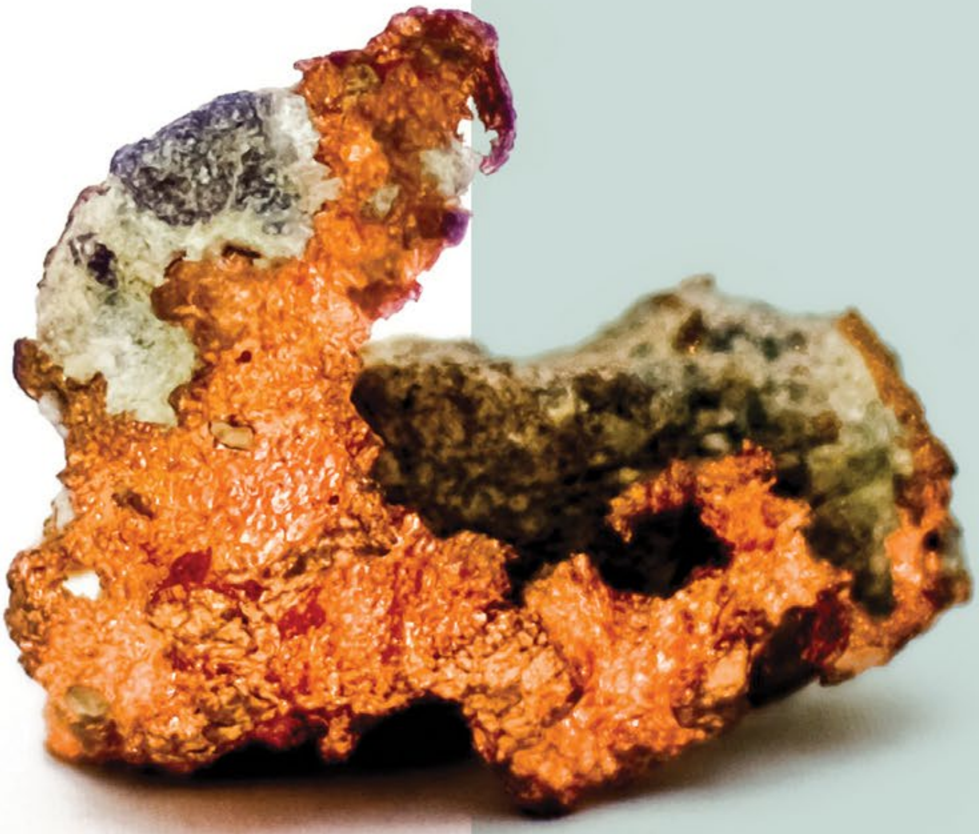
Copper Development Association Inc.
Copper Alliance

Add Copper to the Critical Mineral List Now



Copper's Updated Critical Mineral Supply Chain Calculations

BY IAN LITTLEWOOD

EXECUTIVE SUMMARY

Copper is a critical mineral. It is so critical that life, and our society, would be unimaginable without its widespread use within electrical and plumbing applications, in consumer electronics and in defense, in addition to the emerging use of its antimicrobial properties to kill COVID-19 and other deadly viruses.

Copper is and always has been critical to our economic and national security but now to the clean energy transition as well.

Copper is also used extensively in electric cars and the new green energy applications that will give U.S. industry the competitive advantage of lower costs and save money for hard pressed households, while also reducing pollution.

Copper is so critical that when the Energy Act of 2020 defined the uses of a critical mineral, copper was found in each and every one. The energy transition is forecast to lead to abrupt demand growth, another element of the definition. The Act further states that a critical mineral must be essential to the economic and national security of the United States, which of course it is, unless you think the economy and military could function without electricity.

A final part of the Energy Act definition references the supply chain being vulnerable to disruptions, including foreign political risk, military conflict, violent unrest and anticompetitive behaviors, which are indeed found in some of the major copper producing countries. Ominously, Russia, China, Iran and North Korea now account for approximately half of non-U.S. global refined copper production, up from 43% in 2016 and their share is forecast to increase further. At the same time, the U.S. reliance on imports has increased dramatically over the past few years, with the share of refined consumption that is reliant on net imports rising from 31% in 2016 to a staggering 49.3% in 2021.

Yet in 2021 when the USGS updated its methodology to determine which metals should be considered a critical mineral, copper didn't meet its criteria. Moreover, the latest data that the USGS used in its study was for 2018. The data was already considerably out of date and the world has changed dramatically since then. The USGS methodology certainly has some shortcomings but if that is the approach to be followed, at the very least the very latest available data should be used.

The Copper Development Association (CDA) has replicated the USGS methodology, and our analysis shows that copper now meets the criteria for inclusion as a critical mineral owing in part to ever rising import reliance, in combination with the increasing concentration of production in geopolitical adversaries. Copper is and always has been critical to our economic and national security but now to the clean energy transition as well. With further abrupt demand growth forecast to meet the growing needs of the energy transition, the Secretary of the Interior should act now to add copper to the critical minerals list rather than putting our growth, economy and defense at risk by waiting three years for the next required update.

CDA REPLICATION OF USGS CRITICAL MINERALS METHODOLOGY

The USGS Critical Minerals Methodology aims to quantify supply risk and set a threshold, above which, minerals qualify for inclusion on the critical minerals list.

Supply Risk is defined by the USGS as the confluence of the following three factors:

1. the likelihood of a foreign supply disruption (Disruption Potential)
2. the dependency of the U.S. manufacturing sector on foreign supplies (Trade Exposure)
3. and the vulnerability of the U.S. manufacturing sector to a supply disruption (Economic Vulnerability)

Supply Risk (SR), as a score ranging from 0 (low) to 1 (high), was calculated as the geometric mean of three components, as follows:

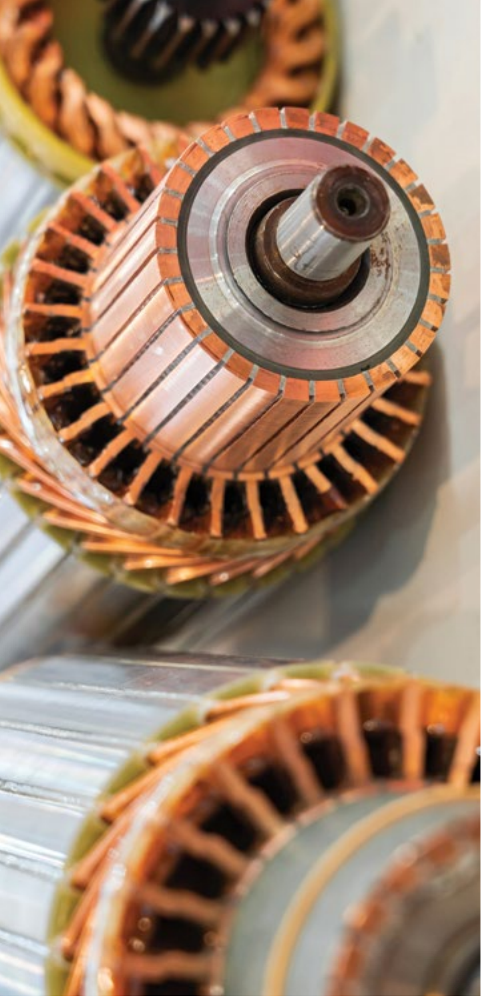
$$SR_{i,t} = \sqrt[3]{DP_{i,t} \cdot TE_{i,t} \cdot EV_{i,t}},$$

In simple terms, Supply Risk is equal to the cubed root of Disruption Potential multiplied by Trade Exposure multiplied by Economic Vulnerability. The USGS Methodology determines that 0.40 is the cut off for inclusion in the critical minerals List. Supply Risk scores for each year were then given a recency-weighted average over a four-year period, with the latest year having a 40% weight, the prior year 30%, the year before that 20% and finally the oldest year, 10%.

We have updated the USGS methodology with full year data to 2021, where available, and provided two separate estimates for 2022. For Disruption Potential and Economic Vulnerability, these are essentially full year estimates for 2022 using a combination of actual data, forecasts from the original source, industry forecasts, or a combination of partial year actual data, with estimates for the balance of the year. We have provided two alternatives for trade exposure, with the first showing full year estimates for 2022 and the second using actual data for the first half of the year.

Our update of the USGS methodology with latest data shows that copper now meets the USGS benchmark Supply Risk score of 0.4 for inclusion on the critical minerals list. The key data points are summarized below.

	2015	2016	2017	2018	2019	2020	2021	2022 FY Est.	2022 H1
Economic Vulnerability	0.932	0.921	0.933	0.922	0.931	0.933	0.978	0.968	0.968
Disruption Potential	0.103	0.101	0.145	0.119	0.141	0.146	0.161	0.163	0.163
Trade Exposure	0.309	0.307	0.380	0.318	0.367	0.367	0.493	0.477	0.479
Annual Supply Risk	**0.310**	**0.306**	**0.372**	**0.327**	**0.364**	**0.368**	**0.427**	**0.422**	**0.423**
Recency Weighted Four Year Supply Risk				**0.334**	**0.349**	**0.359**	**0.387**	**0.407**	**0.407**

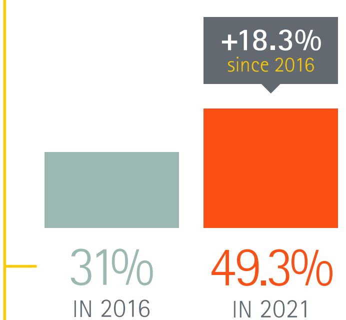


The major changes that have resulted in copper now meeting the threshold for inclusion as a critical mineral relate to higher scores for Disruption Potential and Trade Exposure. The higher Disruption Potential scores stem from an increasing share of copper production in countries that are adversaries of the U.S. Trade Exposure is a relatively straightforward measure as it captures the share of consumption that is met by net imports. This has increased dramatically over the past few years, from 31% in 2016 to a staggering 49.3% in 2021 as imports of refined copper surged from 701 thousand tonnes to 919 thousand tonnes. During the same period, U.S. refined copper production slumped, declining from 1,180 thousand tonnes to 923 thousand tonnes. In the first half of 2022, the net import reliance stood at 48%. The combination of an ever-increasing reliance on overseas imports, amid declining domestic production at the same time as higher potential for disruptions, in addition to an elevated economic vulnerability, has resulted in copper now meeting the threshold for inclusion as a critical mineral in 2022.

The only significant departures from USGS methodology relate to the calculations for Trade Exposure and Economic Vulnerability. Instead of using the USGS' own trade data from the excellent USGS Mineral Industry Surveys, the authors of the USGS Critical Minerals study aggregated their own data but in doing so erroneously included various items that are not typically considered to be refined copper. To correct for these errors, refined import and export data was sourced directly from USGS Mineral Industry Surveys in this updated CDA study.

With regards to Economic Vulnerability, key input data was not available for 2021, let alone for 2022 so an alternative approach was used. The Economic Vulnerability calculation measures the extent to which commodities contribute to the U.S. economy, for which expenditures were high but where operating profits are low. In essence, the calculation is designed to show how changes in the price of a commodity affect industries where metals are widely used and consequently, the economic vulnerability score for copper is highly correlated with copper prices. Rather than partially updating the USGS study for 2019 and 2020 and then devising an alternative approach to estimate scores for 2021 and 2022, a regression with the copper price was used to estimate economic vulnerability scores from 2019 to 2022. Even if the lowest USGS sourced calculated economic vulnerability score for the period 2015-2018 was used as an input to our study for 2019-2022, copper would still meet the threshold for inclusion as a critical mineral.

IMPORTS OF COPPER ARE ON THE RISE



The share of copper consumption that is met by net imports has increased from 31% in 2016 to a staggering 49.3% in 2021.

701 → 919
THOUSAND TONNES THOUSAND TONNES

CONCLUSION

As copper now meets its threshold for inclusion based on the very latest available data, we need to act immediately to enable the copper industry to provide the essential inputs that copper provides to our national defense and economic security.

There is no need to wait 3 years for the next required update to the list. This will allow us to build new and renewable energy sources, invest in semiconductors, and upgrade the U.S. electrical grid to support the energy transition, without having to rely on geopolitical adversaries. By acting now to add copper to the critical minerals list, policymakers will make it easier for copper to provide a step change in our economy that reduces pollution through investment in green energy, helps hard pressed consumers by cutting their bills, and gives our industries a new competitive advantage through lower energy costs.

We provide more detail on the USGS methodology and input data in the appendix attached.

Appendix

EXPLANATION OF METHODOLOGY

Disruption Potential

The Disruption Potential Component of Supply Risk is defined by the USGS Methodology as the sum of the squares of each producing country's share of global production (excluding the United States), weighted by each producing country's willingness or ability to continue to supply using the following equation.

$$DP^{raw}_{i,t} = \sum_c \left(PS^2_{i,t,c} \cdot \max\left(ASI_{t,c}, WSI_{t,c} \right) \right)$$

This equation takes the share of global production of each country then squares it, before multiplying that by the highest value of either the Ability to Supply Index or the Willingness to Supply Index. The methodology then adds the values for each country to get a "Raw" Disruption Potential value. The Raw Disruption Potential scores for each commodity for each year were normalized to a common 0-to-1 scale based on the observed minimum and maximum scores across all commodities and all years, as follows.

$$DP_{i,t} = \frac{DP^{raw}_{i,t} - DP_{min}}{DP_{max} - DP_{min}}$$

In simple terms, this takes the Raw Disruption Potential and subtracts the observed minimum Disruption Potential score from this analysis of all commodities and all years and divides that by the maximum observed Disruption Potential value minus the observed minimum Disruption Potential.

The Ability to Supply Index (ASI) component of Disruption Potential is based on the Fraser Institute's Policy Perception Index, a composite index that measures the effects of government policy on attitudes toward exploration investment. The Policy Perception Index scores range between 0 and 100, with 0 being bad and 100 considered good. The USGS Methodology reverses the scores and scales them between 0 and 1, with higher scores reflecting a worse ability to supply and creates a higher Disruption Potential score.

The ASI is not an appropriate measure for the refining stage of copper production that the USGS uses in its calculations. In essence, the Fraser Institute measures friendliness to mining investment and not the industrial process of smelting and refining. Moreover, more than half of the countries that smelt and refine copper do not have an ASI score at all. In the CDA updated study, data is not yet available for 2022 and we have used 2021 data as an input to the 2022 calculation for Disruption Potential. Given so few countries have an ASI score in any case, this has little to no effect on the Disruption Potential score.

The Willingness to Supply Index (WSI) assesses the trade, ideological, and defense ties that a producing country has with the United States to provide a proxy for the likelihood that it may deliberately disrupt its supplies to U.S. manufacturers. **It is comprised of Trade Ties (TT), Shared Values (SV), and Military Cooperation (MC)** and is calculated as the average of Trade Ties and Shared Values minus 0.1 for Military Cooperation. Countries that have are considered to cooperate militarily are: Australia, Canada, Finland, Italy, Norway, Spain and Sweden.

Trade Ties (TT) refers to the extent of trade that a country has with the United States as is measured as the monetary sum of its imports and exports with the United States each year relative to its Gross Domestic Product (GDP). It uses the following equation.

$$TT^{raw}_{t,c\leftrightarrow USA} = \frac{\sum \left(I_{t,c\leftarrow USA}, E_{t,c\rightarrow USA} \right)}{GDP_{t,c}}$$

In case any reader was lulled into the feeling that Trade Ties appears to be a relatively straightforward calculation, the USGS Methodology adjusted the raw scores using the equation below.

$$TT^{norm.}_{t,c\leftrightarrow USA} = \max\left(1 - \log_{10}\left(100 * \left(TT^{raw}_{t,c\leftrightarrow USA} + 1\%\right)\right), 1\%\right)$$

In simple terms, this normalization limits Trade Ties scores such that a country with a total trade value with the United States that is greater than or equal to 9% of its GDP yields a score of 1 and no country receives a TT score lower than 0.01.

In the CDA update, we have full year data up to 2021 for all countries and have made estimates for 2022. The imports and exports components are based on actual trade data for the first seven months of 2022 and estimates for the balance of the year. For GDP, we used full year data for 2021 and 2022 estimates were sourced from the World Bank June 2022 economic outlook.

Shared Values (SV) refers to the extent to which a country shares similar ideological values with the United States and Freedom House's Freedom in the World (FIW) reports are used to assess this. The reports assess the political rights and civil liberties of over 195 countries and 14 territories through 25 indicators that are aggregated to several subcategories: Electoral Process, Political Pluralism and Participation, Functioning of Government, Political Rights, Freedom of Expression and Belief, Associational and Organizational Rights, Rule of Law, Personal Autonomy and Individual Rights.

To determine how "close" a specific country is to the United States, the euclidean distance between the country in question and the United States is calculated across all Freedom In the World subcategories. The raw SV scores are then scaled such that the maximum observed value across all countries and years is given a score of 1. In simple terms, the equation takes the country sub-index score and subtracts the United States sub-index score and takes the square root of that, before summing the total of all the subcategories.

$$SV^{raw}_{t,c\leftrightarrow USA} = \sum \left(Subcategory_{s,t,c} - Subcategory_{s,t,USA}\right)^{\frac{1}{2}}$$

Freedom in the World data is available for 2022 and so full year data was used in the CDA study.

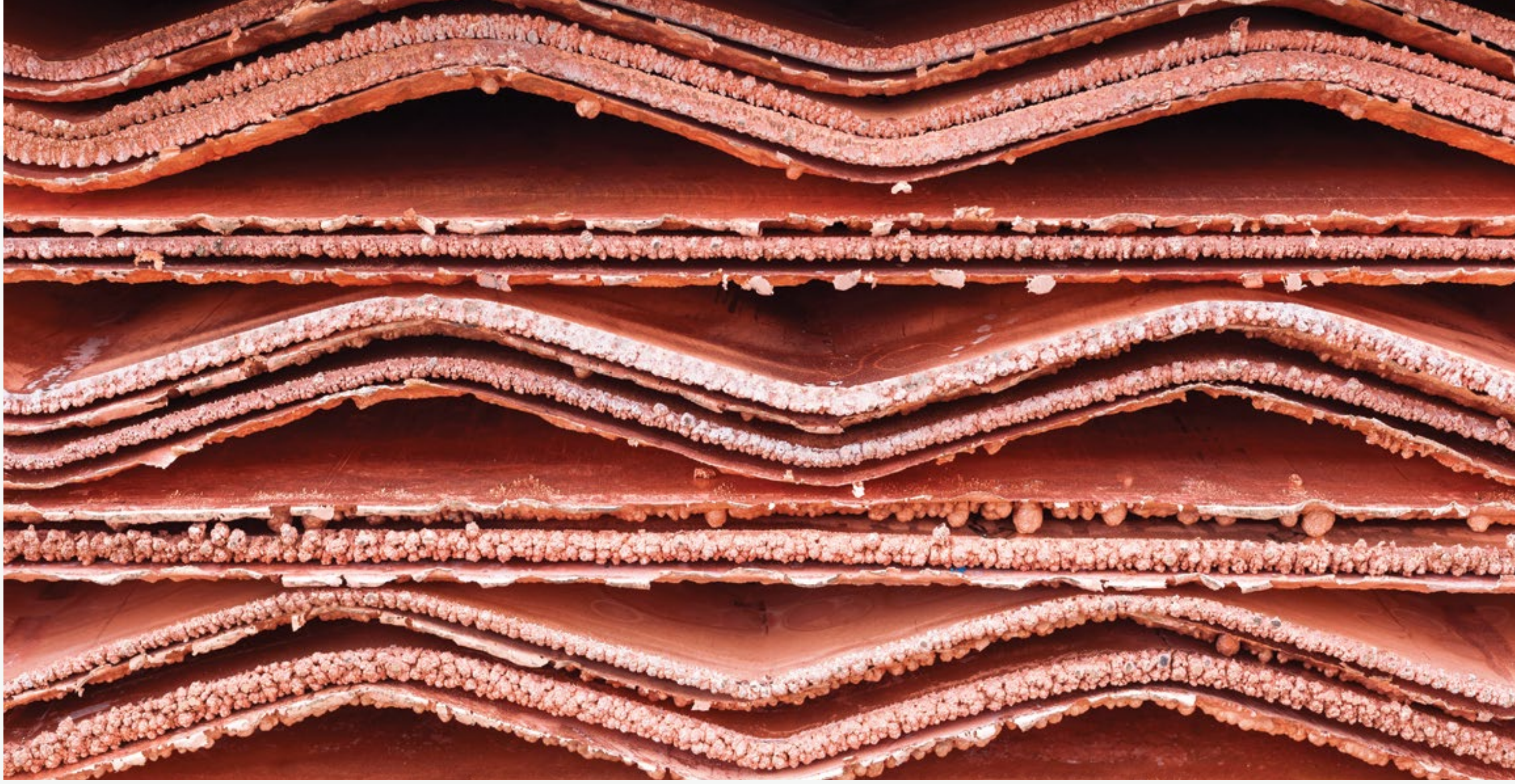
Trade Exposure

Trade Exposure (TE) is based on net import reliance as a percentage of apparent consumption of the United States. It was calculated as follows:

$$TE_{i,t} = \frac{I_{i,t} - E_{i,t} + \Delta S_{i,t}}{AC_{i,t}}$$

In simple terms, it is the Imports (I) of refined copper to the United States, minus Exports (E) plus the change in Stocks (S). This figure is then divided by Apparent Consumption (AC). Apparent Consumption is calculated as Primary Production + Secondary Production + Imports – Exports + the change in Stocks.

Refined copper is typically considered to include HS trade codes 740311, 740312, 740313 and 740319. The USGS has been collecting copper trade data for many years following similar principles but for some reason the USGS failed to source trade data from within its own organization and opted to use various other trade codes. These included various copper and alloy semi-fabricated products and even stretched so far as to consider the copper content of some steel products. In the case of trade data, the authors of USGS critical minerals study were wrong. We corrected for this by using the USGS copper imports and exports helpfully provided in the excellent USGS Mineral Industry Surveys. Data for the first half of 2022 was available and estimates were made for the balance of the year.



Economic Vulnerability

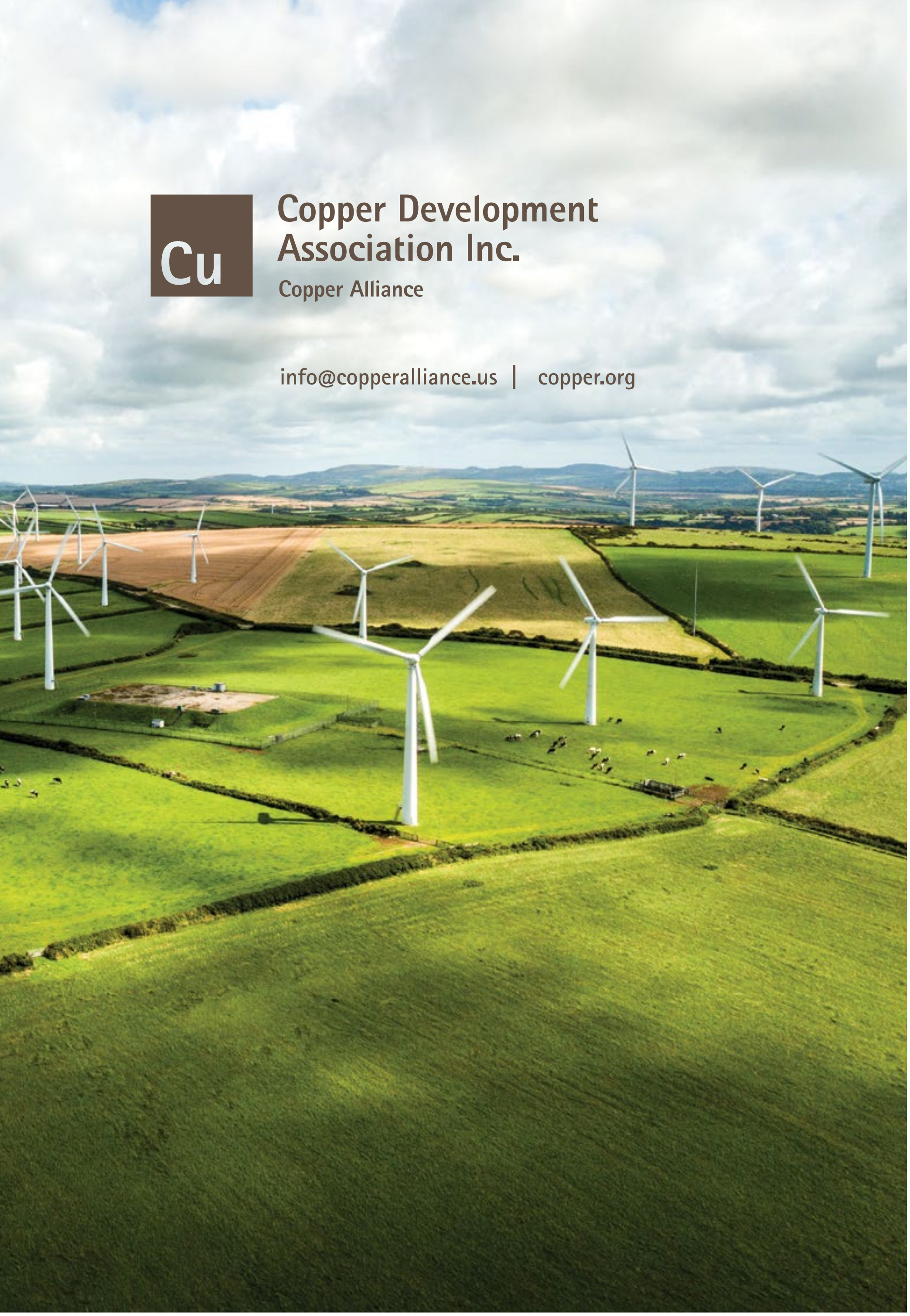
To calculate economic vulnerability, each mineral commodity's uses were linked to a set of manufacturing industries that used that commodity, as defined by the North American Industry Classification System (NAICS). Commodities for which expenditures were high in industries with low operating profits but that contributed greatly to the U.S. economy were given higher economic vulnerability scores, as follows:

$$EV_{i,t}^{raw} = \sum_j \left(\frac{VA_{t,j}}{GDP_t} \cdot \frac{EXP_{i,t,j}}{OP_{t,j}} \right),$$

EXP is industry's expenditure on a commodity in a year, OP is that industry's operating profit, and VA is the industry's value added (i.e., its contribution to GDP). The ratio of EXP to OP provides a measure of each industry's vulnerability, while that of VA to GDP provides a measure of that industry's economic importance to the economy. The raw Economic Vulnerability scores were normalized to range from 0 to 1, with higher scores indicating greater vulnerability, based on the observed minimum and maximum scores across all commodities and years using the equation below.

$$EV_{i,t} = \frac{\ln\left(EV_{i,t}^{raw} \cdot 10^9\right) - \ln\left(EV_{min} \cdot 10^9\right)}{\ln\left(EV_{max} \cdot 10^9\right) - \ln\left(EV_{min} \cdot 10^9\right)}$$

In the CDA study, one of the major input data sets was not available for 2021 and consequently, we had to consider the best approach to give us continuity in the series that we used. The economic vulnerability calculation measures the extent to which commodities contribute to the U.S. economy, for which expenditures were high but where operating profits are low. In essence, the calculation is designed to show how changes in the price of a commodity affect industries where metals are widely used and consequently, the economic vulnerability score for copper is highly correlated with copper prices. Rather than partially updating the USGS study for 2019 and 2020 and then devising an alternative approach to estimate scores for 2021 and 2022, a regression was used to estimate economic vulnerability scores from 2019 to 2022. The input price used in the CDA study was the same U.S. producer cathode price that the USGS used it its methodology, with a price of 400c/lb used as an estimate for the 2022 copper price. It is worth noting that even if the lowest economic vulnerability score for the period 2015-2018 was used as an input to the CDA study in the years 2019-2022, copper would still meet the threshold for inclusion as a critical mineral.



Copper Development Association Inc.
Copper Alliance

info@copperalliance.us | copper.org

About the Author:

Ian Littlewood has worked in the metals and mining industry since 2007 and is an expert in the analysis and forecasting of copper and aluminum markets. He has expertise in building models to forecast end use demand for metals, along with their supply and prices. During his career, he has been at the vanguard of analysis and modelling of aluminum and copper scrap supply and use and has been invited to present at conferences in this area as a result. He also has extensive knowledge of the U.S. copper and aluminum industries with particularly strong insight into the secondary copper and aluminum market and its participants. Mr. Littlewood now works at Paragon Global Markets, where he helps metals producers, consumers and traders to manage price risk as a member of the metals hedging team. Prior to that he worked as an Independent Commodity Analyst, working with various clients such as the CDA to help improve understanding of metals markets. Ian was the head of metals and mining research at Barclays until June 2019, before which, he worked at RUSAL, where he led market analysis and strategy in the Americas region. He has also worked at a commodity focused hedge fund, in addition to metals and mining research consultancies Wood Mackenzie and CRU. He is a Business Economics (BA, Hons) graduate from Middlesex University in the UK and is also a CFA charter holder.

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