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Trade and development implications of key aspects of the energy transition

The sustainable energy revolution: Trade and development implications in critical energy transition minerals markets and maritime transport

Note by the UNCTAD secretariat*

Summary

The increasing urgency of achieving net-zero emissions by 2050 has led to increased demand for critical energy transition minerals. However, without internationally agreed principles on fair, just and sustainable management, global demand for such minerals could exacerbate commodity dependence in developing countries endowed with such minerals and weaken the resilience of global supply chains of essential components of renewable energy and digital technologies. At the fourteenth session of the Trade and Development Commission, discussions will focus on a trade and development perspective on the work of the Panel on Critical Energy Transition Minerals established by the Secretary-General of the United Nations.

The decarbonization imperative also puts maritime shipping stakeholders under pressure to accelerate the energy transition. Progress is under way, yet there is uncertainty regarding the most effective way to achieve low-carbon and zero-emission targets. Small island developing States and the least developed countries face challenges in meeting the significant levels of investment required for decarbonizing shipping and mitigating increased maritime logistics costs. Efforts should aim to reduce the uncertainty undermining timely investment decisions and alleviate transition costs.

To support discussions at the fourteenth session of the Trade and Development Commission on these issues, in this note, the potential developmental risks with regard to demand for critical energy transition minerals are examined, along with challenges linked to decarbonizing maritime transport.

* The present report was submitted to the conference services for processing after the deadline so as to include the most recent information.

1. The United Nations Conference on Trade and Development, at its fifteenth session, highlighted that transforming to a climate resilient and a more sustainable and more resilient economy required diversifying towards more sustainable energy and, in the Bridgetown Covenant, stated that UNCTAD should "support developing countries in identifying relevant trade and investment policies to contribute to the attainment of the climate and environmental goals of the 2030 Agenda".[1]

2. Technologies underpinning the rapid deployment of electric vehicles, batteries and renewable energy technologies depend on the availability of critical energy transition minerals.[2] It is estimated that the demand for such minerals may increase almost fourfold by 2030.[3] Global demand for such minerals, if not coordinated, may jeopardize the sustainable development paths of developing countries. The deployment of more sustainable technologies, including the use of alternative fuels, also needs to be increased in maritime transport. The rapid roll-out of such technologies has already had significant economic, social and environmental impacts worldwide, including in developing countries.

3. The fourteenth session of the Trade and Development Commission presents an opportunity for member States to contribute substantive inputs from the trade and development perspective to ongoing action being taken within the United Nations system on critical energy transition minerals, including the Panel on Critical Energy Transition Minerals, and on possible parameters for common and voluntary principles in this regard. To support discussions at the session, in this note, critical policy questions concerning the management of such minerals are addressed, to contribute to a fair and just energy transition in developing countries while achieving sustainable economic diversification, along with the decarbonization of maritime transport.

I. Challenges in critical energy transition minerals markets

4. The General Assembly has recognized the "need for developing countries rich in critical minerals to add value to their supply chains in line with the three pillars of sustainable development in a balanced manner as a way of contributing to their economic structural transformation, creating decent employment, increasing export revenues and participating in the process of economic development".[4] The General Assembly has also underscored the "continuing need for international support to increase economic resilience and diversification of commodity-dependent developing countries in such a way that their structural transformation is sustainable and economically meaningful".[5]

5. In 2023, a United Nations inter-agency initiative was launched, on harnessing critical energy transition minerals for sustainable development in landlocked developing countries and the least developed countries, aimed at creating a United Nations framework on a just transition for such minerals.[6] UNCTAD leads the substantive preparation of the framework

[1] TD/541/Add.2.

[2] Without prejudice to other relevant definitions, "critical energy transition minerals" encompasses minerals that meet the following two criteria: they are essential to producing clean energy technologies, such as rechargeable batteries for electric vehicles, solar panels, wind turbines and grid battery storage; and they are indispensable to the energy transition due to the absence of viable substitutes. Such minerals include cobalt, copper, graphite, lithium, manganese and nickel.

[3] See https://unctad.org/publication/technical-note-critical-minerals.
Notes: All websites referred to in footnotes were accessed in February 2023.
Mention of any firm or licensed process does not imply the endorsement of the United Nations.

[4] A/RES/78/138.

[5] A/RES/78/134.
Note: An economy is defined as commodity dependent when it derives 60 per cent or more of its merchandise export revenues from primary commodities such as food, agricultural raw materials, base metals and crude oil. According to this threshold, in the period 2019–2021, 95 of the 195 UNCTAD member States were commodity dependent. See UNCTAD, 2023a, *State of Commodity Dependence 2023* (United Nations publication, Sales No. 23.II.D.15, Geneva).

[6] See https://www.greenpolicyplatform.org/initiatives/working-group-transforming-extractive-industries-sustainable-development/UN%20Framework%20on%20Just%20Transitions%20for%20CETM and https://unemg.org/nexus-dialogue-on-the-environmental-aspects-of-minerals-and-metals-management/.

on aspects related to international trade and productive capacities related to critical energy transition minerals.

6. During the twenty-eighth session of the Conference of the Parties to the United Nations Framework Convention on Climate Change, the Secretary-General of the United Nations announced the establishment of the Panel on Critical Energy Transition Minerals, stating that the extraction of critical minerals for the clean energy revolution must be done in a fair, just and sustainable way and that the mistakes of the past, with a systematic exploitation of developing countries reduced to the production of basic raw materials, should not be repeated; the Panel would "bring together Governments, international organizations, industry and civil society to develop common and voluntary principles to guide extractive industries in the years ahead in the name of justice and sustainability".[7]

A. Characteristics of critical energy transition minerals markets

7. Critical energy transition minerals are the most dynamically growing sectors of the minerals trade. In 2017–2022, demand increased by 300 per cent for lithium, by 70 per cent for cobalt and by 40 per cent for nickel. In addition, in the same period, the market size of critical energy transition minerals combined (including cobalt, copper, graphite, lithium and nickel) doubled, reaching a total value of $320 billion.[8]

1. Demand and supply prospects

8. Critical energy transition minerals have applications in various sectors, from information and communication technologies, engineering and chemistry to construction. The need for such minerals in clean energy technologies creates rapidly rising demand and constitutes the majority of their use. In 2022, the share of clean energy applications in total demand for critical energy transition minerals more than doubled, reaching 56 per cent for lithium, 40 per cent for cobalt and 16 per cent for nickel.[9] The trend is expected to intensify; by 2040, clean energy technologies may account for over 40 per cent of total demand for copper and rare earth elements; 60–70 per cent, for nickel and cobalt; and almost 90 per cent, for lithium.[10] By 2040, in a scenario of net-zero emissions by 2050, the demand for lithium for electric vehicles and grid battery storage is estimated to increase by over 1,500 per cent; for cobalt by over 275 per cent; and for nickel by over 950 per cent.[11] However, the evolution of renewable energy technologies may alter future demand for such minerals. Rapid technological advancements, such as in sodium-ion technology, have the potential to reduce the volume of minerals needed for various industrial applications.[12] Much technological development in the renewable energy sector remains uncertain, leading to variations in the estimates of demand growth in 2022–2030, such as for cobalt, with estimates that range from 83 to 255 per cent.[13]

9. On the supply side, the growing demand for critical energy transition minerals has stimulated new production of such minerals. For example, in 2013–2022, lithium production in the five major producing countries, namely, Argentina, Australia, Brazil, Chile and China, representing over 95 per cent of global production, increased fourfold (see figure 1).

[7] See https://www.un.org/sg/en/content/sg/statement/2023-12-02/secretary-generals-remarks-g77china-cop28-leaders-summit-delivered.

[8] See https://www.iea.org/reports/critical-minerals-market-review-2023.

[9] Ibid.

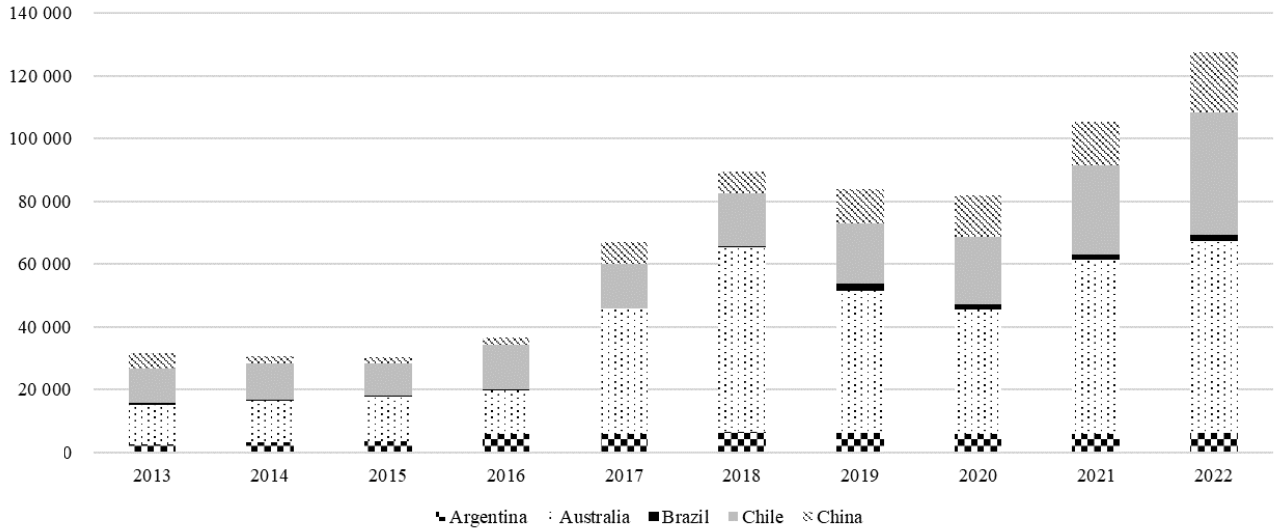
[10] See https://www.iea.org/reports/the-role-of-critical-minerals-in-clean-energy-transitions.

[11] See https://www.iea.org/data-and-statistics/data-tools/critical-minerals-data-explorer.

[12] *Financial Times*, 2023, Northvolt in new sodium-ion battery breakthrough, 20 November.

[13] Xu C, Dai Q, Gaines L, Hu M, Tukker A and Steubing B, 2020, Future material demand for automotive lithium-based batteries, *Communications Materials*, 1.

Figure 1
Lithium production in five major producing countries
(Metric tons of contained lithium)



Note: Data for 2022 are estimates.
Source: UNCTAD secretariat calculations, based on data from the United States of America Geological Survey.

10. In 2022, there was significant investment in critical energy transition minerals for the energy transition, from private mining companies and through government-led initiatives. UNCTAD has identified 110 new projects globally, with 60 in developing countries and 50 in developed countries, attracting a total investment of $39 billion, with $22 billion in developing countries and $17 billion in developed countries.[14] However, it is uncertain whether the increase in supply of critical energy transition minerals can match demand growth.

11. In order to achieve a net-zero emissions scenario by 2030 and to meet the corresponding demand for minerals, the following requirements are projected: around 80 new copper mines; 70 new lithium and nickel mines, each; and 30 new cobalt mines. The investment needed for such expansion in 2022–2030 ranges between $360 billion and $450 billion, leaving an anticipated investment gap of $180 billion–$270 billion. Investment gaps are most pronounced in copper, at 36 per cent of the total gap, and nickel, at 16 per cent, while the gaps for lithium and cobalt are at around 2 per cent and less than 1 per cent, respectively.[15]

12. The future prospects of demand and supply and changes in the renewable energy strategies of major economies influence the prices of critical energy transition minerals, at times almost instantaneously. For example, at end-2022, China discontinued 11-year subsidies for electric vehicle purchases, and the price of lithium carbonate fell by 58 per cent in nominal terms in November 2022–May 2023.[16] Future advances in renewable energy technologies may reduce the need for critical energy transition minerals as necessary components of renewable energy technologies, for example, storage batteries and appliances. In addition, the prices of such minerals are not always transparent; for some minerals, relatively few transactions are conducted on spot markets. For example, most transactions with regard to lithium are part of long-term contracts that take place privately, under which prices are determined bilaterally between suppliers and buyers and are not publicly known.[17]

[14] UNCTAD, 2023b, *World Investment Report 2023: Investing in Sustainable Energy for All* (United Nations publication, Sales No. E.23.II.D.17, Geneva). See also https://www.iea.org/reports/critical-minerals-market-review-2023.
[15] See https://www.iea.org/reports/energy-technology-perspectives-2023.
[16] TD/B/C.I/MEM.2/58.
[17] See https://www.iea.org/reports/critical-minerals-market-review-2023.

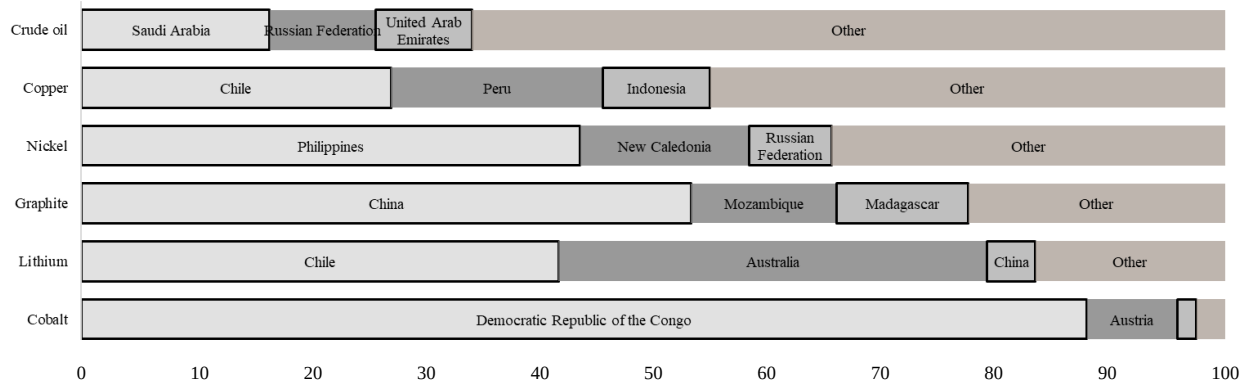
2. Trade flows

13. The value of exports of critical energy transition minerals is small as a share of global minerals trade. According to data on ores and minerals from the United Nations Comtrade database, in 2022, the combined export value of cobalt ore, nickel ore and lithium ore and brine, at $27.5 billion, was around 2 per cent of global exports of ores and minerals, or 1 per cent of the exports of petroleum (crude), coal and natural gas.

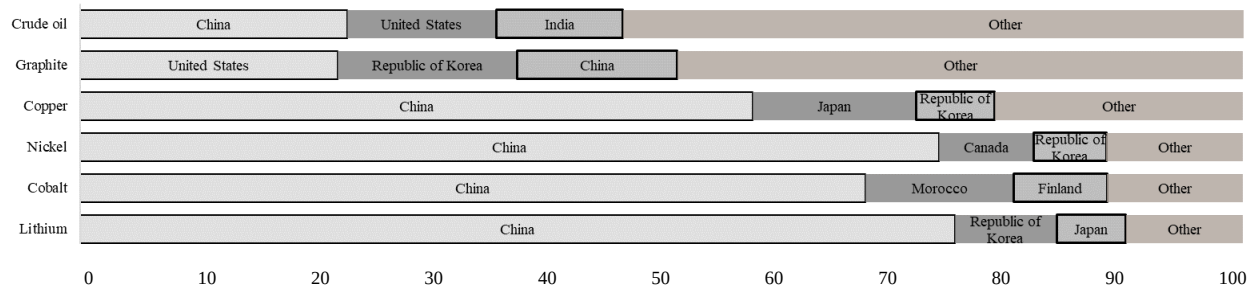
14. Trade in critical energy transition minerals is characterized by market concentration in terms of exporters and importers. The top three exporters of cobalt, copper, graphite, lithium and nickel have a share of 55–97 per cent in the respective markets (see figure 2). This is significantly higher than with regard to the crude oil market, in which the top three exporters account for 34 per cent. Market concentration is even more significant with regard to imports; the top three importers absorb around 80 per cent of the copper and 90 per cent of the cobalt and lithium traded worldwide.

Figure 2
Concentration in trade: Critical energy transition minerals compared with crude oil, 2022
(Percentage)

(a) **Leading three exporters**
(Share of global exports)



(b) **Leading three importers**
(Share of global imports)

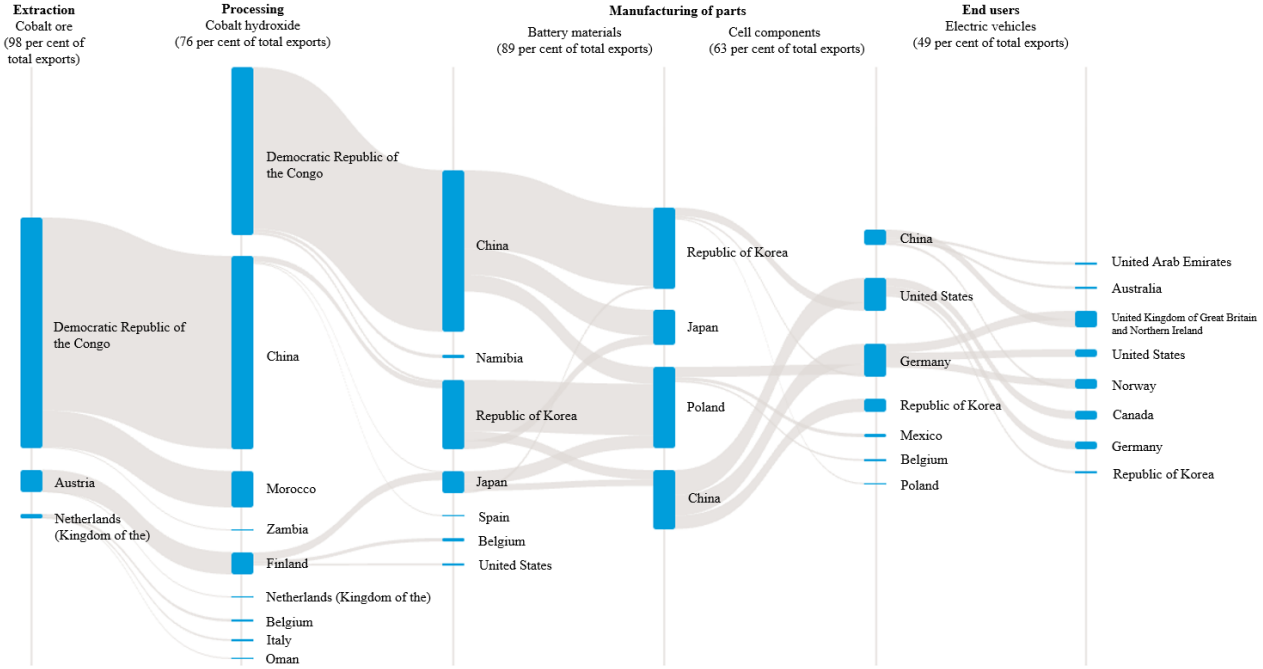


Note: The figure shows the share of trade in total export value for each commodity, based on data reported under the following six-digit level Harmonized System codes: cobalt (260500); copper (260300); crude oil (270900); graphite (250410); lithium (253090, 283691); and nickel (260400).

Source: UNCTAD secretariat calculations, based on data from the United Nations Comtrade database.

15. Market concentration is particularly evident in the upstream stages of the value chain of lithium-ion batteries for electric vehicles, namely the extraction, processing and manufacturing stages. In 2022, the Democratic Republic of the Congo was the dominant exporter of cobalt at the extraction stage, accounting for 64 per cent of global cobalt hydroxide exports, 96 per cent of which were imported by China (see figure 3). Concentration at the refining and processing stage is greater; in 2022, China refined over half of the world's lithium, two thirds of the world's nickel, three quarters of the world's cobalt, and all of the world's graphite. Beyond geographical concentrations in the supply of critical energy transition minerals, the market is highly concentrated in terms of firms participating in value chains.[18] In 2020, the leading three cobalt-producing companies together represented over 40 per cent of global production, namely, CMOC (formerly China Molybdenum Company), Eurasian Natural Resources Corporation and Glencore.

Figure 3
Cobalt trade flows along the electric vehicle value chain, share of total exports, 2022



Source: UNCTAD secretariat calculations, based on data from the United Nations Comtrade database.

B. Policies that influence critical energy transition minerals markets

16. Many Governments are introducing policies aimed at securing the supplies of critical energy transition minerals needed for the green energy transition through, inter alia, industrial policy actions and sectoral agreements to ensure access to such minerals, partnership-type agreements between importers and exporters and policy actions in producer countries, to capture a just share of benefits from resources. An overview of such new policies and agreements is provided in this section.

1. Policy actions of importing economies

17. In the United States, the Inflation Reduction Act, enacted in August 2022, introduces tax credits and subsidies for the purchase of electric vehicles that use critical energy transition minerals sourced from North America or countries that are part of a regional trade agreement

[18] UNCTAD secretariat calculations, based on data from the International Energy Agency. See https://www.piie.com/publications/working-papers/green-energy-depends-critical-minerals-who-controls-supply-chains.

with the United States.[19] Given the size of the vehicles market in the United States, this creates incentives for electric vehicle and battery component exporters that have not yet done so to forge partnerships with the United States.

18. In the European Union, the Critical Raw Materials Act, expected to enter into force in April 2024, is aimed at boosting and diversifying critical raw materials supply, enhancing circularity, increasing domestic value creation and supporting research and innovation in alternative materials, as well as at promoting European Union demand for domestically extracted, processed and recycled critical energy transition minerals, and is designed to incentivize developing countries endowed with such minerals to build partnerships with counterparts in Europe.[20]

19. A number of industrial policy tools are emerging in major economies to help meet requirements for critical energy transition minerals while enhancing domestic value. The strategies reflect a growing trend towards securing supply chains and promoting local industry in the context of global demand for critical resources.[21] Major economies are forming partnerships aimed at increasing participation in the downstream industries of related supply chains. Some of these partnerships are bilateral. For example, the United States has signed sectoral agreements with Canada (2019) and Japan (2023) and is negotiating an agreement with the European Union; the agreement with Japan, for example, aims to "strengthen and diversify critical minerals supply chains and promote the adoption of electric vehicle battery technologies".[22] Other partnerships are plurilateral, such as the Minerals Security Partnership.[23] Analysis is needed to determine whether such efforts can support long-term structural transformation in minerals-endowed developing countries.

2. Importer-exporter strategic partnership agreements

20. Complementary with industrial policies, several major economies are forming strategic partnerships with developing countries producing critical energy transition minerals. In December 2022, the United States signed a memorandum of understanding with the Democratic Republic of the Congo and Zambia, major producers of selected minerals, the purpose of which is to "strengthen cooperation among the participants in furtherance of the development of a cross-border integrated value chain for the production of electric vehicle batteries, leading to increased awareness of investment opportunities and the identification of potential co-financing opportunities for electric vehicle value chain-related investments".[24]

21. In August 2023, Japan signed joint statements on cooperation in the mining sector with the Democratic Republic of the Congo, Namibia and Zambia, each centred on securing supplies of critical energy transition minerals.[25] In 2021–2023, the European Union signed partnership agreements with Argentina, Chile, Kazakhstan, Namibia, Ukraine and Zambia;[26] a standard feature of these agreements was an emphasis on the sustainability aspects of supply, and the primary objective was to secure stable access to critical energy transition minerals, with the agreements including financial, technological and capacity-related training support to host Governments and industry, to speed up extraction, processing, refining and

[19] See https://www.congress.gov/bill/117th-congress/house-bill/5376/text and https://www.irs.gov/credits-deductions/credits-for-new-clean-vehicles-purchased-in-2023-or-after.

[20] European Commission, 2023, Proposal for a regulation of the European Parliament and of the Council establishing a framework for ensuring a secure and sustainable supply of critical raw materials, available at https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52023PC0160.

[21] International Monetary Fund, 2024, The return of industrial policy in data, Working Paper No. 1.

[22] See https://www.canada.ca/en/natural-resources-canada/news/2020/01/canada-and-us-finalize-joint-action-plan-on-critical-minerals-collaboration.html, https://ustr.gov/about-us/policy-offices/press-office/press-releases/2023/march/united-states-and-japan-sign-critical-minerals-agreement and https://www.europarl.europa.eu/legislative-train/theme-a-stronger-europe-in-the-world/file-eu-us-critical-minerals-agreement.

[23] See https://www.state.gov/joint-statement-on-the-minerals-security-partnership-announce-support-for-mining-processing-and-recycling-projects/.

[24] See https://www.state.gov/the-united-states-releases-signed-memorandum-of-understanding-with-the-democratic-republic-of-congo-and-zambia-to-strengthen-electric-vehicle-battery-value-chain/.

[25] See https://www.jogmec.go.jp/english/news/release/news_10_00046.html.

[26] See https://international-partnerships.ec.europa.eu/policies/global-gateway/climate-and-energy_en.

recycling in developing countries endowed with minerals; to promote local value addition; and to assist host Governments and industry, where feasible, in integrating into global value chains of critical raw materials.

22. If such agreements are implemented with sufficient financial support, developing countries endowed with critical energy transition minerals can benefit by increasing local value addition, thereby contributing more processed materials to value chains.

3. Policy initiatives of countries endowed with critical energy transition minerals

23. Countries endowed with critical energy transition minerals implement policy actions to capture benefits from natural resources for present and future sustainable development. Beginning in 2001, China prioritized the manufacture of electric vehicles, to address air pollution issues and reduce reliance on oil imports, introducing subsidies and tax incentives and targeted public procurement for electric vehicles, some of which were also extended to imported vehicles. In 2022, six million electric vehicles were sold in China, accounting for over half of global sales. Parallel to this strategy, China invested in critical energy transition minerals assets worldwide, notably through substantial investments in Africa and Latin America. China was the largest investor in lithium assets in 2018–2021, and is expanding its processing and refining capabilities abroad.[27]

24. Examples of policies on increasing local value addition in minerals-producing countries include Critical Minerals Strategy 2023–2030 in Australia, the National Lithium Strategy in Chile and Mineral Beneficiation Strategy 2021 in Namibia. In Australia, the strategy encompasses programmes to attract investment, fund Australian value added projects and stimulate research activities in the industry. In Chile, the strategy involves State participation across the lithium value chain, from exploration to manufacturing, through the creation of a national lithium company. In Namibia, the strategy includes a road map for value addition and diversification, covering elements such as mineral governance improvement, local beneficiation and manufacturing, skills development, investment promotion, technology access and support for the commercialization of beneficiated products.

25. In Africa, given an appropriate policy framework, reserves of critical energy transition minerals could represent a comparative advantage for the continent in integrating into technology-intensive global supply chains of sectors that rely on these minerals.[28] In order to seize this comparative advantage, countries in Africa need to enhance productivity through technology adoption and by improving logistics and leveraging trade agreements. The African Continental Free Trade Area Agreement and regional integration could contribute to strengthening production chains across the continent, helping domestic industries become more prepared for the global arena. For example, in April 2022, the Democratic Republic of the Congo and Zambia signed a cooperation agreement, to create a value chain of batteries, electric vehicles and renewable energy technologies using minerals from the two countries.[29]

26. Such strategies for increasing value addition with regard to critical energy transition minerals may involve trade-related policy measures such as on export control. In January 2020, Indonesia reinstated export restrictions on unprocessed nickel ore and required foreign buyers to invest in domestic smelters and local processing, leading to a significant foreign direct investment inflow of $22 billion by 2022 (based on data from the United Nations Comtrade database), part of which was used to build five new smelters and increase processed nickel exports from Indonesia and, following the restrictions, value added in the minerals sector increased from $1.1 billion in 2019 to $20.8 billion in 2021; given the relative success of the policy, Indonesia implemented similar measures for other raw materials, such as bauxite (export restrictions as of June 2023) and various unprocessed metals (increase in

[27] See https://www.iea.org/reports/critical-minerals-market-review-2023.

[28] UNCTAD, 2023b, *Economic Development in Africa Report 2023: The Potential of Africa to Capture Technology-Intensive Global Supply Chains* (United Nations publishing, Sales No. E.23.II.D.22, Geneva).

[29] See https://www.uneca.org/stories/zambia-and-drc-sign-cooperation-agreement-to-manufacture-electric-batteries.

export duties as of July 2023).[30] In June 2023, Namibia implemented export restrictions on unprocessed critical energy transition minerals, including cobalt, graphite, lithium, manganese and rare earth minerals, aimed at capitalizing on the growing demand for metals in the energy transition.[31] Other countries are considering similar export-controlling measures on minerals, including Malaysia, with regard to rare earth minerals, and Zimbabwe, with regard to raw lithium.[32]

27. Whether export restrictions of raw materials can result in economic diversification depends on multiple factors, including the availability of alternative sources for a mineral and the potential for replacement by other materials. The influence of such restrictions on global prices and the availability of goods essential for the energy transition is not certain. In this regard, their impact on efforts by developing countries not endowed with such minerals to achieve a fair, just and sustainable energy transition has not yet been fully understood. In-depth analysis and discussions by the international community are needed on how to balance development aspirations incorporating both economic diversification and the energy transition.

C. Parameters for achieving the fair, just and sustainable management of critical energy transition minerals

28. The Panel on Critical Energy Transition Minerals, to ensure that the extraction of critical minerals for the clean energy revolution is done in a fair, just and sustainable way, will bring together Governments, international organizations, industry and civil society to develop common and voluntary principles to guide extractive industries in the years ahead in the name of justice and sustainability. Such principles should ensure, inter alia, that the economic, social and environmental costs of achieving stable access to critical energy transition minerals are not borne by a small group of countries, such as minerals-producing developing countries. Countries and communities endowed with such minerals should be able to pursue economic diversification aspirations by, for example, increasing local value addition in raw minerals by building capacities in beneficiating, refining and processing. With regard to possible parameters of the principles to be considered by the Panel, the following policy areas, involving sustainable development-related challenges, are highlighted in this section: maximizing local value addition and economic opportunities in developing countries endowed with critical energy transition minerals and minimizing negative social and environmental impacts; ensuring a reliable and sustainable supply of minerals for the energy transition; and achieving coherence with multilateral trade rules.

1. Maximizing local value addition and economic opportunities in developing countries and minimizing negative social and environmental impacts

29. Demand for critical energy transition minerals may incentivize developing countries endowed with such minerals to increase exports of minerals in raw form and this could perpetuate or aggravate the socioeconomic challenges associated with commodity dependence, including income volatility, macroeconomic and political instability and exchange rate overvaluation, resulting in lower levels of human and social development. It is therefore critical to ensure that the countries and communities endowed with such resources benefit, by achieving, inter alia, structural transformation and decent job creation. Increasing local value addition would also introduce new upstream and downstream activities in the mining sector in minerals-endowed countries, for example, in safer and cleaner mining

[30] See https://www.imf.org/external/datamapper/profile/IDN, https://asiatimes.com/2023/07/indonesias-mineral-export-bans-face-hot-global-fire/, https://www.globaltradealert.org/state-act/63654/indonesia-government-announced-an-export-ban-on-bauxite and https://www.globaltradealert.org/state-act/76553/indonesia-government-changed-export-duties-on-several-minerals.

[31] See https://www.globaltradealert.org/state-act/75919/namibia-export-ban-of-unprocessed-critical-minerals and https://www.reuters.com/markets/commodities/namibia-bans-export-unprocessed-critical-minerals-2023-06-08/.

[32] See https://www.reuters.com/markets/commodities/malaysia-ban-export-rare-earths-boost-domestic-industry-2023-09-11/ and https://www.reuters.com/markets/commodities/africa-gears-up-keep-more-profits-lithium-boom-2023-02-09/.

technology and equipment, mineral processing spillovers and material sciences and the manufacturing of battery components. Expanding processing capabilities would also contribute to reducing concentration in clean energy-related global supply chains, which is critical to mitigating risks related to price inflation and supply disruption and thereby reinforcing the stability of such value chains.[33]

30. Simultaneously, increasing the level of extraction and processing of critical energy transition minerals could exacerbate social and environmental risks. Mining can negatively affect communities due to human rights abuses, the use of child labour, the displacement of communities, impacts on women and land use change.[34] Notably, energy-intensive mining and processing activities can contribute to water depletion, pollution and biodiversity loss. For example, water withdrawal linked to the extraction of critical energy transition minerals almost doubled in 2018–2021, reducing the amount of water available to local communities, and half of the current production of copper and lithium is produced in areas with high water stress levels.[35] In 2022, the United Nations Environment Assembly of the United Nations Environment Programme, at its fifth session, adopted a resolution on environmental aspects of minerals and metals management, requesting the convening of intergovernmental consultations aimed at developing non-prescriptive proposals to enhance the environmental sustainability of minerals and metals along their full life cycle.[36]

31. Promoting production and value addition related to critical energy transition minerals while mitigating the associated social and environmental risks is a challenge and requires sufficient financial resources. Most developing countries endowed with such minerals face fiscal constraints and external debt burdens that hinder investment in new industrial policies and moving up clean energy-related global supply chains.[37]

2. Ensuring a reliable and sustainable supply of minerals for the energy transition

32. Major minerals-importing countries are establishing partnerships, to ensure access to essential resources. Such a strategy may affect demand and supply dynamics, whereby exclusive access by one entity reduces availability for others. This is of concern since it impacts the overall stability and sustainability of critical energy transition minerals market.

33. Market concentration related to extraction or refinement firms also reduces transparency with regard to the prices of critical energy transition minerals. These prices are often determined directly between suppliers and buyers, rather than on commodity exchanges, and are not always disclosed to the public. In this context, responsible mineral resource governance and contract transparency are critical in ensuring fair risk and reward-sharing, preventing corruption and enabling social and economic progress in resource-dependent countries.[38] Regulation can help ensure transparency in the mining sector by mandating the disclosure of contract details, terms and ownership information. In addition, it is essential to hold further discussions on international standards and guidelines on contracts with regard to critical energy transition minerals, to promote global norms of transparency.[39]

[33] See https://www.iea.org/reports/the-role-of-critical-minerals-in-clean-energy-transitions. For an extensive analysis of commodity-dependent developing countries and value addition in primary commodities, see UNCTAD, 2023a; UNCTAD, 2023c, *Commodities and Development Report: Inclusive Diversification and Energy Transition* (United Nations publishing, Sales No. E.23.II.D.9, Geneva); and the *Commodities at a Glance* series, available at https://unctad.org/topic/commodities.

[34] See https://www.iea.org/reports/the-role-of-critical-minerals-in-clean-energy-transitions/sustainable-and-responsible-development-of-minerals.

[35] See https://www.iea.org/reports/critical-minerals-market-review-2023/implications and https://www.iea.org/reports/the-role-of-critical-minerals-in-clean-energy-transitions/executive-summary.

[36] UNEP/EA.5/Res.12.

[37] UNCTAD, 2023d, *Trade and Development Report 2023: Growth, Debt and Climate: Realigning the Global Financial Architecture* (United Nations publication, Sales No. E.23.II.D.24, Geneva).

[38] See https://www.icmm.com/en-gb/research/mining-minerals/2023/critical-minerals-rush-contract-transparency.

[39] Ibid.

34. Achieving the fair, just and sustainable management of critical energy transition minerals resources needs to reflect the energy transition interests of developing countries not endowed with such minerals, which rely heavily on imports for renewable energy technologies. If products based on critical energy transition minerals become unaffordable or unavailable, this can jeopardize the energy transition-related actions of these countries, making it difficult to implement nationally determined contributions under the United Nations Framework Convention on Climate Change.

3. Achieving coherence with multilateral trade rules

35. Many countries apply trade-related policy measures, to influence the purchase or sale of critical energy transition minerals or to increase domestic value addition. Some measures, such as subsidies to domestic producers or export restrictions, may challenge particular World Trade Organization rules. However, certain members of the World Trade Organization state that some policy actions, particularly those related to achieving the energy transition, are of national security concern or designed to alleviate a critical shortage of essential products in an exporting country and may therefore be exempted from World Trade Organization rules under the General Agreement on Tariffs and Trade, article XXI on security exceptions and article XI on quantitative restrictions. Since 2019, there have been four cases under the dispute settlement mechanism of the World Trade Organization that examined claims that certain trade-related measures had been taken to protect security-related interests.[40] Trade-related measures taken by major economies as a component of industrial policies can impact global prices and the availability of essential commodities because of the significance of these economies in global trade flows. The use of trade-related measures also poses a systemic challenge to trust in the multilateral trading system. A well-functioning multilateral trading system reduces unfair competition and provides a basis for reducing uncertainty and fostering price stability, thereby providing a critical safety net in international trade, particularly to small, low-income and vulnerable countries. In the context of critical energy transition minerals, some trade-restrictive measures, such as export controls, local content requirements and non-tariff measures, have been applied in building or improving productive capacities in downstream industries using such minerals. Export controls can serve to attract global investment for increasing local value addition yet may be considered inconsistent with rules under the World Trade Organization. For example, in December 2022, a dispute settlement panel under the World Trade Organization concluded that export restrictions in Indonesia on nickel and other minerals were not consistent with the General Agreement on Tariffs and Trade; the panel report is under appeal.[41] Policy dialogue is needed to ensure that the multilateral trade system enables countries endowed with critical energy transition minerals to benefit from increased demand for these minerals through value addition and structural transformation.

II. The decarbonization of maritime transport and a shift to the use of cleaner fuels

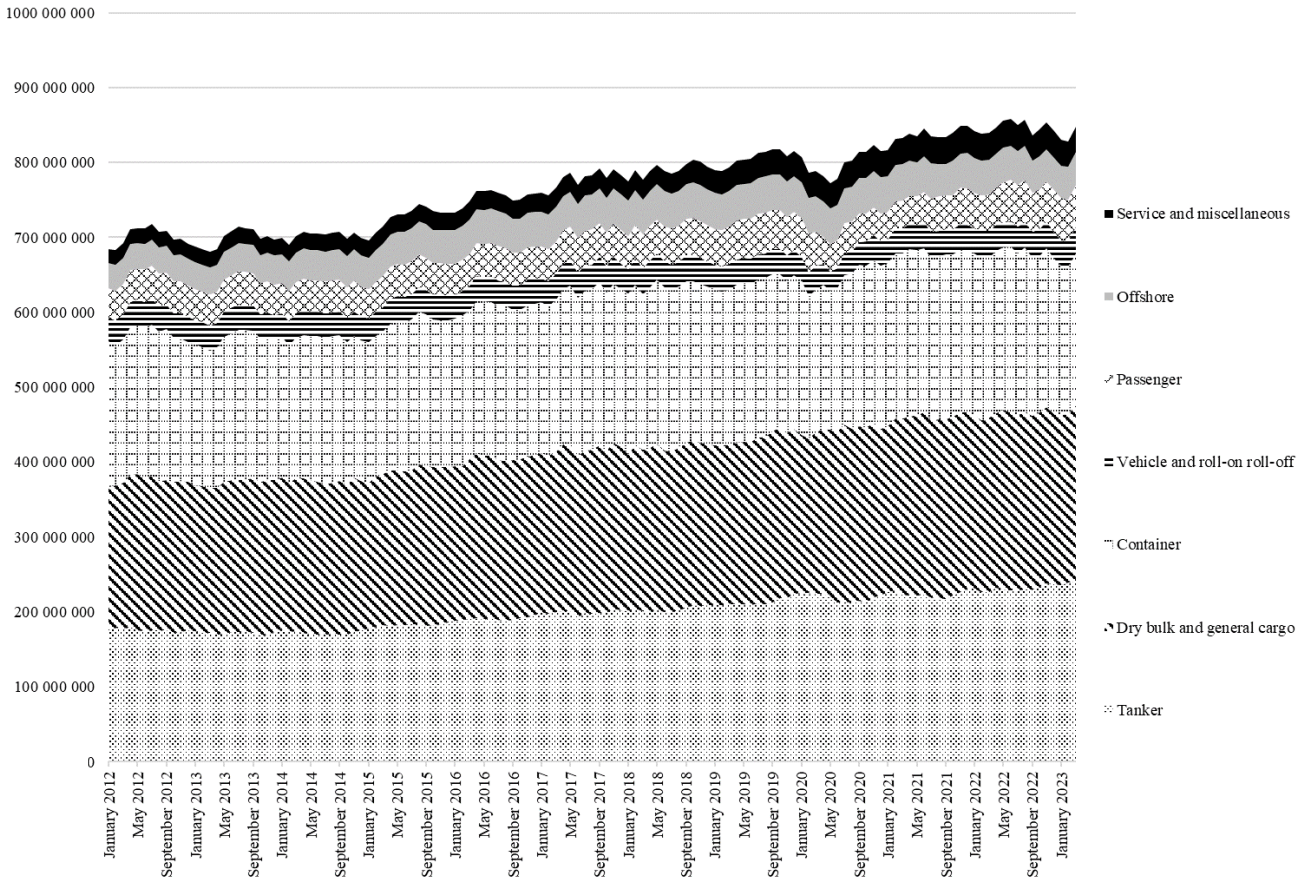
36. Maritime transport is the backbone of the global economy, with over 80 per cent of global merchandise trade by volume transported by sea. When considering maritime transport work on a ton-mile basis, shipping may be the most environmentally sustainable form of transport. However, the sector contributes around 3 per cent of global greenhouse gas emissions and global emissions from shipping have increased by 20 per cent in the past decade, in tandem with global trade expansion (see figure 4). By 2050, without further action,

[40] See https://www.wto.org/english/tratop_e/dispu_e/cases_e/ds512_e.htm, https://www.wto.org/english/tratop_e/dispu_e/cases_e/ds556_e.htm, https://www.wto.org/english/tratop_e/dispu_e/cases_e/ds567_e.htm and https://www.wto.org/english/tratop_e/dispu_e/cases_e/ds597_e.htm.

[41] See https://asiatimes.com/2023/07/indonesias-mineral-export-bans-face-hot-global-fire.

greenhouse gas emissions from international shipping could reach 130 per cent of 2008 levels.[42]

Figure 4
Total carbon dioxide emissions by vessel type
(Tons)



Source: UNCTAD, 2023e.

37. Greenhouse gas emissions need to be reduced in shipping and aligned with the reduction targets set out under the 2030 Agenda for Sustainable Development, the Paris Agreement under the United Nations Framework Convention on Climate Change and the revised strategy on the reduction of greenhouse gas emissions from ships adopted by the International Maritime Organization in 2023.

A. Growing momentum is driven by regulatory and commercial factors

38. Regulatory developments in shipping decarbonization are largely shaped by regulations under the International Maritime Organization. The revised strategy aims to curb well-to-wake greenhouse gas emissions by 20 per cent by 2030, while striving for 30 per cent, then for 70 per cent by 2040, and also aims to achieve a reduction of 80 per cent and to reach net-zero emissions from international shipping by or around 2050, and including levels of ambition with regard to the adoption of zero or near-zero emission technologies, fuels and/or energy sources. The goal is for the uptake of zero or near-zero emission technologies, fuels and/or energy sources to represent at least 5 per cent, striving for 10 per cent, of the energy used by international shipping by 2030. The implementation of short-term measures

[42] This chapter builds on the findings in chapter 3 (with updates included where relevant) of UNCTAD, 2023e, *Review of Maritime Transport 2023: Towards a Green and Just Transition* (United Nations publication, Sales No. E.23.II.D.23, Geneva).

adopted at the International Maritime Organization for the reduction of greenhouse gas emissions began in 2023, including a carbon intensity rating system, a ship energy efficiency management plan and an energy efficiency existing ship index. At present, negotiations at the International Maritime Organization are focused on candidate midterm reduction measures that comprise a technical element, namely a goal-based marine fuel standard regulating the phased reduction of the greenhouse gas intensity of marine fuel, and an economic element, on the basis of a maritime greenhouse gas emissions pricing mechanism, expected to be adopted in 2025 and to enter into force in 2027.

39. National and regional policy initiatives such as those in China, the United States and the European Union add to the momentum. For example, in the European Union, shipping is now included in the emission trading system and the well-to-wake greenhouse gas emissions requirement under the International Maritime Organization. Other international agreements also drive developments in shipping decarbonization, including a declaration on green shipping corridors[43] adopted during the twenty-sixth session of the Conference of the Parties to the United Nations Framework Convention on Climate Change and the agreement at the twenty-eighth session to transition away from fossil fuels in energy systems; the first time that explicit reference has been made to fossil fuels and their role in the climate crisis in the outcomes of sessions of the Conference of the Parties.

B. Fuel transition in shipping: Progress is under way

40. Decarbonizing shipping requires wide-ranging measures affecting ship design, engines, propulsion systems, operations, technologies and the uptake of alternative fuels, including from renewable sources. Logistics and digitalization-related measures (e.g. with regard to speed reduction, vessel utilization, alternative routing and vessel size) have the potential to reduce greenhouse gas emissions by over 20 per cent, while measures related to hydrodynamics (e.g. hull coating, air lubrication and cleaning), machinery (e.g. waste-heat recovery and engine de-rating) and after-treatment (e.g. carbon capture and storage) can reduce emissions by 5–15, 5–20 and up to 90 per cent, respectively.[44] However, the greatest potential is with regard to alternative low-carbon fuels, which have a greenhouse gas reduction potential of up to 100 per cent. The fuel transition in shipping has begun, and progress is under way. There are a number of promising alternative energy sources, such as ammonia, biofuels, electrification, hydrogen, liquified natural gas, liquefied petroleum gas, methanol, nuclear power and wind power. Under some conditions and with many caveats, carbon-capture technology on board ships and nuclear power can be feasible operationally and could compete with other decarbonization solutions.[45]

41. In 2023, the global operating fleet and ship orderbook indicated an accelerated uptake of alternative fuels in ships, compared with in 2022. Ships capable of sailing on alternative fuels represented 1.8 per cent of the number of ships in operation and 26 per cent of the number of ships on order, with the shares of gross tons at 6.5 per cent of ships in operation and 51 per cent of ships on order; in 2022, the shares were 5.5 and 33 per cent, respectively (see figure 5). In terms of number of ships, uptake is dominated by battery/hybrid and liquefied natural gas-fuelled ships. However, in terms of tonnage, liquefied natural gas-fuelled ships dominate, particularly among containerships and vehicle carriers, since battery/hybrid solutions are related mainly to smaller vessels. The number of ships ordered and capable of using methanol has also increased, in particular in the container shipping segment. Orders of liquefied petroleum gas-fuelled ships have also increased. Among carbon-neutral fuels, biofuel is the most widely used in shipping, often as a blend-in with fossil fuels. Bio-blended fuels represent a readily available decarbonization option, as it is possible to use existing conventional fuel bunkering infrastructure, for example in the port of

[43] See https://www.gov.uk/government/publications/cop-26-clydebank-declaration-for-green-shipping-corridors/cop-26-clydebank-declaration-for-green-shipping-corridors.

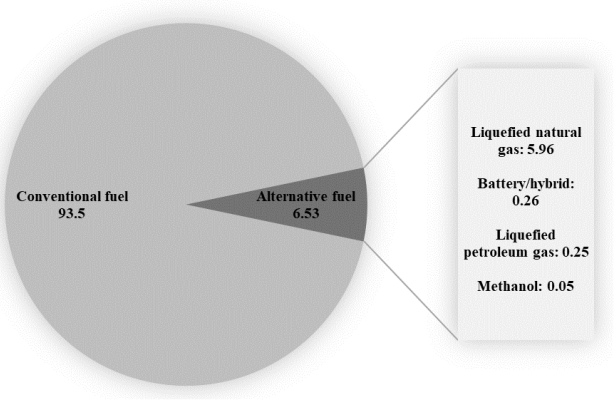
[44] DNV [Det Norske Veritas], 2023, Energy transition outlook 2023: Maritime forecast to 2050, available at https://www.dnv.com/maritime/publications/maritime-forecast-2023/index.html.

[45] Ibid.

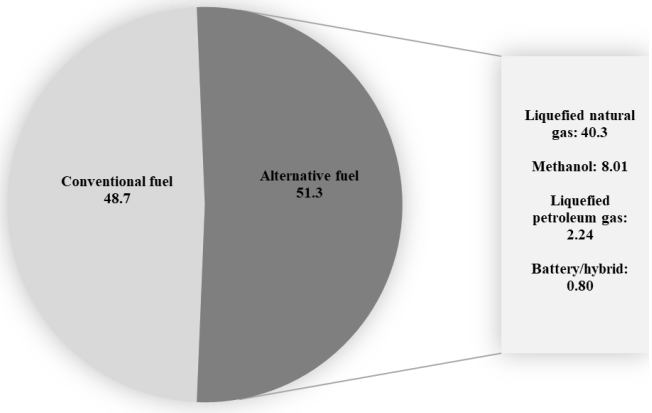
Rotterdam, Kingdom of the Netherlands, and the port of Singapore. Overall, sales of bio-blended fuels increased by over 70 per cent in 2021–2022.[46]

Figure 5
Alternative fuel uptake, share of gross tons as at July 2023
(Percentage)

(a) Ships in operation



(b) Ships on order



Source: DNV, 2023.

C. The energy shift in shipping is an imperative, yet faces considerable challenges

42. Many barriers and layers of complexity stand in the way of rapid decarbonization and the energy transition in shipping. A key challenge is the multibillion-dollar level of investment required amid uncertainty about the best transition pathway.

[46] Ibid.

43. Continued uncertainty about the choice of the alternative fuels of the future and whether these may be readily available, reluctance by shipowners to invest in low-carbon vessels and the lack of a level playing field, reflecting fragmentation of the sector and differing national and regional policies and strategies, amplify the challenges. Shipowners need to decide whether to renew fleets now or wait until there is greater clarity and certainty about alternative fuels, green technology options and regulatory regimes. Ships currently being built are expected to remain in operation for the next 20–30 years; retrofitting is not always possible and is generally expensive. Port authorities may also hesitate to invest in fuel storage and supply facilities until there is greater certainty as to which fuels may be required.

44. There is significant uncertainty concerning the availability of fuels and bunkering facilities. Some observers estimate that meeting the International Maritime Organization greenhouse gas targets by 2030 requires shipping to secure 30–40 per cent of the annual global supply of carbon-neutral fuels, which is challenging, since shipping needs to compete with other sectors for the new fuels. Consequently, energy efficiency measures are critical, whether operational (e.g. by reducing speed or optimizing routes) or technological (e.g. through the use of air lubrication systems or wind-assisted propulsion). Existing estimates indicate that an additional $8 billion–$28 billion may be required annually to decarbonize ships by 2050 and that more substantial investments, ranging from $28 billion to $90 billion annually, may be needed to develop infrastructure for 100 per cent carbon-neutral fuels by 2050. According to some estimates, the more expensive energy sources and onshore investments could increase fuel expenses by 70–100 per cent from present amounts. UNCTAD assessments indicate a potential disproportionate impact on the least developed countries and small island developing States that rely heavily on maritime transport.

45. In 2021, UNCTAD conducted a comprehensive impact assessment of the short-term greenhouse gas emissions reduction measures proposed at the International Maritime Organization, setting out scenarios for 2030 with or without the measures, for three levels of emissions reductions, and showing that the measures would lead to a reduction of 2.8 per cent in average speed, an increase of 1.5 per cent in average maritime shipping costs and an increase of 2.8 per cent in total maritime logistics costs.[47] The impact is expected to be notably greater in small island developing States and the least developed countries, which may require support to mitigate the increased costs and alleviate the consequent impacts on incomes and trade flows. In 2022, UNCTAD research suggested that, at a global level, a 50 per cent increase in maritime logistics costs would imply a change in trade flows of -0.6 per cent, equivalent to an impact on real gross domestic product (GDP) of -0.08 per cent. Based on the global GDP of $104 trillion in 2022, a reduction of 0.08 per cent would be equivalent to a reduction of global GDP by about $80 billion.[48] Countries heavily reliant on particular trade sectors could experience more significant impacts due to the potential for greater increases in maritime logistics costs.

46. The energy transition in shipping also requires upskilling seafarers and onshore labour and ensuring that the safety requirements associated with the new fuels are well understood and implemented given the inherent risks (e.g. toxicity and flammability) and the complexity generated for bunkering operations, storage and distribution. It is therefore critical to ensure that the requisite regulatory, technological and safety-related maturity and readiness levels are in place.

D. System-wide collaboration is key in achieving low-carbon shipping

47. Shipping cannot shift to cleaner fuels and decarbonize on its own. Decarbonization and energy transition efforts need to bring together the broader industry, including carriers, ports, manufacturers, shippers, investors and energy producers and distributors.

48. Collaboration among all stakeholders from within and outside the shipping sector and adequate collaborative frameworks and partnerships are required, such as the declaration on

[47] See https://unctad.org/publication/unctad-assessment-impact-imo-short-term-ghg-reduction-measure-states.

[48] UNCTAD, 2023e.

green shipping corridors, which are zero-emission maritime routes between two or more ports and involve collaboration among an ecosystem of actors such as cargo owners and charterers, ports, shipowners and operators, energy suppliers, financial institutions, authorities and others. To date, at least 30 green shipping corridor initiatives have been announced and are in the early planning stages. These initiatives are intended to serve as learning grounds, to help understand and mitigate risks and costs. The benefits can be scaled up at the regional and global levels. Green shipping corridors recognize the pivotal role of ports in facilitating the energy transition in maritime transport, including by supporting joint initiatives to promote the production, storage, bunkering, distribution and transportation of alternative fuels. Cargo owners also have a role to play. Shippers include some of the largest corporations in the world and are increasingly taking into consideration their carbon budgets and aiming to reduce the carbon emissions generated by their shipments by sea.

III. Way forward

49. The increasing demand for critical energy transition minerals, underscored by the global commitment to achieving net-zero emissions by 2050, presents both a challenge for governance in the supply chains of such minerals and a unique opportunity for developing countries endowed with such minerals to harness them in achieving economic diversification and structural transformation.

50. Against this background, the international community needs to chart a course that balances the urgent need for such resources with the imperative of achieving sustainable development in countries producing such minerals. The need to diversify the sources of such minerals and related value added products is critical. This involves increasing the overall supply of such minerals and promoting value addition, to meet the increasing demand for clean energy technologies; and efforts to reduce reliance on supply from a limited number of countries, to mitigate geopolitical risks and supply chain vulnerabilities.

51. Increasing contract transparency in the mining industry can help ensure the fair sharing of risks and rewards between parties, helping to prevent corruption by making agreements public, promoting informed public dialogue, enabling more informed decision-making and fostering a conducive environment for investment in processing and beneficiation facilities.

52. There appears to be uncertainty with regard to conformity with multilateral trade rules and national industrial policies related to critical energy transition minerals. As economies aim to achieve a balance between fostering domestic value addition through trade-related measures and adhering to the multilateral trading system, engaging in comprehensive policy dialogues is indispensable. Such an approach can help ensure that efforts to accelerate the global transition to the use of renewable energy sources do not inadvertently hinder economic diversification and development in developing countries endowed with critical energy transition minerals by increasing commodity dependence. Strengthening international cooperation and policy alignment can help mitigate this risk, facilitating a more equitable and sustainable global trading environment.

53. Maritime transport should transition to cleaner fuels and decarbonize as soon as possible, while balancing environmental sustainability, regulatory compliance and economic demands. Technological readiness, scalability and regulatory certainty are essential in shifting to low-carbon fuels in shipping. Global regulations need to minimize uncertainty, which holds back investment decisions by shipowners and ports. Collaboration among stakeholders within and outside the sector is critical, as is knowledge and experience-sharing and technology transfer. Green shipping corridor initiatives should be supported, and their scope should be widened, to include more developing countries.

54. The impacts of the decarbonization of international shipping on the most vulnerable economies need to be continually assessed, and technical and financial support should be provided to countries disproportionately affected by a potential increase in maritime logistics costs due to decarbonization measures. Economic incentives such as a levy on shipping emissions can help incentivize action, promote the competitiveness of alternative fuels and narrow the cost gap with conventional fossil fuels. The funds generated could facilitate

investments in ports in small island developing States and the least developed countries, focusing, for example, on climate change adaptation, trade and transport reforms and digital connectivity. Finally, investing in capacity-building programmes to upskill seafarers and maritime professionals in using and maintaining new clean energy technologies is equally important.