

Copper Sector Expansion in Mongolia: Opportunities and Challenges

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Contents

Summary 3

Introduction 7

Copper and the energy transition 10

Copper sector expansion strategies and policies 27

Conclusions 47

Recommendations 50

References 52

Annex: Stakeholder mapping 53

Endnotes 60

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Summary

Copper has long been a pillar of technological and economic progress, and its importance continues to grow with the global energy transition. Copper's exceptional properties make it indispensable for renewable energy technologies, electric vehicles (EVs) and modern power grids.

The increasing demand for decarbonization presents a pivotal opportunity for Mongolia, endowed with vast copper reserves, to position itself as a key player in the global copper value chain. By 2050, global copper demand is projected to increase 1.6 times from today's levels to around 40 million tons under the Net Zero Scenario.[2]

Mongolia's copper sector holds substantial promise due to the size of the country's copper reserves, aligning well with the global energy transition's relentless driving of growth in copper demand. Specifically, Mongolia ranks twelfth globally in terms of copper resources and reserves, as can be seen from the table below. However, as both global and Mongolia's experience shows, realizing this potential requires addressing significant challenges related to economic benefits, environmental sustainability and governance of the sector.

The government of Mongolia has for years prioritized copper mining and processing as a central pillar of its economic strategy.

Copper resources and reserves

Country	Global rank	mm tons	percent	Active projects
Chile	1	721.14	26.9	78
USA	2	264.12	9.8	99
Peru	3	237.87	8.9	66
Australia	4	155.50	5.8	202
Dem. Rep. Congo	5	127.08	4.7	33
China	6	110.90	4.1	163
Canada	7	107.17	4.0	245
Russia	8	104.69	3.9	39
Mexico	9	104.00	3.9	64
Indonesia	10	91.37	3.4	14
Mongolia	12	61.86	2.3	10
Rest of the world	NA	597.25	22.3	373
Total	**—**	**2,682.96**	**100**	**1,386**

Source: Data from SP Capital

All key policy documents including Vision-2050 and the Government Action Plans emphasize as priorities the expansion of responsible mining, including for copper, and especially value addition and copper processing.

However, progress on expanding the sector, both upstream through additional exploration and mining, and downstream through building smelting, refining and manufacturing capacities, has been hindered by various factors.

Among major policy challenges are regulatory uncertainty and policy shifts, stalled exploration resulting in slowing down upstream and eventually downstream projects, slow progress to resolve infrastructure inadequacies, high financing costs, and challenges related to improving governance of the sector and combating corruption. As such, Mongolia risks missing opportunities to ride the tide of increased copper demand and develop its mining sector and economy in the age of energy transition.

Currently, Mongolia's copper production is primarily anchored by two major projects, the Erdenet mine and the Oyu Tolgoi mine, both producing and exporting copper concentrate to China. Emerging opportunities in mining, such as Tsagaan Suvarga and Kharmagtai, add to the sector's potential, but the number of projects in the pipeline is limited currently without increased spending on exploration work. At the same time, Mongolia exports almost all of its copper production as raw materials or copper concentrate, with limited domestic production of value-added products such as copper cathode.

Projects aimed at adding value and producing final copper products currently revolve around ambitions to build a copper smelter and refinery as part of an industrial and technological park. While many actors view value addition as a logical step for a copper mining country, the success of downstream processing and value addition depends on many factors, which are summarized in the table below.

Risks associated with success factors for value addition

	Success factors	Policy considerations	Risk level
1	Size of mineral supply	Significant projects are in the pipeline; exploration is still limited with high potential for new discoveries; location and technology of processing may mean some mining concentrate produced domestically could not be used.	Medium
2	Transport costs	Costs for concentrate shipping are significant given limited railway and roads system; distance to the market for concentrate and copper cathode (China) is relatively short.	High
3	Availability of competitively priced, reliable, clean energy	Energy production is not adequate and may be slow to meet processing needs; cost of energy remains high; opportunities for renewable energy production exist; exising power grid capacity needs improvements.	Very high
4	Competing capacity elsewhere	High competition from China for smelting and refining; Chinese ownership of some mines domestically should be considered.	Very high
5	Good governance	Corruption challenges persist; transparency gains exist; government effectiveness has been low.	Medium
6	Proximity to downstream markets	Neighbor to China, the main market for both concentrate and cathode.	Low
7	Existence of an industrial base	Industry base is low; policy support for value addition is high.	Very high

Note: Factors based on NRGI's "Six Keys" briefing

The Mongolian government and other actors should consider these factors in planning and investing in copper processing, including increasing transparency around all projects as they are likely to affect the public interest and require public funding in one way or another.

Under these circumstances, copper sector expansion should follow policies aiming to ensure economic benefits and environmental sustainability, with accompanying governance reforms including of state-owned enterprises (SOEs) that play a significant role in the sector.

Maximizing economic benefits

Mongolia exports most of its production as raw copper or copper concentrate. Only two mines currently produce copper concentrate while some potential projects have been slow to progress to production. Potentially, Mongolia's copper sector can expand horizontally by developing new mines and vertically by adding value to copper concentrate.

However, whether all projects maximize economic benefits remains a subject of policy debate. For upstream mining, the two existing mining projects have attracted criticism on many issues, starting with corruption allegations, inadequate fiscal revenue, high costs and political interference and ending with disputes with the government over tax payments and questionable linkages to the domestic economy.

One specific issue of concern is the perception that the government's royalty and tax regime is burdensome on new projects, potentially delaying the development of new exploration and mining operations. This is especially important given that costs for new mining projects may be high due to inadequate infrastructure and high interest rates that projects in Mongolia must pay for their funding.

For downstream processing, while Mongolia may have a steady stream of inputs to processing, i.e., copper concentrate, unfavorable market conditions and other factors may render processing projects financially inefficient.

The table above highlights these risks. There are no published detailed feasibility studies for major processing projects. Most of the world's copper processing takes place in neighboring China, which may affect the profitability and competitiveness of new plants in Mongolia.

One aspect that needs better analysis with respect to copper sector projects is ensuring linkages of the sector with the rest of the economy. The proposed industrial park includes an elemental sulfur plant, solvent extraction/leaching and electrowinning (SX-EW) operations and infrastructure, for example. More detailed information on the costs and benefits of these projects and an assessment of the linkages need to feed into the policy decisions.

Environmental sustainability

Environmental risks associated with copper mining and especially with smelting and refining need critical consideration. To mitigate these risks, the government should encourage the use of cleaner technologies for smelting and refining, including sulfur dioxide capture and processing and require the publication of detailed information on environmental impacts.

Hydrometallurgical processing will help avoid some of the risks, as it avoids smelting. But the government needs to ensure projects also comply with best environmental standards.

Governance and institutional challenges

Government policies and regulations, their implementation and institutional capacity are significant red flags that the government and other actors need to address. The governance of SOEs, such as Erdenes Mongol and Erdenet, will be an important factor in the sector's expansion. Inefficiencies, mismanagement and political interference in SOEs could undermine the potential of key mining assets and discourage private investment. Stronger regulatory oversight mechanisms and a clear separation between politics and business operations would help attract both domestic and international investors.

Licensing, especially for exploration, is currently stalled and needs reinvigorating. While the government may be enticed to streamline licensing processes, especially through SOEs, it should strictly follow due diligence and fair play principles.

Under these circumstances, NRGI reocmmends that Mongolian government officials and other key stakeholders undertake several key actions regarding the country's copper sector.

Summary of recommendations

1. Analyze the economic and fiscal impact of new copper projects, especially downstream projects, in detail and communicate these to and discuss them with other stakeholders as widely as possible. Disclose key elements of feasibility studies, including profitability, cost-benefit estimates, and technological aspects to other stakeholders before major decisions on projects.

2. Double down on reforms of SOEs operating in the copper sector, clarifying specific conditions under which partnerships with private sector players will take place. This includes enforcing stricter governance rules, addressing corruption risks, and ensuring that SOEs' financial accounts are transparent and accessible. Increase information flow on planned projects and how potential investors can engage with SOEs and make greater detail available.

3. Revisit the issue of the royalty structure as part of a broader fiscal policy review and clarify legislation on the rate and base for calculation of royalties. The fiscal regime should take account of competition globally and the level playing field domestically, especially given that existing projects may have specific fiscal arrangements.

4. Efficiently plan infrastructure projects that are essential for the copper sector to align with the sector's development, with specific funding plans and careful cost scrutiny. Continuous monitoring and transparency in public spending will help ensure the effective use of resources and contribute to the overall sustainability of the copper sector.

5. Revise environmental standards applicable to the copper sector so that they are comparable to those of leading countries in mining and resource extraction. Implement in stages regulations, similar to those in Australia, Canada and Chile, to address the environmental challenges associated with copper mining and smelting, particularly around air quality and waste management.

6. Recognize and account for the influence of external factors, particularly China's policies for copper, including how the expansion of copper exports and domestic value addition will affect economic dependence on China. Analyze the impact of changes in Chinese economic policies and Chinese stakeholders' direct investments in Mongolia's copper mining and processing.

7. Guarantee local participation in key decisions on copper projects, sharing of benefits, and plans for mitigating environmental and social risks. Pursue consultations with local stakeholders during planning of projects; clarify and simplify revenue sharing formulas for local communities; and continue monitoring environmental impacts and participatory implementation of protection plans.

Mongolia's copper sector has significant potential to drive economic growth, but the government and other actors must carefully manage economic, social, and environmental risks. By implementing these recommendations, Mongolia can create a more favorable environment for investment, ensuring that the sector grows in a sustainable, profitable, and responsible manner, benefiting both the national economy and the global copper market, and by extension the global energy transition.

Introduction

Copper has been a fundamental resource throughout human history, driving technological, economic, and societal development for millennia. Its use dates back to the Bronze Age, when it was used to create bronze, revolutionizing tools, weapons, and artistry. In more recent centuries, copper emerged as a critical material during the Industrial Revolution, enabling advancements in machinery, infrastructure, and electrical systems. The growth of the electrical industry in the nineteenth and twentieth centuries further solidified copper's importance, as its exceptional conductivity made it indispensable for wiring, motors, and telecommunication networks. From household appliances to large-scale power grids, copper has powered homes, cities, and industries, shaping the modern world.

Beyond its industrial applications, copper's antimicrobial properties have been harnessed in healthcare and public hygiene. Moreover, copper has earned the moniker "Doctor Copper" in economic circles, reflecting its reputation as a reliable barometer of global economic health. Since copper demand closely tracks industrial activity, construction, and manufacturing, its price movements offer valuable insights into economic trends and cycles. Various roles copper plays have established it as a cornerstone of development throughout successive waves of innovation and transitions. Today, as the world pivots toward a new era of renewable energy and electrification, copper's legacy as a driver of development continues to evolve.[3],[4]

Copper stands as a cornerstone of the global energy transition, underpinning the technologies and infrastructure critical to decarbonization and a sustainable future. Some industry experts even suggest that we are witnessing a "Copper Age 2.0".[5] Copper's exceptional electrical and thermal conductivity, combined with its durability and recyclability, makes it indispensable to the clean energy transition and electrification.

Copper plays a vital role in the production and transmission of renewable energy, being extensively used in wind turbines, solar panels, and the wiring and components that form the foundation of these systems. It is equally crucial in electric vehicles (EVs), where it is used in batteries, motors, and charging infrastructure, driving the shift away from fossil fuels in the transportation sector. Additionally, copper is integral to modern power grids, enhancing energy efficiency in transformers, wiring, and grid-scale energy storage systems.

As electricity increasingly replaces fossil fuels in heating, industrial processes, and transportation, the demand for copper is virtually certain to surge significantly. Copper's recyclability further enhances its appeal as a sustainable material, perfectly aligning with circular economy principles aimed at minimizing environmental footprints. By facilitating renewable energy adoption and enabling electrification across various sectors, copper serves as both a technological enabler and a catalyst for innovation. This firmly establishes its role as a cornerstone mineral in the transition to a low-carbon, resilient global economy.[6]

This evolving landscape places copper-producing countries in a strategic position to leverage the metal for economic growth and the clean energy transition. Mongolia, with its vast copper reserves, is no exception. Already a key player in the global copper market, the mining sector constitutes a significant pillar of Mongolia's economy. Erdenet, one of Asia's largest copper and molybdenum mines, has long been a foundation of Mongolia's industrial output and export earnings. Complementing this is the Oyu Tolgoi mine, operated by Rio Tinto, which ranks among the world's largest known copper and gold deposits.

The mine has been in operation for almost a decade, and as it expands its underground operations, the mine is set to become a pivotal driver of Mongolia's mining growth.

These flagship projects solidify Mongolia's role as a vital supplier of copper to international markets in general and underscores its importance to China, the primary destination for its mineral exports.[7] In 2024, Mongolia's exports of copper concentrate reached 1.7 million tons of concentrate with the value of USD 3.3; nearly all of the concentrate went to China for smelting and processing.

Despite this established role, Mongolia's copper sector remains limited in terms of new projects coming to life, and expanding beyond raw material extraction, with limited downstream processing or value addition occurring domestically. Primary and advanced exploration projects have stalled in recent years due to a combination of regulatory uncertainty, investment challenges, global market fluctuations and the public attitude. Copper processing has been on the agenda of the government for decades, yet Mongolia still faces significant hurdles in building smelters and refineries. These delays hinder the country's ability to fully capitalize on its copper reserves and secure its position as a key supplier of the metal in the global energy transition.

The government of Mongolia has made efforts to expand copper production through more sustainable practices. For instance, projects around the Erdenet copper mine have initiated small-scale production of copper cathodes from low-grade oxidized ore through hydrometallurgy processes. This process, known as the SX-EW method, helps recover additional copper through heap leaching and solvent extraction of oxidized ores previously considered "off-balance" for the purposes of production. This approach not only helps full utilization of resources, but also provides a means to increase copper output without investing in new mining operations. Although still limited in scale, these initiatives underscore the potential to leverage existing infrastructure and resources to produce more value-added products domestically.[8]

Despite these positive steps, Mongolia's continued reliance on exporting raw copper concentrates limits its ability to capture greater economic benefits and hinders deeper integration into global supply chains for renewable energy technologies and electrification infrastructure.

Because Mongolia's current production of copper is relatively small in relation to the size of reserves it holds, the potential for expanding the sector is immense, especially as global demand surges amid the energy transition and the shift toward electrification. However, unlocking this potential requires overcoming several challenges, including the development of smelting and refining capacities, attracting both foreign and domestic investment, and enhancing infrastructure to support large-scale industrial projects. Policy reforms aimed at promoting responsible mining practices and strengthening local economic impact could also play a pivotal role.

Mongolia's proximity to China - one of the world's largest consumers of copper and a leader in renewable energy technologies - presents a unique opportunity for strategic partnerships and improved market access. By leveraging these advantages, Mongolia has the potential to expand copper mining and move beyond its current focus on raw material exports and emerge as one of the key players in the global copper value chain. Such progress would not only bolster Mongolia's economic growth but also contribute to the broader global effort to achieve a sustainable, low-carbon future.

This research aims to explore Mongolia's ambitions to expand its copper sector, with a focus on the opportunities and challenges involved in positioning the country as a key player in the global copper value chain. In the context of the global energy transition, achieving this goal will require government policies, regulatory frameworks and industry practices to align with both international trends and domestic expectations. The research seeks to provide a comprehensive understanding of existing policies and practices, as well as potential benefits and pitfalls, associated with

Mongolia's copper sector expansion, to help guide policymakers and other stakeholders.

One critical challenge we address here is the apparent slowdown in new exploration projects, compounded by investment constraints, infrastructure limitations and policy obstacles facing copper exploration and mining initiatives. This issue is particularly significant given the government's prioritization of large-scale industrial projects. By analyzing factors that hinder investment and exploration through a political economy lens, the study aims to identify key areas where targeted policies and reforms could enhance the sector's long-term sustainability and productivity.

Another focus of the research is to identify policy gaps and regulatory barriers that limit the development of downstream processing capabilities in Mongolia. Despite its vast copper reserves, the country's mining sector remains predominantly focused on raw material extraction, with much of the value-added processing occurring abroad. This study evaluates the impact of current policies on the sector's growth and examine potential reforms that could stimulate domestic copper processing, smelting and refining activities. These reforms could unlock greater economic benefits, create jobs and more deeply integrate Mongolia into the global copper value chain.

NRGI will communicate the findings from this research to decision-makers in Mongolia, as well as to those seeking comparative insights. The goal is to provide policy-makers with evidence-based recommendations to help balance economic growth objectives with environmental protection, social equity and long-term energy transition goals.

Ultimately, Mongolia's copper sector ambitions must align closely with both the global and the domestic energy transition, recognizing copper's pivotal role in enabling sustainable energy and mining industries. By aligning its copper sector with the demands of the transition, Mongolia can both boost its economic development and play a critical role in the global movement toward a low-carbon, sustainable future.

The remainder of this report is organized as follows. Section 2 examines the role of copper in the context of the global energy transition and its importance to the Mongolian economy. The section also reviews the current state of and outlook for the copper market, with a particular focus on demand and supply dynamics as the energy transition intensifies. Next, Section 3 explores the policy framework that shapes the prospects for copper sector development in Mongolia. The report concludes with Section 4, which summarizes key insights and offers actionable policy recommendations for stakeholders both in Mongolia and internationally. The paper also includes a bibliography and an annex on stakeholder mapping.



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Copper and the energy transition

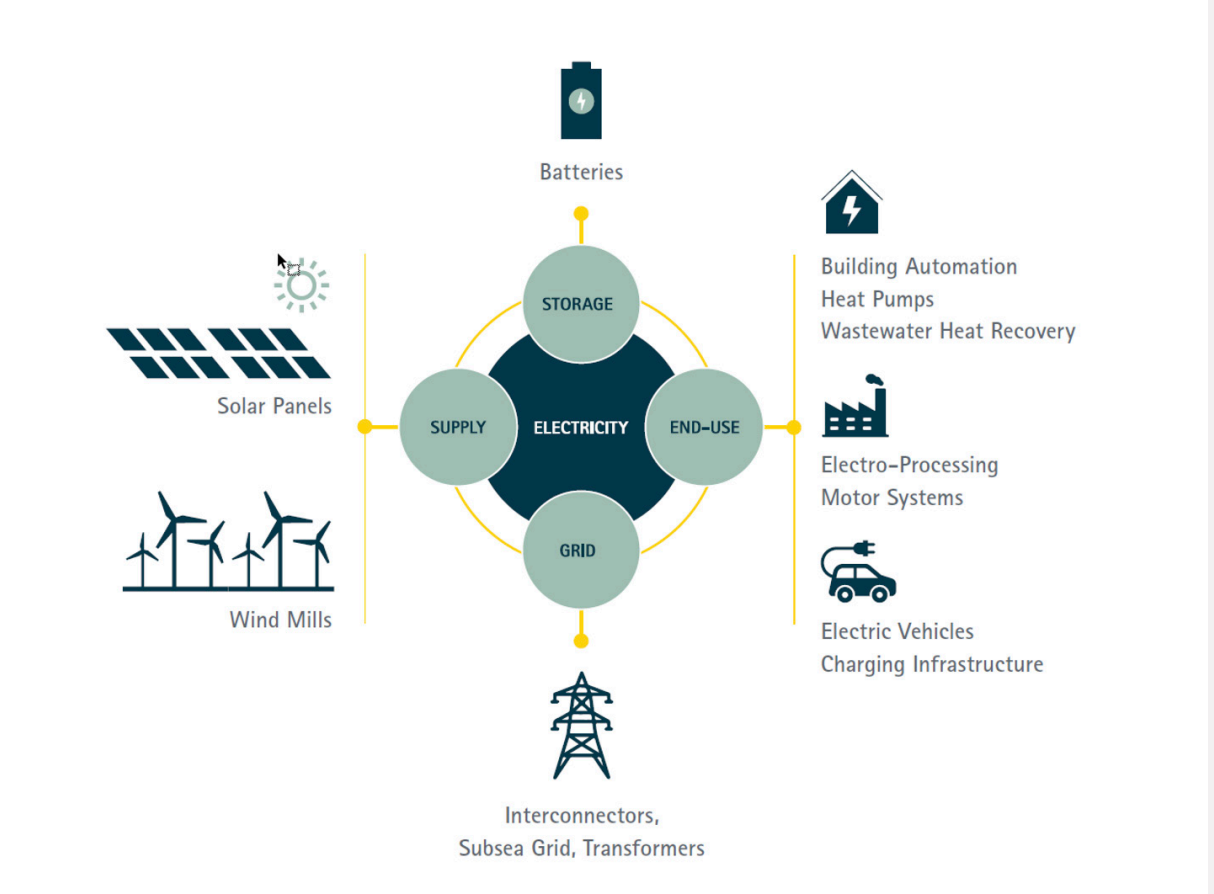
The global picture

Demand-side drivers: copper's role in the energy transition

The role of copper in the global energy transition is integral to technologies that are essential for decarbonization and electrification, such as clean energy production, storage, electric vehicles (EVs), and power grids. As global efforts to combat climate change intensify, the demand for copper is expected to surge. In addition, some countries, particularly those with cold winters like Mongolia, will face increasing pressure and economic opportunities to shift from fossil fuels, such as coal, to electricity for heating. Historically, these countries have relied on coal for large-scale district heating production, but electrification of heating systems will likely become a key strategy in reducing carbon emissions.

Figure 1 illustrates various applications of copper in the energy transition. Copper plays a critical role in the supply of cleaner energy, energy storage technologies, power grid expansion, and end-use technologies such as EVs and charging infrastructure. Alongside these growing uses, more traditional applications of copper will continue to be important.

Figure 1. Uses of copper in the energy transition

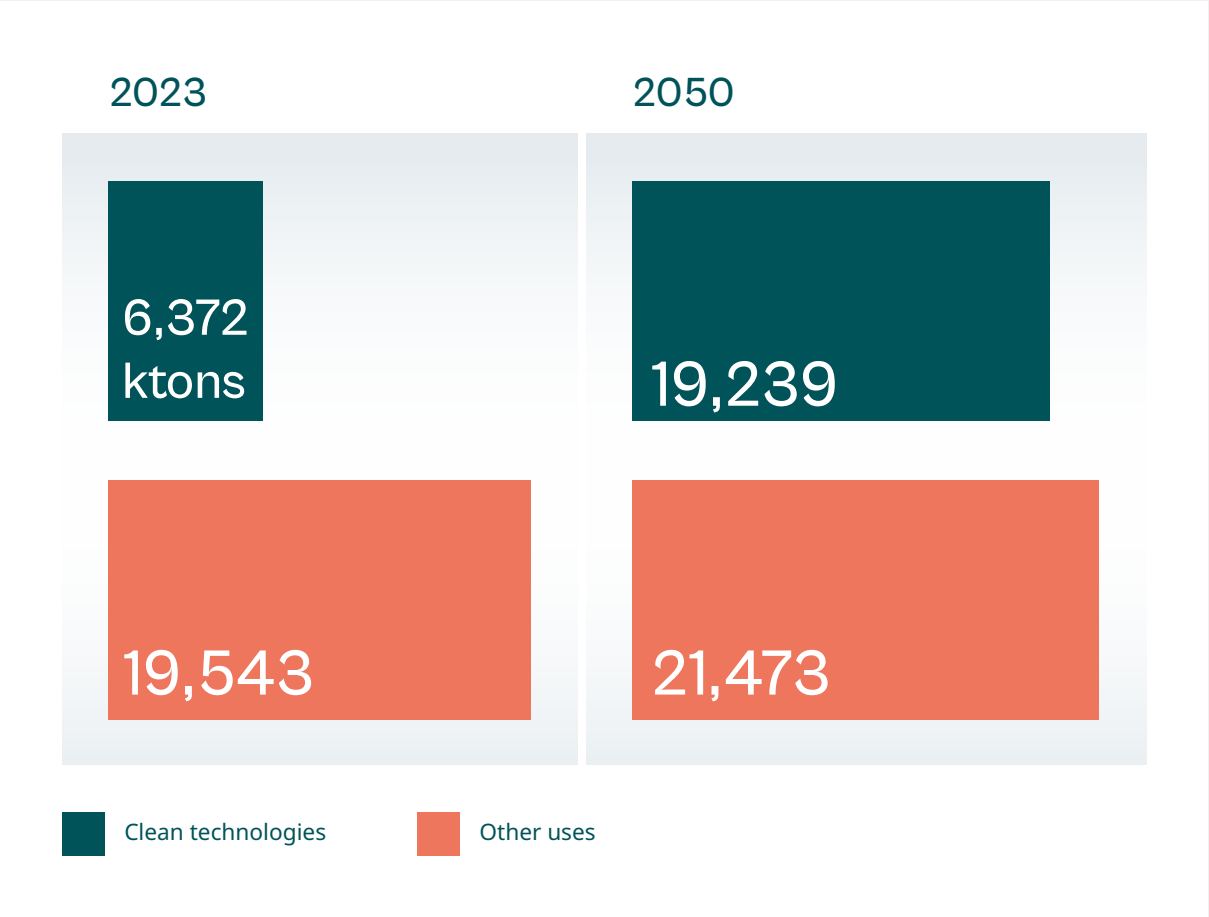


Source: International Copper Association.

Some international agencies have projected an increase in demand for copper and other minerals critical to the energy transition through various studies. One such projection (by the International Energy Agency) suggests that annual copper demand will need to increase from today's level of 25.9 million tons to 40.7 million tons, an increase of almost 1.6 times, by 2050, to meet global net-zero emissions targets.

Most of this increase in copper use will come from the deployment of clean energy technologies. For this purpose, copper demand will increase by 3.0 times over the same period. Figure 2 clearly illustrates this significant increase in copper demand for clean energy technologies, compared to other uses of the metal. The "other uses" category includes copper applications in sectors such as transport and power generation outside of the scope of clean energy.[9]

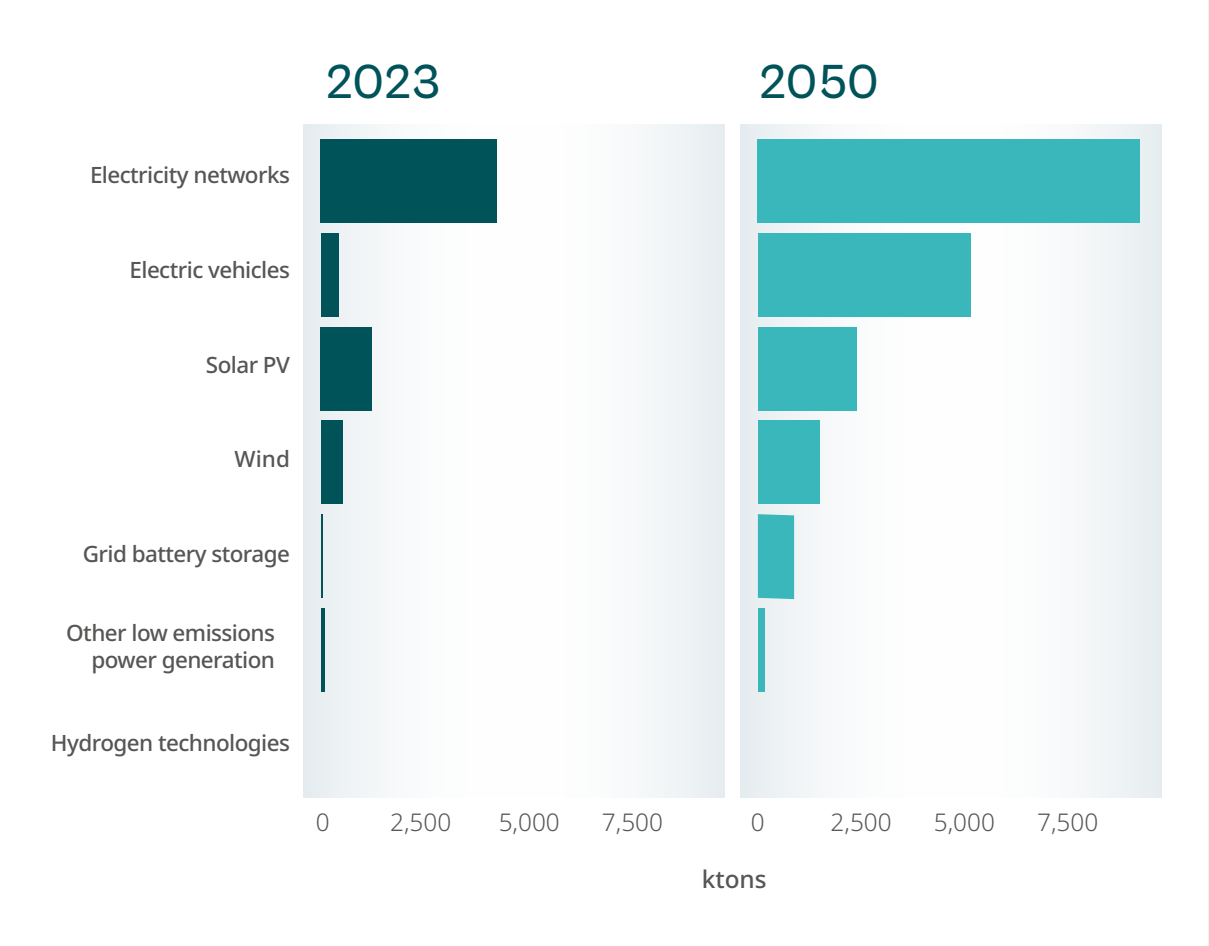
Figure 2. Copper use projections under the IEA Net Zero Emissions scenario



Source: International Energy Agency

Specific uses of copper that drive the largest increases in demand include electricity networks and electric vehicles, which are responsible for increases in copper use by 5.1 and 4.7 million tons, respectively. Figure 3 shows the actual changes needed for various copper uses.

Figure 3. The breakdown of copper demand under the Net Zero Scenario



Source: International Energy Agency

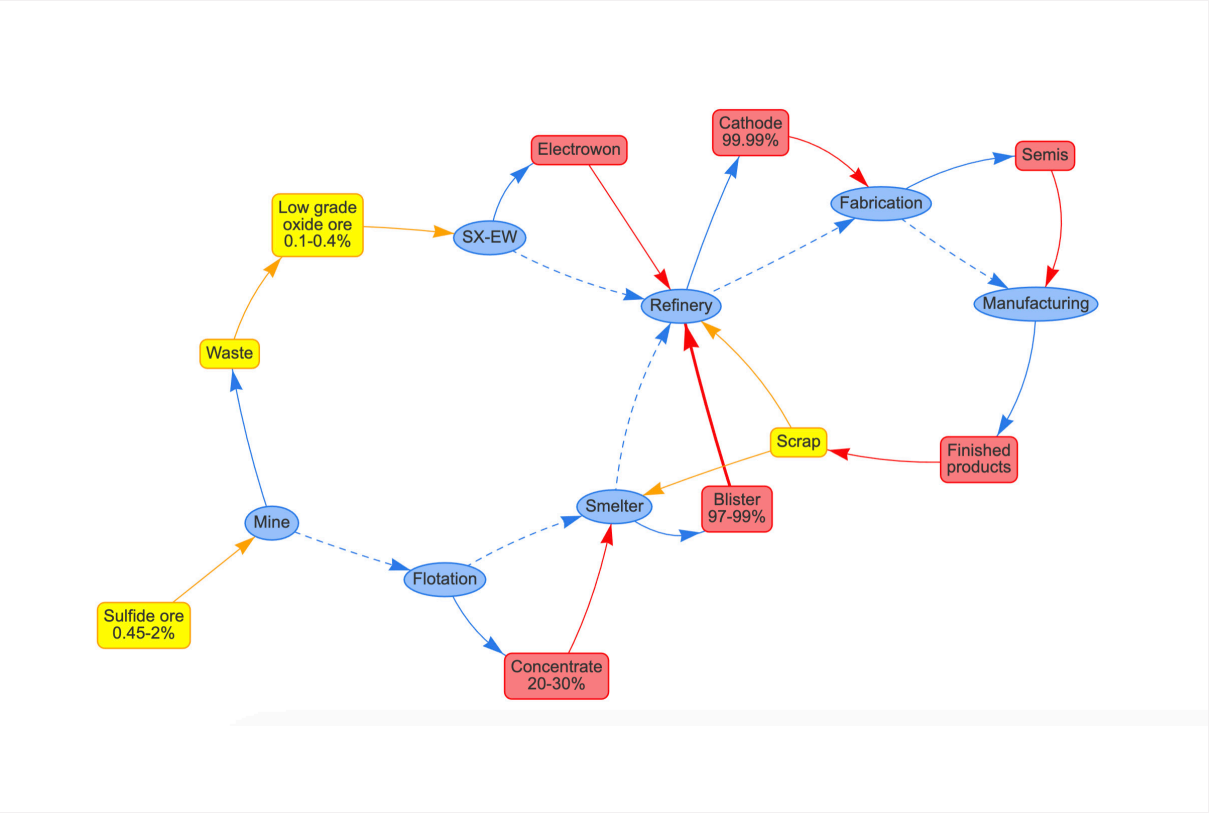
Supply of copper today

The copper supply chain is complex and involves multiple countries and stakeholders at various stages. Generally, the upstream portion of the chain encompasses the production of copper concentrate through exploration and mining. The downstream segment includes the production of refined copper through smelting and refining processes, the fabrication of semi-finished or pure copper products, and the production of finished goods incorporating copper in manufacturing.

The supply chain is further complicated by different methods of copper production and the recycling of scrap copper. Trade in copper occurs across a range of products with varying levels of purity, including concentrates, blisters, refined copper, ingots, alloy metals and semi-finished products.[10]

Current copper demand, estimated at 25.9 million tons in 2023, is met through both mining and processing of copper ore and the recycling of scrap metal. Figure 4 illustrates the general framework of the copper supply chain.

Figure 4. Copper Lifecycle



Primary copper production begins with the extraction of copper from open-pit and underground mines, where most ores contain less than two percent copper. Mining companies crush and grind the extracted ore, and then use flotation processes to produce copper concentrates, which typically contain up to 30 percent copper. These concentrates are then smelted to produce copper blister, which has a purity of up to 99 percent. The blister is further refined to produce copper cathode, or pure copper, with a grade of around 99.99 percent. This process is known as pyrometallurgy, and is suitable for sulfide ores as opposed to oxide ores.[11] The pure copper then feeds into the fabrication of various copper products, such as wire rods, wires, bars, and sheets—collectively known as semis—used as inputs in the manufacturing of end-use products, including consumer goods and construction, transportation (e.g., EVs) and infrastructure components.

Some copper ores contain copper levels that are too low for economical extraction through the pyrometallurgy process, or are formed as a result of oxidization of mining waste stocks. For these ores, copper can be extracted through SX-EW, a method also known as hydrometallurgy.[12] The product of this process is copper cathode. In 2023, an estimated 20.4 percent of total copper mine production (not including secondary or scrap production) came from SX-EW.[13]

Copper production through pyrometallurgy and SX-EW is categorized as primary copper production. However, recycling of copper scrap is also a crucial component of the copper supply chain. Depending on the type of scrap, it can be either smelted or refined. In 2023, secondary copper production, derived from recycled scrap, accounted for 16.9 percent of refined copper production.[14]

Chile, USA, Peru and Australia are the countries with the largest resources and reserves of copper, and their combined share of global copper resources and reserves is approximately 51.4 percent. In total, global copper resources and reserves are estimated at 2.7 billion tons of copper, with data covering 1,386 active projects. Table 1 summarizes these data.

Table 1: Copper resources and reserves

Resources and reserves				
Country	Global rank	mm tons	percent	Active projects
Chile	1	721.14	26.9	78
USA	2	264.12	9.8	99
Peru	3	237.87	8.9	66
Australia	4	155.50	5.8	202
Dem. Rep. Congo	5	127.08	4.7	33
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Rest of the world	NA	597.25	22.3	373
Total	**—**	**2,682.96**	**100**	**1,386**

Source: Data from SP Capital

While the data on resources and reserves suggest that already identified deposits beneath the earth could potentially meet the growing demand for copper, the actual utilization of these resources will likely depend on a variety of factors. These include geopolitical considerations, the cost profiles of different projects, and the need to channel significant investments into the sector.

In fact, only a small fraction of the estimated resources and reserves can be mined at any given time, due to various factors. For example, the current levels of primary copper production, i.e., through mining, amount to about 18.6 million tons. Chile, Peru, Dem. Rep. Congo and China lead the world as the top producers of primary copper, as Table 2 shows.

Table 2: Copper production by countries

Production in 2023		
Country	**ktons**	**rank**
Chile	4,955.2	1
Peru	2,221.0	2
Dem. Rep. Congo	1,600.8	3
China	1,279.5	4
USA	1,158.7	5
Indonesia	918.3	6
Australia	729.7	7
Zambia	714.9	8
Kazakhstan	678.5	9
Mongolia	291.6	16
Rest of the world	4,050.7	

Source: Data from SP Capital

Current production levels must increase to meet the anticipated rise in copper demand. Investments in exploration projects, capital expenditures, and the pipeline of exploration and pre-production projects globally serve as key indicators of the potential for a rapid ramp-up in production.

As Table 3 shows, while overall exploration budgets are gradually recovering from the dip in the mid-2010s, the largest increases in exploration have been in Australia, Canada and Latin American countries. Notably, the Pacific/Southeast Asia region is lagging behind, despite significant projected growth in demand in this region.

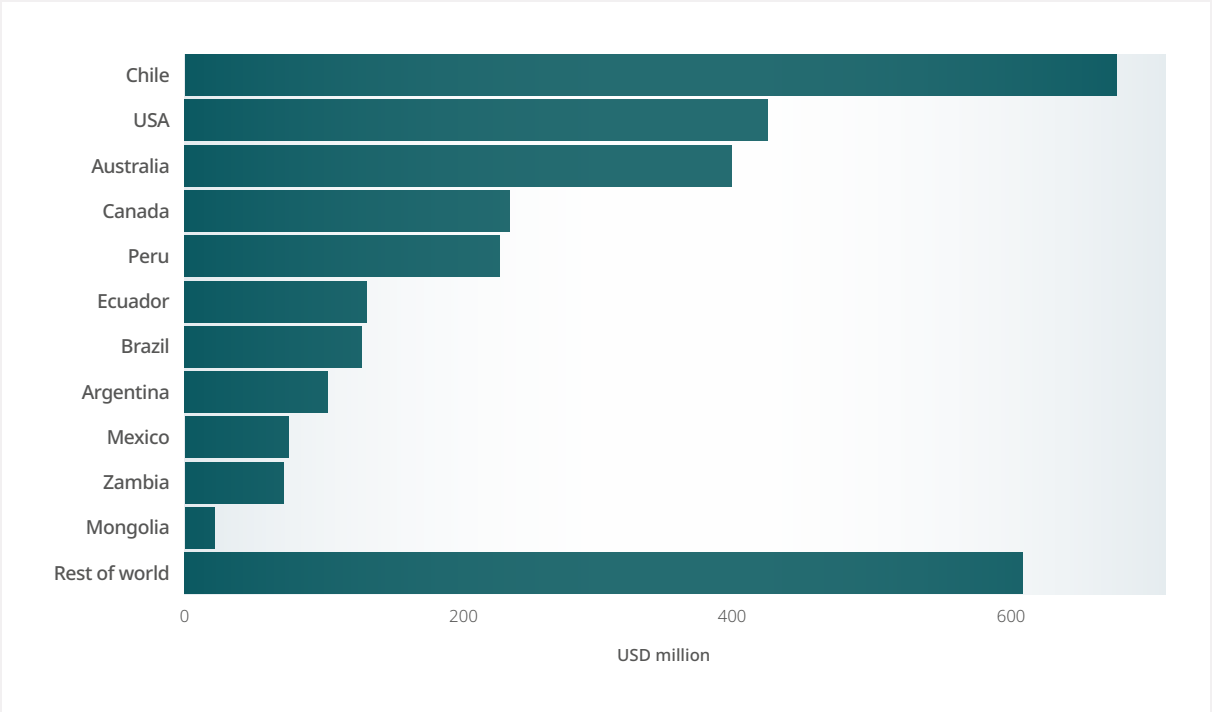
Table 3: Copper exploration budgets in 2009-2023 by locations (in USD million)

Location	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Africa	196.8	237.7	460.7	640.5	523.7	401.7	262.0	164.6	174.4	245.6	168.4	134.6	124.6	155.4	192.0
Australia	140.6	237.0	489.0	571.7	355.8	284.5	201.6	142.2	139.3	199.0	272.0	181.3	297.3	394.2	399.4
Canada	107.2	194.2	253.2	308.4	183.4	141.3	103.6	70.2	59.8	85.6	91.2	81.4	201.5	232.9	235.9
Latin America	641.7	878.6	1,176.3	1,459.6	1,282.1	1,041.4	837.7	632.2	748.4	904.0	998.9	740.0	896.0	1,201.1	1,431.1
Pacific / SE Asia	139.0	221.4	332.3	433.6	306.7	188.3	168.0	174.7	145.1	106.4	118.9	67.1	71.4	59.1	71.4
Rest of World	300.6	337.8	570.1	815.6	478.3	445.6	331.2	266.1	308.2	326.8	298.5	300.2	361.2	340.8	362.8
USA	82.4	150.6	375.4	469.7	335.3	175.0	177.5	126.9	128.9	207.4	373.3	254.1	357.0	407.4	425.3
Total	**1,608.3**	**2,257.3**	**3,657.0**	**4,699.1**	**3,465.3**	**2,677.8**	**2,081.6**	**1,576.9**	**1,704.1**	**2,074.8**	**2,321.2**	**1,758.7**	**2,309.0**	**2,790.9**	**3,117.9**

Source: Data from SP Capital

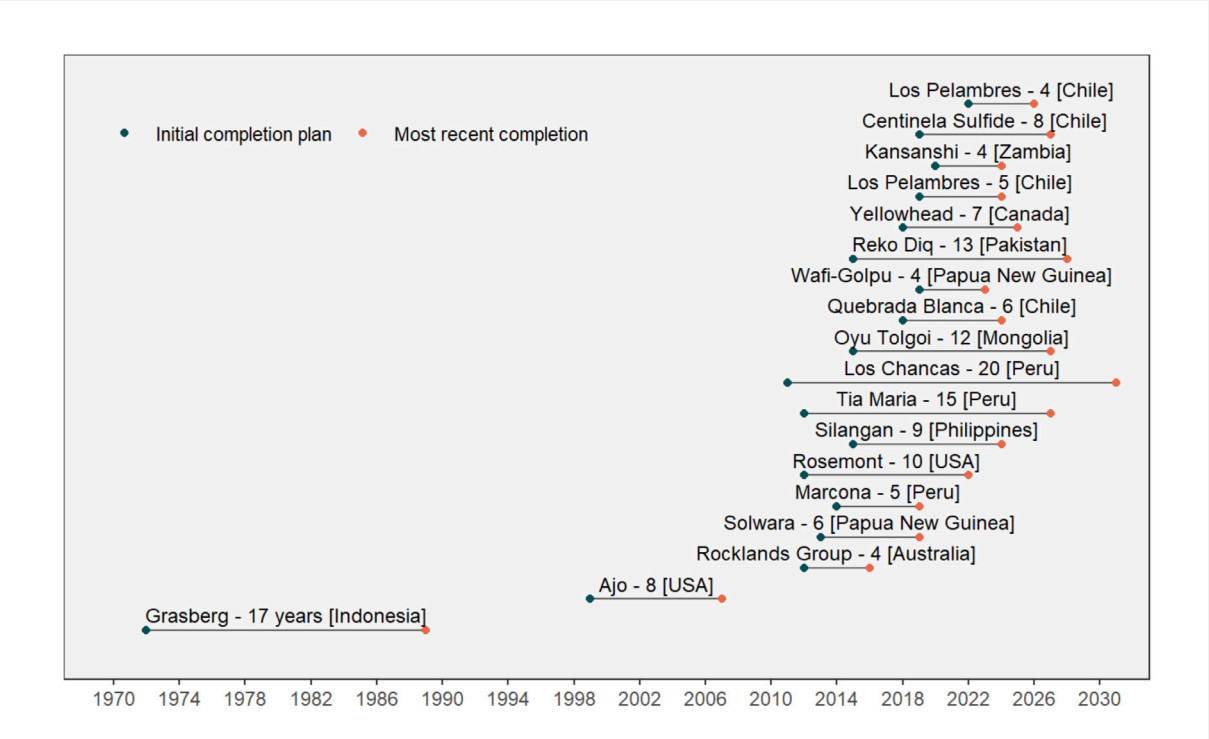
Looking more closely at exploration budgets in 2023, the data from Figure 5 reveals that the top five countries with the highest expenditure on copper exploration projects were Chile, USA, Australia, Canada and Peru.

Figure 5. Copper exploration budgets in 2023



While countries may have significant estimated reserves of copper, they often may struggle exploiting these reserves and bringing the projects to production in a short time period. There may be many reasons to this, from political, infrastructure, geo-physical and other challenges to lack of funding or poor project management. For instance, the data on capital expenditures for constructing, sustaining, or expanding copper mines, illustrated in Figure 6, shows that many projects encounter delays, some extending up to two decades. Notably, even highly experienced companies and large-scale projects like Grasberg and Oyu Tolgoi are not exempt from substantial delays in capital investments.

Figure 6: Copper project delays for more than four years



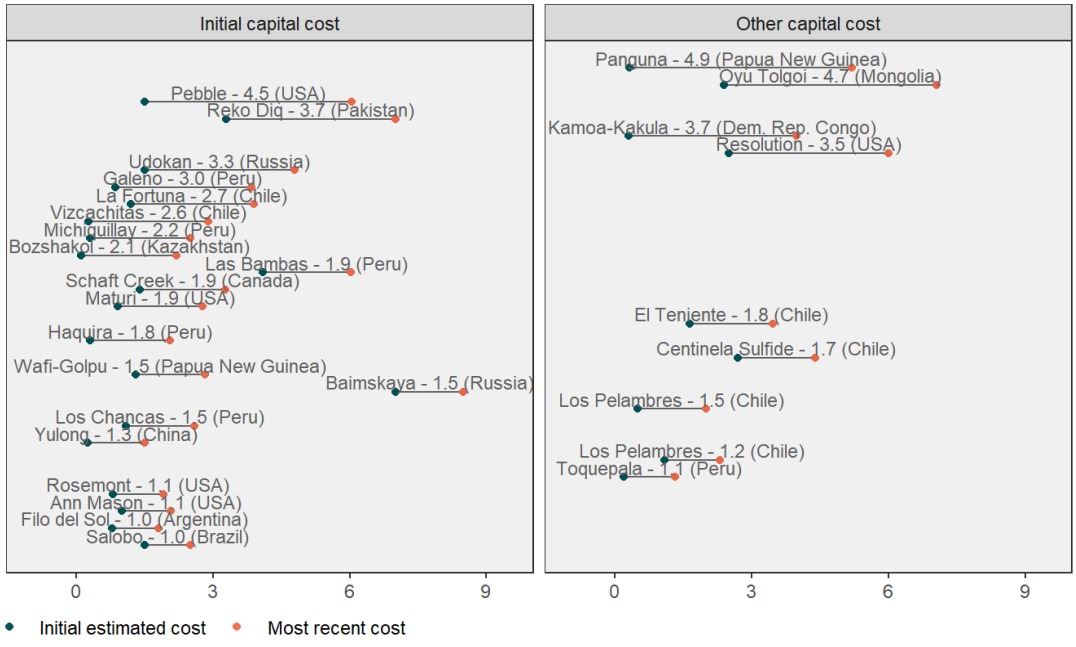
Source: Data from SP Capital

Capital expenditure is crucial for both starting and sustaining copper mines. However, cost overruns have been frequent and substantial, with many projects encountering delays spanning multiple years and significant overruns. These challenges complicate attracting investment for developing reserves identified through exploration.

Figure 7 highlights the “club of project billionaires”, referring to copper projects that have experienced at least a USD 1 billion cost overrun. Some projects have faced cost overruns of up to USD 5 billion, even when categorized into initial, sustaining and expansion capital expenditure.

Notably, out of 1,651 projects with available capital expenditures data, 39.6 percent are brownfield projects (i.e., expansion of existing projects), while only 28.6 percent are greenfield projects. This suggests that developing new mines without existing infrastructure or a history of mining presents significant challenges, even with established copper resources and reserves. Many brownfield projects will likely experience decreasing grades and increasing costs. Data for the remaining projects is unavailable.[15]

Figure 7: Copper project cost overruns (in USD billion)



Source: Data from SP Capital

In terms of specific projects in the pipeline awaiting realization, 154 projects are currently on the radar. Of these, 38 are categorized as close to realization (committed), 51 as probable and 65 as possible. The potential capacity of these projects is projected to reach 12 million tons.[16] Table 4 provides more detailed information about these pipeline projects, which are expected to be commissioned between 2024 and 2044.

Table 4: Copper projects in development (thousand tons)

Status				
Country	**possible**	**probable**	**committed**	**Total**
Chile	1,091	468	700	2,259
Argentina	800	361	0	1,161
Russia	320	385	340	1,045
US	665	147	38	850
Peru	553	240	40	833
Indonesia	315	444	0	759
Canada	449	110	73	632
DRC	155	280	45	480
Philippines	0	393	25	418
Mongolia	75	0	0	75
Rest of the world	1,372	872	943	3,187
Overall	**5,795**	**3,700**	**2,204**	**11,699**

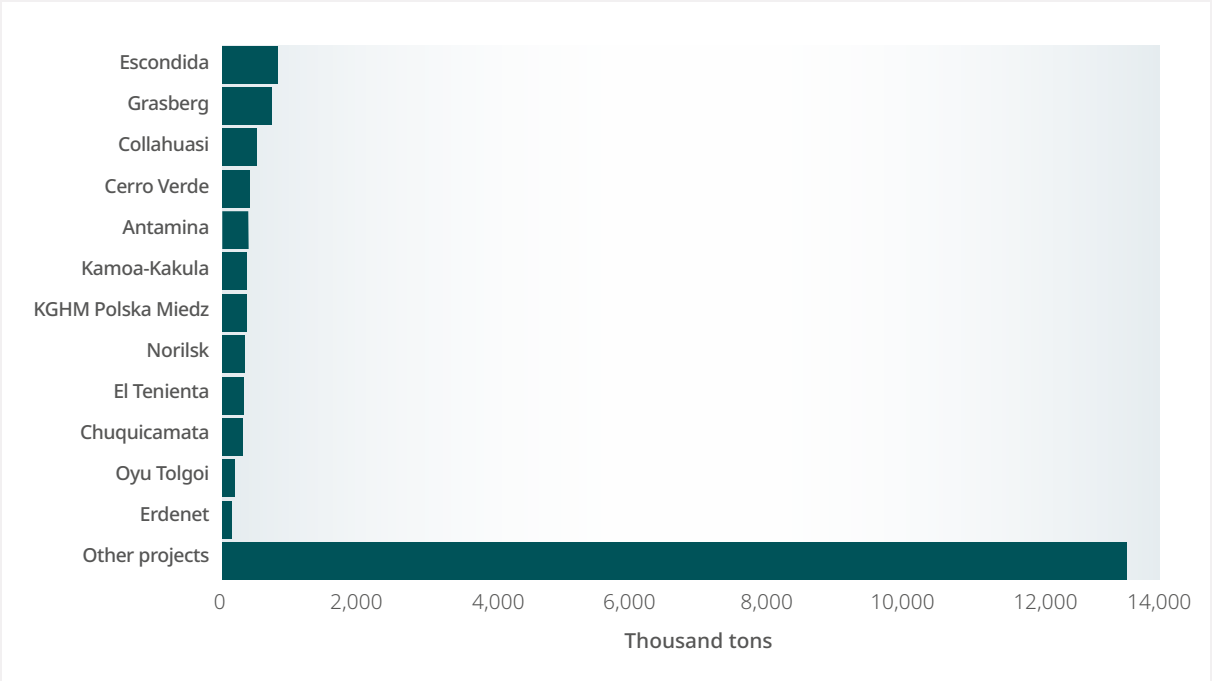
Source: Data from SP Capital

Copper production is geographically widespread, with even the largest projects contributing only a fraction of global output, as Figure 8(a) illustrates.

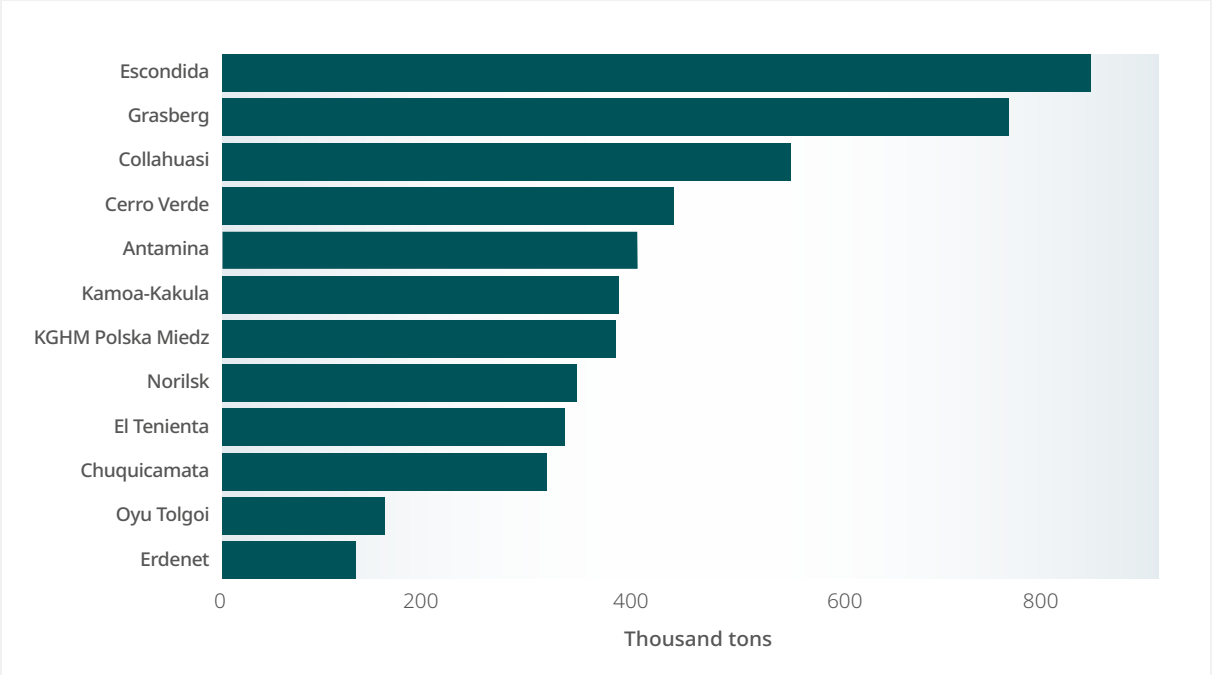
Among the top projects by production volume, Escondida, Grasberg, Collahuasi and Cerro Verde are the leading contributors.

Figure 8: Top copper projects globally and in Mongolia in 2023

(a) All projects



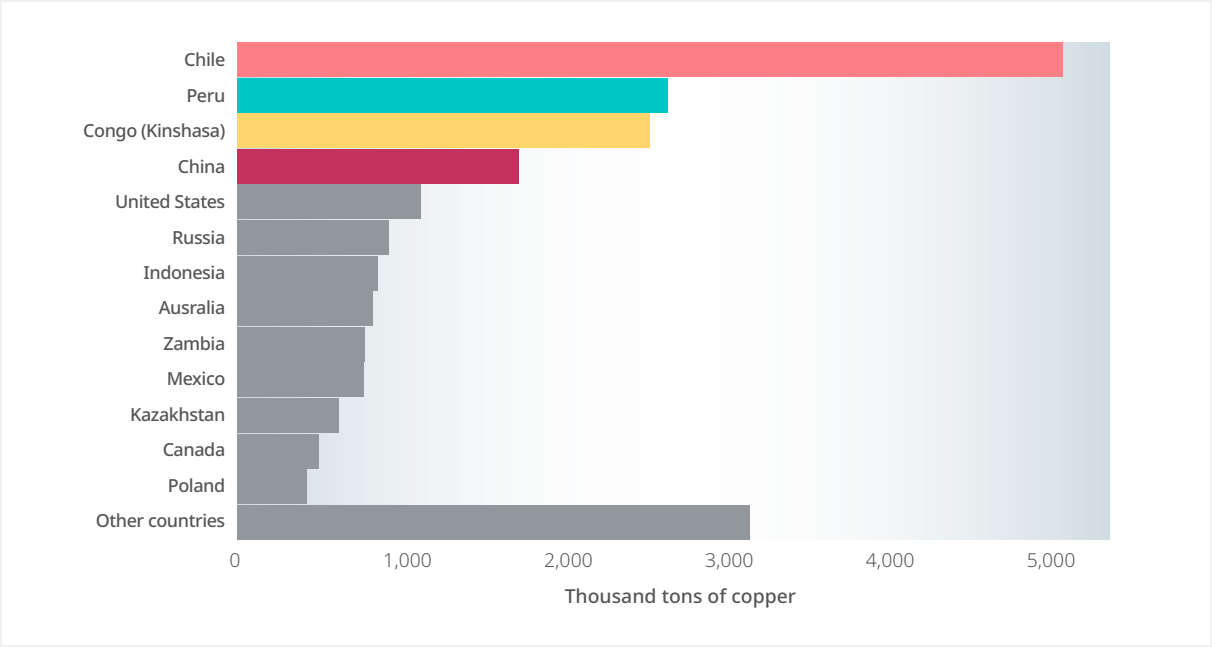
(b) Leading projects



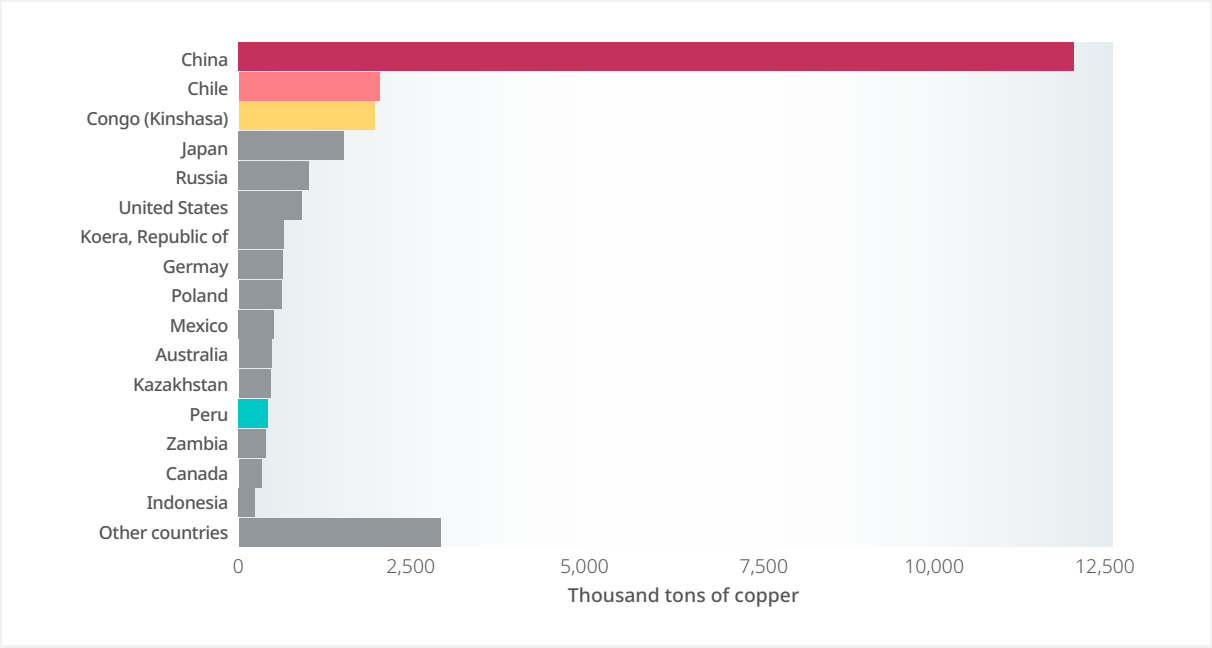
While copper mining occurs in specific regions where there are resources and reserves, processing does not necessarily take place in the same jurisdictions. Many countries with copper mining capacities also engage in processing, but some opt to transport a portion of their mined copper concentrate to other countries for treatment and refining. Notably, China dominates the global processing industry, whereas countries like Peru, despite their significant copper mining operations, have limited domestic smelting and refining capacity, as Figure 9 illustrates.

Figure 9: Mining and refinery production of copper in 2023

(a) Mine production



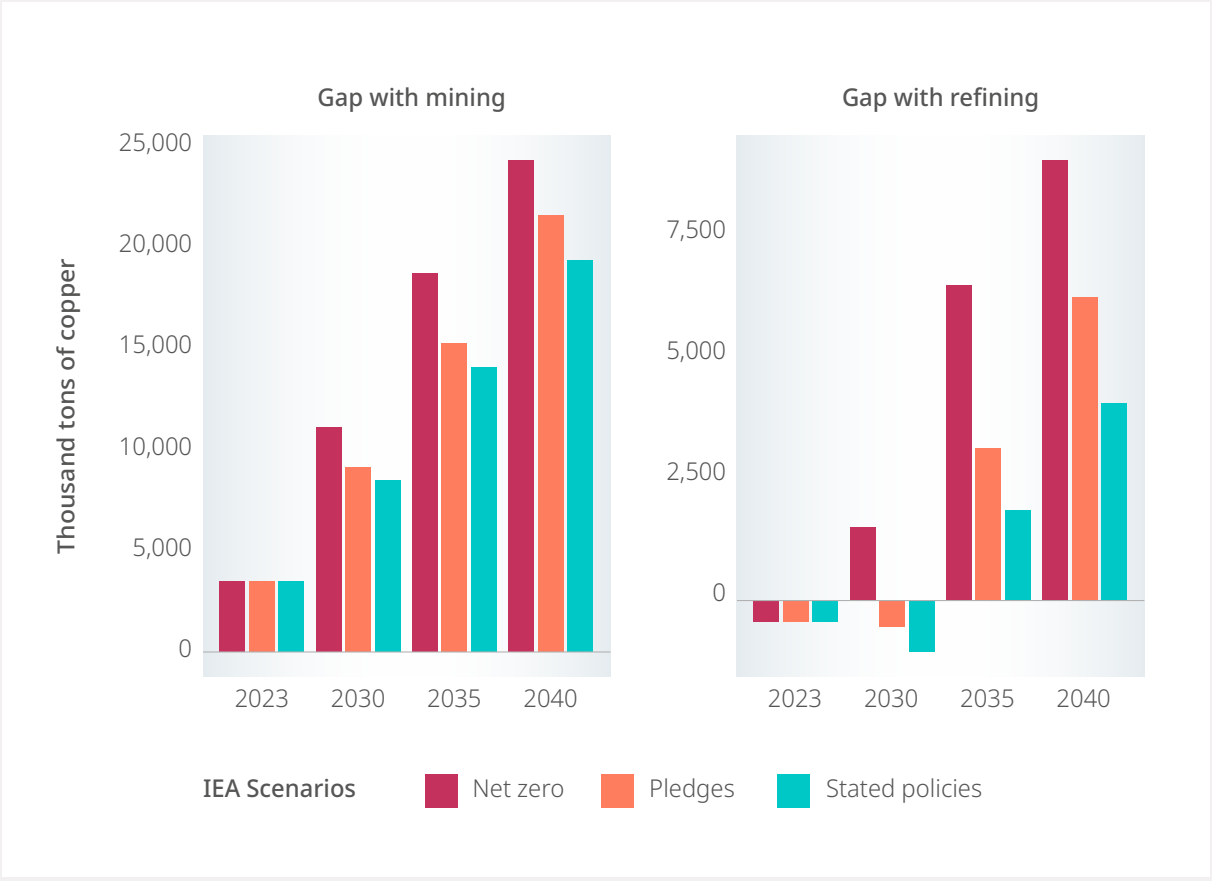
(b) Refinery production



In short, as the world embraces the energy transition, copper demand is likely to grow significantly in the future, mostly due to the increased deployment of clean energy technologies. However, supply pressures may mean that copper supply does not catch up with this increase in demand easily, despite significant established reserves and resources and a pipeline of projects.

In fact, the gap between supply and demand is significant under the IEA's Net Zero-2050 scenario for both mining and refining production, as Figure 10 shows, especially from 2035 onwards. In general, the gap between refining and various demand scenarios is less acute than the gap between mining and demand, suggesting that secondary reprocessing of scrap copper is likely to increase. Still the gap with demand is significant even for refinery products.

Figure 10: Potential supply-demand gap for copper under IEA scenarios



We can conclude that copper demand is expected to rise significantly in the coming years due to the global energy transition and renewed interest in the metal, and that the supply of copper can likely meet this demand if countries with copper reserves can attract the necessary investments and manage their resources sustainably. Before exploring the feasibility of the current approach that Mongolia follows, we first provide a brief introduction to the copper sector in the country.

Mongolia's copper sector

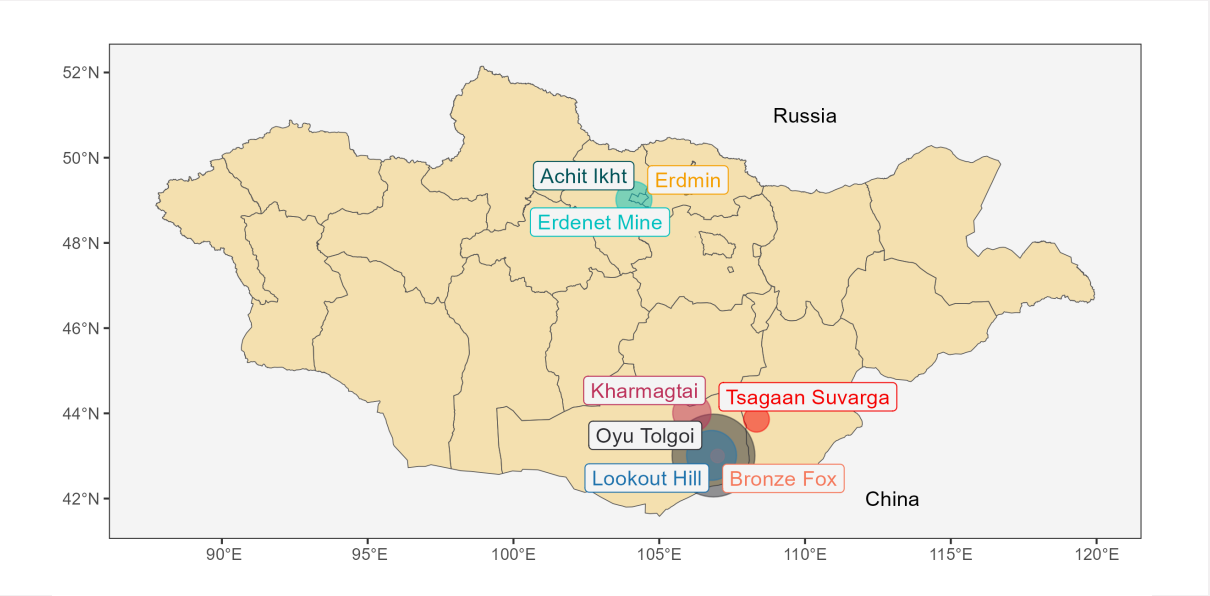
Mongolia is a vast, landlocked country bordered by Russia to the north and China to the south. Despite its expansive size, the country has a relatively small population of about 3.5 million people, making it one of the least densely populated nations in the world. A significant portion of Mongolia's territory remains underexplored geologically. Only 33.7 percent of the territory has been mapped geologically at the scale of 1:50,000, leaving considerable potential for the discovery of new mineral resources. This is especially notable given the history of large-scale mineral discoveries in recent decades.

In recent years, Mongolia has transformed into a mining-driven economy, particularly over the last quarter-century. Mining contributed 28.1 percent of Mongolia's gross domestic product (GDP) in 2023, and accounted for 86.6 percent of its exports. Among the country's key minerals, copper stands out alongside coal, contributing approximately 19.0 percent of the country's total export earnings. While coal remains significant, copper holds greater promise for the future, especially as global demand for coal declines.[17] Copper is expected to play a critical role in Mongolia's economic future, largely due to its increasing importance in the global energy transition. Mongolia is home to substantial copper reserves, particularly in its southern regions, where some of the world's largest copper deposits have been identified.

The Oyu Tolgoi mine, one of the largest known copper-gold deposits globally, is the most prominent mining project in the country. While specific data on copper resources and reserves is scarce, some sources estimate Mongolia's copper resources at around 64.0 million tons, ranking the country 12th in the world.[18] However, much of Mongolia's copper potential remains untapped due to under-exploration, policy and regulatory challenges and the need for substantial investments in infrastructure and mine development.

Two key copper projects are responsible for nearly all of Mongolia's copper output. One is the Erdenet mine, which has been operational since 1978 and was the country's first major copper production facility. The other is Oyu Tolgoi, which began production in 2013. Both mines produce copper concentrate and export their production to China. Additionally, Erdenet hosts smaller-scale SX-EW operations, which use waste dumps from the mine to produce copper cathodes through solvent extraction/leaching and electrowinning. These operations, including Erdmin and Achit Ikht, have been active since 1997 and 2014, respectively. Another company, Zes Erdeniin Huvi, started the third such operation in 2023. Further, there are several advanced copper exploration projects in the pipeline, such as Tsagaan Suvarga and Kharmagtai. Figure 11 shows the location of these projects and their respective reserves.

Figure 11: Selected Mongolian copper projects (size of circles indicates the relative size of reserves)



Source: Data on reserves from SP Capital

Operating mines

Erdenet Mining Corporation, established in 1978, operates the Erdenet mine and is a cornerstone of Mongolia's industrial economy. Initially founded as a joint venture between the Mongolian government and the Soviet Union, it became fully state-owned in 2017 after Mongolia acquired the Russian Federation's stake. Erdenet has long symbolized Mongolia's transition to a mining-driven economy and continues to be a major contributor to the country's GDP and export revenues. The Erdenet deposit, located in northern Mongolia, is primarily a porphyry copper-molybdenum deposit. Exploration work has continued around the mine site and current geological reserves are estimated at 3.9 million tons of copper.[19] In fact, the company itself reports that reserves of the deposit it possesses stand at 10.7 million tons of copper and 500,000 tons of molybdenum, allowing operations for and estimated 70 more years.[20]

Erdenet mine's annual output stands at approximately 600,000 tons of copper concentrate and around 5,000 tons of molybdenum concentrate.[21] The company sells its products to China through various commodity traders and transports the concentrate by railway.

While the Erdenet mine is a mature operation, its long-term sustainability depends on continued modernization and technological upgrades. Ongoing initiatives include improving beneficiation processes to maximize recovery from lower-grade ores and exploring untapped areas around the deposit to extend its operational lifespan. Additionally, the government plans to utilize Erdenet to develop a metallurgical and chemical complex, including a copper smelter. While such plans have been in place for some time, progress has been slow.

Oyu Tolgoi, located in the southern Gobi Desert, is Mongolia's flagship mining project and has brought the country to prominence in the global mining sector over the past two decades. Oyu Tolgoi LLC, the company jointly owned by the Mongolian government (34 percent) and Turquoise Hill Resources (66 percent), holds the licenses for the deposit discovered in 2001. Rio Tinto owns the latter company and manages the mine operations. Production from the open-pit mine began in 2013, and the underground phase, which contains the bulk of the reserves, began in 2023 as the mine enters the final stages of its development.

Oyu Tolgoi is one of the world's largest copper-gold deposits, with estimated reserves of 31.5 million tons of copper and 1,200 tons of gold[22] The deposit also contains silver and molybdenum as by-products. Currently, Oyu Tolgoi produces copper concentrate from its open-pit operations, yielding approximately 120,000 to 150,000 tons of copper annually. With the underground operation now on stream, the company will blend ore from the open-pit with higher-grade ore from underground to maintain steady production.

Upon full commissioning of the underground operations, expected in 2028, production is projected to exceed 500,000 tons of copper per year, positioning the project as one of the largest copper producers in the world. The company sells its production to China, transporting the concentrate by truck. Notably, the Chinese state owned company Chinalco holds shares in Rio Tinto through its subsidiary, comprising at least 14 percent of the capital in Rio Tinto's UK registered company and 10.32 percent in its Australia entity.[23]

The Mongolian government has previously expressed intentions to use both Oyu Tolgoi and Erdenet as the basis for developing copper smelting and refining capacities. However, these plans have yet to materialize.

Projects with potential for near term development

Tsagaan Suvarga, located near Oyu Tolgoi in Dornogovi Province, is a copper-molybdenum project owned by Mongolyn Alt Corporation (MAK), a leading private mining company. Although the deposit was identified decades ago, the development of the project has progressed slowly due to financing and infrastructure challenges. The deposit is estimated to contain 1.6 million tons of copper and 66,000 tons of molybdenum. Once operational, Tsagaan Suvarga is expected to produce approximately 320,000 tons of copper concentrate annually, significantly boosting Mongolia's copper output.

If realized, the project has the potential to position Mongolia as a regional leader in copper production. However, its successful development will depend heavily on investments in transportation and energy infrastructure, securing long-term export agreements with neighboring countries such as China, and addressing fiscal, political and legal arrangements.

Kharmagtai, an emerging copper-gold deposit located in Umnugovi Province, is approximately 120 km north of Oyu Tolgoi. The project is owned by Australian-listed Xanadu Mines and has been under exploration since the 1990s, but it has gained significant attention in recent years due to its high-grade deposits and strategic location.

Kharmagtai hosts an estimated 2.3 million tons of copper and 6 million ounces of gold, making it a promising candidate for future development.[24] While the project is still in the exploration phase with no current production, feasibility studies indicate the potential for a large-scale open-pit mine with significant copper and gold output. The project's proximity to Oyu Tolgoi and existing infrastructure provides a strategic advantage for its development. Its expansion, however, is contingent upon attracting further investment and navigating regulatory approvals. Zijin, a Chinese mining giant, holds a 50 percent interest in Xanadu Mines which in turn holds the overwhelming majority interest in the project company.[25]

Hydrometallurgy projects

Achit Ikht, founded in 2014, is a hydrometallurgical plant, specializing in the production of copper cathode. Unlike traditional mining operations, Achit Ikht processes oxide ores from another company, Erdenet mine. The plant produces approximately 10,000–15,000 tons of copper cathodes annually using solvent extraction/ leaching and electrowinning (SX-EW) technology.

As global demand for refined copper grows, Achit Ikht has the potential to expand by securing additional feedstock sources and upgrading its processing facilities. Its focus on hydrometallurgical processing aligns with global trends toward increased use of this method in copper production. However, the future of the project depends on the availability of feedstock from Erdenet.

Erdmin, established in 1997, near the Erdenet mine, was one of the first facilities in Mongolia to adopt SX-EW technology and pioneered domestic value addition to copper production. Like Achit Ikht, Erdmin relies on the derivative ore from Erdenet. The plant produces approximately 3,000 to 5,000 tons of copper cathodes annually, catering primarily to domestic and regional markets. Although Erdmin's scale limits its growth, further investments in feedstock supply and processing technology could enable it to expand its production capacity.

In summary, Mongolia's copper sector presents a dynamic mix of mature operations, globally significant projects and emerging opportunities. From Erdenet's long-standing contribution to Oyu Tolgoi's world-class potential and the promising prospects of newer developments like Kharmagtai, the sector is poised for further growth. However, challenges such as infrastructure limitations, high capital costs and regulatory hurdles need to be addressed. Projects like Achit Ikht and Erdmin demonstrate Mongolia's potential to move up the value chain through innovative processing technologies, highlighting opportunities for sustainable and diversified growth in the country's copper industry. Despite this progress, copper processing in Mongolia has mostly remained aspirational and faces significant challenges.

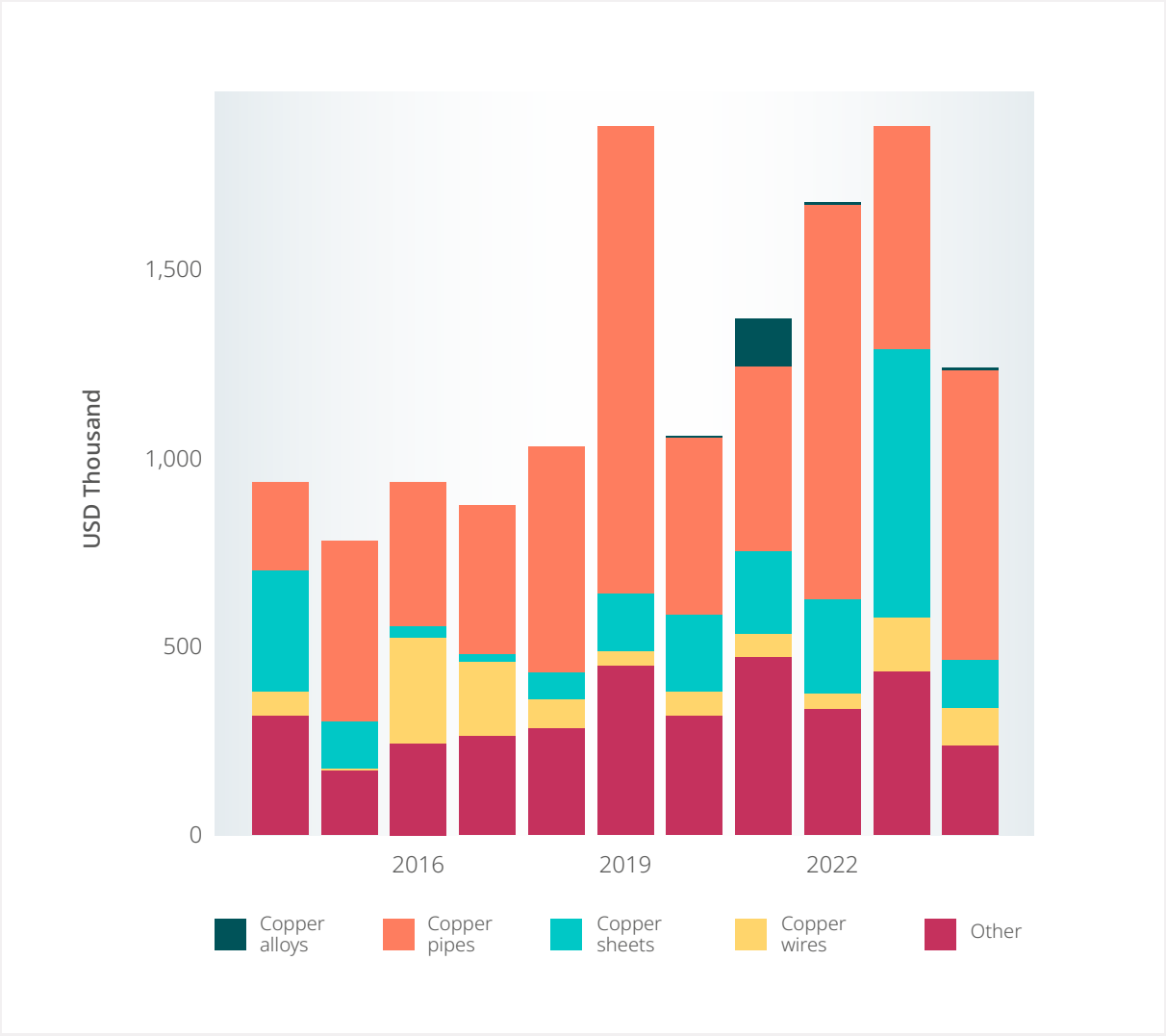
Copper product imports

While Mongolia is a copper producer, it primarily imports final copper products, especially for use in the energy and industrial sectors. As the country seeks to revitalize its energy sector, there is a growing need to expand its existing energy production and transition to cleaner sources of power. These technologies rely heavily on copper, but will also require substantial investments in Mongolia's power grid. Currently, the grid is insufficient to meet the increasing demand for electricity, especially given the country's vast territory and rapid urbanization, and the challenges of integrating renewable energy sources into the centralized grid.

Copper plays a crucial role in power grid infrastructure due to its excellent electrical conductivity. It is essential in the construction of transmission lines, substations, and other vital components of electrical networks. As Mongolia moves to modernize and expand its energy grid, domestic copper demand is expected to rise, particularly as the country advances renewable energy projects such as wind and solar power.

Figure 12 illustrates the value of copper product imports to Mongolia. While the import value is not substantial, these data represent only semi-final copper products, excluding imports of other final or semi-final products that contain copper.

Figure 12: Mongolia's copper product imports by product type

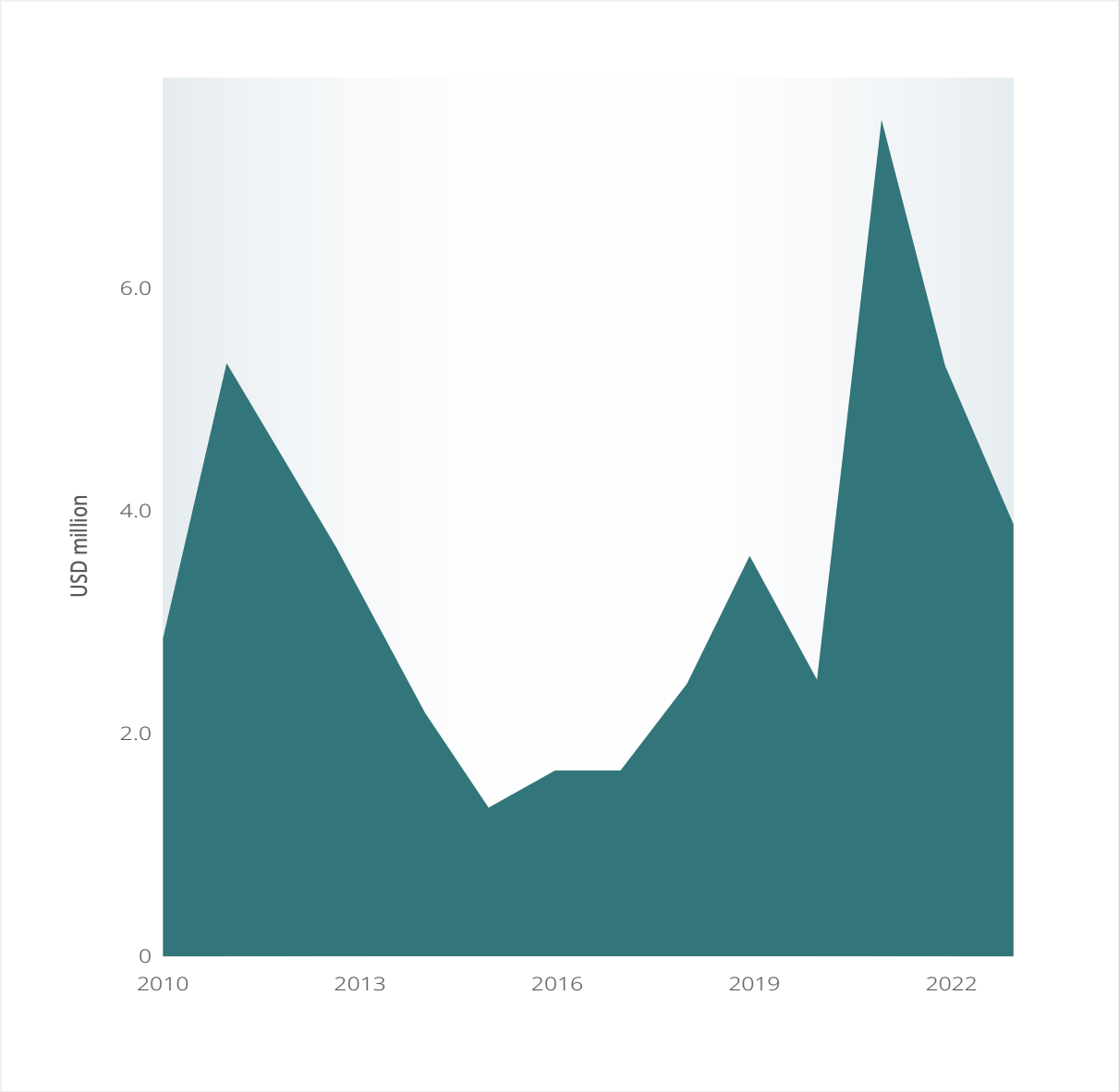


Source: 1212.mn

Data from other sources suggest Mongolia's copper imports are significantly higher than previously mentioned, having increased in recent years The value of these imports reached USD 7.5 million in 2021, as Figure 13 shows. Another important aspect of Mongolia's copper sector is the role of the government.

The state not only sets targets and policies for development and regulation but also owns specific copper mines and operations. We discuss the policy environment governing the copper sector in the next section.

Figure 13: Mongolia's copper product imports by total value



Source: Trade in critical minerals data

Copper sector expansion strategies and policies

While Mongolia possesses significant copper resources, it faces challenges related to exploration, mining capacity, processing, and infrastructure development. However, as mentioned above, with the global demand for copper rising - driven by the energy transition and renewable energy technologies - Mongolia has the potential to become a major player in the global copper market. Achieving this will require it to attract investment, expand processing capacity and leverage copper's role in the development of energy infrastructure, particularly in the power sector.

The Mongolian government has expressed its intent to support copper sector development through various policies and initiatives. In general, Mongolia's copper sector expansion ambitions can be categorized into two main areas: copper production through mining and copper processing to add value to copper products.

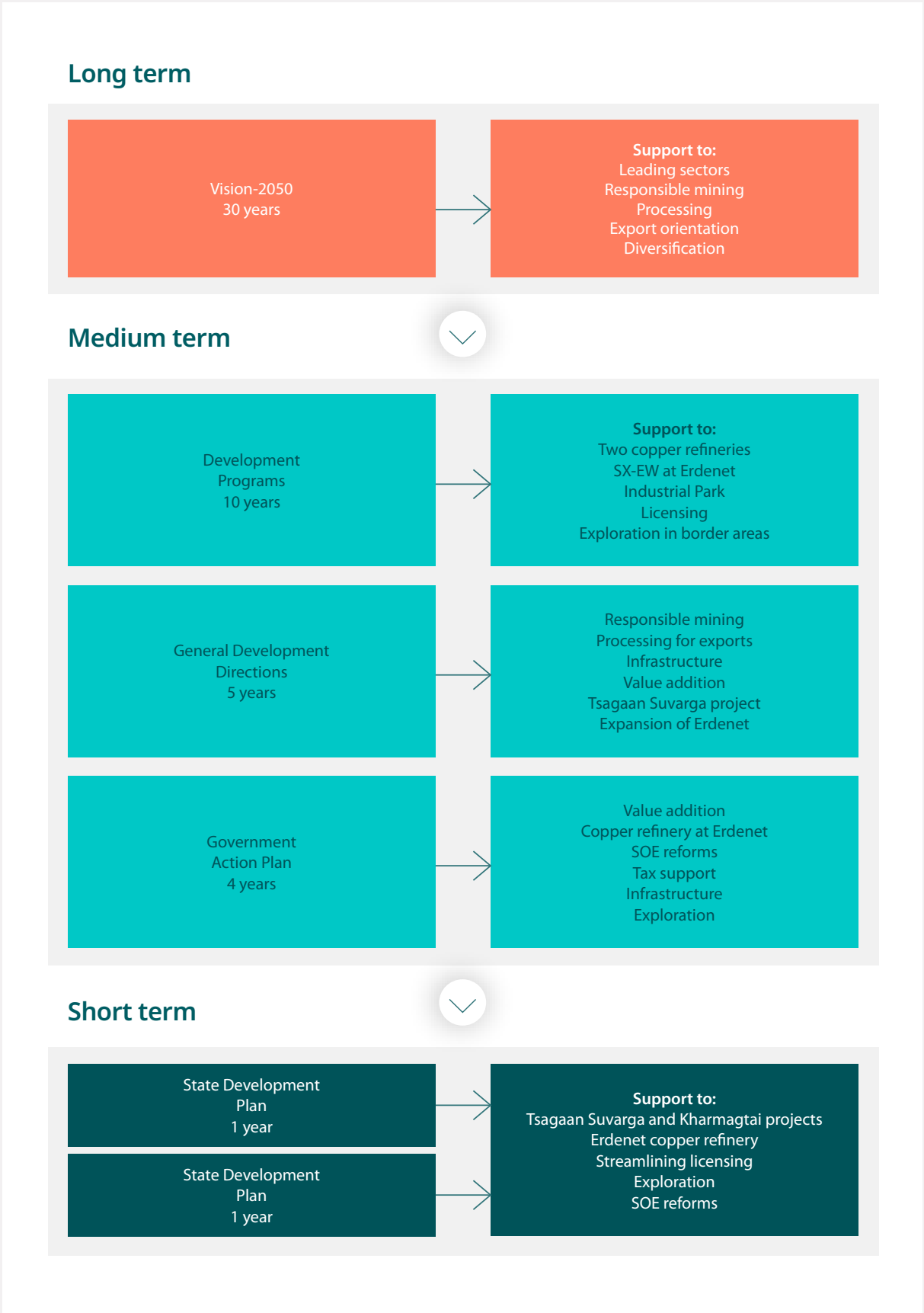
Government policies

As outlined in the preceding section, Mongolia's copper mining sector currently centers on two major projects: Erdenet and Oyu Tolgoi. Other potential projects, such as Tsagaan Suvarga and Kharmagtai, have faced delays and remain in the pipeline. Additionally, as much of Mongolia's territory remains under-explored, the country has the opportunity to attract new players into copper exploration and mining, provided the investment environment is favorable.

Mongolia's copper exploration and mining policies are guided by the country's broader goals of attracting foreign investment, ensuring sustainable development and increasing state revenue, while balancing the needs of local communities and environmental protection. The country operates within a sophisticated legal framework that influences the government's policies and priorities.

Government policies generally comprise long-term, medium-term and short-term strategies. Policy planning is formalized through the Law on Development Policy, Planning and Management (2020), which sets out a range of guiding principles for development policy planning and implementation. These principles include consistency with national interests and global development trends, comprehensiveness, integrity, sustainability, transparency, research-based decision-making, and the availability of necessary resources. Figure 14 illustrates the country's key policy planning documents and their respective durations.

Figure 14: Policy planning in Mongolia



The long-term policy is known as Vision-2050 and was adopted by the State Great Hural, the legislature, in 2020. The document is based on Mongolia's commitments to achieve the Sustainable Development Goals and, as the name suggests, provides aspirational development objectives up to 2050.

In terms of economic development, Vision-2050 sets three stages for development, each for a period of one decade. The first stage, up to 2030, focuses on creating a favorable business and investment environment; the second, up to 2040, focuses on increasing national savings; the third, up to 2050, aims to create a stable macroeconomic framework with mid-income social groups dominating the population. In more detail, the document prioritizes support to leading sectors and export orientation, including support for responsible mining and an increase in the level of processing of mining products (for the first stage); support for export orientation and export of energy, as well as restructuring the economy to expand processing industries (second stage); and diversification of the economy with leading sectors competing globally (third stage).

Vision-2050 names several copper-related projects as the government's priority. Some of the projects, like Oyu Tolgoi, are included in the document as projects that are already in implementation and that the government will continue prioritizing. Others, like Tsagaan Suvarga, are listed as projects in the pipeline that will launch within a short time period. In addition, the document lists a wide array of policies that should directly or indirectly support the development of the copper sector, including protecting investors, reforming state-owned companies, and investing in infrastructure to support mining and processing.

Medium-term policy comprises several policy documents, including Development Programs for 10 year periods, General Directions for Developing Mongolia for five-year periods, and Government Action Plans covering four-year periods. The government is due to adopt eight specific development programs in line with this law. The State Investment Program is a document to support the implementation of General Directions by specifying various capital expenditure needs.

Currently, the Development Program for 10 years is embodied in the New Recovery Policy that the State Great Hural adopted in December 2021. The policy came into existence during the heights of the COVID-19 pandemic, which possibly affected priorities and the details included in it. While Vision-2050 focuses much on supporting specific mining projects but is vague in what support processing and value addition projects will get from the government, the New Recovery Policy has no details on specific mining projects but names specific copper processing and value addition projects as a priority. For instance, the policy prioritizes two copper refineries, one based in Erdenet and the other around Oyu Tolgoi; it mentions Erdenet SX-EW processing and an industrial and technology park as specific value addition projects; and it expresses policy support for copper exploration and mining more generally through intentions to streamline licensing in the mining sector and to allow exploration in border areas.

The legislature adopted the five-year General Directions for the period 2021-2025 in August 2020, i.e., prior to the adoption of the longer-term New Recovery Policy. The document identifies objectives and priority areas of development for Mongolia in general terms, including the focus on developing responsible mining, increasing processing of minerals for exports, enhancing infrastructure to support other sectors including mining, and prioritizing value addition for minerals including copper. Supporting the directions, the State Investment Program provides the list of specific projects that the government will pursue. This program includes support for copper mines such as the development of Tsagaan Suvarga and expansion of Erdenet and for processing and value addition such as building the Erdenet copper refinery as part of the industrial and technology park and starting SX-EW operations at Erdenet. Interestingly, these shorter-term policy documents do not include the refinery at Oyu Tolgoi, although the New Recovery Policy mentions it.

Perhaps most concrete among Mongolia's policy documents are the Government Action Plans covering four-year periods as they follow the electoral cycle and are based on campaign

promises of political parties. In addition, the monitoring and evaluation of action plans are more formalized than those for other documents. The most recent Government Action Plan covers the period 2024-2028 and places much significance on minerals processing and value addition projects, including for copper. More specifically, the document pledges the establishment of a copper refinery to produce 125,000 tons of copper cathode as well as support to expand the Erdenet mine. Various policy support initiatives such as reforming state owned companies, tax policy support, investor protection, infrastructure provision and reviving exploration work are also mentioned, albeit in more general terms.

State development plans and government budgets comprise short-term policy documents as they are adopted on an annual basis. In principle, shorter-term policy documents should be based on the longer-term policies, and the annual development plans contain specific reference to longer-term policies for each project included in the documents. The annual development plan, adopted in 2023 and covering 2024, includes specific plans for developing the Tsagaan Suvarga and Kharmagtai deposits, building the Erdenet copper refinery, and providing broad policy support such as offering protections for investors, supporting private sector investments, streamlining licensing, increasing exploration, and reforming state-owned enterprises (SOEs).

The annual government budgets represent the most specific priorities that the government is willing to finance using fiscal revenues. They are good indicators of whether specific projects get real support from the government or not. While most of these budgets cover recurrent government expenditure, the capital investments part details specific projects that the government budget will fund. However, in terms of large-scale projects such as copper mines or refining, it is likely that private or state-owned investors will fund such projects, and they are usually not included in the government budget. For instance, the budget for 2024 assumes increasing revenue from copper, but does not contain any specific funding for copper expansion plans including smelting or refining. Any specific costs related to these projects that ought to be borne by the government and financed through various state-owned companies are therefore off-budget arrangements rather than part of state budgets.

In addition, the government occasionally announces priority projects it is planning to support. Mostly these projects are of a major scale or could be described as mega projects and involve predominantly infrastructure and mining, reflecting Mongolia's needs in these areas. Most recently, the current government announced 14 mega projects that will be at the heart of the policy agenda. This list of projects includes copper processing to produce around 125,000 tons of copper cathode (assuming the smelter is fed from Erdenet production), as well as building a gold smelter based at the Oyu Tolgoi copper mine.

These development policy documents are closely intertwined with many laws and regulations that govern various sectors or specific policies. For instance, the Law on Mineral Resources regulates many policies for expansion of exploration and mining, especially in terms of licensing and mineral royalty payments. The Law on Investments determines security and stability of investments, and the Law on Environment and other such laws are also relevant. The Law on Legal Status of Industrial and Technological Parks, the Law on State and Local Property Policies and other laws further regulate policies in relation to developing copper processing. We will refer to these and other relevant laws in the next subsection during the discussion of sector growth and expansion strategies and challenges.

In summary, Mongolia has set up a complex framework for planning and implementing its development policies. Policy documents have clearly prioritized further development of the mining sector including copper mining, but have prioritized even more profoundly the value addition and processing of copper. At the same time, it appears that the implementation of these policy priorities has not always been straightforward, as the copper sector remains limited and lacks processing capacities.

Many factors come into play such as poor infrastructure, market dynamics, and poor governance and management. However, the lack of funding opportunities is probably the biggest issue for the sector's development. Specifically, as the overview of policies indicates, state funding through government budgets for large-scale projects with cost estimations of billions of dollars is not a viable solution, as budget revenue is limited and spending needs are diverse. Both the government's debt levels and sovereign interest rates are high, prohibiting additional borrowing to fund long term, high cost projects.[26] Funding through SOEs is possible, and the government has pursued this.

But this source of funding depends on the financial performance of SOEs, which in turn depends on market conditions. Especially in terms of copper, Erdenet is an aging mine whose costs will likely be rising given the lower grade of copper in its ore body, and Oyu Tolgoi is still to ramp up its production now that the project's underground mine construction is almost complete. So these two projects will likely be ill-positioned to provide enough revenue for the government to finance further expansion of the copper sector. Further, any funding of copper expansion projects from the state budget or SOEs has a high opportunity cost in light of other priorities such as education and health. Under these circumstances, the involvement of private sector actors for successful funding and implementation of copper sector projects is likely to be the most rational choice.

Sector expansion options and challenges

This subsection explores the potential expansion pathways for Mongolia's copper sector, focusing on two key areas: (1) exploration and mining, and (2) smelting and refining. While copper scrap recycling offers some potential, it is unlikely to be a major focus of policy initiatives and is therefore not discussed here.

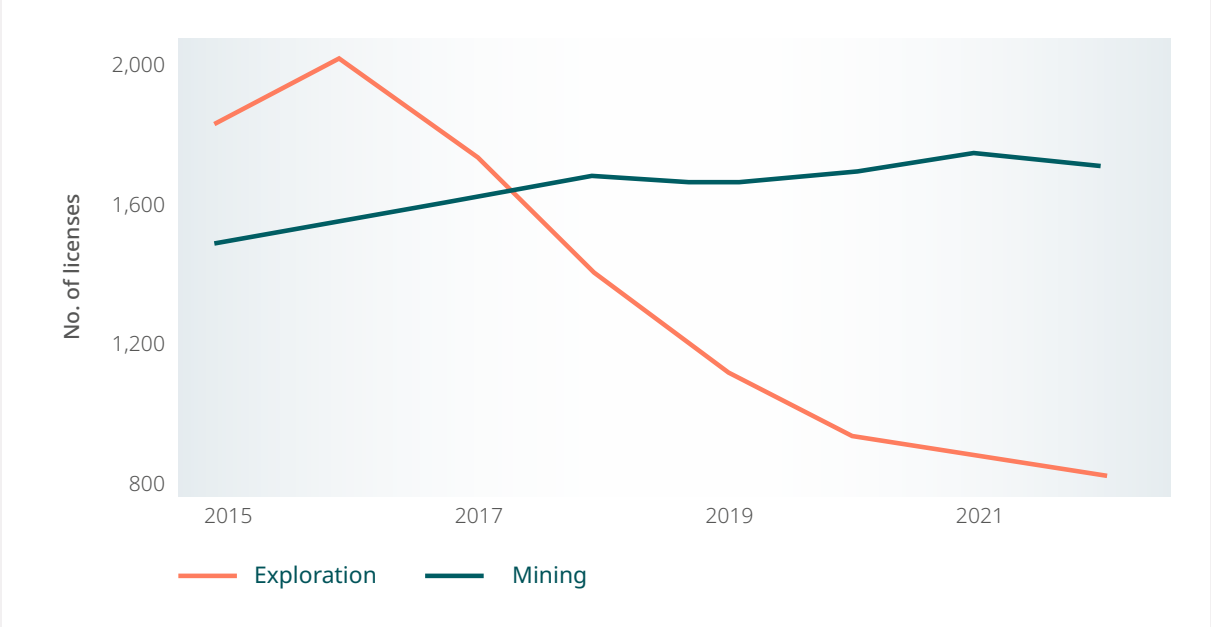
Upstream expansion

Upstream expansion, which involves increasing copper exploration and mining, is crucial for maximizing Mongolia's overall copper production and tapping into the country's vast geological potential. As of now, the country's exploration has stalled, and the copper mining comprises two mines only. Upstream expansion could revive foreign investments in the country, take advantage of many skilled workers who were involved in the Oyu Tolgoi's mine construction, which will soon be completed, increase exports and foreign exchange earnings, and contribute to fiscal revenue. Additionally, expansion in the upstream sector may allow Mongolia to build a viable downstream sector, as copper smelters and refineries, if built in Mongolia, would need sufficient resources to feed them.

The scale and pace of exploration largely depend on private sector funding, especially from foreign investors, due to the limited domestic financial resources available. Consequently, Mongolia competes with other countries to attract investors, necessitating government policies that make exploration appealing. Key indicators of success include the number of exploration licenses issued and the effectiveness of exploration activities by license-holding companies. However, exploration is inherently risky and costly, with many projects taking years to transition from discovery to revenue-generating mining operations. Figure 6 and Figure 7 illustrate the common delays and cost overruns in such projects. Therefore, any plans for expanding the copper sector must prioritize increased exploration efforts and a robust project pipeline for short-term commissioning.

Over the past decade, Mongolia has been stringent in issuing new exploration licenses. This restraint has been influenced by various factors, including regulatory efforts to control license transfers, the rise of populist policies, public discontent with mining's environmental impact, the COVID-19 pandemic, and a global decrease in exploration budgets. As Figure 15 shows, the number of exploration licenses has lagged behind mining licenses. Given that only a fraction of exploration efforts culminate in actual mining, this trend needs to be reversed to ensure the mining sector's expansion in the near future.

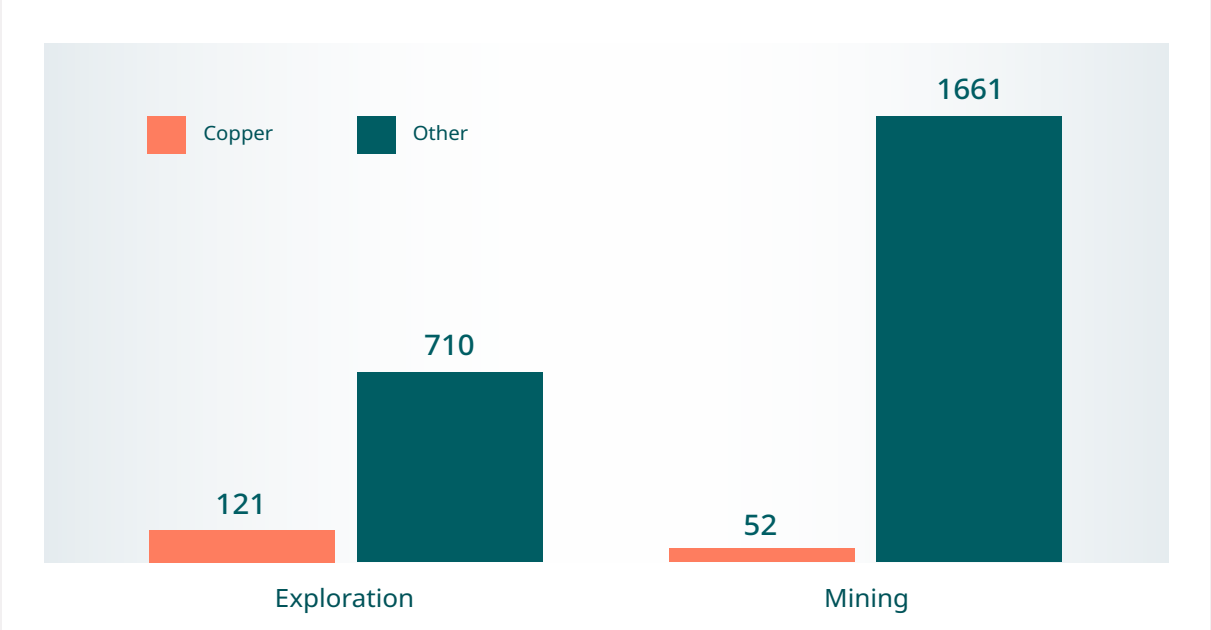
Figure 15: Active licenses in Mongolia



Source: MRPAM Statistics

These constraints have impacted exploration work for copper and other minerals. Despite this, 14.6 percent of 831 current exploration licenses in Mongolia are designated for copper exploration.[27] However, when it comes to mining, only 3.0 percent of 1,713 mining licenses are for copper. Figure 16 illustrates this general picture. While the number of copper mining licenses appears relatively high, note that some projects comprise multiple licenses, and only a few projects are currently operational.

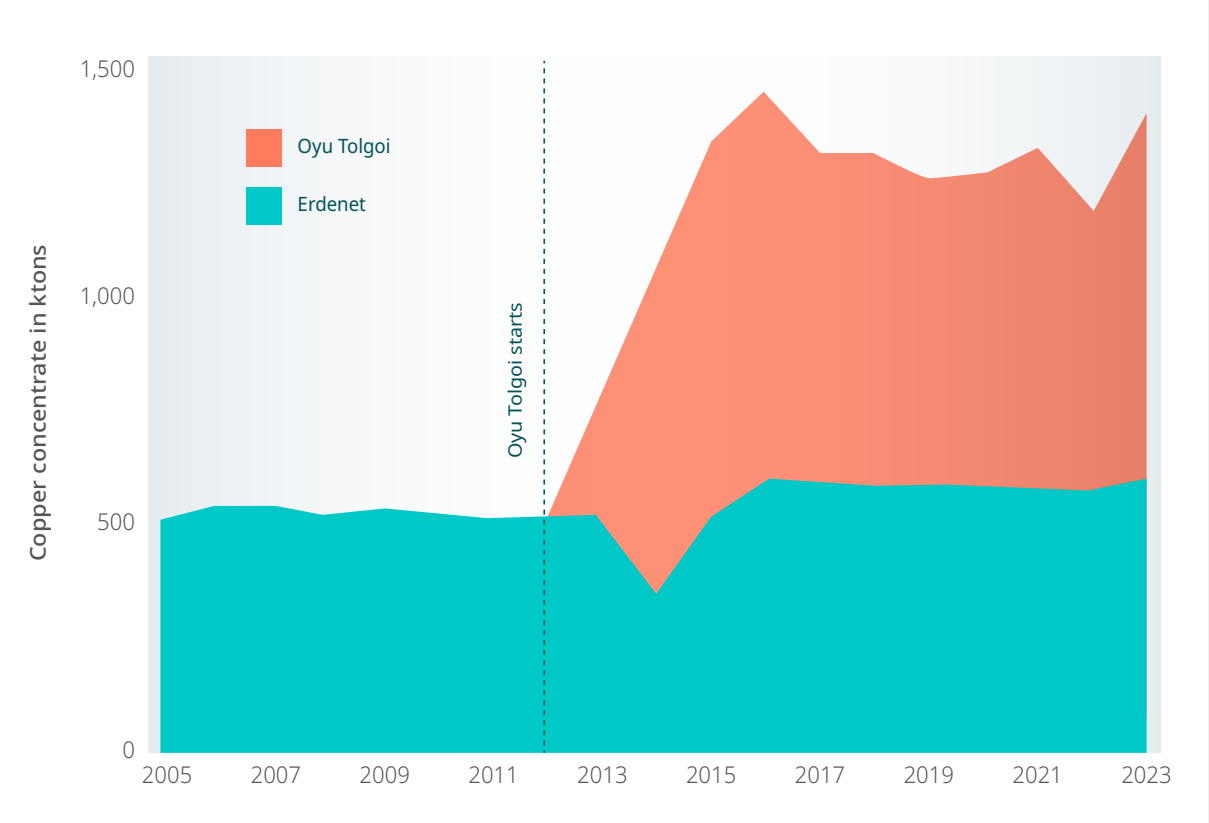
Figure 16: The number of active copper and other licenses in Mongolia in 2022



Source: MRPAM Statistics

In terms of production, copper concentrate is the main product, primarily produced by the Erdenet and Oyu Tolgoi mines. Figure 17 shows the production volumes for each project. Mongolia more than doubled its copper concentrate production with the commencement of mining operations at Oyu Tolgoi in 2013, demonstrating that large-scale new projects can significantly boost overall production levels in a relatively short period.

Figure 17: Copper concentrate production in Mongolia

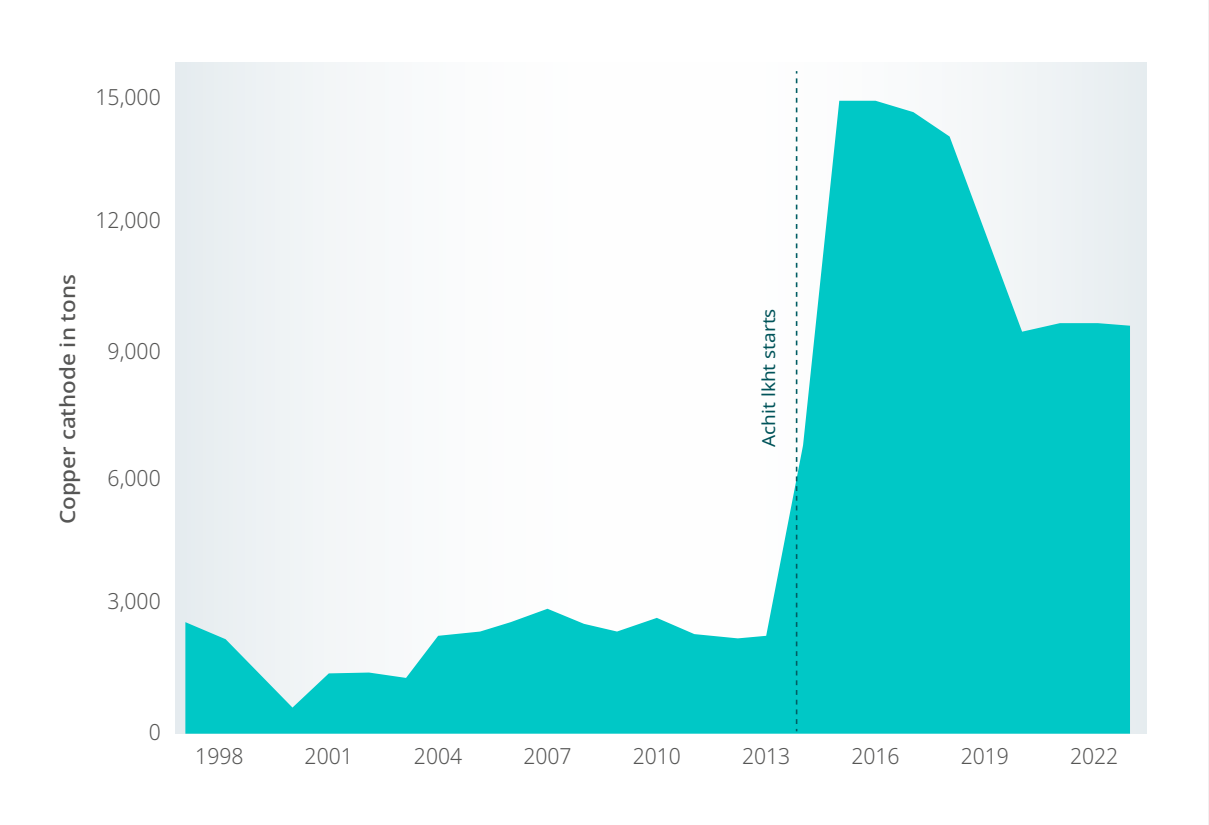


Source: Total production from 1212.mn and Oyu Tolgoi from ot.mn

In recent years, producing copper cathode from low-grade oxidized ore around the Erdenet mine has gained traction and shows potential for expansion. While the value and quantity of copper cathode produced using solvent extraction and electrowinning (SX-EW) technology are relatively low compared to copper concentrate production, such projects offer a cost-effective way to utilize existing ore bodies and produce semi-final copper products domestically. Globally, around one-fifth of copper mining production results from SX-EW technology, indicating potential for growth in Mongolia, especially as existing open-pit mines have oxidized ore bodies that can be exploited with relatively low capital investment.

Currently, three companies operate using oxidized ore piles around the Erdenet mine, each managing a separate pile stock. Overall, Mongolia has reported total production of 153,009 tons of copper cathode since 1997, with annual production peaking at 15,010 thousand tons in 2016. Production has since declined, primarily due to companies' failure to access new ore bodies. Figure 18 shows the production of copper cathode through SX-EW.

Figure 18: Production of copper cathode through SX-EW in Mongolia



Source: MRPAM

One of the significant issues surrounding these operations is the ownership of the companies and how they have accessed the ore bodies, which technically were part of the balance sheet of Erdenet - an SOE - since there were no open selection processes.[28] Erdmin, the first company to operate an SX-EW facility, has been in operation since 1997 and is minority-owned by Erdenet. However, foreign and domestic investors hold the majority of shares (75 percent). The company is currently facing challenges in accessing additional ore bodies, as the last ore received from Erdenet dates back to 2009 and is depleting rapidly.

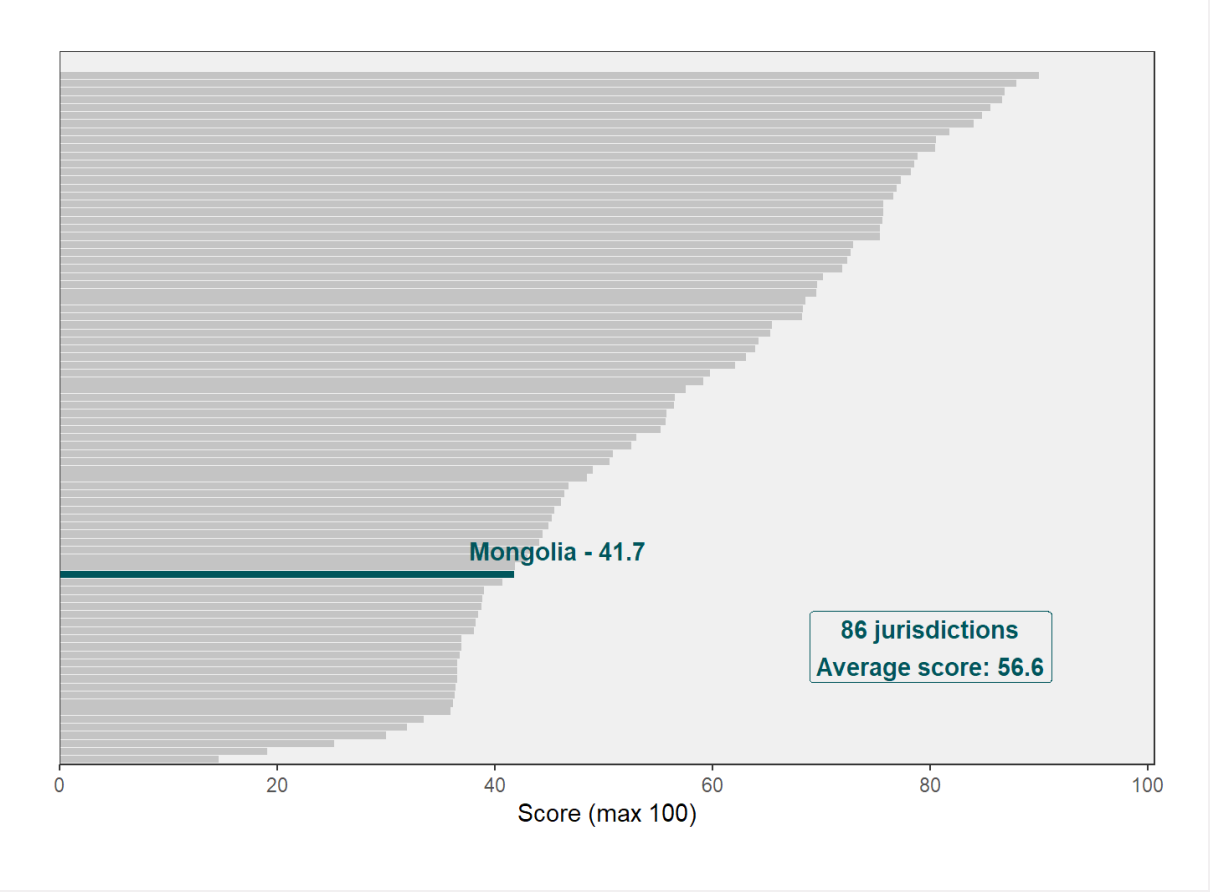
Achit Ikht, whose production commenced in 2014, is owned by private domestic investors and has been negotiating with the government regarding state equity participation in the project. The company also faces the risk of exhausting its current ore bodies and may not be able to continue operations if it cannot secure access to new ore bodies.

Zes Erdeniin Huvi, or Copper Treasure, is the third company that entered into an agreement with Erdenet, in 2015, to exploit low-grade ore piles from Erdenet. It is partially (30 percent) owned by approximately 24,500 individual residents of Erdenet town. The company has just started its operations after the completion of the construction work and is expected to ramp up the production. This ownership structure highlights policy challenges mining projects face, where local communities demand a greater share of the benefits.

Currently, Erdenet mine plans to initiate its own SX-EW processing using low-grade ore piles. This development places the future of the three existing processors in doubt. Oyu Tolgoi, which has been operating an open-pit mine for more than a decade, has yet to announce plans for processing its low-grade ore through hydrometallurgy, or to indicate whether its stockpiles fit technologically.

Overall, the upstream copper sector in Mongolia has been relatively limited and stagnant over the past decade, as new projects have been slow to materialize and investments in both exploration and mining have been modest. The country faces numerous challenges in reversing this trend. For instance, Mongolia ranks 63rd out of 86 countries in the latest global mining executives' perception survey on the investment environment, as Figure 19 shows.[29].

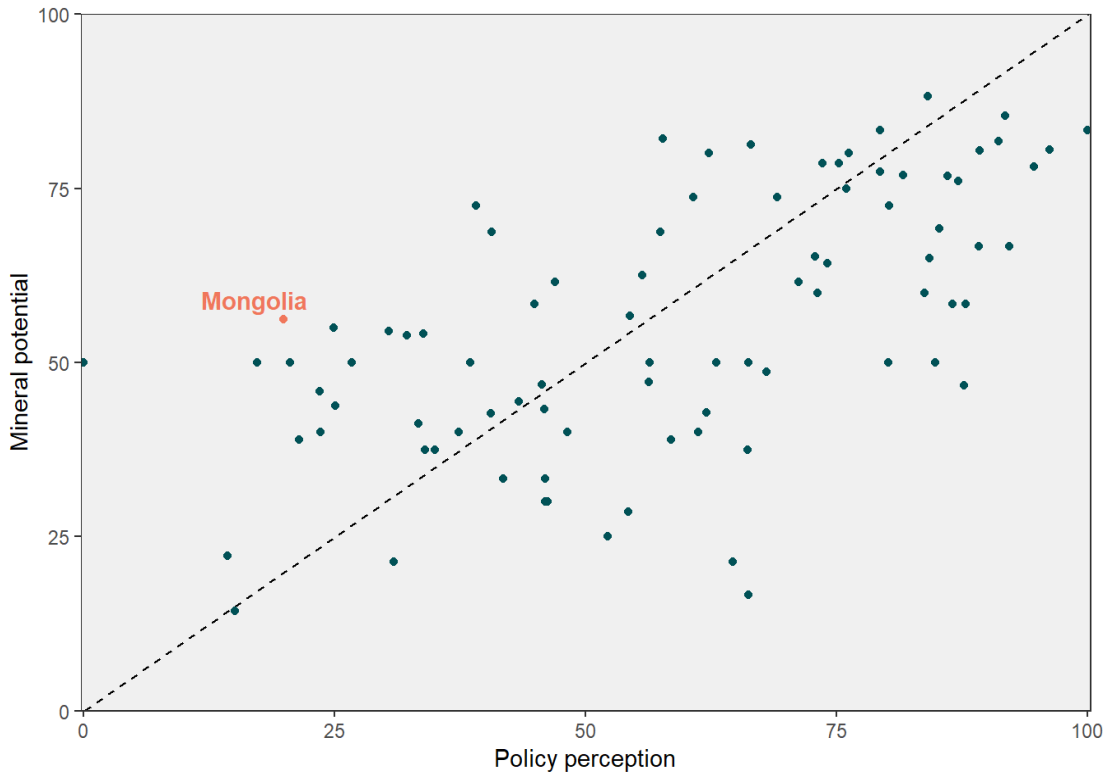
Figure 19: Investment attractiveness in mining in 2023



Source: Fraser Institute

In fact, while Mongolia ranks in the middle of the pack regarding pure mineral potential, it sits near the bottom of the rankings concerning the perception of whether government policies are supportive of mining. Figure 20 illustrates this contrast, highlighting a significant gap between the country's mineral wealth and its policy environment's attractiveness to investors.

Figure 20: Policy perception vs mineral potential in 2023



Source: Fraser Institute

Table 5 presents the policy questions that mining company executives were asked to voice their concerns about. On one hand, 11 percent of respondents viewed regulatory inconsistencies and community development issues as prohibitive of investments, while no other issue was named as a critical deterrent.

On the other hand, it is concerning that mining executives viewed 11 out of 16 issues as not encouraging investment. The quality of infrastructure, political stability, the legal system and the taxation regime ranked overall as the biggest policy issues of concern to investors in the mining sector.

Table 5: Mining executives' perception on key policy issues in Mongolia

	What is the relationship to investments?				
Policy issue	Encourages	Not a deterrent	Mild deterrent	Strong deterrent	Fully stops
Mineral potential, assuming policies based on best practices	38%	38	12	12	0
Uncertainty concerning environmental regulations	0	44	33	22	0
Security	11	33	44	11	0
Trade barriers	12	25	38	25	0
Availability of labor and skills	0	38	50	12	0
Uncertainty concerning disputed land claims	0	33	11	56	0
Uncertainty over which areas will be protected as wilderness, parks or archeological sites	0	33	44	22	0
Labor regulations/employment agreements and labour militancy/work disruptions	11	22	22	44	0
Regulatory duplication and inconsistencies	0	22	22	44	11
Socioeconomic agreements/community development conditions	0	22	44	22	11
Quality of geological database	11	11	67	11	0
Uncertainty regarding the administration, interpretation, and enforcement of existing regulations	0	20	40	40	0
Taxation regime	0	12	75	12	0
Legal system	0	11	56	33	0
Political stability	0	11	56	33	0
Quality of infrastructure	0	0	44	56	0

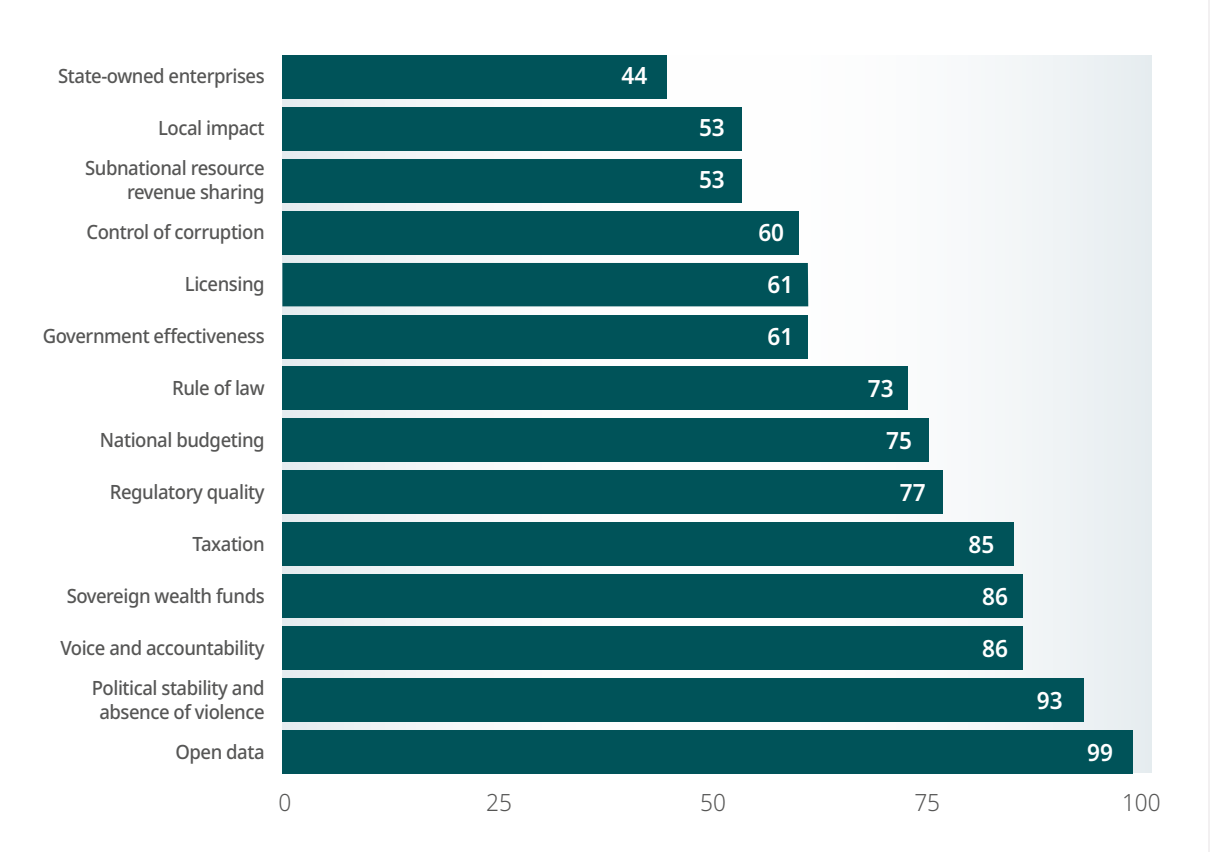
Source: Fraser Institute

Other business environment studies corroborate these findings. For instance, Mongolia's Business Environment study of 2020 found that the mining sector had the most difficult environment to operate in comparison to other sectors, while governance and legal issues ranked as the worst among policy issues.[30] Among economic policy issues, funding opportunities and the tax environment were viewed as poor. A large-scale study of Mongolia's minerals sector companies (674 in total) in 2023 identified political instability, public perceptions toward mining, legal protections for investors, infrastructure development and local community relationships as the most challenging issues in the sector.[31]

NRGI's Resource Governance Index[32] also indicates that Mongolia's mining sector governance faces several key challenges. While the country's overall score of 70 out of 100 points may suggest that sector governance is relatively good, certain governance issues the study raises are likely to have a prohibitive impact on the sector's expansion prospects. For instance, the governance of SOEs is the area that is weakest, as Figure 21 shows.

Given the important role SOEs play in the copper sector and the government's expansion plans, Mongolian SOEs' under-performance may pose a major obstacle preventing realization of these plans. The state owns two current large-scale mines, Erdenet and Oyu Tolgoi, the former fully and the latter partially. Projects in the pipeline will also potentially involve state equity participation, as they may be deemed strategic. Additionally, SOEs manage copper smelting and refining, key downstream projects (discussed in the next subsection). Other issues needing improvement include local impacts and sub-national revenue sharing, control of corruption, licensing and government effectiveness.

Figure 21: Mongolia's resource governance performance by policy area in 2021



Source: Resource Governance Index

One policy area that may particularly hinder the expansion of the upstream copper sector is the level and administration of taxes, especially mineral royalties. Mongolia's fiscal regime for copper comprises a basic royalty, an additional royalty that varies depending on the level of copper processing and market prices, corporate income tax, and withholding tax on interest and dividends. In addition to these taxes and payments, the Mongolian government is entitled to an equity share in project operators if copper deposits are legislatively designated as strategic. The government can also negotiate with investors to forego the equity share in exchange for a special royalty. However, the two existing copper mining projects are unique cases, and the current fiscal regime is not fully applicable to them.

Mongolia's copper royalty is two-tiered, with a base royalty of five percent levied on total revenue, which does not allow for deductions for treatment and refining costs or the transportation of copper concentrate to smelters. Additional royalty rates apply, depending on the level of processing and market prices, as Table 6 shows.

Table 6: Additional copper royalty charge in Mongolia

	Additional royalty rate (%)		
Price range (USD per ton)	Ore	Concentrate	Product
0-5,000	0	0	0
5,000-6,000	22	11	1
6,000-7,000	24	12	2
7,000-8,000	26	13	3
8,000-9,000	28	14	4
9,000 and above	30	15	5

In other words, if a mine produces copper concentrate only, it can end up paying a 20 percent royalty on its gross sales revenue, consisting of 5 percent base and 15 percent additional royalty, if copper prices exceed USD 9,000 per ton. While the imposition of additional royalty on top of the base royalty was motivated by the country's desire to capture a larger share of the profits and promote downstream processing, the rates and calculation basis for the royalty may deter the development of new projects solely based on financial returns. This is one of the reasons the Tsagaan Suvarga and Kharmagtai projects have not moved ahead to production despite the copper deposits being discovered many years ago.

Regarding the two operating mines, Oyu Tolgoi pays a five percent base royalty and is protected against additional royalties by an investment agreement that stabilizes royalty rates. In contrast, Erdenet, which the state fully owns, sees the higher royalty rates it pays partially offset by lower dividends paid to the government. Erdenet ranks 380th among 392 copper projects worldwide in terms of royalty levels paid and 384th for the share of royalty in total cash costs. This means Erdenet ends up paying one of the highest royalty rates globally. Oyu Tolgoi, on the other hand, ranks among the lower royalty-paying projects by these indicators, as Table 7 shows.

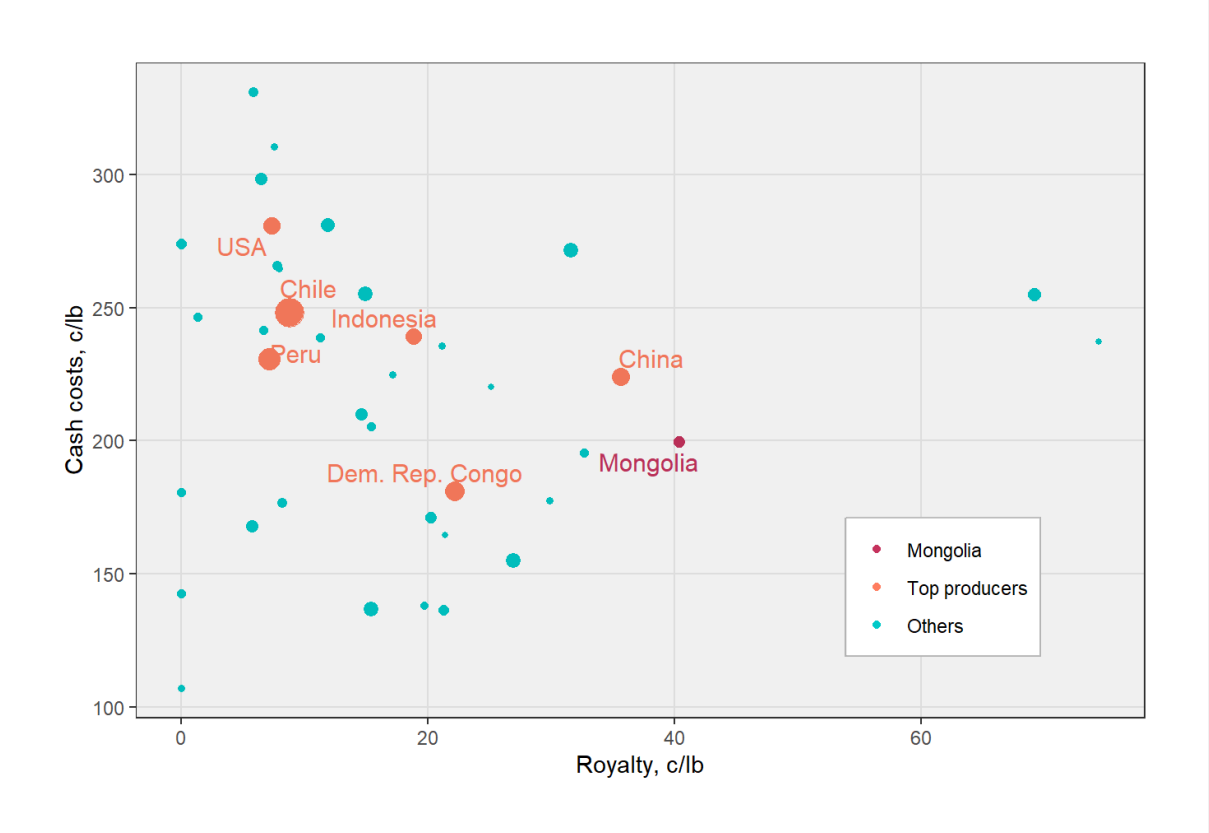
Table 7: Comparison of copper project costs in 2023

				Rank (out of 392)	
Projects	Royalty c/lb	Cash cost c/lb	Share Royalty/ cost	Royalty	Cost share
Erdenet	61.48	249.43	24.65%	380	384
Oyu Tolgoi	19.23	230.14	8.36%	224	212

Source: SP Capital Note: 'c/lb' - US cents per pound

Compared with other major copper producers, Mongolia's two projects are generally competitive in terms of average costs that exclude royalty payments and other taxes. However, regarding mineral royalty payments, the country imposes one of the highest burdens, as Figure 22 illustrates. The proper comparison of countries in terms of overall fiscal burden for copper projects should consider other (profit-based) taxes, government dividends and financial modelling. Aside from the mechanics of the overall regime, high royalty rates can be a particular challenge for attracting new investment, given that royalties are payable from the start of production, have limited responsiveness to profitability (even with a variable rate schedule) and are hard for companies to avoid.

Figure 22: Copper project cash costs and mineral royalty costs



Source: Data from SP Capital Note: 'c/lb' - US cents per pound

In short, the growth of exploration and mining for copper in Mongolia has been a government policy priority. However, high rates of royalties, risks associated with SOE governance, infrastructure and other challenges may prove critical concerns in the government's efforts to attract investments and ensure Mongolia becomes a bigger player in the copper mining sector. This is especially true in the short to medium term, as experience shows that significant time often passes between project inception and production stages, with many delays, cost overruns and even project cancellations occurring worldwide.

Downstream expansion

Downstream expansion, encompassing the development of copper smelting, refining and fabrication, and final product manufacturing, is a crucial step for a copper mining country like Mongolia. This development could yield long-term economic benefits while transforming the nation's economy. It can create new jobs, generate additional revenue from value added products, save on transportation costs, and diversify the buyer market for Mongolia's copper. Downstream processing will also allow the country to develop other industries, such as chemical processing.

There are significant risks associated with such expansion, though. Processing requires large-scale investments, produces chemicals that need to be dealt with, increases the economy's dependence on one or few commodities, and needs long-term supplies of copper concentrate. In addition, processing fees will depend on the competition globally, and the margin may not be as high as with the mining of copper concentrate. In fact, moving along the copper value chain and processing more copper concentrate into copper cathodes "will not yield the same government revenue outcome given that processing copper into cathodes tends to only add 4-6 percent of value."[33]

As we noted above, the government has prioritized the development of the downstream copper industry for many years, though it has yet to succeed in this endeavor. This is partly because potential investors are not convinced of the financial return, and political rhetoric about expanding the domestic economy by supporting value addition may not have sound economic backing. The public does not have access to feasibility studies or even to information about whether such studies have been conducted and indicate such projects are viable.

The government announced the prioritization of an industrial and technological park at the Erdenet mine. This initiative designated Erdenes Mongol, the holding SOE controlling key mining assets, including Erdenet, as the park's owner. In 2022, the Law on The Legal Status of Industrial and Technological Parks established the framework for commissioning, funding and managing such parks. Consequently, Erdenes Mongol founded a special-purpose subsidiary company, Erdenet Industrial and Technological Park, to oversee the project.

The government's strategy regarding the refinery's location has fluctuated over the years. Initially, there were plans to build the smelter in Sainshand, Dornogovi Province, in the south, but current plans favor constructing it at Erdenet, in the north. The proposed park will include a smelter and refinery for copper concentrate, a molybdenum concentrate processing plant, an elemental sulfur plant, and a hydro-metallurgical refinery, all supported by shared infrastructure.[34]

Several factors drive the choice to attach the industrial park to the Erdenet mine. Proximity to the mine ensures a steady supply of raw materials, reducing transportation costs. Additionally, this strategy aims to extend the mine's life by processing lower-grade concentrates, despite the potential inefficiencies and increased transportation costs.

The core component of the park is the copper smelter and refinery. While establishing domestic smelting and refining capabilities holds potential benefits, it is essential to carefully assess the associated risks before committing substantial funds and seeking to attract private investment. Two critical issues require thorough examination: the economic and financial viability of the project, and the management of environmental safeguards and by-products. Although the government has announced the completion of a feasibility study for the copper

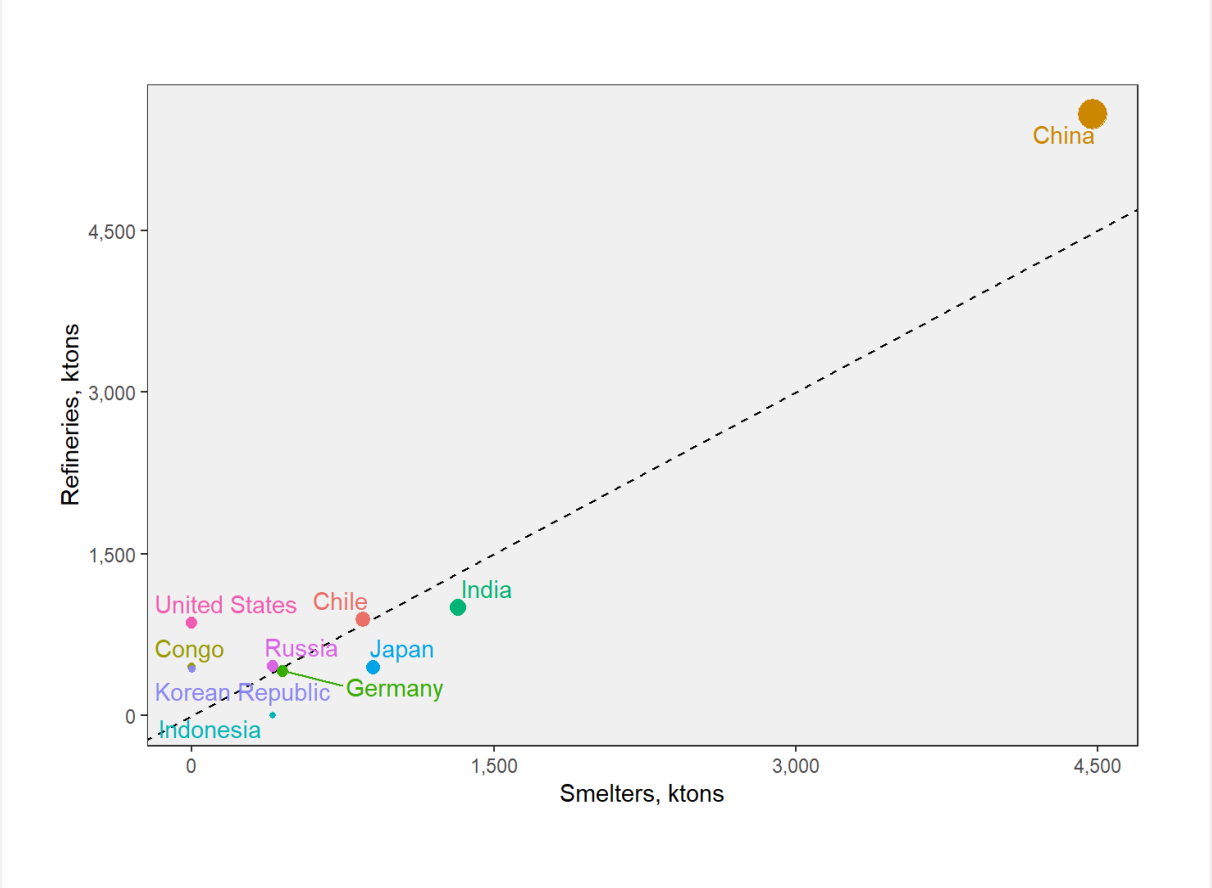
park, the document has not been published, preventing an analysis of its financial viability and environmental impact management strategies.

The smelting and refining processes convert copper concentrate into high-purity copper cathode, as Figure 4 illustrates. Globally, numerous smelters and refineries, including those in China processing Mongolian copper concentrate, present competitive challenges for new projects. Lessons from these existing operations are invaluable.

Copper smelting involves heating concentrates to extract copper, producing copper oxide, which is then combined with silica and limestone in a furnace to yield blister copper, removing sulfur and iron. This blister undergoes further refining, typically through fire or electrolytic methods. A by-product, sulfur dioxide, contributes to air pollution but can be captured and converted into sulfuric acid for fertilizer production. The smelting and refining processes are energy-intensive and produce various by-products, like sulfuric acid. Plans on how to ensure stable energy availability and deal with environmentally polluting chemicals should influence any decision to develop new smelters and refineries.

Globally, China stands as the undisputed leader in both smelting and refining capacity, as Figure 23 illustrates. This dominance is a consequence of several factors, including cost efficiency, economies of scale and comparatively less stringent environmental standards than in other countries. Given its proximity to China, Mongolia should evaluate whether it can achieve similar economic efficiencies while adhering to minimum environmental standards.

Figure 23: Top 20 countries in smelting and refining (size of circles indicates capacity)



Source: Data from World Copper Factbook-2024, ICSG

In a recent publication, NRGI describes key factors of success for value addition.

Table 8 shows how these factors relate to Mongolia's copper sector downstream processing plans.

Table 8: Risks associated with success factors for value addition

	Success factors	Policy considerations	Risk level
1	Size of mineral supply	Significant projects are in the pipeline; exploration is still limited with high potential for new discoveries; location and technology of processing may mean some mining concentrate produced domestically could not be used.	Medium
2	Transport costs	Costs for concentrate shipping are significant given limited railway and roads system; distance to the market for concentrate and copper cathode (China) is relatively short.	High
3	Availability of competitively priced, reliable, clean energy	Energy production is not adequate and may be slow to meet processing needs; cost of energy remains high; opportunities for renewable energy production exist; exising power grid capacity needs improvements.	Very high
4	Competing capacity elsewhere	High competition from China for smelting and refining; Chinese ownership of some mines domestically should be considered.	Very high
5	Good governance	Corruption challenges persist; transparency gains exist; government effectiveness has been low.	Medium
6	Proximity to downstream markets	Neighbor to China, the main market for both concentrate and cathode.	Low
7	Existence of an industrial base	Industry base is low; policy support for value addition is high.	Very high

Note: Factors based on NRGI's "Six Keys" briefing

Currently, copper smelters and refineries operate with excess capacity, with the average operating efficiency hovering around 80 percent.[35] In this context, treatment and refining charges might not offer significant margins, particularly if Mongolian smelters cannot compete on cost with other global players.

Copper smelting and refinery production saw an increase over the four years to 2020, with growth in both primary and secondary (scrap) smelting and refining, as Table 9 depicts. However, when China is excluded from the equation, the global scenario shows a decline in primary smelting and refining, whereas secondary production experienced an uptick.

Several factors contribute to this trend of countries closing or scaling back smelter and refinery operations. These include outdated technology in aging facilities, newly implemented environmental regulations necessitating substantial investment to upgrade existing operations, and insufficient revenue due to low treatment and refining charges, which collectively make sustaining operations challenging.

Table 9: Global smelter and refinery capacity change, 2016-2020

	Count of plants			Capacity (tons)		Net change (tons)	
	Increase	Unchanged	Decrease	Increase	Decrease	With China	Without China
Smelters							
Primary	20	1	13	2,648,191	−1,240,717	1,407,474	−284,526
Secondary	15	3	3	673,141	−33,210	639,931	215,531
Refineries							
Primary	16	1	24	2,884,264	−1,563,961	1,320,303	−484,397
Secondary	14	4	7	283,712	−270,787	12,925	246,425

Source: USGS Copper 2020

Stakeholders should evaluate Mongolia's plans for constructing a copper smelter and refinery at the Erdenet site within this global context, considering both the international market dynamics and the country's domestic economic and environmental priorities. As the global landscape shows trends of decreasing primary production outside China and increased reliance on secondary production, Mongolia should ensure that its investments in new smelting and refining technology align with these shifts. Additionally, given the challenges other countries face due to aging technologies, stringent environmental standards, and low treatment and refining margins, Mongolia should carefully assess the financial viability and environmental impact of its proposed facilities. Balancing these factors will be crucial for the successful integration of Mongolia's downstream copper sector into the global market.

Economic impact and financial viability

Large-scale projects require significant funding and are inherently high-risk, making it essential to evaluate their economic impact and financial viability—particularly when public funds are involved. In the case of the Erdenet-based copper processing project, Erdenes Mongol and its subsidiary, Erdenet Industrial and Technological Park, are managing the initiative.

Since the state fully owns these entities, any benefits or liabilities arising from the project will ultimately fall on taxpayers. The governance of SOEs in Mongolia is a key policy challenge, as the Resource Governance Index notes (discussed earlier).[36] The government has acknowledged this challenge and has prioritized reforms in the laws and regulations governing SOEs, but reforms are not likely to give results immediately.

The project is estimated to cost around USD 1 billion. The primary component—the copper smelter and refinery with a capacity of approximately 125,000 tons of copper—will require an initial investment of USD 762 million, with USD 307 million of this amount planned to come from the Erdenet mine, while loans will fund the rest.[37] Although officials claim that feasibility studies have been completed, they have also admitted that these documents need to be revised.[38]

Because these documents have not been published, it is impossible to assess whether the project is truly beneficial to the ultimate owners of the SOEs—the general public. Officials also acknowledge that smelters and refineries may not be financially profitable, with internal rates of return typically around 6 to 7 percent. The main benefits would stem from the linkages this project could create with the aging Erdenet mine,

hydro-metallurgical plant, and sulfur production facilities.[39] The smelter could prolong the life of the Erdenet mine by processing a lower-grade concentrate that other smelters would not accept. The production of elemental sulfur, the product that has much wider market potential than sulfuric acid, could boost the sulfur production. And the industrial park, as it is designed, would also allow processing of molybdenum concentrate, a by-product of Erdenet.

In addition, the SX-EW plant, which has a capacity of 10,000 tons of cathode copper production, is projected to require an initial cost of USD 110 million. The Erdenet mine has also financed infrastructure expansion (electricity, road, railway, water, etc.) that the industrial park will eventually use, with these projects expected to be completed in 2025 at a cost of USD 68 million.[40]

Given the high investment requirements, it is crucial for detailed information on the benefits and costs of the project to be made publicly available to prevent opposition or political pressures from emerging. A critical aspect of this project is the site selection for the park, which the availability of feedstock has determined. Given the planned capacity (125,000 tons of copper) and the location of the park, it is evident that the smelting and refining facilities are tailored to processing the Erdenet mine's concentrate. This approach may be short-sighted, as it hinges entirely on the use of lower-grade concentrate from an aging mine. There needs to be a comprehensive economic and financial impact analysis for both the smelter and the Erdenet mine, particularly to understand risks such as cost increases, fluctuations in copper prices, treatment and refining charges, and potential cost overruns.

For copper processing, several technologies are available to choose from. For the Erdenet smelter and refinery, the government selected the technology known as SKS (an oxygen bottom blown copper smelting process). Chinese companies that invented this technology may be interested in collaborating with and potentially investing in Mongolia's project.

Treatment of sulfuric acid

A significant challenge associated with copper smelters and refineries is the management of sulfuric acid produced during the processing of copper ores. Copper is often located in ores that also contain sulfur, and the smelting process releases sulfur dioxide gas. This gas needs to be captured and processed into sulfuric acid, which the chemical industry commonly uses, particularly in the production of fertilizers and other industrial processes. SX-EW copper production also uses the acid.

In Mongolia, however, the market for sulfuric acid is limited, creating a concern about how to effectively manage this by-product. If the sulfuric acid can be converted into elemental sulfur instead, its potential market could become much more viable, especially in the context of global demand for sulfur in the fertilizer industry. Elemental sulfur is also used in the production of sulfur-based chemicals and in refining processes.

According to reports from government officials, there have been experimental tests to assess the feasibility of converting sulfuric acid into elemental sulfur at the proposed smelter and refinery in Erdenet. These tests are still in the early stages, and industry experts should rigorously analyze their results to determine their reliability for large-scale production. If successful, this conversion process could help create a secondary revenue stream for the plant, potentially reducing the environmental impact of sulfur dioxide emissions and creating a more sustainable operation.

However, stakeholders should consider several factors before committing to large-scale production of elemental sulfur. First, the supply of sulfuric acid must be sufficient to maintain continuous production. This requires detailed planning regarding the capacity of the smelter and refinery and the amount of concentrate to be processed. Second, the price and cost of sulfuric acid and elemental sulfur are highly volatile, with fluctuations in global supply and demand directly influencing their market value.

Therefore, any feasibility study or business case for the project must consider the risks associated with these fluctuations and ensure that the plant can remain economically viable even if market conditions change.

Moreover, the environmental implications of sulfuric acid and sulfur management are crucial. The capture and treatment of sulfuric acid can be energy-intensive, and there are significant environmental risks if sulfur dioxide emissions are not managed properly. While sulfuric acid can be neutralized and used in various chemical products, including fertilizers, the process of managing the emissions and waste by-products needs thorough evaluation. Effective waste management practices and compliance with environmental standards are paramount to ensure that smelting and refining operations do not negatively impact local communities or the surrounding environment.

In conclusion, while the conversion of sulfuric acid into elemental sulfur presents an opportunity to expand the market for by-products and mitigate some of the environmental challenges associated with copper smelting, careful analysis of the technical, economic, and environmental risks is crucial. Publicly accessible feasibility studies, rigorous testing and expert consultations are essential to ensure that these projects are both financially viable and environmentally sustainable.

Lessons from Chile

Chile, the world's largest copper producer, has faced significant challenges in its smelting and refining sector in recent years. Due to aging infrastructure, rising environmental standards, and increasing costs, several smelters in the country have been forced to close or reduce their operations. For example, in 2019, the Chilean state-owned copper company Codelco shut down its Ventanas smelter, one of the country's oldest, in response to mounting environmental pressures and the high costs of modernizing its facilities to meet stricter emission regulations.

The closure of these smelters has raised concerns about the economic sustainability of the sector, particularly in terms of the loss of refining capacity and the resulting impact on copper producers that rely on domestic smelting. The closure also highlights the need for copper-producing countries, including Mongolia, to carefully assess the long-term viability of their own smelting and refining projects, especially in the face of rising environmental concerns and the global push toward cleaner, more sustainable production methods.

The Chilean experience serves as a cautionary tale. While domestic smelting may seem like an attractive option to add value to the copper sector, the closure of smelters in Chile underscores the financial, technical, and environmental risks associated with such large-scale investments. The Mongolian government and other actors should carefully weigh these risks, including the potential for under-utilization of facilities and environmental non-compliance, in any decision regarding downstream expansion.

Mongolia's government should ensure that there are solid economic, environmental, and technical assessments to support any new smelting and refining projects, taking lessons from Chile's struggles to maintain a sustainable and profitable copper processing sector.

Conclusions

Mongolia's copper sector holds substantial promise, given the country's vast copper reserves, but its development faces significant challenges that need to be addressed if the sector is to realize its full potential and benefit from the expected rise in copper demand due to the global energy transition. While the government has prioritized the expansion of copper mining and processing as a key element of the country's economic development strategy, there are challenges associated with this expansion that need careful management to ensure long-term success. These challenges revolve around maximizing economic benefits from copper production, ensuring environmental sustainability, and improving governance and institutions for copper sector expansion.

Maximizing economic benefits

The energy transition, driving growth in copper demand, and Mongolia's endowment with significant resources of copper seem to be a perfect match that can transform the country's economy while contributing to global efforts to move to cleaner energy. Mongolia has a history of producing copper, but it exports its production as copper concentrate, with limited production of copper cathode in recent years. Moreover, only two mines currently produce copper concentrate, while some potential projects have been slow to progress to production.

In terms of processing, other than small-scale production of copper cathode using SX-EW technology, Mongolia currently has no other capacity, despite policies aimed at boosting value addition. Potentially, the country's copper sector can expand horizontally by developing new mines and vertically by adding value to copper concentrate.

However, whether all projects maximize economic benefits remains a subject of policy debate. For downstream processing, the performance of the two mining projects that have been the backbone of the economy for years will likely impact the success of smelters and refineries in Mongolia, as they will be the key suppliers of raw inputs to these plants. Yet various stakeholders have criticized the operators of these two mines on a range of issues.

For instance, the Erdenet mine has been a subject of corruption allegations, had failed to generate much fiscal revenue for decades before becoming a significant taxpayer, and faces high costs and political interference. Oyu Tolgoi, although in production for only about a decade, has been in dispute with the government over tax payments and has renegotiated some aspects of its investment agreement with the government, supposedly improving the government's take from the project. There have also been questions around Oyu Tolgoi's linkages to the domestic economy as foreign companies are major suppliers for the mine's construction and the mine sources its energy - a crucial input to production - from China.

While various institutions have carried out studies measuring the impact of these projects on the economy from time to time, they have not quelled such criticism. In short, improving economic benefits from existing mining projects may be the first step to ensure that new projects do benefit the country, as fiscal and other regulations will likely be similar.

One specific issue of concern is the perception that the government's royalty and tax regime is burdensome on new projects, potentially delaying the development of new exploration and mining operations.

This is especially important given that costs for new projects may be high due to inadequate infrastructure for mining projects, especially in terms of access to energy and transport, and high interest rates that projects in Mongolia have to pay on their funding. In addition, since the government has designated most of the promising projects as strategic, they require state involvement as a partner in operating companies. The management of SOEs has been a major challenge for the government as they tend to under-perform compared to private counterparts and are subject to influence by politicians and current government priorities.

For downstream processing, financial viability is vulnerable to fluctuations in global copper prices, treatment and refining charges, and costs associated with processing, in addition to infrastructure requirements. While Mongolia may have a steady stream of inputs for processing, i.e., copper concentrate, other factors and unfavorable market conditions may render processing projects financially inefficient. There need to be detailed feasibility studies and financial transparency for all major projects, so that both public and private stakeholders can accurately assess risks and benefits, especially considering that state-owned companies and public funding will likely be involved.

In addition, most global copper processing takes place in neighboring China, and many smelters and refineries produce at below full capacity, which may affect the profitability and competitiveness of new plants in Mongolia.

One aspect that needs better analysis with respect to copper sector projects is how to ensure the sector's linkages with the rest of the economy. For instance, economic analysis of Mongolia's envisaged industrial and technological park around the Erdenet copper mine, including its components such as the elemental sulfur plant, needs to ensure that projects have a positive impact on the economy as a whole. For this, policy makers and the public require more detailed information on costs and benefits.

In addition, Mongolia's infrastructure remains inadequate for expanding the sector in a short time period. Stakeholders need to see analysis of government investment in infrastructure through SOEs to support new copper projects, especially for the industrial and technological park given the high financial and opportunity costs of these projects.

Environmental sustainability

Environmental risks associated with copper mining, and especially with smelting and refining, need critical consideration. The smelting process produces sulfur dioxide, a potent air pollutant, and other by-products that can harm local ecosystems. To mitigate these risks, the government should encourage the use of cleaner technologies for smelting and refining, including sulfur dioxide capture and processing. While plans for the production of elemental sulfur have been announced, the actual investments in the project also need detailed accompanying information about environmental impacts and the sulfur market demand for each project. Ensuring the copper sector adheres to stringent environmental standards will not only safeguard public health and the environment but also help Mongolia maintain its reputation internationally and contribute to the long term success of its copper expansion.

Hydrometallurgical projects will help Mongolia avoid some of the issues, as they bypass smelting. But the government needs to ensure these projects also comply with best environmental standards.

Governance and institutional challenges

Many industry executives and experts indicate that Mongolian government policies and regulations, their implementation, and the country's institutional capacity are significant red flags that the government needs to address. Since new projects in the copper sector will likely involve SOEs, such as Erdenes Mongol and Erdenet, their governance and efficiency will be an important factor in the sector expansion.

Inefficiencies, mismanagement and political interference in SOEs could undermine the potential of key mining assets and discourage private investment.

The government should prioritize reforms that ensure the professional management, transparency and accountability of SOEs. Additionally, stronger regulatory oversight mechanisms and a clearer separation between politics and business operations would help attract both domestic and international investors and instill greater confidence in the sector.

One important stage of copper sector expansion is the licensing of new projects. Currently, licensing, especially for exploration - a critical stage for attracting new investments - has stalled and needs reinvigorating.

While the government may be enticed to streamline licensing processes, especially through SOEs, it should ensure strict due diligence and fair play principles, including consultations with local communities on any licensing decisions as existing legislation prescribes. The country's mining sector and especially its mining SOEs have been embroiled in many corruption scandals over the years, and the sector's transparency and accountability remain a challenge, despite much government effort. Officials should revie current due diligence processes in this regard.

Under these circumstances, NRGI makes the key recommendations below,chiefly to the Mongolian government, but also to other stakeholders in Mongolia's copper sector.



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Recommendations

The government of Mongolia should pursue the expansion of the copper sector in conjunction with the following policy reforms.

1. Ensure that detailed analysis of the economic and fiscal impacts of new copper projects, especially downstream projects, takes place and that the implications are communicated to and discussed with stakeholders as widely as possible. Disclosure to stakeholders of key elements of feasibility studies, including profitability, cost-benefit estimates and technological aspects, is essential before major decisions on projects occur. There needs to be a public communication plan accompanied by dissemination of information on economic, financial, environmental and social impacts of each project in much more detail than currently available.

2. Double down on reforms of SOEs operating in the copper sector, clarifying specific conditions under which partnerships with private sector players will take place. Drawing on best practices from the NRGI's past reports on SOEs[41] and the Resource Governance Index, the OECD guidelines on SOEs[42], World Bank guidelines[43], and lessons learned from past governance challenges, focus reforms on increasing transparency, accountability and efficiency. This includes enforcing stricter governance rules, addressing corruption risks, and ensuring that SOEs' financial accounts are transparent and accessible. The Extractive Industries Transparency Initiative (EITI) and "glass accounts" for SOEs are essential tools to ensure greater transparency and necessary as platforms for policy discussion and monitoring, and there needs to be improved maintenance of data. Increase the information flow on planned projects and how potential investors can engage with SOEs and make greater detail available.

3. Revisit the issue of the royalty structure as part of a broader fiscal policy review and clarify legislation on the rate and base for calculation of royalties. Assess the royalty burden in the context of the overall fiscal burden on the copper sector, including existing projects, and clarify this for hydro-metallurgical and processing companies. The fiscal regime should take account of competition globally and the level playing field domestically, especially given that existing projects may have specific fiscal arrangements.

4. Efficiently plan infrastructure projects that are essential for the copper sector, such as roads, railways, water supply and energy, to align with the sector's project development, with specific funding plans and careful cost scrutiny. Public and governmental oversight is necessary to prevent cost overruns and inefficiencies, and to ensure that infrastructure investments bring long-term value to the sector without an excessive financial burden. Continuous monitoring and transparency in public spending will ensure the effective use of resources and contribute to the overall sustainability of the copper sector.

5. Revise environmental standards applicable to the copper sector so that they are comparable to those of leading countries in mining and resource extraction. Implement in stages regulations, similar to those in Australia, Canada and Chile, to address the environmental challenges associated with copper mining and smelting, particularly around air quality and waste management. For example, the adoption of stringent sulfur dioxide capture and processing technologies, as well as waste disposal practices that meet international standards, will help mitigate the environmental risks of smelting and refining operations.

Additionally, the government should engage with international environmental organizations and adhere to global best practices to ensure that Mongolia's mining sector is both sustainable and responsible.

6. Recognize and account for the influence of external factors, particularly China's policies for copper, including how the expansion of copper exports and domestic value addition will affect the country's economic dependence on China. Analyze the impact of changes in Chinese economic policies, including trade tariffs, demand fluctuations and environmental regulations, and communicate the results to policy makers and the public together with plans for mitigating these risks. In addition, analyze direct investments by Chinese stakeholders in Mongolia's copper mining and processing.
7. Guarantee local participation in key decisions on copper projects, sharing of benefits, and plans for mitigating environmental and social risks. Pursue consultations with local stakeholders during planning of projects; clarify and simplify revenue sharing formula for local communities; and ensure continuous monitoring of environmental impacts and participatory implementation of protection plans.

Mongolia's copper sector has significant potential to drive economic growth, but the economic, social, and environmental risks require careful management. By implementing these recommendations, the country can create a more favorable environment for investment, ensure that the sector grows in a sustainable, profitable and responsible manner, and benefit both the national economy and the global copper market, and by extension the global energy transition.



Photo by Dmitry Chulov for iStock

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Annex: Stakeholder mapping

Introduction

This Annex supplements the preceding analysis of copper sector expansion opportunities and challenges in Mongolia as part of NRGI's research funded by the European Climate Foundation. The analysis below focuses on key players shaping copper sector policies and involved in the further development of the sector. Understanding the different stakeholders and their positions and interests will help all actors to implement the recommendations we have provided in the main analysis and facilitate dialogue.

Stakeholders and their roles

The expansion of Mongolia's copper sector involves a wide array of stakeholder groups, each with distinct formal and informal roles, interests and powers. A comprehensive stakeholder analysis is critical to ensure the mutual recognition of these diverse interests so that the design and implementation of sector reforms and the sector's development are sustainable and mutually beneficial.

In general, stakeholders in the sector can be grouped into (1) Mongolian government actors, (2) businesses, (3) non-government entities and (4) international institutions including intergovernmental organizations. The Mongolian government includes the legislature, the executive branch, including the cabinet, and various ministries and agencies. The business sector comprises private and state-owned companies, financial institutions and associations representing their interests. The non-governmental sector comprises civil society and non-governmental organizations (NGOs), local communities, academic institutions and the media. International institutions include multistakeholder initiatives like EITI and intergovernmental organizations such as the World Bank. We next consider the roles of these stakeholder groups in advancing the copper sector's expansion.

Government actors

The government of Mongolia, including ministries such as the Ministry of Industry and Mineral Resources, the Ministry of Environment and Climate Change and the Ministry of Finance, plays a pivotal role in shaping the copper sector. Government actors' power stems from various mandates given by laws and regulations. These actors set policies, manage licensing and reserves estimation, can fund or influence funding for mining and processing projects, regulate and sign contracts with investors and contractors, levy and collect taxes, plan and provide infrastructure, and inspect the sector's operations.

The State Great Hural, the legislature, sets all the rules with regard to the development of the country and uses data from different government and non-government institutions to base its decisions on. In addition, the parliament oversees the implementation of the legislation it creates. In relation to the copper sector, the parliament establishes long- and short-term policies including copper-related plans and projects such as Vision-2050, Government Action Plans and others, as we described in the foregoing section on "Copper sector expansion strategies and policies".

The executive branch of the government, including various ministries, proposes and coordinates policies and plans, and comprises the main actors responsible for the implementation of these policies and plans. Licensing, a key step in expanding exploration, mining and processing, is mainly under the authority of the Ministry of Industry and Mineral Resources and the agencies attached to it. Funding of large-scale projects requires private or at least state-owned company involvement; government agencies therefore play more of a coordination and communication role. Many agencies are usually involved in drafting contracts for mining and processing companies, and such contracts tend to reflect specific agencies' positions.

Infrastructure development is an area where many government ministries and agencies are involved, setting the rules of the game and coordinating among actors. In addition, inspection and oversight are an important function of the government, with many ministries and agencies involved in implementation, requiring a degree of coordination. Table 10 illustrates the various roles of government actors in relation to copper sector expansion.

Table 10: Roles of government actors in copper sector expansion

	Policies	Licensing	Reserves	Funding	Contracts	Taxes	Infrastructure	Inspection
State Great Hural	Set, regulate, oversee, approve	Oversee	Use data	Regulate	Regulate, approve, set procedures, communicate	Set	Regulate, fund, oversee	Regulate, oversee
Government of Mongolia	Propose, regulate, oversee, set procedures, approve	Oversee, regulate, set procedures	Oversee	Coordinate, oversee, propose	Regulate, approve, set procedures, communicate			
Cabinet Secretariat	Coordinate, implement, propose, set procedures			Coordinate	Coordinate, draft, implement, monitor		Coordinate, propose	Coordinate, implement
Ministry of Finance	Propose, implement, budget			Budget, propose	Draft	Set procedures, oversee collection, regulate soe transactions, disclose	Budget, propose	
Ministry of Industry and Mineral Resources	Propose, implement, set procedures, coordinate	Oversee		Budget, propose, communicate	Draft		Propose, budget, coordinate	Coordinate
Ministry of Economic Development	Propose, implement, coordinate, budget		Use data	Propose, budget, coordinate, communicate	Draft		Propose, implement, coordinate, budget	
Ministry of Energy	Propose, implement, coordinate			Coordinate	Advise		Propose, implement, set rules	Implement
Ministry of Environment and Climate Change	Propose, implement, budget, set procedures	Advise					Advise	Implement
Mineral Resources and Petroleum Authority of Mongolia	Propose, implement, set procedures	Issue, collect fees, disclose	Use data		Advise			Implement
National Geological Service	Propose, implement, set procedures	Disclose information	Register, disclose		Advise			Implement
Energy Regulatory Commission	Set tariffs, supply energy			Set procedures, set tariffs			Set tariffs, contract	Implement
Erdenet Town	Propose, coordinate	Advise			Advise		Coordinate, advise	Implement
Mongolian Tax Authority	Implement				Advise, implement	Collect		Implement
Mongolian Customs	Implement				Advise, implement	Collect		Implement
Minerals Professional Council	Advise		Accept	Advise			Advise	

Business entities

Investors, both domestic and international, state-owned and private companies, and business interest groups are crucial to expanding the copper sector. Their primary motivation lies in securing profitable opportunities through mining, smelting and refining operations. These stakeholders are generally interested in a stable regulatory environment, favorable fiscal policies and predictable investment returns. At the same time, some businesses may have different positions on whether processing of copper should go ahead full steam, or whether the country should focus on upstream copper production.

The current royalty structure, along with the uncertainty surrounding state equity participation in projects, may deter potential investors, particularly in upstream exploration and mining. In addition, the presence of large-scale SOEs and the increasing roles they play may crowd out private investments and create unlevel rules for businesses.

The role that Mongolian SOEs play in the provision of infrastructure necessary to expand copper exploration, mining and processing, as well as in proposing and implementing various policies, has increased in recent years, with Erdenes Mongol taking the lead. As such, these SOEs' governance is a critical issue, because corruption, inefficiency and lack of transparency in decision-making can hinder their ability to contribute to sector growth. The implementation of governance reforms based on global best practices, such as those that NRGI, EITI, the OECD and the World Bank promote, is essential for the SOEs' success.

Business associations representing their members have been active in policy setting in Mongolia, mostly through government consultations and making specific proposals for policy changes. But they have not played much of a role in other aspects of policy setting and implementation.

Businesses involved in the commodity trading sector, particularly those with a focus on copper, play a critical role in connecting the copper sector to global markets. Their interests are primarily financial, seeking to secure a steady supply of copper at competitive prices. These businesses may offer inside knowledge of the sector and could be more effectively involved in shaping the government's plans to support copper sector expansion.

Table 11 shows some of the roles businesses currently play in Mongolia's copper sector and their potential future roles.



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Table 11: Roles of business actors in copper sector expansion

	Policies	Licensing	Reserves	Funding	Contracts	Taxes	Infrastructure	Inspection
Erdenes Mongol	Propose, implement, coordinate	Obtain	Explore	Propose, coordinate, communicate	Sign, oversee, set procedures	Pay	Coordinate, propose, implement, budget, fund	Coordinate, implement
Erdenet Industrial and Technological Park	Propose, implement, coordinate, communicate	Obtain		Propose, coordinate, communicate	Sign	Pay	Coordinate, propose, implement, budget, fund	Coordinate, implement
Erdenet Mining Corporation	Observe	Obtain	Explore	Fund	Sign	Pay	Propose, fund, implement	
Oyu Tolgoi	Observe	Obtain	Explore	Fund	Sign	Pay	Fund, propose, implement	
Achit Ikht	Observe	Obtain		Fund	Sign	Pay	Propose	
Erdmin	Observe	Obtain		Fund	Sign	Pay	Propose	
Zes Erdeniin Huvi	Observe	Obtain		Fund	Sign	Pay	Propose	
Other Miners	Observe	Obtain	Explore	Fund	Sign		Propose	
Commodity Traders	Observe			Fund	Sign	Pay		
Banks	Observe	Observe, use for collateral		Fund, advise			Fund, advise	
Mongolian Chamber of Commerce and Industry	Propose, advise, montior							
Business Council of Mongolia	Propose, advise, montior							
Mongolian National Mining Association	Propose, advise, montior							

Non-governmental actors

Non-governmental actors such as civil society organisations, NGOs, local communities, academic institutions and the media also play a significant role in shaping and implementing copper sector policies. Mongolia's civil society is wide-ranging and active. Civil society actors that focus on governance, environmental sustainability and human rights are particularly key stakeholders in the copper sector. Their role in the sector can be both positive and negative, depending on the issues at hand.

NGOs, including international ones such as NRGI, can be a valuable resource in advocating for better governance and transparency, providing technical advice, pushing for anticorruption measures and promoting the implementation of environmental standards. However, NGOs may also oppose certain aspects of sector expansion if they perceive that local communities' interests or environmental safeguards are overlooked. Local communities, especially those in mining regions, can both benefit from and suffer due to copper sector expansion.

The benefits include job creation, improved local infrastructure and the potential for greater economic activity. However, negative externalities, such as environmental degradation, land use conflicts and social disruption, can also emerge, particularly if mining activities are not well managed.

Communities in Mongolia often resist mining operations if they perceive the costs outweigh the benefits or if they do not receive adequate compensation for environmental or social impacts. Often such resistance leads to project delays or even cancellation. Therefore, communities' role in participating in policy-making and implementation is crucial for large-scale projects. It is vital that local communities have a real say in the decision-making process and are provided with appropriate mitigation measures, including environmental remediation, and opportunities for local economic development.

Academic institutions that focus on mining can provide valuable research on mining technologies, resource management and environmental impacts, which can inform better decision-making and the development of sustainable mining practices. Non-mining academia, including those focused on economics, political science and environmental studies, also play an important role in shaping policies related to fiscal management, governance and sustainable development. Academic insight into the broader impacts of the copper sector on the national economy and society can guide the government in making informed decisions. The media has the power to influence public opinion and hold both government and private-sector actors accountable. In the context of the copper sector, media outlets can play a positive role by informing the public about the benefits and challenges of sector expansion. They can also act as a watchdog, exposing potential issues such as corruption, environmental violations or governance failures. Media freedom and constructive public dialogue around the sector's development will be crucial to maintain public trust.

International institutions

Lastly, international bodies, such as the multi-stakeholder EITI, the World Bank, the International Monetary Fund, and the United Nations Environment Programme, can help guide the Mongolian copper sector's expansion by providing technical expertise and financial support, and by ensuring that the sector adheres to international standards. Mongolia can align with these organizations to gain access to best practices, financing (in some cases) for infrastructure projects, and technical assistance in implementing sustainable development strategies.

Table 12 shows the roles of selected non-governmental actors and international institutions in the copper sector decision chain.

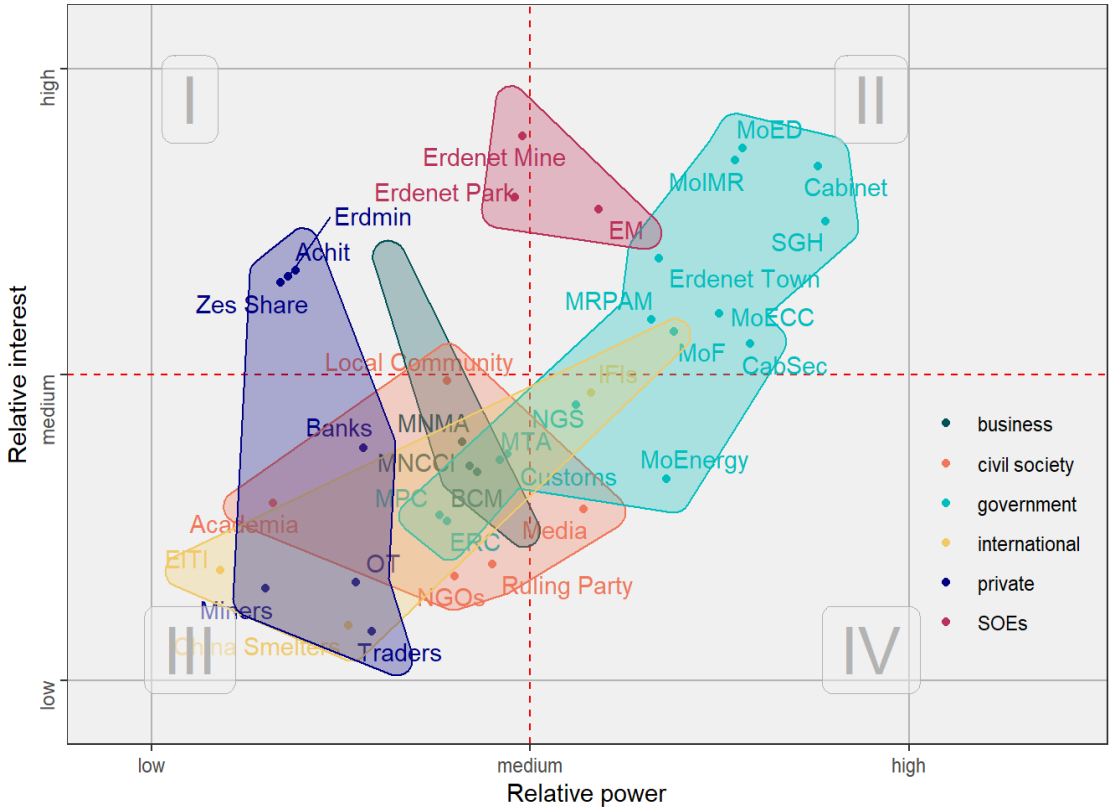
Table 12: Roles of non-governmental actors and international institutions in copper sector expansion

	Policies	Licensing	Reserves	Funding	Contracts	Taxes	Infrastructure	Inspection
Local Community	Monitor, advise	Advise		Monitor	Monitor, advise		Advise	Advise, monitor, propose
Ruling Parties	Propose					Propose	Propose	
Academic Institutions	Observe, monitor, advise			Advise	Observe, advise		Advise	
Governance NGOs	Monitor, advise, observe, propose	Monitor	Monitor	Monitor	Monitor		Monitor, advise	Monitor, propose
Media	Observe, communicate	Observe, communicate	Observe, communicate	Observe, communicate	Observe, communicate		Observe, monitor	Observe, monitor
International Organizations	Advise, observe		Use data	Fund, advise	Advise		Advise, fund	Advise
EITI	Advise, propose	Disclose	Disclose	Disclose	Disclose	Disclose	Disclose	Disclose

Power and interests of stakeholders

We can categorize stakeholders in terms of their relative power and interests in influencing policies on copper sector expansion in Mongolia. Figure 24 illustrates this power–interest mapping of stakeholders.

Figure 24: Relative power and interest of stakeholders



It is not surprising that government agencies tend to have high powers, but in terms of expanding the sector, they are also the group with the most interest in such changes. As such, they are the group that will spearhead policy changes and direct the implementation of copper projects in Mongolia. Quadrant II of Figure 24 shows this.

On the opposite side, civil society seems to be a group with the least powers and least interest in copper sector expansion. This might be linked to the history of tensions between the government and civil society, on the one hand, and mining businesses and civil society, on the other, rising from various governance, environmental, local benefit and other issues. Therefore, this group, depicted in Quadrant III, may not need immediate attention to move copper projects in Mongolia; but if they are fully informed and engaged in the process, their interest in the projects could increase and lead to better performance due to external monitoring and pressure. Similarly, engaging academia in public debates and policy formation can ensure that the development of the sector is grounded in research and data.

International organizations seem to have low to medium interest and low power in influencing copper sector expansion in Mongolia. But they could also be invited to engage more through regular consultations and information sharing, and they could in principle be important players in attracting investors and possibly participating in the projects, especially in the longer run.

State-owned companies such as Erdenes Mongolia and the Erdenet mine and industrial park seem to have the highest interest in the expansion of the sector in Mongolia. Their powers to influence policies are also significant, and so they should be increasingly engaged in formulating policies at parliamentary and government levels.

Existing copper concentrate producers in Mongolia, such as Oyu Tolgoi, may have less interest in the expansion of the downstream sector, as the status quo in terms of copper processing may satisfy them. On the other hand, SX-EW producers may have more interest in both downstream and upstream expansion, as their operations could benefit from greater copper concentrate supply and the development of domestic processing capacity. Chinese smelters and refiners may, however, have a low interest in Mongolia developing its own processing, while still being highly interested in the growth of mining so that they can get a steady supply of raw materials.

Conclusions

This short analysis highlights the diverse range of stakeholders involved in Mongolia's copper sector and their varying levels of power and interest. Successful expansion of the country's copper sector will require careful management of these interests, addressing concerns while fostering an environment conducive to sustainable and profitable growth.

By engaging with all stakeholders, Mongolia can ensure its copper sector expansion is inclusive, sustainable and mutually beneficial for both the country and its international partners. Transparent dialogue and an effective balance between the needs of various groups will be critical to overcome challenges and achieve long-term success.



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Endnotes

1 This study was conducted by Natural Resource Governance Institute (NRGI) with generous support from the Pooled Fund on International Energy (PIE) of the European Climate Foundation (ECF).

2 International Energy Agency (IEA), Net Zero Emissions by 2050 Scenario, www.iea.org/reports/global-energy-and-climate-model/net-zero-emissions-by-2050-scenario-nze; the IEA has developed this and other scenarios.

3 "World copper factbook 2024".

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7 Krusekopf, "Mongolia's Development of Critical Minerals".

8 O.Erdene and D.Galsandorj, *Comparative Study of International Compatitiveness of Oyu Tolgoi and Erdenet Mines and Processing Plants*.

9 "Critical minerals data explorer".

10 "World copper factbook 2024".

11 Sulfide ores are often located deep underground, while oxide ores are usually closer to the surface.

12 SX-EW production often takes place at or near the mine site, while the location of smelters/pyrometallurgy depends on a range of factors including costs associated with the transportation of concentrates. Factors determining where value addition physically takes place are therefore often outside the government's control, and they may differ not only between various kinds of minerals but even between various ores of the same mineral.

13 "World copper factbook 2024".

14 "World copper factbook 2024".

15 "Commodity profile".

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17 Coal demand is projected to decline under all scenarios developed by th IEA. ("World energy outlook-2024")

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33 Thomas Scurfield, "Six keys to unlocking equitable value addition in mining".

34 B.Altangerel, "Economic impact will go beyond Erdenet mine and spread to Mongolia's economy".

35 "World refined copper production and usage trends".

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37 Kh.Batsaikhan, "Mega projects: Copper smelter and refinery, dreamed of ever since Erdenet deposit was discovered".

38 N.Ariuntuya and S.Bold-Erdene, "Interview with G.Yondon: Copper concentrate processing plant is the guarantee of the future of Erdenet".

39 N.Ariuntuya and S.Bold-Erdene.

40 "Erdenet Industrial Park presentation".

41 For instance, Wild growth, 2019, ("Wild growth: an assessment of Erdenes Mongol") and A deeper Look into glass accounts data, 2022 ("Mongolia's state-owned mining enterprises: a deeper look into glass accounts data").

42 "OECD guidelines on corporate governance of state-owned enterprises 2024".

43 "Guidelines on anti-corruption and integrity in state-owned enterprises".

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About NRGI

The Natural Resource Governance Institute is an independent, non-profit organization that supports informed, inclusive decision-making about natural resources and the energy transition. We partner with reformers in government and civil society to design and implement just policies based on evidence and the priorities of citizens in resource-rich developing countries. Learn more at **www.resourcegovernance.org**



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