'ifa, an Assistant Geologist at the Tongan Ministry of Lands, Survey and Natural Resources, took part to campaign 7b during the collection-system trials in 2022. After she performed above and beyond during her first experience offshore, we hired Ms Fifo'ou to have her on campaign 8a to endorse additional responsibilities as a scient

Online Training Opportunities

Marawa commenced implementing its agreement with the ISA Secretariat to support students from developing states enrolling in this ISA's new online short-term training program "Deep Dive". Marawa sponsored the submission and fees for three students selected by the ISA's Legal and Technical Commission, who successfully completed their traineeships in 2023.



Scholarships

At TMC, we prioritize support for educational opportunities and recognize that scholarships play an important role in building capacity in developing nations. We continue to provide technical training and secondary school, undergraduate, and graduate scholarships, to foster science, technology, engineering, and mathematics (STEM) education, and to promote women's participation in these opportunities.

In 2021, we partnered with the local University of the South Pacific (USP) campus through a pre-university level scholarship agreement which we call "academic upgrading". The program equips students with the necessary skills through an eight-unit foundation course, enabling them to successfully progress to bachelor's degrees at USP or other universities worldwide. We committed to support 20 science-related scholarships at pre-degree levels in 2022 and 2023, and in 2023 we awarded these scholarships to 10 Nauruan students. In 2023, we also supported 13 new undergraduate students from Nauru, Tonga, Kiribati, Samoa, Solomon Islands, and Nigeria to pursue their bachelor's degrees through our comprehensive multiyear scholarship program — bringing the total number of active program beneficiaries to 32. The scholarships cover tuition, accommodation, and return airfare, university fees, books, a new laptop, and a living allowance for their three- or four-year programs.

NORI, TOML, and Marawa scholarship recipients enrolled at USP Laucala in Fiji (picture from August 2023).

In Tonga, TOML launched a new internship program in 2023 to empower recent graduates of its scholarship program to gain practical work experience in their field of study. The program yielded immediate results, and we are pleased to share some success stories below.

Ms. Sulili Fa'oso with co-workers at Universal Pharmacy

Ms. Sulili Fa'oso completed in March 2023 with a Bachelor of Science in Biology and Chemistry. She was the first TOML-USP scholarship graduate and the inaugural recipient of the TOML internship program. The scholarship's monthly stipend enabled her to successfully complete her three-month internship as an Assistant Pharmacist at Universal Pharmacy. Her valued performance then led to a full-time job offer.

Ms. Sulili Fa'oso with co-workers at Universal Pharmacy

In 2023, Ms. Melei Maloto completed her Bachelor's Degree in Marine Science from USP with impressive grades. She was subsequently selected by TOML for a three-months internship she will undertake in 2024 as an Assistant Geologist at Tonga's Ministry of Lands, Survey, Planning and Natural Resources.

Additionally, in Tonga, we developed a program that started in 2021 to support secondary school scholarships to cover tuition costs, exam fees, school materials and uniforms. The program began supporting nine students in 2022, and in 2023 we awarded seven new scholarships, exceeding our goal of supporting 15 active students annually.

Scholarship recipients with their parents, TOML country manager and guest of honour at the 2023 scholarship award ceremony

TMC-and Subsidiaries	2020	2021	2022	2023
Total Number of Trainings and Scholarships Implemented	22	17	29	37
Vocational Trainings	16	8	4	7
Internships	0	0	0	1
At-sea Trainings	11	8	4	3
Workshops / Courses	3	0	0	3
Sponsoring States Capacity Building[1]	0	0	21	0
Scholarships	6	9	18	30
Secondary School / Academic Upgrading	0	4	9	17
Trades	6	4	0	0
Bachelor Degree	0	1	9	13
Postgraduate Degree	0	0	1	0
Breakdown by Educational Field				
Engineering	0 %	0 %	6 %	5 %
Environmental Studies	72 %	47 %	31 %	18 %
Geology	0 %	0 %	4 %	8 %
Marine Studies	0 %	0 %	29 %	14 %
Science	0 %	29 %	17 %	38 %
Trades	27 %	24 %	0 %	8 %
Mentorships/Mary*	0 %	0 %	21 %	27 %
Breakdown of Beneficiaries by Gender and Origin				
Male	56 %	35 %	42 %	48 %
Female	56 %	65 %	58 %	51 %
From Developed Countries	31 %	6 %	0 %	0 %
From Developing Countries	58 %	94 %	100 %	100 %

[1] Encompasses all trainings offered to sponsoring states representatives

* Refers to pre-university level programs

Community Programs

We have formulated a grant program in Nauru and Tonga for community-led initiatives focused on six themes: 1) ocean health and the environment, 2) women empowerment, 3) youth and healthy living, 4) sanitation and water, 5) education, and 6) agriculture and food security. In Tonga, we also created a special priority area to support disaster-relief projects following the devastating earthquake and tsunami that occurred on 15 January 2022. The table below summarizes the projects we supported over the last 2 years.

Community Programs	2022	2023
Total Number of Grants Awarded	40	42
NORI	13	22
TOML	27	21
Priority Areas (% of Total Number of Projects Funded)		
Agriculture & Food Security	13 %	19 %
Disaster Assistance	23 %	5 %
Education	13 %	38 %
Women Empowerment	21 %	14 %
Ocean Health & the Environment	8 %	12 %
Sanitation & Water	5 %	5 %
Youth & Healthy Living	18 %	21 %
Total Estimated Number of People Benefitted[1]	**8,237**	**6,788**

[1] For 2022, we initially reported the potential number of people benefitted over the expected project lifetime. We decided to change the methodology and report instead the estimated number of people benefitted over the reporting period. As a result, the figure for 2022 is lower than was published in our Impact Report 2022.

NAURU: COMMUNITY ASSISTANCE GRANTS

In 2023, we supported 22 projects in Nauru. These included 15 new initiatives focused on community development and seven multiyear projects that have a proven track record of benefitting local communities. We list them below (we categorized by priority area for clarity, but it's important to note that many of these projects address multiple priorities at once).

Agriculture and Food Security

- Funded the construction of a **canoe-making project** for a group of youth aspiring to bolster their fishing skills to support their families.
- Donated to construct four small-scale enclosures for the IBORI community piggery to support subsistence farmers.
- Donated a 5,000-liter water tank to the Nauru Farmers and Growers Association to support the irrigation of their fruit tree nursery (distributed tree of charge to households across the island).
- Supported the construction of an aquaponic system in the Denig District community that combines vegetable cultivation with fish farming. This project could be replicated across the island and potentially benefit many more communities.
- Sponsored a multi-year banana plantation project. In 2022, NORI partnered with the Secretariat of the Pacific Community (SPC) in Suva, Fiji, to grow 250 breadfruit plantlets which the local NGO Nauru Farmers and Growers Association distributed freely to communities. In 2023, this partnership yielded 50 banana plantlets.

Concrete foundation for a small pig enclosure in the IBORI community

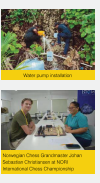
Education

- Equipped a group of underprivileged youth with vocational training in carpentry and engine maintenance through the Lusen Today Lead Tomorrow project.
- Funded essential building repairs at the Secret heart primary school. At the onset of the El Niño climatic phenomenon and the rainy season 2023, several classroom's rooftops were leaking and causing flooding in the facilities.
- Donated for a multi-year project to support less fortunate children's Christmas celebrations in Nauru's five infant schools.

Christmas celebration in Nibok School

Women Empowerment

- Supported a group of single mothers to set up a t-shirt printing business to supplement their income and alleviate single mothers' financial challenges.



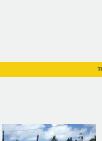
Ocean Health and the Environment

- Funded the Nauru Plastic Free NGO to raise community awareness about proper plastic waste disposal practices and to facilitate bin purchases.
- Funded the major Anabar District beach clean-up initiative launched by a group of youth to remove human-made waste on beaches.

Anabar District Youth Beach Clean-up

Sanitation and Water

- Funded the renovation of sanitary installations in the Nibok infant school.
- Supported repairs of the Baitsi community's roof gutters to collect and store rainwater in residual tanks.

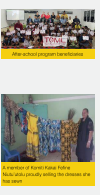


Water pump installation

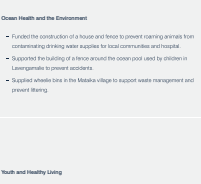
Youth and Healthy Living

- Sponsored the first ever NORI International Chess Championship: Players from Fiji, Kiribati, Vanuatu, and even Norway, travelled to Nauru to compete.
- Funded the Boda Youth Basketball Club to acquire new training equipment.
- Donated cleaning supplies to Dogoronaya Cultural Dance Group in support of their community clean-up fundraising campaign which enabled them to take part to the Pacific Festival of Arts in Hawaii.
- Supported the Women's Empowerment Nauru Association to educate young women about health effects of drug use.
- Continued sponsoring the Nauru Powerlifting Federation's Powerlifting Championship. Over 450 lifters from all ages participated, and the best competitors were selected to represent Nauru's national team at the Pacific Games in the Solomon Islands in December 2023, where they dominated the competition and won 8 gold medals.

Norwegian Chess Grandmaster Johan-Sebastian Christiansen at NORI Marshallese Chess Championship



Dogoronaya Cultural Dance Group



TONGA: COMMUNITY ASSISTANCE GRANTS

In 2023, we funded 21 projects in Tonga, including 16 new community assistance projects, four short-term skills training programs and one Christmas initiative for children.

Agriculture and Food Security

- Supported the construction of 8 piggeries in Talakaimotonga and Sopu to prevent the growing population of roaming pigs from damaging crops and contaminating water supplies.
- Sponsored the Fu'amotu Cluster Farming Project to acquire 4 acres of land for subsistence community farming.

Talakaimotonga's piggery project

Education

- Supported after-school programs in Atsau and Kolomotu'a villages, providing educational materials and equipment to benefit over 60 children and help reduce dropout rates.
- Empowered 25 individuals through a new multi-year program, equipping them with essential business and computer skills alongside expertise in cultivation, crafts, and cuisine.

After-school program beneficiaries

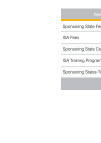
Women Empowerment

- Supported women's sewing income generation through equipment purchases and training in Utulei and Navutoka villages.
- Funded the purchase of materials and equipment to continue the tradition of Ngatu (tapa) making, a vital part of Tongan culture.
- Purchased equipment to support a group of women's efforts to tackle littering and maintain a clean village in Utulei.

A member of Komiti Kakai Fefine Niu'atoputa proudly selling the cheeses she has made

Ocean Health and the Environment

- Funded the construction of a house and fence to prevent roaming animals from contaminating drinking water supplies for local communities and hospital.
- Supported the building of a fence around the ocean pool used by children in Lavengamalie to prevent accidents.
- Supplied wheelie bins in the Matalika village to support waste management and prevent littering.



Child participating in the Matalika village's waste management project

Youth and Healthy Living

- Purchased chairs and tables in the Ofmoua village to support youth activities like choir practice and after-school programs.
- Supported the purchase of uniforms and equipment for Tofoa's female handball team and Ofmoua's Eua Sub-Rugby Union—enabling the rugby team to participate in Tonga's biggest tournament, where they reached the quarter finals.
- Partnered with the Tonga National Visual Impairment Association for our "Bring Joy to a Child this Christmas" initiative through which we offered Christmas gifts and a dinner for 52 visually impaired children and their families.

The island of Eua's rugby team sponsored by TOML

Economic Contributions to Governments

As part of the exploration regulatory regime, we need to provide annual payments to the ISA and our sponsoring states. Our 2023 contributions were 85% higher than in 2022 and 111% higher than in 2021, and we expect benefits to continue increasing as we near commercial operations and begin collecting nodules.

The ISA's exploitation regulations will stipulate royalties and taxes payable on any future production from the CCZ. While the ISA has yet to set the payment rates, the 1994 Implementation Agreement (Section 8(1)(c)) prescribes that such payments "shall be within the range of those prevailing in respect of land-based mining of the same or similar minerals in order to avoid giving deep seabed miners an artificial competitive advantage or imposing on them a competitive disadvantage".

Fees and Contributions (USD)	2021	2022	2023
Sponsoring State Fees (Administrative)	$ 453,800	$ 463,109	$ 726,705
ISA Fees	$ 122,800	$ 379,396	$ 203,877
Sponsoring State Community Programs	$ 140,800	$ 149,160	$ 244,815
ISA Training Programs	$ 23,882	$ 68,543	$ 219,296
Sponsoring States Training Programs	$ 41,218	$ 10,780	$ 107,812
TOTAL	**$ 781,498**	**$ 1,071,017**	**$ 1,502,505**

Under the NORI sponsorship agreement between Nauru and NORI and under the TOML sponsorship agreement between Tonga and TOML, after reaching a minimum recovery level in the tenement areas, NORI and TOML have agreed to pay Nauru and Tonga a seabed mineral recovery payment for polymetallic nodules recovered from the tenement area, annually adjusted (from the fifth production year) on a compounding basis based on the official inflation rate in the United States. In addition, NORI and TOML will also pay corporate income tax in Nauru and Tonga, respectively in addition to the annual administration fee they already pay for administration and sponsorship, which is subject to review and increase in the event an exploitation contract is granted by the ISA.

^ What We Do Next section: About This Report >

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About this report

General Information

- Scope and Boundary
- Abbreviations

Framework Indexes

- GRI
- SASB Metals and Mining
- SASB Marine Transportation
- Ocean Stewardship Coalition

Next: Scope and Boundary >

We're building a carefully managed metal commons that will be used, recovered, and reused again and again.

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Scope and Boundary

We present the information in this report for The Metals Company (TMC) and all of its consolidated subsidiaries covering exploration activities from 2012 until 31 December 2023.

We have prepared this report using the Global Reporting Initiative (GRI) Standards as guidance – GRI referenced. In addition to GRI, the report references additional frameworks, such as Task Force on Climate-related Financial Disclosures (TCFD), the Task Force on Nature-related Financial Disclosures (TNFD) and Sustainability Accounting Standards Board (SASB) for the metals and mining sector in addition to the marine transportation sector. This report also serves as a complement to TMC's U.N. Global Compact Communication of Progress for 2023 and illustrates our contribution to the Ocean Stewardship Principles.

^ Back to the section page Next: Abbreviations >

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Abbreviations

Acronyms	
APEIs	Areas of Particular Environmental Interest
AMS	Adaptive Management System
BBNJ	U.N. Intergovernmental Conference on Marine Biodiversity of Areas Beyond National Jurisdiction
CBD	Convention on Biological Diversity
CCZ	Clarion-Clipperton Zone
CHH	Common Heritage of Humankind
Co	Cobalt
CO_2	Carbon dioxide
CO_2e	Carbon dioxide equivalent
Cu	Copper
DRC	Democratic Republic of the Congo
DSM	Deep-Sea Mining
EEZ	Exclusive Economic Zone
EHS	Environment, Health & Safety
EIA	Environmental Impact Assessment
EIS	Environmental Impact Statement – used interchangeably with ESIA
EMS	Environmental Management System
EPRP	Emergency Preparedness and Response Plan
ESG	Environmental, Social and Governance
ESIA	Environmental and Social Impact Assessment - used interchangeably with EIS
ES	Ecosystem Services
EV	Electric Vehicle
FAO	Food and Agriculture Organization of the United Nations
GHG	Greenhouse gas
Gt	Gigaton
GRI	Global Reporting Initiative
GWP	Global Warming Potential
HAC	High Ambition Coalition
HIRAs	Hazard Identification and Risk Assessments
ICE	Internal Combustion Engine
IEA	International Energy Agency
ILO	International Labour Organization
IPBES	Intergovernmental Science-Policy Platform on Biodiversity and Ecosystems Services
IPCC	Intergovernmental Panel on Climate Change
ISA	International Seabed Authority
JAMSTEC	Japan Agency for Marine-Earth Science & Technology
KPM	Kingston Process Metallurgy
kg	Kilogram
km	Kilometer
KWh	Kilowatt hour
ktpa	Kilotons per annum
LCA	Life cycle assessment
LTC	Legal and Technical Commission
LTIFR	Lost Time Injury Frequency Rate
m^2	Square meter
m^3	Cubic meter
Mn	Manganese
Mt	Megaton
Mtpa	Million ton per annum
MSS	Maersk Supply Services
Nauru	Republic of Nauru
NMFR	Near-Miss Frequency Rate
NORI	Nauru Ocean Resources Inc.
NORI-D	Nauru Ocean Resources Inc. Contract Area D
Ni	Nickel
NiCuCo	Nickel-Copper-Cobalt
NOx	Nitrogen oxides
MoU	Memorandum of Understanding
PAMCO	Pacific Metals Co Ltd
PFR	Pre-Feasibility Report
PIPA	Phoenix Islands Protected Area
PM	Particulate Matter
PRZs	Preservation Reference Zones
PSIDS	Pacific Small Island Developing States
RALS	Riser And Lifting System
RKEF	Rotary Kiln-Electric Furnace
RRSP	Registered Retirement Savings Plan
S&I	Sustainability & Innovation Committee
SASB	Sustainability Accounting Standards Board
SIA	Social Impact Assessment
SIDS	Small Island Developing States
SMS	Seafloor Massive Sulfides
SO_2	Sulfur dioxide
SO_4	Sulfate
SOx	Sulfur oxide
TCFD	Task Force on Climate-related Financial Disclosures
TMC	The Metals Company
TMPI	Tonga Maritime Polytechnic Institute
TNFD	Task Force on Nature-related Financial Disclosures
TOML	Tonga Offshore Mining Ltd.
Tpa	Ton per annum
UN	United Nations
UNCLOS	United Nations Convention on the Law of the Sea
UNEP	United Nations Environment Programme
USP	University of the South Pacific
UN SDG	United Nations Sustainable Development Goals
VOCs	Volatile Organic Compounds
WEF	World Economic Forum
WEO	World Energy Outlook
XPS	Expert Process Solutions

^ Scope and Boundary Next: GRI Content Index >

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GRI Content Index

Global Reporting Initiative (GRI) 2 General Disclosures 2021

GRI Disclosure		Page/Location
The organization and its reporting practices		
2-1	Organizational details	Our Vision - Our challenge; Our Responsibility; Our Key Milestones. Currently, The Metals Company (TMC) does not have heaquarters as we are a global virtual workforce with individuals located mainly in Tonga, Nauru, the United States, Canada, Australia, the United Kingdom, and the United Arab Emirates
2-2	Entities included in the organization's sustainability reporting	10-K
2-3	Reporting period, frequency and contact point	Scope and Boundary. This is TMC's third impact report and we will report annually. Erica Ocampo, CSO impact@metals.co
2-4	Restatement of information	Updated figures for water discharges and estimated number of people benefited from our community programs
2-5	External assurance	There was no external assurance
Activities and workers		
2-6	Activities, value chain and other business relationships	Metal-Intensive future
2-7	Employees	Our People
2-8	Workers who are not employees	Our People
Governance		
2-9	Governance structure and composition	How We Do It; TMC's Governance Structure; Business Ethics & Transparency
2-10	Nomination and selection of the highest governance body	TMC's Governance Structure; Nominating Committee Charter
2-11	Chair of the highest governance body	TMC's Governance Structure
2-12	Role of the highest governance body in overseeing the management impacts	TMC's Governance Structure
2-13	Delegation of responsibility for managing impacts	How We Do It; TMC's Governance Structure; Business Ethics & Transparency
2-14	Role of highest governance body in sustainability reporting	TMC's Governance Structure; Sustainability and Innovation Committee Charter
2-15	Conflicts of interest	10-K
2-16	Communication of critical concerns	Stakeholder Engagement; 10-K
2-17	Collective knowledge of the highest governance body	TMC's Governance Structure; 10-K
2-18	Evaluation of the performance of the highest governance body	10-K; Compensation Committee Charter
2-19	Remuneration policies	10-K; Compensation Committee Charter
2-20	Process to determine remuneration	10-K
2-21	Annual total compensation ratio	Our People; 10-K. We have not yet assessed compensation ratio
Strategy, policies and practices		
2-22	Statement on sustainable development strategy	Letter From the CEO; Sustainability Approach; Other Initiatives We Support
2-23	Policy commitment	Our Responsibility; Doughnut-Shaped Solution Space; TMC's Governance Structure; Sustainability Approach; TCFD and TNFD
2-24	Embedding policy commitments	TMC's Governance Structure; Sustainability Approach; Other Initiatives We Support
2-25	Process to remediate negative impacts	Our Responsibility; Business Ethics & Transparency; Other Initiatives We Support; Governance Documents
2-26	Mechanisms for seeking advice and raising concerns	Business Ethics & Transparency; Stakeholder Engagement; Governance Documents
2-27	Compliance with laws and regulations	No instances of non-compliance during the reporting period
2-28	Membership and associations	Stakeholder Engagement
Stakeholder engagement		
2-29	Approach to stakeholder engagement	Stakeholder Engagement
2-30	Collective bargaining agreements	Our People

^ Back to the section page Next: SASB Metals and Mining >

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SASB Metals & Mining Content Index

Sustainability Accounting Standards Board (SASB) Metals & Mining, Industry Standard, Version 2021 - 12

Topic	Accounting Metric	SASB Indicator	Page / Location
Greenhouse Gas Emissions			
	Gross global Scope 1 emissions, percentage covered under emissions-limiting regulations	EM-MM-110a.1	Energy and Emissions
	Discussion of long-term and short-term strategy or plan to manage Scope 1 emissions, emissions reduction targets, and an analysis of performance against those targets	EM-MM-110a.2	TCFD & TNFD
Air Quality			
	Air emissions of the following pollutants: (1) CO, (2) NOx (excluding N2 O), (3) SOx, (4) particulate matter (PM10), (5) mercury (Hg), (6) lead (Pb), and (7) volatile organic compounds (VOCs)	EM-MM-120a.1	Energy and Emissions
Energy Management			
	(1) Total energy consumed, (2) percentage grid electricity, (3) percentage renewable	EM-MM-130a.1	(1) 242,877 GJ; (2) 0%; (3) 0%; TCFD & TNFD; Energy and Emissions
Water Management			
	(1) Total freshwater withdrawn, (2) total freshwater consumed, percentage of each in regions with high or extremely high baseline water stress	EM-MM-140a.1	Water
	Number of incidents of non-compliance associated with water quality permits, standards and regulations	EM-MM-140a.2	None
Waste & Hazardous Materials Management			
	Total weight of non-mineral waste generated	EM-MM-150a.4	Waste
	Total weight of tailings produced recycled	EM-MM-150a.5	We are currently in the exploration stage of our development; in addition, the collection of polymetallic nodules does not generate tailings, which is a key advantage of this resource
	Total weight of waste rock generated	EM-MM-150a.6	Not applicable
	Total weight of hazardous waste generated	EM-MM-150a.7	Waste
	Total weight of hazardous waste recycled	EM-MM-150a.8	Waste
	Number of significant incidents associated with hazardous materials and waste management	EM-MM-150a.9	None
	Description of waste and hazardous materials management policies and procedures for active and inactive operations	EM-MM-150a.10	Environment, Health & Safety (EHS)；Waste；Currently in the exploration stage of our development
Biodiversity Impacts			
	Description of environmental management policies and practices for active sites	EM-MM-160a.1	No current active sites; however, a robust environmental program is currently underway
	Percentage of mine sites where acid rock drainage is: (1) predicted to occur, (2) actively mitigated, and (3) under treatment or remediation	EM-MM-160a.2	No current active sites; however, a robust environmental program is currently underway
	Percentage of (1) proved and (2) probable reserves in or near sites with protected conservation status or endangered species habitat	EM-MM-160a.3	None
Security, Human Rights & Rights of Indigenous Peoples			
	Percentage of (1) proved and (2) probable reserves in or near areas of conflict	EM-MM-210a.1	None. The CCZ and Abyssal Plains；International Treaty for the High Seas
	Percentage of (1) proved and (2) probable reserves in or near Indigenous land	EM-MM-210a.2	None. The CCZ and Abyssal Plains；International Treaty for the High Seas
	Discussion of engagement processes and due diligence practices with respect to human rights, Indigenous rights and operation in areas of conflict	EM-MM-210a.3	The contracted areas are located in the CCZ, which is international waters; no human settlements exist there. The CCZ and Abyssal Plains；International Treaty for the High Seas；Stakeholder Engagement
Community Relations			
	Discussion of process to manage risks and opportunities associated with community rights and interests	EM-MM-210b.1	Stakeholder Engagement; Environmental Impact Statement (EIS); Sponsoring States
	Number and duration of non-technical delays	EM-MM-210b.2	Zero
Labor Relations			
	Percentage of active workforce covered under collective bargaining agreements, broken down by U.S. and foreign employees	EM-MM-310a.1	Our Employees
	Number and duration of strikes and lockouts	EM-MM-310a.2	Zero
Workforce Health & Safety			
	(1) MSHA all-incidence rate, (2) fatality rate, (3) near-miss frequency rate (NMFR) and (4) average hours of health, safety, and emergency response training for (a) full-time employees and (b) contract employees	EM-MM-320a.1	Environment, Health & Safety (EHS)
Business Ethics & Transparency			
	Description of the management system for prevention of corruption and bribery throughout the value chain	EM-MM-510a.1	Anti-Corruption and Anti-Bribery Compliance Policy
	Production in countries that have the 20 lowest rankings in Transparency International's Corruption Perception Index	EM-MM-510a.2	None
Tailings Storage Facilities Management			
	Tailings storage facility inventory table: (1) facility name, (2) location, (3) ownership status, (4) operational status, (5) construction method, (6) maximum permitted storage capacity, (7) current amount of tailings stored, (8) consequence classification, (9) date of most recent independent technical review, (10) material findings, (11) mitigation measures, (12) site-specific Emergency Preparedness and Response Plan (EPRP)	EM-MM-540a.1	Not applicable. We are currently in the exploration stage of our development. In addition, the collection of polymetallic nodules does not generate tailings, which is a key advantage
	Summary of tailings management systems and governance structure used to monitor and maintain the stability of tailings storage facilities	EM-MM-540a.2	Not applicable. We are currently in the exploration stage of our development. In addition, the collection of polymetallic nodules does not generate tailings, which is a key advantage
	Approach to development of EPRPs for tailings storage facilities	EM-MM-540a.3	Not applicable. We are currently in the exploration stage of our development. In addition, the collection of polymetallic nodules does not generate tailings, which is a key advantage
Activity Metrics			
	Production of (1) metal ores and (2) finished metal products	EM-MM-000.A	We are currently in the exploration stage of our development and there is no commercial production of metals ores or finished metal products
	Total number of employees, percentage contractors	EM-MM-000.B	Our People

^ GRI Next: SASB Marine Transportation >

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SASB Marine Transportation Content Index

Sustainability Accounting Standards Board (SASB) Marine Transportation, Industry Standard, Version 2018 - 10

Topic	Accounting Metric	SASB Indicator	Page / Location
Greenhouse Gas Emissions			
	Gross global Scope 1 emissions	TR-MT-110a.1	Energy and Emissions
	Discussion of long-term and short-term strategy or plan to manage Scope 1 emissions, emissions reduction targets, and an analysis of performance against those targets	TR-MT-110a.2	TCFD & TNFD
	(1) Total energy consumed, (2) percentage heavy fuel oil, (3) percentage renewable	TR-MT-110a.3	(1) Energy and Emissions; (2) 0%; (3) 0%
	Average Energy Efficiency Design Index (EEDI) for new ships	TR-MT-110a.4	Not applicable. The Hidden Gem and our contractor's vessel for campaign 8a are exempt as they are not classified as new ships according to the International Maritime Organization (IMO)'s applicable regulations.
Air Quality			
	Air emissions of the following pollutants: (1) NO_X (excluding N_2O), (2) SO_X, and (3) particulate matter (PM_{10})	TR-MT-320a.1	Energy and Emissions
Ecological Impacts			
	Shipping duration in marine protected areas or areas of protected conservation status	TR-MT-160a.1	3 days and 23 hours
	Percentage of fleet implementing ballast water (1) exchange and (2) treatment	TR-MT-160a.2	100%
	(1) Number and (2) aggregate volume of spills and releases to the environment	TR-MT-160a.3	(1) 0; (2) 0
Employee Health and Safety			
	Lost time incident rate (LTIR)	TR-MT-320a.1	Health and Safety
Business Ethics			
	Number of calls at ports in countries that have the 20 lowest rankings in Transparency International's Corruption Perception Index	TR-MT-510a.1	None
	Total amount of monetary losses as a result of legal proceedings associated with bribery or corruption	TR-MT-510a.2	None
Accident & Safety Management			
	Number of marine casualties, percentage classified as very serious	TR-MT-540a.1	None
	Number of Conditions of Class or Recommendations	TR-MT-540a.2	None
	Number of port state control (1) deficiencies and (2) detentions	TR-MT-540a.3	None
Activity Metrics			
	Number of shipboard employees	TR-MT-000.A	Up to 67 (up to 29 on our contractor's vessel for C8a and up to 38 on the Hidden Gem)
	Total distance traveled by vessels	TR-MT-000.B	About 5,915 nautical miles
	Operating days	TR-MT-000.C	Not applicable. We remain in an exploration stage and do not currently generate revenue.
	Deadweight tonnage	TR-MT-000.D	63,903 metric tonnes.
	Number of vessels in total shipping fleet	TR-MT-000.E	Our 2023 offshore operations involved 2 vessels.
	Number of vessel port calls	TR-MT-000.F	3
	Twenty-foot equivalent unit (TEU) capacity	TR-MT-000.G	Not applicable. The vessels that took part to our 2023 offshore operations do not transport containers.

^ SASB Metals and Mining Next: Ocean Stewardship Coalition >

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Ocean Stewardship Coalition

At first glance, it might seem counterintuitive that a company looking to develop seafloor minerals can directly and positively contribute to healthy and productive ocean, but we do seek to add value in this area. In 2022, TMC became a signatory to the Ocean Stewardship Coalition because we firmly support and promote the nine principles that the initiative proposes and because we believe it provides a useful framework to report how our actions contribute to these principles, the U.N. Sustainable Development Goal (SDG) 14: "Life Below Water", and the SDGs in general.

Sustainable Ocean Principles		TMC Actions Examples (and page location)
Ocean Health and Productivity		
Principle 1	Assess the short and long-term impact of their activities on ocean health and incorporate such impacts into their strategy and policies.	– Commissioned 100+ studies to better understand deep-sea and marine environment (EIS). – Performed a nodule-collection system test in the CCZ to better understand the potential impact that our operations could have on the environment (Collection System Trials). – Developing an environmental impact assessment (EIA) and environmental management and monitoring program (EMMP) for the NORI Area D Project (EIS) to minimize the impact that our operations have on ocean ecosystems. – Commissioned several environmental impact lifecycle assessments associated with our onshore and offshore operations, such as our impact on marine euthrophication (Comparative Life-Cycle Studies).
Principle 2	Consider sustainable business opportunities that promote or contribute to restoring, protecting or maintaining ocean health and productivity and livelihoods dependent on the ocean.	– Mineral extraction on land impacts ocean health in coastal areas indirectly via rain runoffs that leach exposed rock chemicals to the ocean or directly via deep sea tailings disposal among others. While our offshore operations occur in the ocean, we focus on the abyssal seafloor—the most common habitat type on Earth and one of the least productive areas in the ocean. As our operations leave more productive marine ecosystems untouched, mitigating terrestrial mining also helps to mitigate impacts on more productive and biodiverse areas on the planet. (Our Hypothesis; Why We Focus Only on Nodules; The CCZ and Abyssal Plains). – The ISA has set aside 1.97 million km2 of the Clarion-Clipperton Zone (CCZ) as areas of particular environmental interest (APEIs) that no one can ever exploit (42% more than all contracted areas in the CCZ combined), and TMC expects to set aside approximately 10% of its contracted areas as additional "no-take zones" or preservation reference zones (PRZs) (Environmental Program) – We have and will continue to protect and enhance ocean-dependent livelihoods by creating shared value with our sponsoring states (e.g., revenue generation, community initiatives and sponsorships, education, training, and capacity-building opportunities) and support their efforts to increase their resilience against challenges (e.g., natural disasters). (Sponsoring States - State Profiles; Sponsoring States)
Principle 3	Take action to prevent pollution affecting the ocean, reduce greenhouse gas emissions in their operations to prevent ocean warming and acidification, and work towards a circular economy.	– Circular economy and decarbonization are at the center of the company's vision to build a carefully managed metal commons that will be used, recovered and reused again and again—for millennia. To get there, we first need to supply metals for the energy transition with the least possible negative environmental and social impact as we build up enough metals stocks to transition to a circular business model that focuses on secondary metals (Our Vision - Our Challenge) – We study our operations' lifecycle impacts, which include impacts related to pollution and emissions, and continuously look for ways to prevent or minimize adverse impacts (Comparative Life-Cycle Studies; TCFD & TNFD) – Our sustainability goals include "systematically implement path toward net-zero emissions" and "drive circularity of critical minerals" (Sustainability Approach)
Principle 4	Plan and manage their use of and impact on marine resources and space in a manner that ensures long-term sustainability and take precautionary measures where their activities may impact vulnerable marine and coastal areas and the communities that are dependent upon them.	– We have commissioned 100+ studies to better understand deep-sea environments (EIS) – Developing an EIA and EMMP to eliminate or mitigate the adverse impacts from our operations (EIS; Environmental Program); – Aiming for net-positive impact on people and the planet and committed to change course if our path does not deliver on that aim (Our Vision - Our Challenge) – Creating shared value with sponsoring states (e.g., revenue generation, community initiatives and sponsorships, education, training, and capacity-building opportunities) (Sponsoring States - State Profiles; Sponsoring States) – Undertaking the first-ever social impact assessment (SIA) for a deep-sea resource exploitation project (EIS)
Governance and Engagement		
Principle 5	Engage responsibly with relevant regulatory or enforcement bodies on ocean-related laws, regulations and other frameworks.	– We base our stakeholder engagement approach on the IFC engagement principles, which we commit to implementing throughout our projects' entire lifetime (Other Initiatives We Support) – We commit to working openly and collaboratively with our stakeholders. As a result, we engage proactively and transparently with our regulatory bodies—the ISA and our sponsoring states' governments (Stakeholder Engagement)
Principle 6	Follow and support the development of standards and best practices that are recognized in the relevant sector or market contributing to a healthy and productive ocean and secure livelihoods.	– We strive to embrace and develop best practices to manage environmental and social risks, which includes risks to a healthy and productive ocean (EIS; Sustainability Approach; TCFD & TNFD; Environmental Program) – TMC joined an international consortium to develop the first ESG Handbook for Marine Minerals – In partnership with our island nation sponsoring states, we create opportunities that contribute to secure, diversify, and enhance livelihoods that depend on a healthy and productive ocean (Sponsoring States - State Profiles; Sponsoring States)
Principle 7	Respect human-, labour- and indigenous peoples' rights in the company's ocean-related activities, including exercise appropriate due diligence in their supply-chain, consult and engage with relevant stakeholders and communities in a timely, transparent and inclusive manner, and address identified impacts.	– We are undertaking the world's first Social Impact Assessment (SIA) for a nodule project in international waters, which focusses on these issues (EIS) – Our stakeholder engagement approach is based on the IFC principles of engagement, which we are committed to implement throughout the entire lifetime of our projects (Other Initiatives We Support) – Our sustainability goals support Principle 7 (Sustainability Approach) – In 2023, we began assessing the potential impacts from the NORI-D Project on intangible cultural heritage (ICH) and establishing a cultural heritage management plan based on good international practice (i.e., aligned with the World Bank's Environmental and Social Standard 1 (ESS1) and the International Finance Corporation's (IFC) Performance Standard 8 (PS8) for Cultural Heritage) (EIS).
Data and Transparency		
Principle 8	Where appropriate, share relevant scientific data to support research on and mapping of relevance to the ocean.	– We contribute to society's knowledge of the deep ocean through our comprehensive environmental program. With the help of research institutions around the world, we have supported over 100 original studies which analyze the CCZ from the surface down through the water column to the abyssal plain. These organizations are independent, and researchers contractually retain their academic freedom to reach conclusions on findings and publish results (Our Operations; Environmental Program; Contribution to Research) – We are sharing the data we collect with the ISA and the international community, and we are providing deep-sea samples to labs around the world. In 2023, the ISA published the environmental data we collected through two benthic baseline campaigns, and NORI became the single largest contributor of biological occurrence data to the OBIS ISA-node, providing almost 60% of the records and increasing biodiversity records available for the Clarion Clipperton Zone (CCZ) by about 150%. Biological occurrence records from NORI-D to the OBIS ISA-node will continue to grow considerably as we submit to the ISA the remaining environmental baseline and collector test data (Environmental Program; Contribution to Research)
Principle 9	Be transparent about their ocean-related activities, impacts and dependencies in line with relevant reporting frameworks.	– By publishing an impact report since 2021 (before any commercial operations start), we aim to communicate transparently and proactively about our ocean-related activities, impacts, and dependencies (Our Responsibility). – We are using a variety of reporting and disclosure recommendations frameworks with the intent to provide relevant, standardized and quality information to our stakeholders (e.g. GRI; SASB; TCFD; TNFD).

^ SASB Marine Transportation

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