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ABSTRACT

Transitioning from fossil fuels to renewables is at the core of ensuring global access to affordable, reliable, and sustainable energy. Demand for renewables is expected to accelerate in light of their multiple benefits compared to fossil fuels, ranging from their increasing affordability, lower exposure to global economic shocks, and multiple contributions to sustainability including for combating climate change, supporting health, and reducing environmental destruction.

Building resilient and sustainable global value chains (GVCs) for the goods and services that underpin this energy transition is critical. Past bottlenecks in these GVCs have already put a spotlight on the challenges ahead of us. Enormous demand growth is likely to exacerbate the strain. There are no quick fixes, and strengthening the resilience and increasing sustainability along these value chains is essential.

To target this objective, international cooperation is key. To this end, this policy brief outlines five key pillars: (1) monitoring global value chains, (2) defining and strengthening standards, (3) leveraging fiscal policies, (4) averting export restrictions, and (5) aligning finance.
Despite advances over the last decade, the challenge to ensure global access to affordable, reliable, and sustainable energy remains significant. 2.4 billion people continue to lack access to clean cooking fuel. 733 million people still have no access to electricity. And both the pandemic and the war in Ukraine have reverted progress towards achieving this goal (IEA et al. 2022).

**Renewable energy is vital for addressing this challenge and is increasingly becoming the most affordable choice.** Between 2009 and 2021, the costs of solar and wind power have gone down by 90% and 72% respectively. Today, energy from new wind or utility-scale solar power facilities is already cheaper than from new gas or coal plants. In some cases, it is also more affordable than energy from fully depreciated, existing gas or coal plants (Lazard 2021; IEA et al. 2022). In spite of bottlenecks in value chains and volatile mineral prices, this price advantage has persisted in 2022 (IEA 2022e). And it is expected to increase as deployment continues to expand (Way et al. 2022).

**Disruptions in fossil fuel markets and the concerns they triggered on reliability provide further impetus to this development.** The pandemic and the war in Ukraine have wreaked havoc on coal, oil, and gas prices, contributing to inflation and volatility worldwide. On the other hand, the operating costs for renewables have remained largely unchanged as their fuels—e.g., wind or sunshine—are unaffected. The cost of renewables is heavily front-loaded with capital expenditures for the production facilities and storage to level out intermittency. In contrast, for fossil fuel-based power generators a significant share of the costs is the fuel itself. Fluctuations in the price of coal, oil, or gas thus have a large effect on power generation that depends on them (Schnabel 2022; Bolhuis and Kovacs 2022). The short-term exposure of renewables to global shocks is much more limited (Gross 2022; IRENA 2019).

**Renewables are also at the heart of the world’s response to climate change.** To keep global warming below 1.5°C, the International Energy Agency (IEA) calls for a fivefold increase in annual installations of renewable capacity between 2020 and 2050 compared to 2018-2020. Its roadmap also includes a strong electrification push: 50% of all used energy would be electric, up from about 17% in 2020, and with 90% of electricity produced by renewables, up from about 28% in 2021 (IEA 2021a).

**In addition, the expansion of renewables contributes to a multitude of further sustainability objectives.** Positive health effects from reducing emissions of greenhouse gases and other pollutants from fossil fuel combustion are a case in point (GW 2019, 2022). A drastic reduction in land use and related environmental impacts from mining provides further illustration. The IEA’s roadmap to net zero estimates the volume of mined coal to fall by 90% from 5,640 million to 560 million tons per year, and oil and gas production to drop by 75% and 55%. On the other hand, mining of the materials that are required for the energy future, e.g., copper, lithium, and zinc, will need to increase significantly compared to current levels. Yet the required volumes are orders of magnitude smaller than those for the fossil fuels that underpin the current energy system (IEA 2021b, 2022d; Krane and Idel 2021).

**Against this background, demand for renewables is expected to accelerate.** The IEA’s main forecast projects an 85% increase in renewable energy deployment between 2022-27 compared to the prior five years. Its accelerated case foresees higher growth rates still. And its roadmap to net zero by 2050 would demand a yet more ambitious expansion (IEA 2022e).
TOWARDS RESILIENT AND SUSTAINABLE GLOBAL VALUE CHAINS

Building resilient and sustainable global value chains (GVCs) for the expansion of renewables is critical. Producing adequate supplies of the metals and minerals underpinning the energy future is a key aspect for this. Driving innovation and raising the manufacturing capacity for the required technologies and products, such as solar PV cells, wind turbines, semiconductors, hydrogen, and batteries, is a further key step. Building up the services offering to deploy and manage an energy system that is profoundly different from the one we have today is equally vital.

Past bottlenecks in the GVCs for the energy future have already put a spotlight on the challenges ahead of us. The price of lithium carbonate in China soared more than tenfold during the last two years as demand for EV batteries increased and supply was unable to keep up (Trading Economics 2022). Nickel and Cobalt prices rose by 75% and 60% during the same period after even higher peaks earlier this year. Limited smelting capacity is putting up barriers in the copper market (Bloomberg News 2022). And congestion in Asian ports as well as rising freight costs contributed to increasing prices and delivery times for solar panels and wind turbines (Hook 2022; IEA 2022c; Keating 2022).

Enormous demand growth over the next decade and beyond will put additional strain on these value chains. To reach the goals of the Paris Climate Agreement, the IEA estimates that the world will need a fourfold increase of yearly transition mineral output from 2020 until 2040. The largest increases are for lithium (42-fold), graphite (25-fold), cobalt (21-fold), and nickel (19-fold). By 2030, the supply of lithium and copper needs to rise by 100% and 25% respectively above current projections (IEA 2021b).

There are no quick fixes. Building out the required value chains takes time. New mines of lithium, nickel, or copper have historically taken 16 years to come online. Exploration and feasibility studies take up over 12 years, with construction accounting for an additional four (IEA 2021b; Sturman et al. 2022). Building the plants for processing ores is typically also a multi-year endeavor (Fernyhough 2022).

Moving towards a more circular economy can reduce the necessary mining capacity significantly. As the amount of transition minerals in products increases, so will the amount which can be recycled and reused. Increasing circularity can play a large role in easing supply bottlenecks from mining. The World Bank (2020) assessed that an increased recycling rate for copper could reduce the need for newly mined ores by up to 26% by 2050. For nickel, cobalt, and lithium the potential savings make up around 23%, 15%, and 26% respectively. In that context, raising end-of-life recycling rates through appropriate design is essential to reduce dependence on newly mined material (KPMG 2021).

Strengthening the resilience of these GVCs is key. To that end, diversity in technologies and trade partners (both up- and downstream) is essential. While mineral deposits are unequally distributed globally, higher sourcing diversity is possible, especially since new deposits keep being found (Sturman et al. 2022). Further downstream, diversification in processing capacity as well as manufacturing and services for the transition is equally critical. The IEA expects current policies to reduce China’s share in renewables manufacturing across different segments from the current 80-95% to 70-90% (IEA 2022e). Further steps towards geographical diversification are key. Technological diversity provides an additional pillar. For the latter, batteries serve as an illustration: The World Bank (2020) estimates that—
depending on the technology—cumulative lithium demand for batteries until 2050 could vary by 20%, and reliance on nickel, cobalt, and manganese can shift by up to a factor of two.

**Increasing sustainability along these GVCs is fundamental.** A successful transition to renewables depends on sustainable prosperity that is shared widely. Creating quality jobs, supporting communities, and safeguarding the environment is essential (e.g., IRENA 2022). Hitherto, local populations have often been left behind in mining projects and industrial transitions. Communities worldwide have opposed projects perceived as unjust or environmentally destructive. A case in point are disputes on new mines in Australia (Milne 2022), the US (Hortareas 2022), Serbia, and Chile (The Economist 2022). In short, the social license to mine has suffered. To regain it, sustainability in mining and along the value chain is moving up government and corporate agendas (e.g., Biedermann 2018; Boer, Pescatori, and Stuermer 2021; Broderick 2022; European Commission 2020; IEA 2022b; The White House 2021; World Bank 2020).

### FIVE PILLARS OF INTERNATIONAL COOPERATION

As competition over these value chains increases, international cooperation among governments, industry and further stakeholders is crucial. The imperative of diversification should not obscure the need for global collaboration. Striking an appropriate balance between the two is critical.

**Developing a roadmap to target this objective is urgent.** Countries around the world are deploying a rapidly growing set of policy measures to expand and reconfigure the GVCs for the energy future. The sharp rise in the number of policies addressing the supply of critical minerals is a case in point. Governments enacted over 100 new such policies during the last three years alone – more than during the prior decade combined (IEA 2022a). Further initiatives, such as the recently announced Minerals Security Partnership and the European Commission’s proposal for a Critical Raw Materials Act, provide additional examples. Many of these measures are important cornerstones for the GVCs we need for the energy future. At the same time, many of them also pose a risk of international fragmentation that may hinder the energy future we aim for.

**To seize these opportunities and mitigate the risks, international cooperation across five pillars is key:** (1) monitoring global value chains, (2) defining and strengthening standards, (3) leveraging fiscal policies, (4) averting export restrictions, and (5) aligning finance.

**1) Monitoring Global Value Chains**

Global monitoring of GVCs for the energy future is of the essence to enable more cooperative decision-making. Such monitoring should cover geological availabilities and recycling options, sustainability assessments for mining and recycling locations, risks for populations and the environment, likely opposition from local communities, legal limitations to production, time lags in the development of new mines and industrial plants, new uses for minerals, further business risks, and risks to financial stability. As such, it should also provide early warnings of bottlenecks and concentration risks. It should furthermore offer an overview on each country’s position in these GVCs as well as country-specific risks, and thus the foundation for policy recommendations to strengthen the resilience and sustainability of GVCs for the energy future (e.g., Ali et al. 2017; Geng, Sarkis, and Bleischwitz 2019; Miller et al. 2023).
Defining and Strengthening Standards

Coordination on technical as well as social and environmental standards needs to be strengthened. GVCs for the energy future are subject to a wide and growing range of mandatory and voluntary standards, covering an increasing number of technical, social, and environmental aspects (e.g., WTO and IRENA 2021). They include domestic laws and regulations, bilateral, regional, and multilateral agreements between governments, as well as private initiatives from industry and further stakeholders. General social and environmental legal requirements such as those that came into force at the beginning of this year with the German Supply Chain Due Diligence Act and those that are currently being negotiated for the European Union’s Corporate Sustainability Due Diligence Directive are cases in point. Industry-specific initiatives such as the multitude of standards aimed at the decarbonization of the steel sector provide further illustration (WTO 2022c). A growing number of disclosure regulations—both for the real economy and the financial sector—add an additional layer.

Understanding where different standards are mutually supportive and where they are misaligned is critical. In this context, transparency requirements such as the one prescribed through the WTO Agreement on Technical Barriers to Trade play an important role. Identifying potential areas for the harmonization of standards or their mutual recognition is a further important step. To that end, developing a solid grasp of the intended goals of standards is a key pillar. Increasing technical assistance to support countries in meeting national and international standards is also essential (Bellmann and Sell 2021; Deere Birkbeck 2021; Yamaguchi 2021).

Leveraging Fiscal Policies

Building GVCs for the energy future will require a myriad of fiscal policy measures. International convergence on core principles for doing that is key. In this context, it is essential to address the urgency with which policies need to be enacted, while accounting for their acceptability and feasibility, both internationally and domestically. International pushback against the discriminatory effects of domestic content requirements for the tax incentives in the US Inflation Reduction Act for renewables, hydrogen, and electric vehicles is a case in point. Vice versa, national and regional proposals for higher carbon prices frequently trigger domestic opposition pointing to a loss in competitiveness, carbon leakage, and its regressive effects.

Advancing international agreement on the potential role of a global minimum carbon price, international climate clubs, and carbon border taxes as a response to these concerns is important and urgent. Collaboration must also be deepened on the phase-out of fossil fuel subsidies as well as the alignment of public procurement and tax incentives with the energy transition. In this context, countries should work towards principles to address adverse distributional impacts across countries both from the transition in general and specifically from policies to support the GVCs for the energy future.

Averting Export Restrictions

It is crucial to reduce related export restrictions and mitigate the risk of new ones being created. Export restrictions—such as export taxes, licensing requirements, or export bans—have steadily increased over recent decades and have gained more relevance with geo-economics, supply shortages, and national security concerns moving up policy agendas. Some of them, such as those on critical minerals as well as restrictions affecting technology
exports, are at the core of the energy future (Kowalski and Legendre 2023; Murtaugh 2023; WTO 2022a). Export restrictions may be part of a larger policy package to build national industries for the transition. Indonesia’s export ban on nickel ore to move up the value chain into nickel processing is a case in point (Huber 2021). However, whether such measures pay off for the country applying them is subject to debate (e.g., Brutschin et al. 2016; Fliess, Idsardi, and Rossouw 2017). In addition, both fear of restrictions and restrictions themselves—as well as potential retaliation—may lead to costly adjustments across value chains. In this context, a vicious cycle of fear and retaliation could undo a significant part of the cost advantage of renewables over fossil fuels.

The WTO generally limits export restrictions, banning quantitative export restrictions in most cases. WTO agreements also often cap the maximum level of export duties which countries may apply. Many countries have also committed to such rules under Regional Trade Agreements (RTAs), sometimes going beyond their WTO commitments in terms of giving notice and providing their counterparts opportunities for due consideration and consultation. Several RTAs further limit the exceptions under which exports may be restricted (Jiang 2018).

In recent years, though, the consensus and the mechanisms to avert export restrictions have weakened. Between 2008 and 2019, the number of effective export bans has consistently inched upwards. Each year during this period, an average of 12 new export bans were implemented while about 8 were rescinded, according to data from the Global Trade Alert (Evenett and Fritz 2021). Moreover, and crucially, with a non-operational WTO Appellate Body—and its plurilateral alternative only being used by a small group of countries (MPIA 2021)—the enforcement of multilateral disciplines on export restrictions is severely weakened. Indonesia’s export ban on nickel ore again provides an illustration: In 2022, a WTO panel found it to be illegal under WTO law, yet Indonesia appealed to the Appellate Body and thus ‘into the void’ (WTO 2022b).

Under these circumstances—and given the obstacles that export restrictions may impose—international cooperation is critical to avert such restrictions in GVCs for the energy future. One measure to mitigate harmful effects of restrictions is to enhance their transparency and predictability, as some RTAs already do (Bridle et al. 2021). Enforcing disciplines on export restrictions in existing RTAs and introducing related disciplines into new ones may also help. And to the extent export restrictions remain part of national policy toolboxes, countries need to navigate them. For this, supporting diversity in trading partners across global value chains is vital.

(5) Aligning Finance

For all this to happen, the critical role of finance deserves much greater attention. Funding the investments and operations that underpin energy value chains will require the involvement and coordination of a broad array of private and public financial market participants. Ensuring that sustainability standards are accounted for in bank and non-bank lending as well as capital markets is a key aspect for this. To that end, international coordination of disclosure rules is critical to allow investors to reflect social and environmental factors in their allocation of capital, e.g., through the International Sustainability Standards Board.

Developing a solid understanding of the roles played by different segments of financial markets and their regulation is also key. Core aspects of this are trade finance and commodity trading. A further aspect which demands more attention is the growing share of funding for parts of the energy value chain by private equity funds (e.g., S&P Global 2022). It
is furthermore vital that all players are embedded into a governance framework that safeguards financial stability and supports the allocation of capital for an affordable, reliable, and sustainable energy future.

**Against this background, global cooperation on the governance of different financial market segments needs to move up policy agendas.** Particular aspects to address include the lack of transparency as well as high financial leverage and concentration of liquidity among market participants (see, e.g., Bhinder 2020). Further examples are measures to streamline compliance with anti-money laundering requirements, such as the use of “Legal Entity Identifiers” in transactions (ADB 2021), strengthening due diligence standards in commodity trading (Carbó and Duparc 2020), and steps to ensure that the wide use of commodity derivatives does not further amplify market volatility (Hendrix and Bazilian 2022). At the same time, it is critical to reduce regulatory hurdles for small and medium-sized enterprises—particularly those that are women-led—in accessing affordable trade finance (WTO and IFC 2019).

**International cooperation to leverage public finance must also be scaled up.** By any count, rich countries have fallen well short of the promised US$100bn in climate finance by 2020. Cooperation is necessary to deliver on this promise and beyond (Timperley 2021). In this context, an important avenue to explore is to increase financial support from Multilateral Development Banks to de-risk investments, and for export credit agencies to shift support to clean energy infrastructure (UN 2023; New York Times Editorial Board 2023). One aspect to consider on that path is for OECD countries to update the “Arrangement on Officially Supported Export Credits” and strengthen cooperation on these topics with their non-OECD counterparts (Jansen 2022). It is also key to review the potential role of sovereign guarantees by the country hosting an investment and the repercussions such guarantees have on its debt profile (IRENA 2020). In addition, support from international and multilateral donors needs to be better aligned with sustainability standards (e.g., NRGI 2022). Debt restructuring—and the role of private lenders in such restructuring—is another crucial area to reduce risk premia in developing countries (V20 2021). Strengthening the G20 Common Framework and further aligning the role of the IMF and World Bank with the requirements of effective global climate action are key building blocks for that (e.g., Gallagher 2022).


