Republic of the Philippines
DEPARTMENT OF SCIENCE AND TECHNOLOGY
PHILIPPINE COUNCIL FOR INDUSTRY, ENERGY AND EMERGING TECHNOLOGY RESEARCH AND DEVELOPMENT

PCIEERD POLICY BRIEF

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BUILDING CAPACITY FOR METALLIC MINERAL PROCESSING IN THE PHILIPPINES

Key Policy Recommendations:

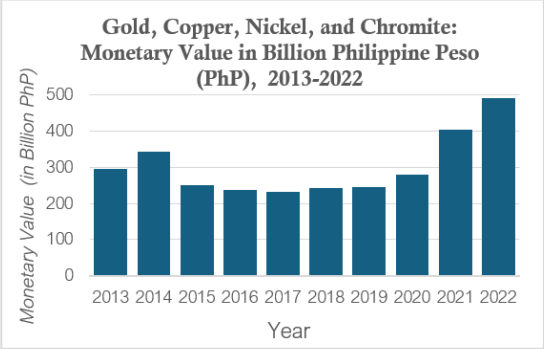
- *Review the Philippine Mining Act of 1995 and other related laws on mining*
- *Harmonize national and local policies*
- *Processing facilities be put up first before imposing export prohibition*
- *Switch to Renewable Energy to reduce power costs*
- *Gradual instead of total restriction on direct shipment of metallic ores*
- *Technologies for value-adding of metallic minerals should be supported*
- *Capacity Building for Human Resource, Technical Experts, and Skilled Workers*

Ore is a deposit of one or more precious minerals in the Earth's crust. The most valuable ore deposits like gold (Au), iron (Fe), and copper (Cu) contain metals critical to trade and industry (*Ore*, n.d.). Ore deposits are rock volumes that contain selected elements in sufficient concentration and quantity that they can be extracted economically. Except for aluminum (Al) and iron (Fe), all technically important metals and other elements are scarce, in total constituting less than ~1% of the earth's crust (Heinrich & Candela, 2014). Ore deposits and ore minerals fall into several main commodity groups: metallic and semi metallic elements, nonmetallic elements, gems, construction and manufacturing materials, fertilizer and chemical minerals, and energy resources. For the metallic and semi metallic elements, examples include gold (Au), silver (Ag), copper (Cu), iron (Fe), manganese (Mn), and aluminum (Al) (OpenGeology, n.d.). Ores and minerals are essential resources used in many industries such as manufacturing, construction, and energy production. Large volumes of raw materials need to be extracted and processed by mining companies in order to meet the increasing demand for these resources.

The processing of metallic minerals has been an important part of the economy of many natural resource-rich countries. The impact of mining has been one of the major factors in the continuing positive overall contribution of the mining and quarrying industry sector to the national economy. In addition, the Republic Act (R.A.) No. 7942 or also known as the *'Philippine Mining Act of 1995'* provides strict adherence to the principle of sustainable development. This strategy mandates that the needs of the present should be met without compromising the ability of the future generations to meet their own needs, with the view of improving the quality of life, both now and in the future. Sustainable development provides that the use of mineral wealth shall be pro-people and pro-environment in sustaining wealth creation and improve quality of life.

Metallic Mineral Production in the Philippines

Article XII of the 1987 Constitution of the Republic of the Philippines states that all natural resources, which include mineral resources, are owned by the State and that the exploration, development, and utilization thereof shall be under the State's full control and supervision. The primary mining laws in the Philippines are the R.A. No. 7942, also known as the *'Philippine Mining Act of 1995',* with its Implementing Rules and Regulations (IRR) embodied in the Department of Environment and Natural Resources (DENR) Administrative Order (A.O.) No. 2010-21, Executive Order No. 79, series of 2012, and the R.A. 7076, also known as the *'People's Small-scale Mining Act of 1991'.* The Philippine Mining Act governs the large-scale mineral resource development, exploration, and utilization while the People's Small-Scale Mining Act governs small-scale mining. The Philippines is one of the few countries richly blessed with mineral resources, with an estimated US $1 trillion worth of untapped mineral reserves, mostly copper, gold, nickel, aluminum, and chromite. Of the country's total land area of 30 million hectares, at least 9 million hectares are known to hold high mineral deposits (International Union for Conservation of Nature - Netherlands, n.d.). Only 5% of the mineral reserves have been explored, and 3% are covered by mining contracts (Austrade, n.d.).



Source: Philippine Statistics Authority

According to the Philippine Statistics Authority (PSA), the value of metallic mineral reserves of the country rose to 22% in 2022. The PSA stated in its mineral accounts report that Class A gold, copper, nickel, and chromite resources were valued at P491.19 billion, an increase from P402.73 billion in the previous year. (Philippine Statistics Authority, n.d.)

On the other hand, based on the data from the Mines and Geosciences Bureau (MGB) of DENR, the value of the metallic mineral production in the Philippines remained robust during the first three quarters of 2023 from PhP176.24 billion to PhP189.08 billion, year on year, a growth of PhP12.84 billion or 7.28% as shown in Table 1 (Mines and Geosciences Bureau, 2023).

The biggest share was from nickel ore and its nickel by-products, nickel-cobalt mixed sulfide (NCMS), and scandium oxalate with PhP89.99 billion or 47.60%. Production volume and value of nickel direct shipping ore jumped by 24.08% and 13.60%, respectively, from 23,291,619 dry metric tons, with an estimated value of PhP47.13 billion, to 28,899,580 dry metric tons, with an estimated value of PhP53.54 billion year-on-year. Gold came in second with production volume growing from 21,631 kilograms, with an estimated value of PhP67.69 billion, to 22,935 kilograms, with an estimated value of PhP77.65 billion, ahead by 1,303 kilograms and PhP 9.96 billion, respectively. Copper grabbed the third position accounting for PhP18.79 billion or 9.94%. Copper volume grew by 2% from 190,767 dry metric tons to 195,533 dry metric tons.

Meanwhile, overall silver production volume and value were lackluster by 14% and 9% from 41,543 kilograms, with an estimated value of PhP1.56 billion, to 35,784 kilograms, with an estimated value of PhP1.42 billion year-on-year. The shared value of silver, chromite, and iron ore amounted to PhP2.64 billion, which is

about 1.40% (Mines and Geosciences Bureau, 2023).

During the first three (3) quarters of 2023, the estimated excise tax collected by the National Government was about PhP 5.09 billion, while the estimated collection from the royalties derived by the government from the development and utilization of the mineral resources within the mineral reservation areas was about PhP1.97 billion. Currently, there are 20 nickel mining projects and a chromite mining project being monitored by the MGB located within the mineral reservation areas (Mines and Geosciences Bureau, 2023).

Furthermore, records from the MGB indicate that, as of 2023, there are 56 operating metallic mines in the Philippines. Nickel has 33 operating mines, followed by gold with 12 operating mines. Chromite and iron both have four (4) operating mines while copper has three (3) operating mines (Mines and Geosciences Bureau, 2022). The MGB has placed the gross production value in large-scale metallic mining from Q1 to Q3 of 2023 at PhP166.9 billion (Mines and Geosciences Bureau, 2023). Meanwhile, the total contribution of mining to the country's gross domestic product (GDP) from Q1 to Q3 of 2023 was PhP 81.3 billion or 0.54% (at constant 2018 prices) (Mines and Geosciences Bureau, 2023).

Table 1. Philippines Metallic Mineral Production
January – September 2023 vs. January – September 2022

Mineral Commodity	Unit Used	JAN-SEP 2023		JAN-SEP 2022		% Change	
		Quantity	Estimated Value	Quantity	Estimated Value	Quantity	Value
Gold	Kilograms	22,935	77,650,428,269	21,631	67,693,784,212	6	15
Silver	Kilograms	35,784	1,423,160,211	41,543	1,558,807,472	(14)	(9)
Copper Concentrate	Dry Metric Tons	195,533	18,794,398,305	190,767	18,954,088,297	2	(1)
Nickel Direct Shipping Ore	Dry Metric Tons	28,899,580	53,539,102,548	23,291,619	47,128,215,455	24	14
Nickel-Cobalt Mixed Sulfide	Dry Metric Tons	58,297	36,255,206,386	59,458	39,805,069,813	(2)	(9)
Scandium Oxalate	Dry-Kg	12,545	199,084,093	14,264	313,858,394	(12)	(37)
Chromite	Dry Metric Tons	67,877	957,652,721	57,326	613,303,041	18	56
Iron Ore	Dry Metric Tons	78,213	257,785,026	57,040	171,097,407	37	51
TOTAL			189,076,817,558		176,238,224,090		7.28

Source: Mines and Geosciences Bureau

Direct Shipment of Unprocessed Ores

The Philippines, which has vast but largely untapped mineral resources, has been looking at ways to raise the contribution of mining to its economy. Currently, nickel mines in the Philippines directly ship laterite nickel ore to China and other countries.

In 2022, the Philippines produced 360,000 metric tons or 11% of the global mined nickel output, placing the country in a far second spot next to Indonesia (Dela Cruz, 2023).

The S&P Global Market Intelligence reports that according to the data from China's General Administration of Customs, the Philippines' nickel ore exports to China amounted to $2.67 billion in that year. That is 96.5% of the Philippines' nickel ore exports according to the PSA (Chen, 2023). Records from the MGB also indicate that the exports of minerals and mineral products from Q1 to Q3 of 2023 accounted for US$ 5.3 billion or 9.76%

contribution to the total export. China was still the major trading partner of the Philippines for nickel ore during the period. Indonesia has also emerged as the newest trading partner of the country for nickel ore (Mines and Geosciences Bureau, 2023).

Mineral Processing and Value Addition

Mineral processing[1] deals with the process of separating valuable minerals from the surrounding rock which involves various techniques such as crushing, grinding, screening, gravity separation, magnetic separation, and floatation to recover minerals of interest from the ore. It also refers to smelting and refining. Value addition, on the other hand, is done by achieving higher market prices for exports, since processed critical raw materials yield a higher market value than raw ores and concentrates, or done through job creation, attracting other downstream industry, or building the country's resilience in global supply chains (Pickles, 2023).

The Philippines has been one of the top nickel-producing countries in the world next to Indonesia followed by Russia (Pistilli, 2023), while 7th on world ranking in terms of cobalt production as shown in Table 2. Nickel, cobalt, along with manganese, graphite, and lithium are the major critical materials needed in producing lithium-ion battery materials used in automotive and other consumer electronics sectors.

Table 2. Top Nickel and Cobalt - Producing Countries

Nickel (Ni)		Cobalt (Co)	
Indonesia	48.8%	Democratic Republic of the Congo	70%
Philippines	10.1%	Indonesia	5.4%
Russian Federation	6.7%	Russian Federation	4.8%
France (New Caledonia)	5.8%	Australia	3.2%
Australia	4.9%	Canada	2.1%
Canada	4.0%	Cuba	2.0%
China	3.3%	**Philippines**	2.0%
Brazil	2.5%	Others	10.5%
Others	13.9%		

Adapted from: US Geological Survey and US Department of the Interior

The Lithium battery materials market is projected to grow from US$34.2 billion in 2023 to US$97.5 billion by 2028. At present, lithium-ion batteries are the dominant type of rechargeable batteries used in electric vehicles (EVs). EVs have been a crucial component in the global effort to achieve the Sustainable Development Goals (SDGs) of the United Nations (UN) specifically Goal 7 which is focused on ensuring access to affordable, reliable, sustainable, and modern energy for all. Various countries and companies have stated policies to accelerate the adoption of EVs in the transportation sector. Such public and private commitments suggest that EV sales could continue into the expected future, with some estimates indicating 200 million total EVs sold by 2030 (Tracy, 2022). The energy transition is expected to surge the mineral resource demand and presents an opportunity for attracting new investment flows.

Meanwhile, Indonesia is actively building out its EV battery industry and its proximity to China,

[1] *In the Philippine Mining Act, mineral processing means the* ***milling, beneficiation or upgrading of ores or minerals and rocks or by similar means to convert the same into marketable products****. It is also covering the secondary processing of waste streams to produce usable or saleable products with the objective to totally eliminate air emissions, dust emissions, water emissions, slurried tailings, or other solid wastes.*

the world's leading EV manufacturer, makes an ideal setup for Indonesia.

Processed materials command significant price premia over unrefined ores, potentially improving the trade balance and lowering the input cost of infrastructural and industrial projects, spurring local economic development (International Renewable Energy Agency, n.d.). The United Nations Conference on Trade and Development (UNCTAD) Technical Note on Critical Minerals suggests that processed and refined critical minerals enjoy significantly higher values than those in their raw form and can stimulate the development of related downstream industries in the mineral-producing developing countries (United Nations Conference on Trade and Development, 2023).

Several countries have recognized the strategic importance of mineral supply chains and updating, if not, came up with their critical materials strategy by anticipating and offset potential supply risks, while those mineral rich producing countries seek to boost their competitiveness and attract investments.

Strategies in Increasing Value Retention of Mineral-Rich Developing Economies

Significant steps are being undertaken by the developing countries in managing and optimizing the benefits from their mineral resources. In 2018, the Democratic Republic of Congo renegotiated foreign access to cobalt reserves to secure a more favorable agreement. Also, Peru reformed its copper royalty regime in 2021 to increase government revenue from the mining sector. Meanwhile, the Chilean government plans to create a state-owned company for lithium to ensure greater state control over the country's lithium reserves. Further, Zimbabwe has banned raw lithium export to curb artisanal mining and attract downstream industries (Ghorbani, et al., 2024).

The Case of Indonesia

The export of nickel ore was first outlawed in Indonesia as early as January 2014, and while some ore with concentration below 1.7% could legally be exported between January 2017 and December 2019, any export of nickel ore has been banned as of January 2020 (International Energy Agency, 2023). The aim of this policy is to strengthen domestic processing facilities and encourage value-added activities, and this attracted more than US$ 15 billion of foreign investment in nickel processing, mostly from Chinese companies, in the metals and mining industry, and in the electric vehicle supply chain (Nguyen & Liu, 2023). The Indonesian government seeks to climb the nickel value chain further, having a long-term goal to develop a full EV supply chain, including the production of cathodes, battery cells, and EVs. There have been some initial successes. For example, the Republic of Korea's LG Energy Solution is building a US$ 1.1 billion battery cell plant, while car maker *Hyundai* opened a plant to assemble electric cars. China's CATL, the world's largest battery manufacturer, has invested in the country, while Tesla and BYD have either signed or finalizing investment deals (Medina, 2024).

However, in November 2019, the European Union (EU) filed a complaint with the World Trade Organization (WTO), claiming that Indonesia's ban on nickel ore exports violate free trade rules (World Trade Organization, n.d.).

In October 2022, the WTO ruled against the nickel ore export restrictions by Indonesia, declaring that the domestic processing requirement (DPR) and the ban on nickel exports were in violation of international trade rules. Indonesia appealed in November 2022 and was allowed to uphold the ban, pending a decision (Soeriaatmadja, 2023). In their complaint, the EU alleged that the Indonesia's nickel export ban violates the General Agreement on Tariffs and Trade (GATT) 1994 of which the Indonesia is a signatory. The Philippines is also a signatory to the GATT since December 27, 1979 (*World Trade Organization*, n.d.).

What is it for the Philippines?

The Department of Trade and Industry (DTI) suggested further processing of minerals in the country, such as nickel, instead of exporting them to other countries (Ochave, 2023). The DTI said that developing an ore-processing industry would help add value to the mining industry. The agency also said it is working towards establishing a domestic mineral processing industry to tap the potential of Philippine metals for the burgeoning EV industry. The agency is in collaboration with various mining companies in the Philippines to consider higher-value activities. This move is also highlighted in MGB's mineral sectors roadmap (Mines and Geosciences Bureau, 2023). However, the lack of enabling policies and appropriate technologies from relevant government authorities hamper these initiatives.

Government (DOST-PCIEERD) Intervention to Improve the Mining Industry in the Philippines

Research and development (R&D) is not the primary business of mining companies, but it is vital to the long-term health of the mining industry (McKinnon & Ferguson, 2018). Research in mining is pivotal in improving safety, efficiency, economics, acquiring new technologies, and advancing technical skills of personnel. It entails developing new applications from existing knowledge.

The Policy Group of the Policy Coordination and Monitoring Division (PCMD) of PCIEERD conducted a study with government agencies, mining companies, and DOST and PCIEERD-funded and/or monitored projects related to mining. The randomly selected mining projects are consisting of the following project teams from the University of the Philippines – Diliman (UP Diliman), Mapua Malayan Colleges Mindanao, and Mindanao State University – Iligan Institute of Technology (MSU-IIT).

The project titled ***'Removal and stabilization of arsenic in gold and copper ores using aqueous and non-aqueous solvents'*** implemented by UP–Diliman, focuses on arsenic[2] found in gold-copper deposits in the Philippines. The study investigates the behavior and distribution of arsenic in gold and copper deposits and adapt an economic and eco-efficient technology that will separate the arsenic minerals from the ore/concentrate and transform them into environmentally benign forms for safe disposal. The removal process of arsenic in this study will be significantly influenced by the ore characteristics, particularly mineralogy and liberation. Kinetic analysis will be performed to investigate the rate of dissolution and to help optimize the removal efficiency. Process parameters such as pH, reagent dosage, and temperature will be optimized. Arsenic

[2] **Arsenic** *is a naturally occurring, semimetallic element widely distributed in the Earth's crust. Arsenic levels in the environment can vary by locality, and it is found in water, air, and soil.*

stabilization will be done through either adsorption or precipitation. Adsorption[3] will be applied to solutions with low concentration while precipitation[4] will be applied to solutions with high concentration.

This project can help mining companies by removing arsenic minerals, which are highly toxic in their inorganic forms, from the ore/concentrate. When smelters heat this ore to retrieve the other metals, the arsenic is often released into the air as flue dust. Arsenic has long been recognized as a poison, and large oral doses can cause death (McCartor & Becker, 2010).

The project intends to recommend the process to copper-gold ores containing arsenic. Most of these operations do not remove the arsenic, so it goes with the concentrate along with the copper and gold. Arsenic is a penalty metal, therefore if it is present in concentrates, the value of the concentrate is reduced. The stabilization process is also recommended for the removal of arsenic from wastewater, not only the wastewater from mining.

On the other hand, the project '*Innovative Technology for Refractory Gold Extraction using Deep Utectic Solvent (DES) and Hypochlorite Solution,'* a project led by Mapua Malayan Colleges Mindanao in collaboration with UP Diliman, aims to investigate the geology and mineralogy of refractory gold ore resources and adapt an economic and eco-efficient process of extracting gold from refractory ores. This research project will develop an economic and environmentally sound metallurgical process to extract gold from refractory ores by employing advanced ore characterization techniques. This will be accomplished by investigating details of the host rock, the ore and gangue minerals, and their textures and relationships by combining conventional and automated technologies. The results could significantly aid in understanding not just the gold ore characteristics but also identify potentially problematic elements in the ore that hinder efficient gold extraction.

From this, alternative hydrometallurgical or solvometallurgical processing routes will be examined, taking into consideration the cost efficiency and the effect on the environment. Hydrometallurgy uses strong inorganic/ organic acids or caustic watery solutions to selectively dissolve and precipitate metals, while solvometallurgy is defined as the processing of ores or wastes for metal recovery. The methods that will be developed from this research study will aid the efficient extraction and recovery of refractory gold ores in the country.

Another project that was subjected to policy study is the *'Establishment of Common Service Facility for Artisanal Small-Scale Gold Mining in Mindanao'* from MSU-IIT. The project designed and built an environmentally friendly and cost-effective common service facility (CSF) for artisanal small-scale gold mining in selected areas in Mindanao and utilized mine tailings as cermet material for a profit. This project can help small-scale miners by using an environmentally friendly method of extracting gold that has a recovery of 80-99%. This project will provide a higher yield for the artisanal gold miners. The processing plant could process three (3) tons of gold ore per eight (8) hours with an overall estimate of five thousand pesos (PhP 5,000) per ton of ore charge regardless of the head grade of the ore. The study was also able to estimate that at least 6.14 grams per tonne (gpt) should be operated by the processing plant if it decided to process bought gold ore.

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[3] *The process of* **adsorption** *involves separation of a substance from one phase accompanied by its accumulation or concentration at the surface of another.*

[4] **Precipitation** *means reducing solubility of a dissolved species that compound gets insoluble.*

The gold recovery in this CSF pilot plant is applicable for free gold and oxide gold ores. Thus, the project team recommends enhancing the pilot plant to extract gold from refractory gold ores via galvanic interaction using aluminum and roasted pyrite using a more environmentally friendly chemical. Moreover, the team aims to remove all heavy metals using the same technique including arsenic, and selenium.

One of the notable challenges that the projects have encountered is the shortage of metallurgical engineers in the country. Currently, there are only two (2) universities offering metallurgical engineering courses throughout the country (*edukasyon.ph*, n.d.). This has been exacerbated by unclear enforcement of mineral processing law, and the country's decades-long insurgency. Political instability is also one of the hurdles as the agencies implementing the project were not able to secure the necessary permit due to changes in local leadership with different priorities. The restrictions and processes in the procurement law in the purchase of research equipment also contributed to the delays in the project completion.

ISSUES AND CHALLENGES

One of the issues that mining has been dealing with is that it is a generally extractive activity the way it has been traditionally practiced. As a result, this makes the country a mere exporter of raw materials to industrialized countries and unable to benefit from value-addition. To help address this problem, a long-term strategy of national industrialization in the mining sector is needed (Israel, 2010). Among others, this strategy will enable the sector to expand into processing and other downstream activities and transform low value outputs of raw materials into processed products with higher value-added.

On Mining Laws and Regulations

Lengthy process of securing permits

Mining companies in the Philippines have faced challenges in filing applications, securing permits and certifications, and operation of mining projects. Mining companies complain about the lengthy process of securing permits which usually take years to complete. Currently, there are 14 requirements for processing of mining rights applications (Mines and Geosciences Bureau - Regional Office No. XIII, 2011). For Minerals Processing Permit, there are 14 mandatory requirements in the acceptance of applications. After the acceptance of applications, another 4 requirements must be submitted by the applicant (Mines and Geosciences Bureau - Regional Office No. XIII, n.d.)

According to the Fraser Institute's 2022 Annual Survey of Mining and Exploration Companies, Nevada, along with Western Australia, Saskatchewan, Newfoundland & Labrador, and Quebec are major global mining centers having a legislation and permitting process conducive to attract new investments and with permitting process that is relatively smooth. The survey was an assessment on how mineral endowments and public policy factors such as taxation and regulatory uncertainty affect exploration investments (Mejia & Aliakbari, 2023).

Restrictive regulatory measures of government agencies

From the result of the key informant interviews with several mining companies, the study team found out that restrictive regulatory measures affect the operation of the mining companies. In fact, one company is facing a possible non-renewal of their minerals processing permit (MPP). Under Section 55 of the '*Philippine Mining Act of 1995*', the term of an MPP shall be for a period of 25 years only. This limitation

on MPP would negatively impact the investors' perception since they will not be able to continue their operations once the term is reached. This limitation affects their company and the other mining companies that process minerals in the country. Such uncertainty regarding the future of their operations is not palatable for investors.

Local laws are not aligned with national laws

Under the '*Philippine Mining Act of 1995*', there is no clear role for the local government units (LGUs) in the operations of mining companies. As a result, local ordinances related to mining are in contrast with national policies in most cases. For instance, some mining companies are being compelled to pay local taxes by some LGUs aside from the mandated taxes by the national government. Under Section 82 of the Act, the government share shall be shared and allocated in accordance with Sections 290 and 292 of Republic Act No. 7160, otherwise known as the '*Local Government Code of 1991',* wherein the local government units have a share of forty percent (40%) of the gross collection derived by the national government from the preceding fiscal year from mining taxes and other taxes. Various LGUs issue permits for small-scale mines and have passed ordinances limiting operation or banning certain types of mining such as open pit mining. Differences in fiscal regimes for small-scale and larger mines provide an incentive for LGUs to issue small-scale mining permits and oppose large-scale mining operation. To increase investment in mining and government revenues from mining, LGUs' revenue sharing system must be improved. This would also improve the cooperation of LGUs in the government's efforts to stimulate growth in mining (Sunley, et al., 2012).

On Mining Operations and Production

Lack of processing plants for metallic ores

At present, there are only two (2) nickel processing plants in the Philippines, the Coral Bay Nickel Corporation and the Taganito HPAL Nickel Corporation. These two mining companies operate a hydrometallurgical processing plant using high-pressure acid leach (HPAL) technology that converts low-grade nickel ore into nickel and cobalt mixed sulfide. These intermediate products are further refined in Japan to turn into valuable components in the electronics, chemical engineering, and aerospace industries and these are also used as battery materials for EVs.

High Energy Cost and Infrastructure Requirements

Among the concerns of the mining companies is the relatively high cost of electricity which is the main and essential requirement in mining operation. According to the study of Ateneo Center for Economic Research and Development, the price of electricity in the Philippines is high by regional standards, which makes the country unable to draw in foreign direct investments (Ravago, 2023). As shown in Table 3, the Philippines continues to have the second highest electricity prices for businesses in Southeast Asia next to Singapore (*GlobalPetrolPrices.com*, n.d.).

Table 3. Electricity prices for business, June 2023 (kWh, U.S. Dollar)

Country	U.S. Dollar
Singapore	0.314
Philippines	**0.157**
Thailand	0.124
Malaysia	0.121
Vietnam	0.072

Source: Global Petrol Prices

POLICY RECOMMENDATIONS

On Mining Laws and Regulations

Review the Philippine Mining Act of 1995 and other related laws on mining

There must be a review of Philippine mining laws especially the '*Philippine Mining Act of 1995'*. It is recommended to address the vague provisions on mining permits and simplify the process of securing them. In addition, the issue of the 25-year term of an MPP must be addressed to assist companies that will be affected should their permit not be renewed.

Harmonize national and local policies

It is recommended to harmonize the national and local policies to avoid the confusion and inconvenience being experienced by the mining companies. For instance, large-scale metallic mining companies are lamenting the taxes being imposed by the LGUs through ordinances on top of the mandated taxes and fees stated in the *'Philippine Mining Act of 1995'*. Some companies are being obliged to pay a monitoring fee and other local fees by the local government for the cost of ores being extracted. However, LGUs have the power to levy taxes, fees and charges as provided under Section 5, Article X, of the 1987 Constitution which states that each local government unit shall have the power to create its own sources of revenues and to levy taxes, fees, and charges subject to such guidelines and limitations as the Congress may provide, consistent with the basic policy of local autonomy. Such taxes, fees, and charges shall accrue exclusively to the local governments. The guidelines and limitations mentioned in Section 5 are spelled out in Book 2 of the *'Local Government Code of 1991'*, which provides the legal basis and parameters for the taxing and revenue-raising powers of local governments (Department of Interior and Local Government, 2012).

On Mining Operations and Production

Processing facilities be put up first before imposing export prohibition

There is a need to prepare both the midstream and downstream industries which are the direct users of raw metallic ores. Putting up plant facilities that will process these ores should be a priority. Putting up processing plants is crucial to encourage Filipino metallurgical engineers to work in the country since most of them are working in other countries due to the lack of processing plants in the country. In the study of Radetzki (1977), the author argued that mineral exporting countries could derive substantial benefits from the establishment of mineral processing within their territories, even when such a location is against the economic interests of the multinational companies. The country can benefit significantly from investing in mineral processing facilities. By adding value to raw materials, the country can increase its exports and generate more revenue, which can be used to fund social and economic development programs.

Switch to Renewable Energy to reduce power costs

Establishing processing plants would be advantageous but there is also a need to consider other factors such as power costs, etc. One of the primary concerns of mining companies is the power supply. Mining companies say that their main cost driver is power, which accounts for a high percentage of their total operating costs. To address this problem, the case of Mauritania, the second largest iron producer in Africa can be considered (Georges, 2022). Mauritania is targeting to switch to renewable energy to fulfill the energy needs of the mining sector. The country has enormous potential for both solar

and wind energy because of its unique geography. Expanding renewable generation capacity could improve the sustainability of mining operations in this country, which currently represent close to a quarter of their GDP (*International Energy Agency*, 2023).

Gradual instead of total restriction on direct shipment of metallic ores

A gradual prohibition on direct shipment of metallic ores should be considered instead of totally prohibiting the export of ores. A policy that would gradually restrict the exportation of ores would also pave the way for more mineral processing and value-adding in the country's mining sector. The government should consider giving subsidies or assistance for equipment and facilities to be utilized by the mining companies. Prohibition on exports should only be implemented once facilities are completed and about to be operated. In addition, a pricing regime shall also be formulated once the mining companies start selling their ores to these processing facilities. The government may then intervene and require all mining companies to make use of the plant facilities to process the raw ores. Furthermore, putting up a policy against the export of metallic ores will help map the direction for supply value chain, which includes establishment of downstream industries. Through an export prohibition, it will support the industry sector in putting up projects that will address the whole value chain from mine ores to industrial products.

The prohibition will also trigger the development of the country's mineral processing industry and enhance the value of mineral products. In addition, it gives the right approach for value-adding activities for metallic ores. It will also give us the drive to invest in innovative technologies for metallic minerals to produce competitive intermediate products for industrial applications. The prohibition will also ensure that there is adequate supply of raw materials to process as the government has the possible direct control on the exports and imports of raw and intermediate products. This will also establish predictability and stability of government's direction. It will also address any distortions in pricing. Furthermore, the prohibition will also generate more domestic income, attract more investments, and lead to more jobs and livelihood for the Filipino people. In response to this policy, the government can also provide additional benefits to stakeholders.

Technologies for value-adding of metallic minerals should be supported

The progressive development of value chain requires gradual export prohibition, first of the ore, followed by the produced intermediate or semi-finished products. Thus, extraction and refinement techniques and technologies to produce high purity metals should always be endeavored. New technologies and innovations are continually being developed in the mineral processing sector to increase productivity, save costs, and lessen the negative effects of mining activities on the environment.

The DOST-PCIEERD funded and monitored projects that were subjected to this study can help mining and minerals industry by providing an economic and environmentally sound metallurgical process to extract gold from refractory ores. Through these projects, concentrates with reduced impurities, which would increase the saleable value of the concentrate, can be provided. The higher education institutions (HEIs) in mining regions can also benefit from these projects by capacitating them so that they can establish mineral resource-related degree programs and can assist the large-scale and small-scale mining operators in their respective regions.

Other Policy Recommendation:

Capability Building for Human Resource, Technical Experts, and Skilled Workers

If the direction of export ban of mineral ores is to be pursued further by the Philippine government, it must prepare the Labor Sector as well. Putting up facilities and downstream industries requires technical experts and skilled workers to maintain and optimize the plant operations. The Philippines may need more metallurgical engineers because there is a limited number of metallurgical professionals in the country, despite the Philippines being one of the few countries richly blessed with mineral resources. The UP Diliman and MSU-IIT are the only HEIs offering metallurgical engineering courses in the country. On the other hand, the *Balik Scientist Program (BSP)* of DOST should be supported. The endeavors of the BSP are a good start for the government to attract more experts in the field of metal extraction, mining, metallurgy, and mineral processing.

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