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A nationally determined contribution framework for energy transition minerals

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A framework for governments to define their domestic energy transition mineral needs, sources, and contributions to the global energy transition can improve domestic policies around the world and enable greater national and global coordination to avoid supply crises and resource conflicts.

There is a global consensus on the urgency of the renewable energy transition, and intense disagreement[1] over how and under what conditions to source the requisite energy transition minerals (ETMs), such as lithium, nickel, copper, and rare-earth elements, among others, to build solar cells, rechargeable batteries, and wind turbines. Urgency, while valid, aggravates ETM supply security fears and extends mining in areas vital for climate stability. Meanwhile, unchecked ETM capture by non-climate-critical sectors[2] is enabled by highly fragmented information on ETM production and consumption. This threatens to turn scarcity-induced transition failure into a self-fulfilling prophecy. Yet basic questions such as the projected ETM quantities needed to achieve the energy transition remain elusive[3], hindering much-needed international and domestic coordination on this issue, as highlighted by the Intergovernmental Panel on Climate Change[4].

Two factors explain current information fragmentation. First, it is common for industries to withhold or misreport their ETM production, consumption, and trade data to avoid taxation, maintain investor confidence, or to protect trade secrets. Second, military capture of ETM is formidable and increasing, yet difficult to quantify because defence industries do not have deep insight into their own supply chains, and much is classified[5]. The good news is that these issues are the result of policy decisions and can therefore be improved through corrective policy design and planning. Broader shifts are already underway, with major national-level policy changes[6] unlocking increased investment in research, industrial development, and supply stability. These are important steps toward the global strategy called for in the April 2024 establishment of the UN Secretary-General's Panel on Critical Energy Transition Minerals. However, greater international coordination on ETM supply is needed.

International coordination, especially when perceived as contrary to national interests, is a particular challenge for ETMs in light of the abovementioned issues. But we can learn from previous international coordination efforts in the wider energy and climate arena. The international community navigated similar challenges in the evolution of climate policy from the 1997 Kyoto Protocol to the 2015 Paris Accords. A transformative outcome of the Paris Accords was the introduction of the nationally determined contributions (NDCs), in which countries define their own context-appropriate actions toward the shared goal of limiting global warming. An NDC for ETMs would be no different.

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Learning from NDC strengths and weaknesses to provision the energy transition

The NDCs are both inadequate and innovative: inadequate because they do not yet add up to sufficient global reduction in greenhouse gas emissions to meet the Paris Agreement goals of keeping warming "well-below" 1.5 degrees Celsius, but innovative in terms of fostering consensus in form and procedure on the critical challenge of climate change while allowing for diversity and even disagreement in content[7]. Coherency, transparency, and implementability of NDCs has been noted as crucial for harnessing their full potential[8]. Relatedly, renewable energy, central to most NDCs, cannot be realized at scale without ETMs. But uncoordinated ETM mining may further destabilize climate-critical ecosystems and cause periodic supply crises due to chain duplication, price fluctuations, and low extraction, recovery, and circularity rates. Global coordination is needed to avoid energy transition failure, and for coordination to work there must be broad political buy-in at all levels. Adapting NDCs to the ETM challenge can provide a framework, outlined here, to foster integrative research and political buy-in at the sub-national, national and international levels to achieve secure and equitable ETM supply for the energy transition. Like the Paris NDCs, this should include a combination of research, reporting, planning, and domestic policy actions.

Building blocks of a nationally determined contributions framework for ETM

A first step would be for parties to the Paris Accord to create their own national determination of ETM units (NDEU) required to achieve domestic energy transition goals. While there are many national-level estimates of which types of renewable energy infrastructure can be developed to achieve the energy transition, these tend to be calculated by generation capacity (expressed in watt hours), and not by the physical units such as how many tonnes of lithium or nickel are needed to build sufficient infrastructure to achieve energy transition goals. National-level data on energy consumption and renewable

capacity development potential is readily available for most countries[9], which can inform an NDEU and a renewable energy infrastructure phase-in plan. Strategies for energy demand reduction and ETM waste minimization, long called for by the scientific community, can be factored in to reduce estimates of total ETM units needed based on current growth projections[10]. Leveraging this data to define ambitious and contingency scenarios for demand reduction will ease pressure on ETM supplies and provide governments with flexibility during any unanticipated crises, allowing them to remain on track to achieve energy transition goals. Publishing the NDEU with a phase-in timeline will enable international coordination across governments and other stakeholders, ideally stemming the intensifying resource scramble.

The second step would for parties to consolidate national inventories of ETM reserves (NIER) to account for the total potentially accessible ETM stocks within their territories — not just those that are below ground. Immense quantities of potentially more accessible above-ground ETM stocks are currently mischaracterized as waste, languishing in landfills, scrapyards, mine tailings, and legacy industrial sites[11]. A comprehensive NIER will correct this oversight, thereby enabling the more rapid and wide-spread development of above-ground sources. This would clarify how much new mining of geological reserves is needed to supplement above-ground ETM stocks, which is crucial to securing ETM supply and safeguarding climate-critical environments. Depending on the national context, halting exports of discarded electronics, appliances, and vehicles could build up domestic reserves while strengthening existing conventions intended to control the e-waste and toxic waste trade[12]. Despite logistical challenges, rapidly scaling ETM recycling may offer faster climate and security gains compared to the long timelines and socioecological complexities of expanding mining operations. Publishing this inventory has the potential to foster greater international cooperation, investment, and development in broad-based ETM provisioning while respecting diverse government norms on geological information-sharing[13].

The third and complementary step would be to include a national inventory of climate assets (NICA) in determining an NDC for ETMs. Even with reduced reliance on primary extraction informed by the NIER, provisioning the energy transition amidst competing uses for ETMs will still require mining. A NICA can inform decisions on where best to open new ETM mines without compromising climate assets, defined as socioenvironmental systems that enhance mitigation and adaptation while fostering local and regional resilience to climate change impacts. Much of this information can be aggregated from existing databases of protected areas, biodiversity hotspots, and world heritage sites, to name a few. NICA comprehensiveness could be ensured by formally soliciting public input to identify climate assets that may be excluded from current protected areas[14]. Being able to refer to NICA across countries will be useful for international cooperation, and will help prospective investors and firms avoid environmental, social, and governance (ESG) risks. It could help rebalance energy transition debates to prioritize protecting climate assets, and could provide an organizing framework to help networks of scientists and advocates generate actionable data for ESG improvements in regions where undemocratic governments are hostile to climate, environmental, and Indigenous concerns.

These steps can be brought together to inform a public designation of ETM development sites (PDES). Mapping the overlaps between the national inventories of ETM reserves and climate assets can identify climate-safe priority areas for ETM industry. Prioritizing ETM development of above-ground stocks (for example, waste sites) that are in close proximity to climate assets (for example, forests, waterways, or Indigenous lands) is a win-win that fast-tracks environmental remediation while growing ETM supply. This would buy time for careful planning and full ESG adherence in prospective new ETM mines. A PDES approach could involve putting ETM development siting to a public vote or context-appropriate equivalent in local jurisdictions, thereby operationalizing free, prior, and informed consent. This would help ensure national consensus, maximize benefits, and minimize climate asset losses and could help inform more sophisticated policy incentives and safeguards tailored to communities voting in favour of hosting an ETM site. Although adoption of this practice will likely be uneven given the global destabilization of democratic systems[15], PDES provides an important opportunity for established and re-emerging democracies to lead by example.

An important factor for the public, policymakers, and investors to consider when evaluating a new ETM site is whether the proposed development will in fact be used to provision the energy transition. There are currently no measures in place to verify, much less enforce, that ETM mine output is used for climate-friendly purposes. A climate designation assurance (CDA) for ETM industries could take multiple forms: national and international policies as well as binding and voluntary measures. For example, a binding measure could require any new ETM industry to provision the energy transition, verified by a robust traceability system to prevent supply chain capture by climate-hostile sectors. An example of a voluntary CDA measure could be for existing mining and processing facilities to specify a dedicated portion of their output to provision the energy transition, with policy incentives for increasing that share over time.

Ways forward

Given the common but differentiated responsibilities, interests, and capacities among United Nations member states for realizing the energy transition — and the deep divisions over who should be responsible for what — NDCs for ETMs could support a more organized and fair approach to addressing the issue of ETM supply security and associated challenges. Although policy makers and stakeholders in climate and energy communities will ultimately need to determine context-appropriate data management and participatory mechanisms to advance this initiative, the current course all but ensures that ETM production, demand and supply will be subject to periodic crises and conflicts. An NDC for ETMs could be a standalone initiative led by an existing international organization, or it could be incorporated into ongoing work within the United Nations Framework Convention on Climate Change and in periodic global stocktakes to assess progress toward the Paris Accords. Addressing the ETM provisioning question with associated NDCs could lend momentum for achieving climate and energy transition goals, identifying areas for national and international ETM strategy adjustment, and fostering new essential areas of cooperation.

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Competing interests

The authors declare no competing interests.