ENVIRONMENTAL AND SOCIAL IMPLICATIONS OF SUSTAINABILITY AND TECHNOLOGICAL ADVANCEMENTS: CONTRARIAN CONSIDERATIONS

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Abstract

Sustainability, climate change, and transition risks are on the global agenda. However, achieving sustainability, climate change mitigation, and technological advancements are punctuated by environmental and social casualties not often articulated in public discourse. This viewpoint seeks to caution that while attempting to deal with environmental and climate risks, we should not be oblivious to the resultant environmental and social implications of sustainable technologies and innovations. Contemporary tech-anchored lifestyles increase demand that supports the mining of rare earth elements (REE) which are used to manufacture sustainable technologies (Satchwell et al., 2022). The viewpoint is theoretically anchored in the rebound effect and Jevons paradox. A qualitative meta-summary was used to support and provide coherent contrarian considerations expressed in this viewpoint. Academics, policymakers, and practitioners must recognise the enormity of the carbon footprint caused by using REE. Sometimes, price tags are people relocations (Sovacool, 2019), and they subsequently forfeit their heritage, land rights, and possibly, cultural identity. This opens opportunities to research moral licensing in sustainability and climate change and transition. A holistic approach to sustainability is suggested. The approach insists that net positive benefits should first accrue to local communities and a share of REE profits invested in specific environmental and social projects in REE mining communities.

Keywords: Climate Change, Rare Earth Elements, Rebound Effects, Sustainability, Sustainable Technology, Transition Risk

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1. INTRODUCTION

Sustainability and its related issues as well as climate change and transition risks are on the global agenda. Though these issues are critical to humanity, they are not sacred and so there is room for them to be critiqued; their resultant adverse implications must be subjected to evaluation. The route to sustainability and technological advancements is punctuated by environmental and social casualties (Sovacool et al., 2020; Charalampides et al., 2016), which are problematic to future generations. This viewpoint is not just stroppy. It serves to heighten alertness to the fact that while academics, policymakers, and practitioners drive research and implementation of sustainable technologies and climate risks mitigation solutions, there should not be a creation of other critical problems that will be extremely difficult for future generations to deal with. Benefits derived from sustainability and technological advancements should not be antithetical to the environment and communities. We should not be bushwhacked by the sustainability and mitigation of climate risk fads but remain objective in the solutions offered and implemented. We must be circumspect because sustainability and climate solutions have genuine environmental and social consequences to be considered. Frequently, the consequences disproportionately affect women, youth, and children who endure socio-economic challenges. The consequences affect governments' ability to deliver on their sustainable development goals (SDGs), Africa Union's Agenda 2063 aspirations, and related goals and leverage on their demographic dividends, especially for developing countries, which often have a young population. Governments' national development plans and their expected outcomes are rendered ineffective because of unintended environmental and socio-economic consequences of REE mining.

With our lifestyles anchored in modern technology (Satchwell et al., 2022), as the use of sustainable technologies burgeons and the exigent need to innovate on technologies that address climate risks remaining in focus, there are unintended environmental and social implications. This viewpoint considers sustainable technologies to comprise those technologies that are energy efficient, reduce environmental impact and waste, optimise recyclability of outputs and carbon emissions in the production process, and contribute to general environmental climate resilience.

The raw materials used to manufacture sustainable technologies and innovations, and climate risk mitigation solutions are mostly the seventeen (17) rare earth elements (REE henceforth) and oxides (Zapp et al., 2022). REE are:

- *Lanthanum* is used in rechargeable batteries for electric and hybrid cars.
- *Cerium* and *neodymium* are used for catalysts in cars (also for air pollution control), electric motors, catalytic converters, power steering, electric windows, power seats, wind turbines, and the production of special alloys.
- *Praseodymium, samarium,* and *dysprosium* are used in permanent magnets found in wind turbines and electric vehicles. Samarium is used in precision-guided weapons, "white noise" production in stealth technology while praseodymium is used in lasers, sensors, guidance systems, and glass polishing.
- *Yttrium, europium,* and *terbium* are used in laptops, computers, hard disk drives, monitors, televisions, LED light bulbs, and panels.
- *Promethium*, which is used in specialised atomic batteries, pacemakers, guided missiles, and radios. This element produces radioactive material that when it decays, can be used to manufacture a phosphor which gives light. The light it produces can be converted into electricity by a solar cell.
- *Gadolinium* is used in magnetic resonance imaging (MRI), surgical lasers, and positron emission tomography scintillation detectors.
- *Erbium* is used in fibre-optic data transmission amplifiers.
- *Holmium* has neutrons absorbing qualities that are used in nuclear reactors to control chain reactions. The element can also be used in some types of magnets.
- *Thulium* has its uses in the manufacturing of lightweight and portable X-ray machines that have medical applications such as surgical lasers.
- *Ytterbium* is finding nascent uses in memory devices, tuneable lasers, and industrial catalysts and gradually replacing other more toxic and polluting catalysts as it has low toxic qualities.
- *Lutetium* has less commercial use but is mostly used as a catalyst for breaking down hydrocarbons in oil refineries. It has wide use in research.
- *Scandium* can be used in combination to make alloys. Scandium can be combined with aluminium to make an aluminium–scandium alloy to manufacture fighter planes, high-end bicycle frames and baseball bats. Iodide scandium can be combined with mercury vapour lamps to make a very efficient light source which looks like sunlight. The lamps are used to assist television cameras to reproduce magnificent colour in indoor and night-time filming. In addition, radioactive isotope scandium-46 is also used in underground pipes to detect leaks.

As can be apparent from the above, these REE are applied to manufacture everyday use devices. For example, lanthanum, neodymium, and samarium are used in the making of speakers for mobile phones, digital camera lenses, haptic engines that make phones vibrate, night vision devices, and phosphors used in digital displays. There are observable continuous innovations in the use of the 17 REE as technological advancements evolve (Royal Society of Chemistry, n.d.; King, 2020; Reuters, 2019).

Although REE are abundant, they are found in small concentrations from the ground, and that makes them less economical to mine as they are mined in small quantities (Nayar, 2021; Reuters, 2019). That said, REE are critical raw materials in the production of everyday use technologies depicted already. The increase in demand for sustainable energy, technological advancements, and climate mitigation solutions is expected to continue to prop up the mining of REE (Satchwell et al., 2022). The contrarian consideration of the demand for REE is evaluated in a later section.

Apart from China and the USA, REE are also mined in Burma (Myanmar), Madagascar, India, South Africa, Canada, Australia, Russia, Estonia, Malaysia, Mongolia, Brazil, Thailand, Vietnam, Burundi, Tanzania, and Greenland. This list is not exhaustive. The viewpoint or perspective seeks to provoke considerations around the environmental and social implications of sustainable technologies and innovations aimed at mitigating climate risks. The view raises consciousness on the fact that while many are excited about the need to discover and produce sustainable technologies and innovations, address the genuine problems imposed by climate change, and better standards of living technological innovations bring, some must be sober and courageous to highlight the dangers to the environment and communities.

In this viewpoint, the author expects to incite and raise orange flags or caution. The caution stresses the fact that while attempting to deal with environmental and climate risks, we should not be oblivious to the environmental and social implications of sustainable technologies and innovations. Mining and processing of REE undermine the attainment of SDGs, specifically, the following SDGs: SDG 1–SDG 8, SDG 10, SDG 12, SDG 13, and SDG 15. Moreover, the achievement of Africa's continental vision articulated in Agenda 2063's aspirations and goals are affected albeit with superficially short-term gains. Very significant quantities of REE are used in the production of clean energy equipment and technologies, as well as climate mitigation solutions. These clean energy equipment and technologies are expected to benefit people and various sustainability spheres. However, we should not ignore the environmental and social implications of their production and subsequent obsolescence because they potentially threaten the achievement of SDGs and Africa's continental vision.

The remainder of this paper is structured as follows. Section 2 presents the theoretical anchoring and reviews the relevant literature. Section 3 analyses the methodology that has been used to support and provide coherent contrarian considerations expressed. Section 4 critically discourses the contrarian considerations, while Section 5 is the conclusion.

2. LITERATURE REVIEW

This section outlines the theoretical anchoring of the viewpoint and the literature reviewed. The viewpoint seeks to accentuate potential unintended implications that might exacerbate sustainability and climate risks in the future. In doing so, it naturally leads to the rebound effect and Jevons paradox. Ruzzenenti et al. (2019) highlight that the rebound effect is a broad term applied where the expected energy savings acquired through improvements in energy efficiencies are diluted. This contests the notion that better energy efficiency leads to lower energy use, decreased carbon emissions, and relieves diminution of resources. While the Jevons paradox highlights that the rebound effect usually surpasses and likely erodes the saved energy through energy efficiency. A case in point where the rebound effect and Jevons paradox may be demonstrable is that of Petroliam Nasional Berhad's (PETRONAS), which seems to set the pace in decarbonising its operations but continues to unfurl oil and gas explorations activities in regions it operates (theedgemarkets.com, 2023). It is conceivable that the oil and gas exploration activities and subsequent carbon-heavy operations will erode benefits attained from its agile and innovative carbon-neutral solutions. In such situations, technically measuring gains and losses is like a Gordian knot (Sonter et al., 2014; Virah-Sawmy et al., 2014, as cited in Sonter et al., 2018).

Ruzzenenti et al. (2019) motivated the application of the rebound effect and Jevons paradox when they asserted that their use in other disciplines, such as economics, is gaining traction. This is even though the rebound effect is a dominant discourse in the energy efficiency field. Moreover, Ruzzenenti et al. (2019) aver that the rebound effect is entrenched in human psychology. The rooting in human psychology assertion provoked the researcher to want to express an orange flag viewpoint or reflection. The orange flag is to accentuate that while legitimate sustainability and climate risks exist, academics, practitioners, and policymakers should not take their eyes off the environmental and social implications of sustainable technologies and innovations. Academics, practitioners, and policymakers should not be blinded by trends in sustainable technologies and innovations aimed at mitigating climate risks while being neglectful of environmental and social implications. This matter becomes complex and controversial when it is argued that past technological innovations have not yielded or demonstrated lower resource consumption — it can be contended that there have been increased demands on the environment (Awasthi et al., 2021). In public discourses, the impact of mining REE and their processing is often restricted to the mining sites and surroundings without considering the breadth and comprehensiveness of impacts in other environmental, social, and economic contexts (Sonter et al., 2018). This makes it difficult to make the case for a just transition to clean and sustainable energy especially when environmental and social implications seem to be made peripheral in the main conversations, as well as policy considerations. Appreciating the breadth and comprehensiveness of impacts is critical at this point in our history because rebound effects are often underestimated (Ruzzenenti et al., 2019) and not fully captured in policies and regulations — making them fall short in protecting citizens. Irfan (2017) demonstrates this point by stating that innovations in digital technologies expend two percent (2%) of global emissions while yearly bitcoin mining uses 32.36 terawatt hours of energy (as of 2017). The energy consumption is through electricity used for computational processing power. To contextualise this energy consumption, 32.36 terawatt hours is the yearly total electricity needed by Serbia or 2.9 million households in the USA. This can be critical for developing countries that often encounter energy crises. Such electricity consumption can be expected to significantly contribute to environmental and social implications. One would need to ascertain the enormity of the carbon footprint of the energy consumed in REE mining, processing, manufacturing, and use of sustainable technologies. There is an acknowledgement that generating low-carbon emission energy is mineral intensive (Sonter et al., 2018). Moreover, e-waste that is recycled, such as laptops, computers, monitors, televisions, light bulbs, panels, batteries, etc., is adding to environmental pollution challenges that affect human health (Pozo-Gonzalo, 2021). In instances where REE are recoverable through recycling of e-waste, chemicals, and electricity are used. The chemical impact on the environment and communities are not established and more electric energy (which increases the carbon footprint in its generation) is used. Additionally, e-waste recycling to recover REE tends to be expensive and damaging to the environment (Pozo-Gonzalo, 2021). Most of the e-waste ends up in landfills which contaminate the soil, surface, and groundwater exposing, especially children, to health risks (Pangkaj & Rafizul, 2019, as cited in Awasthi et al., 2021). E-waste currently comes with challenges of its nature, characteristics, and monitoring which seems not yet to be fully understood by municipalities that often have responsibilities of managing it (Awasthi et al., 2021). The resultant rebound effects may be pecuniary and non-pecuniary (Dütschke et al., 2018) and these need to be ascertained. The non-pecuniary impacts include a legacy of environmental and human mortification, poorly resourced public health, marginalised former workers and communities, and damaged biodiversity (Sovacool et al., 2020; Sovacool, 2019). Other noticeable non-pecuniary impacts may include over-exploitation of resources, e.g., hunting and over-fishing, the introduction of invasive species, and alternative uses of land in emerging communities where REE mining and processing occurs (Sonter et al., 2018). This introduces anthropogenic climate risks.

3. METHODOLOGY

A qualitative meta-summary was used to support and provide coherent contrarian considerations expressed in this viewpoint. The viewpoint is propped by qualitative data obtained while conducting literature reading around the topical themes of sustainability, climate change, and technological advancements formulated to transition to renewable sources of energy. A qualitative meta-summary was considered to be the most appropriate approach. A general narrative review could have been applied as an alternative methodology to provide a broad overview of the topic and its critical analysis (Onwuegbuzie & Frels, 2016). However, it would have fallen short of addressing the specific contrarian considerations which are central to this paper. Meta-summary enabled the writer to look beyond the obvious and positive mainstream discussions on sustainability, climate change, transition to renewable energy, and technological advancements and articulate less-considered environmental and social implications of sustainability and technological advancements. This approach also allowed for holism to be attained. Holism is critical for identifying and raising orange flags highlighting that while academics, policymakers, and practitioners seek to solve today's problems, there are resultant environmental and social implications that cannot be ignored and can be catastrophic for future generations. Holism is very important for the just transition to sustainable and renewable energy transition. In applying the meta-summary approach, a literature review was used as a data collection tool, i.e., to identify, record, understand, interpret (Onwuegbuzie & Frels, 2016), and inform contrarian considerations. Data collected through a literature review (Onwuegbuzie et al., 2011, as cited in Onwuegbuzie & Feels, 2016) was evaluated and supported the viewpoints and recommendations provided. Thus, the contrarian viewpoints and recommendations are informed by a meta-synthesis of qualitative research findings from reviewed literature related to sustainability, climate change, transition to renewable energy, and technological advancements.

4. RESULTS AND DISCUSSION

Applying the qualitative meta-summary approach and Jevons paradox in this viewpoint, the author considered the environmental and social implications of sustainable technologies and innovations that are aimed at mitigating climate risks.

The considerations are in the domains of minerals needed to make components for electric cars, wind turbines, solar panels and batteries, lithium batteries, smart mobile phones, smart TVs, and other uses of critical properties found in REE. Mostly, the use of technological devices leads to digitalisations that have sustainability difficulties around socio-economic inequality. The inequality is driven by the digital divide between those that have access and those that become unemployed because of technological advances, and the protection of the environment, which becomes susceptible to a higher carbon footprint due to increased demand for smart technologies (Linkov et al., 2018). These difficulties may arise from governments' incentivising private sector innovations in quests to use digitalisation to mitigate the challenges. The mining of REE used in the manufacturing of sustainable technologies impacts native plants and related cultivars and general land management thereafter. Ultimately, some of the indigenous plants and other species become extinct thus denying future generations of nature's beauty, as well as adversely affecting interdependencies within the ecosystems.

Environmental and social damages in areas where REE are mined are considered. There is the reopening of old mines to mine REE that were previously closed because they were considered unviable (e.g., Mountain Pass Mine, California in the USA reopened in 2012, according to King, 2020, Molycorp Minerals in California, which was abandoned in 2002, according to Ives, 2013, and revamping of Bikita Minerals by China's Sinomine Resource Group to mine lithium in Zimbabwe, according to Reuters, 2022). Technological advancements have found use of these "old" minerals thus necessitating the re-mining and viability of the old mines. These considerations support the assertion that mining is not a sunset industry but a sunrise one.

There are leading technological entities that use REE and are at the forefront of renewables as well as other technological advances. The leading entities may behave as having moral licenses because they are leading contributors to sustainability and climate risk mitigation solutions (which are globally topical). However, they may be behaving immorally with regard to the extraction, sourcing, and processing of REE used in the manufacturing of sustainable technologies. The need for sustainable technologies and innovations to mitigate sustainable and climate risks may result in unintended rebound environmental and social effects, and moral licensing by entities. In the process of manufacturing and sourcing REE as raw materials used to make components, these said tech leaders need to evaluate the impact of their environmental and social footprint — even within their supply chains.

As innovations in sustainable technologies continue and improve, and climate risks, as well as solutions to the risks, are found, there is increased demand on the environment because of the mining of REE. This perpetuates the moral licensing problem (i.e., moral behaviour in finding solutions that mitigate sustainable and climate risks while immorally behaving in the way REE are sourced and extracted from the earth, ill-treatment of people in mining communities, and greenwashing in the reporting by entities). This kind of moral licensing paralyses the effectiveness of sustainable and climate policies, subsidies, and tax incentives offered to entities that invest in energy-efficient technologies (Dütschke et al., 2018), and capital allocated to carbon emission technologies. Moreover, moral licensing emboldens entities to behave unethically in the context of providing innovative sustainable, and climate solutions. This opens research gaps to study moral licensing in the fields of sustainability, climate change, and transition.

In continuing the case of arguing this viewpoint, the author reverts to the earlier introduced increasing demand for REE that are used to manufacture new sustainable technologies and innovations. The demand is expected to globally increase to 315,000 tonnes per annum by 2030 (Pozo-Gonzalo, 2021) while the obsolete technology (which becomes e-waste) continues to pollute the environment and communities. Beyond 2030, the demand for REE is expected to continue to increase as new REE properties that are useful to the sustainability agenda are discovered. In the meantime, what do we do with the ever-increasing e-waste? Even if the e-waste is recycled, unintended consequences arise through the use of chemicals, electric energy (currently, this tends to be energy-intensive), and emissions of pollutants, as well as corrosive waste that have further environmental and social footprint challenges. This exacerbates the environmental and social implications emanating from sustainability and technological advancements. It is as if humanity does not know what to do with what it creates when it is no longer needed. Moreover, the rate of obsolescence of technological devices is faster — creating e-waste at a faster rate than their recyclability or our ability to recycle in climate-clean ways. The ever-increasing demand for sustainable technologies and innovations has the danger of creating more e-waste and causes policymakers, industry bodies, as well as users, to be unmindful of negative environmental and social implications. While academics, policymakers, and industry bodies are focusing on net zero carbon emissions and clean-energy generations, there are counterintuitive processes. These counterintuitive processes have environmental and social implications originating from the mining of REE that are used in manufacturing sustainable technologies and innovations. Increased demand for clean, sustainable technologies and innovations that use REE as raw materials cause environmental damages, and negative footprint, and unsustainable socio-health challenges in localities where REE are mined. This becomes a zero-sum game where communities (people) that afford the technology have positive net benefits (usually, far away from where REE mining occurs) whereas the environment and communities where REE are mined endure net losses. Overall, the result is net losses (rebound effects and Jevons paradox) since climate change affects both environments and communities (i.e., those that have net benefits and those with net losses). This significantly negates the attainment of SDGs and Agenda 2063 aspirations and related goals to various degrees.

In further considering environmental costs, it can be appreciated that mining REE is difficult, complex, and costly to extract and process to the required refined standard. Mining REE requires vast tracks of land upon which small quantities can be mined and processed (Pozo-Gonzalo, 2021). Generally, renewable energy generation requires huge pieces of land which is often scarce. For example, wind turbines need spacing for them to be efficient and solar farms also need land for solar panels. All these might compromise food production as farmers give up land for renewables as they financially mitigate farming challenges arising from drought and other climate-related risks. Giving up land by farmers may be financially sustainable and more lucrative for them than farming as they transcend into electricity generation as a business. This change in the type of business affects the local environmental and social structures — bringing other structures that may be undesirable to local communities and may polarise them.

Back to REE mining — it leaves a legacy of heavy environmental alterations that compromise and extinct indigenous flora and fauna and creates toxic waste and radioactive elements (thorium) that arise from REE mining and processing. All these are detrimental to the environment, employees' health, and communities (exposing them to lung, pancreatic and other cancers, respiratory challenges, and skin irritations) (Ives, 2013; Nayar, 2021; Pozo-Gonzalo, 2021). Moreover, REE mining and processing contaminates waterways and groundwater through leaching pond chemicals (Nayar, 2021) which intern poison everything as water is crucial to all forms of life. To mention what might be apparent, the mining of REE has legacies of wastewater, foul air, and damaged vegetation (deforestation or depletion of rainforests). Damaged vegetation then leads to soil erosion, siltation of rivers, and barren land for food production thus worsening the current food crisis. The released toxins also affect crop yields which contributes to the food crisis. Nayar (2021) and Penke (2021) accentuate the toxicity problem of mining REE by stating that one tonne of mined REE produces approximately 2,000 tonnes of toxic waste. Academics, policymakers, and practitioners need to conduct a cost-benefit evaluation to ascertain who derives benefits from sustainable technologies and innovations, who gets affected, and to determine net benefits or costs. The methodologies to conduct the said evaluations are still subject to further research by academics and practitioners. This evaluation is particularly important in Africa and other developing countries where there are severe negative impacts in areas where REE are mined but with very limited benefits accruing to the communities where the mining occurs. The environmental and social price tags that local communities pay need not be ignored due to the rebound effect and Jevons paradox. Sometimes, the price tags come with the relocation of people who subsequently forfeit their heritage, land rights, and possibly cultural identity (Sovacool, 2019). In contemplating the price tags, the future research question is: *How can* *a balance be achieved to ensure local communities and their environment experience sustainable net benefits in the longest while?* Due to the aspects raised above, the SDGs that affected governments are likely to fail in attaining include SDG 9 and SDG 11. Achieving the earlier mentioned SDGs and African Union aspirations targets will also be missed.

The socio-economic costs come in the form of lost tax benefits extended by governments to entities mining and processing REE and those manufacturing sustainable technologies and innovations. These governments will be seeking to attract investments, modernise their economies and make them competitive, and create employment. Tax incentives and subsidies offered become lost tax revenue to the fiscus and citizens in general. It can be argued that these tax incentives and subsidies are extended without consideration of rebound effects and the Jevons paradox. The result is net losses rather than expected net benefits acquired from sustainable technologies and innovations, as well as climate change mitigation solutions. Other costs are in the form of environmental clean-ups. These costs are often incurred by governments that ordinarily pay the health bills of members of society whose health is affected by the mining and processing of REE. The costs are paid by governments through social spending (specifically, public healthcare) allocated from the fiscus. Nayar (2021) posits that China annually spends US$5.5 billion on environmental clean-up costs. The waste tonnage and magnitude of clean-up costs seem to highlight the existence of serious rebound effects that cannot be ignored by anyone. High clean-up costs in the face of dwindling tax bases in developing countries severely compromise the protection, restoration, and promotion of sustainable use of terrestrial ecosystems, sustainable management of forests, combating desertification, and halting and reversing of land degradation and biodiversity loss. This is because governments tend to prioritise socio-economic spending over expenditure on environmental clean-up in the face of perennially constrained financial resources.

Other economic costs of sustainable technologies and innovations incurred by global citizens have their origins in geopolitical tensions. These costs spill over into socio-economic and public health challenges. China's withholding supply of REE to Japan in 2010 and imposition of a 25% import tariff on USA-mined 50,000 tonnes of REE processed in China in 2017 are sources of geopolitical strains (Reuters, 2019). Reuters (2019) suggest that China exploited its dominance in REE mining and processing, and this resulted in geopolitical tensions and price increases. The world depends on China (which has a greater market share, 81% to 95%) for the supply of REE. Geopolitical tensions between China and other developed countries have the effect of increasing prices on REE, such as neodymium, dysprosium, erbium, and gadolinium (King, 2020; Reuters, 2019). These REE are used to manufacture sustainable technologies and innovations, as well as devices used daily by most citizens. Some of these devices include medical imaging equipment, speakers, permanent magnets used in wind turbines and electric vehicles, fuel cells, and others as already articulated. These everyday technologies become expensive as their REE raw material prices escalate due to geopolitical tensions. The price increases in REE raw materials have their origins in geopolitical tensions and:

- creates inflationary pressures in medical or healthcare (i.e., contribution to higher healthcare inflation);
- makes clean energy costly for the less privileged citizens who are the majority population in most countries (e.g., use of wind turbines that have initial higher energy costs which filter into inflation);
- makes electric cars expensive to buy and operate for most people.

All these cost-push inflationary pressures have their tentacles in geopolitical tensions emanating from REE mining economy. They negatively affect healthcare, devices, energy sources, and other sustainable technologies and innovations that have become necessary for modern-day lifestyles. These aspects result in the failure of governments to attain the already mentioned SDGs and Africa's continental aspirations and related goals.

The contrarian considerations discussed in this section have highlighted the severity of the rebound effect and Jevons paradox. Currently, the rebound effect and Jevons paradox are not being seriously considered in the sustainability and climate change mitigation discourses. The impact of sustainability and technological advancements on achieving various SDGs and the Africa Union's aspirations are also accentuated.

5. CONCLUSION

Academics have no subjects that are sacrosanct to be researched and critiqued (no matter how popular they may be). For that reason, as an academic, the author ventured to express a contrarian viewpoint on what might be currently considered unpopular. The subjects of sustainability, climate change, and technological advancements have grabbed the attention of academics, policymakers, and practitioners. However, we mostly found trendy discourses on these subjects which seem to neglect the negative impacts emanating from the mining of REE raw materials used in the manufacturing of sustainable technologies and climate risks mitigation solutions. This viewpoint sought to heighten awareness or raise caution and grab the attention of academics, policymakers, and practitioners. These role-players need to consider that while they drive research and implementation of sustainable technologies and climate risk mitigation solutions, there should not be creating other critical anthropogenic problems that will be extremely difficult for future generations to deal with.

It will be improper to just express a viewpoint that points to what was found to be mostly missing in sustainability discourses and not offer a thought or two on advancing the conversation. The author concludes and advocates for what can be considered a holistic approach to sustainability and climate risk mitigation solutions. This holistic approach equally focuses on both positive and negative impacts and conducts cost-benefit-evaluations. Based on this, the author concludes that it is essential to prioritise the well-being of local communities where REE mining takes place by ensuring that any economic benefits from the mining accrue to them first. Emphasising national or overall economic benefits at the expense of localities where REE mining occurs is not a sustainable approach. Tangible and observable net positive benefits should first be attained in local REE mining communities before national and international communities realise these net positive benefits. This limits externalisation of net benefits to the rest of the nation and world at the expense of REE mining communities. This is a bottom-up approach that is expected to ensure that REE mining communities become first net positive beneficiaries before the rest of the world benefits. The bottom-up approach should be designed to attract other forms of investments in REE mining communities to bolster the net positive benefits that the communities acquire. As such, we envisage that the best and most appropriate way to ensure that net positive benefits accrue to communities is for authorities to consult them and allow them to give inputs to confirm existence of claimed net positive benefits to avoid potential greenwashing by mining entities. Thus, contributing to the achievement of SDGs, Agenda 2063 aspirations, mitigating unequal socio-economic development, reducing migration to big cities, improving the revenue base of local municipalities and bettering service delivery, and establishment of infrastructure. Of course, the development will have to occur under the oversight of government and non-governmental agencies that have an eye of a hawk on environmental impact. Policymakers will need to listen and have the political will to implement recommendations from non-governmental agencies. Social scientists need to establish models that can be used to ascertain net positive benefits accruing to communities where REE mining takes place.

Coupled with the above conclusion and recommendation, the author suggests a substantial share of REE profits with communities where REE are mined. The profit shared must be transparently invested in specific environmental and social projects that contribute to the attainment of various SDGs and Africa Union's Agenda 2063 aspirations and related goals in the local communities where REE are mined. The author recommends that shared profits do not get mixed up with the national revenue purse but are set aside for the specific development within communities where REE are mined. The conclusion here is that a well-developed and environmentally conscious approach to mining REEs can lead to a profit-sharing model that benefits both local communities and the government. By redistributing the profits from REE mining, the government can allocate funding for infrastructure and development in areas that do not have REE mining, leading to more balanced economic growth across the country. The advantage of this approach is that in countries that are endowed with REE, governments will only focus on funding development and infrastructure efforts in areas where REE mining is non-existent.

Another conclusion is that since governments seem to have less effective policies or regulations or laws to deal with e-waste, they should exercise caution when it comes to recycling e-waste to extract REEs. Until safe and environmentally friendly recycling methods are developed and tested, it is important to limit the extraction of REEs from e-waste. This approach will help minimise the potential harm to both human health and the environment while still allowing for the recovery of valuable resources. Relevant researchers in this field must be at the forefront of this research to establish safe methods and advice for policymakers.

The conclusions and recommendations offer a starting point for addressing the issue of REE mining with minimal adverse effects on the environment and communities. However, it is necessary to recognise the limitations of this perspective, as it requires further testing and validation through the consideration of the contrarian viewpoints presented. In progressing the conversations, researchers can play an important role in formulating models (through research) that accurately measure net positive benefits and profit-sharing schemes that benefit local communities. They can also explore safe and environmentally friendly methods for recycling e-waste, which is precipitously growing in quantities, and evaluate the impact of REE supply chains on mining communities. It is also critical to address the issue of moral licensing, where entities engage in unethical practices while presenting themselves as sustainable and climate-conscious champions. This ensures that entities prioritise authentic ethical and sustainable practices in their operations and contribute to the collective effort towards mitigating climate risks for the sake of current and future generations.

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