The Green Transition: Balancing Carbon Emissions and Other Environmental Harms

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Abstract. The transition away from fossil fuels as the predominant source of energy in the world is arguably the 4th great energy transition in human history. It is necessitated by rising global temperatures and changing climactic patterns caused by the emission of Greenhouse Gases, with carbon dioxide being the most prominent. However, the global focus, represented by research and technological funding as well as policy man-hours dedicated to the reduction of carbon dioxide emissions tends to obscure and hide the myriad other environmental harms that will be necessary to implement the Green Transition. In particular, this obscurity is facilitated by the complexity and opacity of supply chains and the reducing role of the 'Material World' in the economic growth figures of the developed West- phenomena downstream of neoliberalism. This paper will shed light on these comparatively obscured environmental harms which tend to miss the most 'urgent' headlines but may ultimately impact humanity much more than carbon emissions themselves. Such harms are causally linked to the Green Transition because moving away from energy-dense fossil fuels will require much more mining of critical materials such as Lithium, Cobalt, Copper and Sand. We will investigate the link between environmental harm to marginalised populations of the Global South having lesser salience to Western policy-formulating audiences, and the role of neoliberalism in hiding away vast swathes of this non-carbon emission environmental harm. The broad policy options available to lawmakers to balance out Climate Change (predominantly carbon emissions) with other environmental harms will be considered and assessed.

Keywords: Green Transition, Mining, Carbon Emissions, Energy Usage, Material World.

1 Introduction

The threat of Climate Change is, at its most abstract, a uni-variate problem. One metric, which is the amount of Greenhouse gases (GHGs) being released into the atmosphere, is responsible for an outcome, which is increasing global temperatures. The actionable milestones to address Climate Change are thus defined in terms of the outcome or dependent variable, which is a certain degree of global temperature

T. Pradhan et al. (eds.), *Proceedings of the NDIEAS-2024 International Symposium on New Dimensions and Ideas in Environmental Anthropology-2024 (NDIEAS 2024)*, Advances in Social Science, Education and Humanities Research 848,
https://doi.org/10.2991/978-2-38476-255-2_13

increase (1.5C being the 'target', with scenarios extrapolated for higher figures at 2C, 4C etc). Undoubtedly the dynamics of this relationship are affected by many different factors (IPCC Report), but the underlying input of GHG, the output of higher global average temperatures is the defining, overarching concern.

The 'Green Transition' is, as a consequence of this overarching concern with the input-output mental model of Climate Change, predominantly focused on reducing the input (GHGs). The primary challenge in doing so is eliminating or at least reducing our reliance on fossil fuels. This is sought to be achieved by replacing the energy generation currently being done through fossil fuels with alternate, non-carbon-emitting sources of energy, most stereotypically Solar and Wind energy. One of the long-standing and defining disputes among those concerned with Climate Change is the nature of these non-carbon-emitting (NCE) sources. Thus, while nuclear energy is certainly NCE, many advocates, activists and policymakers have concerns as to the collateral environmental damage and risk of irreversible disasters that nuclear energy may entail (Barnaby, Goldblat, Jasani and Rotblat, 1979). The possibility of nuclear energy proliferation leading to nuclear weapon proliferation is also a key concern of many opponents of the expansion of nuclear energy and its positioning as one of the key NCE sources (Jackson, 2009). However, the 'renewable' energy sources proposed as the best alternative NCE sources to replace fossil fuels also suffer from the same vice of collateral environmental damage. Solar energy primarily relies on photovoltaic cells whose manufacture is heavily dependent on large amounts of coking coal and silica. The mining of these two components itself will require fossil fuels in large quantities. Furthermore, the manufacturing process results in the release of GHGs. But more importantly, the mining process itself generates a large number of different environmental harms. As compared to the simple input-output mental model of Climate Change, these harms are too numerous and diffuse to easily enlist and summarise, and we think that this results in their discounting when it comes to advocacy and policymaking (Conway, 2023).

Renewables are further complicated by requiring a complete restructuring of our energy distribution mechanism- since they are intermittent and less energy dense all things considered, storage (stereotypically batteries) and transmission (electrical grids) will require to be revamped to unprecedented degrees. Indeed, the 'mascot' product of the Green Transition, electric cars, will need an entirely new set of infrastructure no matter which model (battery swapping, public or private charging stations etc.) of transmission is deployed (Kumar, Mulukutla and Pai, 2023). All of these are engineering challenges dependent upon economic feasibility. No national government today, no matter how powerful and endowed in resource terms, could create without substantial international trade and investment, the necessary infrastructure of the Green Transition. Indeed, no national government of significance has approached the Green Transition as a fully governmental project- such a folly, the experience of 'planned economies' in the 20th century teaches us, certainly fails (Hallegatte, Fay and Vogt-Schilb, 2013).

The Green Transition from a governmental point of view is thus a set of policy and legal changes to reduce the economic feasibility of fossil fuel sources and increase the engineering and economic feasibility of NCE sources and the attendant storage and transmission infrastructure necessary for them. Much attention in policy-making has been paid to using economic incentives to make fossil fuels less attractive- carbon pricing or carbon cap and trade being paradigmatic examples.

The flip side of increasing the economic feasibility of NCE sources has largely been addressed through subsidies and product-linked incentive schemes. Comparatively less attention has been paid to increasing the engineering feasibility of NCE sources. There are several reasons for this- fundamentally, the assumption is that the engineering challenge will be addressed by technical research and development. There is also the lack of a clear picture of what regulatory changes relate to engineering feasibility- in the case of fossil fuels, there is relative clarity due to our simple Climate Change mental model. We must reduce their conversion into GHGs- thus we must stop using them. However, when it comes to NCE sources, there is a tendency among policymakers to be unaware of the vast regulatory barriers that stand in the way of them becoming feasible alternatives to fossil fuels.

2 Forecasting India's Requirements for Minerals in Green Technologies

The COP26 conference convened in November 2021 in Glasgow with a focus on expediting efforts to meet the objectives outlined in the "Paris Agreement" (UNFCCC, 2021). India aims to increase non-fossil fuel (ie, non-carbon emitting) sources to 500 GW by the year 2030, surpassing the previous target of 450 GW used in this analysis for mineral demand projections. Additionally, India aims to decrease the carbon intensity of its economy by about 45 per cent by 2030 compared to 2005 levels and achieve "Net Zero" by the (rather far away) year 2070 (PIB 2022; External Affairs Ministry, 2021).

India's needs for critical minerals will be influenced by the "clean energy technologies" adopted during the transition and the balance between domestic production and imported reliance for each technology. Consequently, discussions will vary depending on the energy types and their forecasts. Solar energy is anticipated to be a significant factor in India's transition to clean energy. Essential minerals for the manufacture of photovoltaic cells consist of tellurium, gallium, germanium, indium arsenic, silicon and silver, of which there are no commercially available reserves in India's domestic production capacity. Wind turbines will also contribute to India's transition to clean energy. Minerals crucial for their production include Rare-earths, Nickel, Chromium, Molybdenum and Manganese. Some Manganese, Rare-earths (REs) and elemental Chromium are extracted by India, but the majority of REs are currently both extracted and refined in China (United Nations, 2016). India targets

170GW wind power capacity by 2030, which will require quadrupling it over the next 6-7 years (Statista, 2024).

India is advancing the adoption of electric vehicles (EVs) through the "Faster Adoption and Manufacturing of Hybrid and Electric Vehicles (FAME) scheme" (Mint, 2021). Transitioning to electronic transport aims to curb emissions from vehicles and diminish dependence on fossil fuels. Critical minerals required for electronic vehicle battery manufacturing encompass lithium, rare earths and cobalt. Despite this, India has not invested substantially in the mining of either cobalt or lithium, although it possesses some cobalt resource reserves. NITI Aayog targetted for 2030, aiming for EV sales to represent "70% of commercial car sales, 30% of private car sales, 40% of buses, and 80% of two-wheelers and three-wheelers" (Narasimhan, 2020). Furthermore, the nation must enhance its public-charging infrastructure.

As India shifts toward renewable power generation and electric vehicles, there will be a great surge in the quantities demanded for the various critical minerals mentioned above. Transitioning to renewables will need larger quantities of diverse minerals. Similarly, the adoption of electric vehicles will drive up the demand for various minerals. Nevertheless, Indian land lacks reserves of all these. Copper and silver demand also far exceed existing Indian reserves.

3 Policy Considerations: Charting the Path Ahead

The findings of this projection reveal that India cannot fulfil its green or sustainable technology needs solely using domestic mining. To comply with its policy objectives on climate change mitigation, imports of minerals for local manufacture or imports of the end product containing these minerals will be required. Although India will depend on imports for these technologies in the coming two decades, there is a need for additional efforts to optimize the utilization of available minerals within the country for its future requirements. Considering that the renewable energy infrastructure established currently will require renewal in two to three decades, India can improve its preparedness for the subsequent wave of green technology implementation by commencing exploration and mining operations. Although India holds considerable reserves of rare earths, nickel, molybdenum and cobalt, additional exploration is required to find out the total quantities of such reserves. Cobalt and rare earths face significant supply risks. Although nickel as of date has a lower supply risk compared to other minerals in this analysis, its economic significance is much higher, and securing a domestic source would mitigate possible future supply risks. Certain minerals, such as lithium and indium, lack known reserves in India, requiring obtaining access to foreign proven sources of supply and consolidating those supply chains, to ensure uninterrupted supply. Mitigating import risks associated with critical minerals is possible through the development of resilient supply chains, the negotiation of well-thought-out trade agreements, and the acquisition of mining assets abroad in politically stable and economically viable locations.

India requires critical minerals to achieve its climate change mitigation goals. Relying solely on domestic mining is insufficient to meet the demands of green technology manufacturing. Therefore, there is a need for enhanced efforts to optimize the utilization of available minerals within the country for its future requirements. Ensuring the development of secure supply chains for critical minerals and acquiring foreign mineral assets to ensure uninterrupted supply is essential for India. There is no doubt that for the next 20 years, India will have to depend on imports for clean energy technologies. Protracted effort is needed to optimise the utilisation of currently existing mineral resources within India for long-term sustainability.

Significance of cohesive supply networks in facilitating a worldwide energy transition

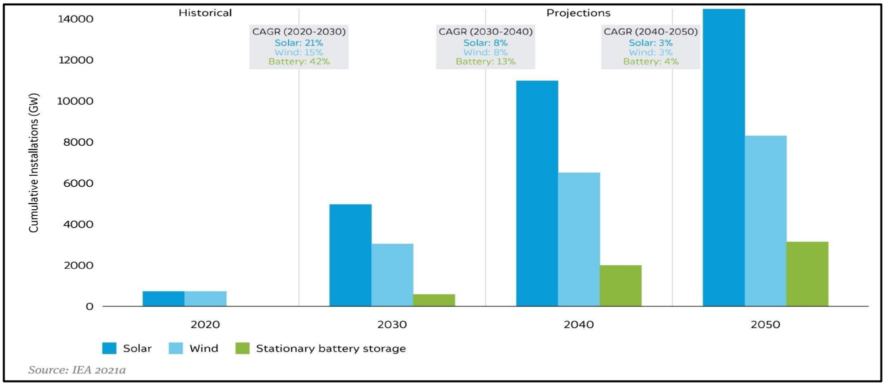

Figure 1 (According to the IEA's net-zero scenario, "capacities for solar, wind, and stationary storage must increase by 20, 11, and 172 times, respectively, between 2020 and 2050".), Source: IEA 2021a

According to the report dealing with renewable electricity by the International Energy Agency (IEA), achieving Net Zero 2050 requires increasing the share of renewable energy in the electricity sector from "28.7 per cent in 2021 to 90 per cent in 2050" (IEA, 2022a). Solar and wind technologies are projected to be the primary contributors, with a combined capacity expected to escalate from "1,449 GW in 2020 to over 22,723 GW by 2050" (refer to Figure 1 above). The intermittent nature of these renewables means that energy storage has to also expand rapidly. Battery technology is anticipated to be the preferred energy storage solution for the next several decades, with projected installations of "2,311 GW in 2030 and 3,860 GW in 2050" (IEA, 2022b). Batteries are also predicted to have significant applications in the mobility sector, with an expected demand of "5,600 GWh and 10,400 GWh by 2030 and 2050, respectively" (WRI, UC-DAVIS, CEEW, IEA, 2023).

At present, lithium-ion batteries are prevalent in the market. Nonetheless, there's an anticipation that while the demand for lithium-ion batteries will continue to rise, simpler and shorter supply chain alternative technologies might also gain popularity. Similarly, green hydrogen is poised to have a crucial role in reducing emissions in hard-to-decarbonize sectors. Meeting Net Zero 2050 will need electrolyser capacity to reach “850 GW by 2030 and 3,500 GW by 2050” (IEA, 2021b). 100 GW of electrolyser manufacturing is needed to reach 850 GW. Until 2021, creating from raw materials production was approximately 8 GW every year. However, various countries are enhancing their production capabilities, aiming to achieve the 2030 target of 62GW (International Energy Agency, 2022b). It is estimated that this is about 61% of the total needed capacity and is expected to be achieved only by 2030.

Therefore, there is a notable requirement for additional capacity in the near term to achieve the production goals set for 2030. To achieve global net-zero emissions, the production capacity for green hydrogen must escalate to 75 MTPA by 2030 and 330 MTPA by 2050, which marks a significant increase from the current 0.8 MTPA (Hydrogen Council, 2022). The capacities for electrolyzer and green hydrogen production underscore the considerable expansion needed in supply chains. Hence, the swift establishment of the entire supply chain is imperative. This situation presents both an “opportunity and a challenge”. Embracing a collaborative approach will accelerate the expansion of green hydrogen and ensure that nations achieve their 2030 agenda objectives and subsequent net-zero targets. In the realm of renewable energy, the supply chain encompasses the production and distribution of raw materials for components, energy generation, transmission, and distribution to end-users, as well as maintenance and operation, and considerations for end-of-life such as recycling and waste management. This intricate process involves a diverse spectrum of individuals, companies, and nations (Jelti et al., 2021). Consequently, a multitude of stakeholders with varying objectives and interests must collaborate to establish continuous, secure, and cost-effective renewable energy supply chains.

4 Global Trade for Green Technologies

Meeting the challenge of achieving net zero CO2 emissions by 2050 entails a substantial increase in the international trade and production of numerous raw materials crucial for transitioning the global economy from fossil fuel dominance to reliance on technologies related to renewable energy (IEA, 2021). Emerging technologies typically entail greater mineral resource demands in comparison to their fossil fuel equivalents. For instance, an onshore wind farm needs "nine times the amount of mineral resources than a gas-fired plant," and a typical electric automobile requires six times the mineral inputs compared to a conventional vehicle (IEA, 2021). Consequently, while the clean transition targets a reduction in global dependency on fossil fuels, it concurrently amplifies the need for the manufacture and effective global commerce of other raw materials. This is evident in the increased mineral requirement for an increase in power generation capacity of "50% since 2010" as a result of increased use of renewable energy sources in new energy sector investments (IEA, 2021).

Certain raw materials, such as aluminium, copper, iron ore, and steel, which have historically been fundamental to industrial production, will continue to be indispensable in green sectors and their associated technologies. Additionally, rare earth minerals like “neodymium and dysprosium, along with lithium, cobalt, or nickel”, are prevalent in emerging technologies, indicating a significant anticipated increase in their demand (Gielen, 2021).

During the COVID-19 pandemic, there was a notable contrast with the "Global Financial Crisis of 2008-2009" (GFC) regarding the pricing dynamics of imported "precious stones, minerals, and non-ferrous and ferrous metals." While these commodities experienced only marginal decreases in prices during the initial phase of the pandemic in the first half of 2020, they witnessed significant increases in the latter half of 2020 and throughout 2021. Consequently, certain raw materials like precious stones and ores saw their trade values rise amidst the widespread decline in trade during the pandemic's first year, whereas iron, steel, and aluminium products experienced comparatively lesser declines during the same period (Arriola, Kowalski, and van Tongeren, 2021).

Following a one-sided retrieval from the impacts of the “COVID-19 pandemic”, the “invasion of Ukraine by Russia in February 2022” introduced newborn complexities to global trade and the economy. This event affected the “international supply of agricultural and industrial raw materials, for which both countries historically served as significant suppliers”. By mid-2022, prices of various imported non-energy commodities had risen to historically high levels or approached them. This pattern was observed in all significant groups of industrial raw materials, such as ferrous metals, non-ferrous minerals and ores, and precious metals (INSEE, 2022). In a wider context, given the disruptions caused by the COVID-19 pandemic and escalating geopolitical tensions, including “Russia's invasion of Ukraine in February 2022”, several nations have initiated evaluations of their reliance on various imported goods, particularly raw materials. The objective is to identify items that could potentially disrupt production or consumption due to unexpected supply interruptions or pose national security risks if used as tools of coercion.

5 Manufacturing and Commerce

Over the past decade, significant expansions in production volumes have been observed for “lithium, rare earth elements, chromium, arsenic, cobalt, titanium, selenium, and magnesium, ranging from 33% (for magnesium) to 208% (for lithium)”. However, even notable increases pale in comparison to the four- to six-fold surge in demand that is predicted for the green transition. Meanwhile, the worldwide industry of certain critical raw materials, such as “lead, natural graphite, zinc, precious metal ores and concentrates, as well as tin", has experienced declines over the same period (Przemyslaw Kowalski and Clarisse Legendre, 2023).

Global trade in critical raw materials has surpassed that of overall merchandise trade, witnessing a "38% increase between 2007-09 and 2017-19, compared to 31% for all products". Lithium trade has exhibited the most substantial surge among all critical raw materials, with a notable 438% increase, while "manganese, natural graphite, cobalt, titanium, lead, rare earth elements, arsenic, and zinc" have all demonstrated growth rates exceeding the average for all critical raw materials. Over the last decade, critical raw material production has become more concentrated among producing nations worldwide, showing a tendency towards greater concentration than their global imports and exports (Przemyslaw Kowalski and Clarisse Legendre, 2023).

This emphasises how crucial global supply chains and trade are to the processing and delivery of these materials to final consumers, while simultaneously highlighting how vulnerable they are to interruptions in higher echelons of these chains. A small number of major producing nations, some of which make considerable contributions to the production of numerous vital raw materials, are mostly responsible for the concentration of crucial raw material production. For example, China is in the top three producers of six of the ten most production-concentrated vital raw materials; Australia, the Russian Federation, South Africa, and Zimbabwe are included three times, twice, and three times, respectively (Przemyslaw Kowalski and Clarisse Legendre, 2023). Although the concentration of vital raw material imports and exports has increased in some nations, the overall trade of these materials appears to maintain a relatively diverse distribution. This indicates that the potential for significant disruptions to the worldwide green transition resulting from interruptions in the import or export of critical raw materials is somewhat limited. But occasionally, there are noticeable import and export concentrations, especially in the upstream parts of supply chains for certain vital raw resources (ores and minerals) such as "lithium, borates, cobalt, colloidal precious metals, manganese, and magnesium" (Przemyslaw Kowalski and Clarisse Legendre, 2023). The worldwide imports of certain important raw materials are concentrated more than the exports, such as trash and scrap of "arsenic, mercury, thallium, gold, silver, platinum, iridium, osmium, palladium, rhodium, ruthenium, and rare earth elements". This discrepancy suggests considerable market power for buyers. This observation also implies that, to the extent that concentrated exports can cause disruptions in certain supply chains, import concentration may likewise have significant impacts on some critical raw materials supply chains (Przemyslaw Kowalski and Clarisse Legendre, 2023).

6 The Policy Space: 'Justness' and Trade-offs

In international policy documents, there is a commitment to the 'justness' of the Green Transition (Devezas 2022). However, since 'just transition' originated in the labour and trade union movements as a response to (then new) environmental regulation, the policy priorities of 'justness' tend to include standard 'progressive' ones aiming predominantly to protect labour rights (UN, 2022). While there is a mention and cursory discussion of the possible environmental harms of the technologies and systems sought to be promoted as a part of the (just AND green) transition, it tends to get crowded out by the other political commitments of the groups invested in the process.

The difficult questions of the transition qua environmental harm will persist. The core of the problem is comparing emissions-related harm (the headline-grabbing global metric) to all other harms (usually much more localised). How does a policymaker compare the effects of a hydroelectric power project which will inevitably inundate a large area, cause displacement of (usually marginalised) communities, result in changing the course, siltation and broadly the aquatic system across perhaps thousands of kilometres of the river floodplain etc, with a thermal coal-based power plant which will have a much large emissions impact but a lower overall environmental impact?

The urgency of Climate Action (which is emissions action) militates against the thermal power plant- should this override other, greater (by perhaps any measure except emissions) environmental harms from the hydroelectric power project?

7 Political and Geopolitical Constraints

The response of developing economies such as India to emission reduction asks has been to suggest that India (and other such developing countries) should be allowed to emit more because the 'just' metric of emissions reduction is historic per capita emissions, and not total emissions as they stand today. However, the Climate does not respect such demands- the reality of the situation is that most of the emissions reduction has to come from today's biggest emitters before certain tipping points are reached (and this needs to happen as soon as possible). Can the developed and developing world strike a bargain here? We suggest that the bargaining chips on the table simply aren't big or effectively implementable enough to 'buy out' developing countries' fast-growing energy needs. These bargain-able chips on the table take the following forms- carbon credits, technology transfer, and interest-free capital.

Carbon credits rely on accurate accounting of emissions. Since developing countries have large informal economies and corrupt information collection systems, it is simply utopian to expect that any measure of carbon emissions for developing countries will not be gamed if there are fiscal incentives to game it. Technology transfer has been tried and tested as part of other international bargains such as the TRIPS Agreement- and it is fair to suggest they have largely failed to live up to the ideas of the parties involved (Fox, 2019). Increasing geopolitical tensions, especially between the Chinese and the Russians and the 'West', have resulted in the weaponisation of intellectual property and trade (trade secrets, technological edge in 'strategic fields') as well as the financial architecture necessary for technology transfer- it has become harder and not easier over the last few decades. Similar issues, accentuated by geopolitics, haunt capital transfers (Galeotti, 2022).

Undoubtedly great effort is still being made for all these bargains. But all of them together still don't supply the necessary incentives for developing countries to reduce emissions. The proof is simply in the graphs- economic growth remains deeply correlated with emissions, a relationship that has changed in the last 2 years for developed economies but not for developing ones like India.

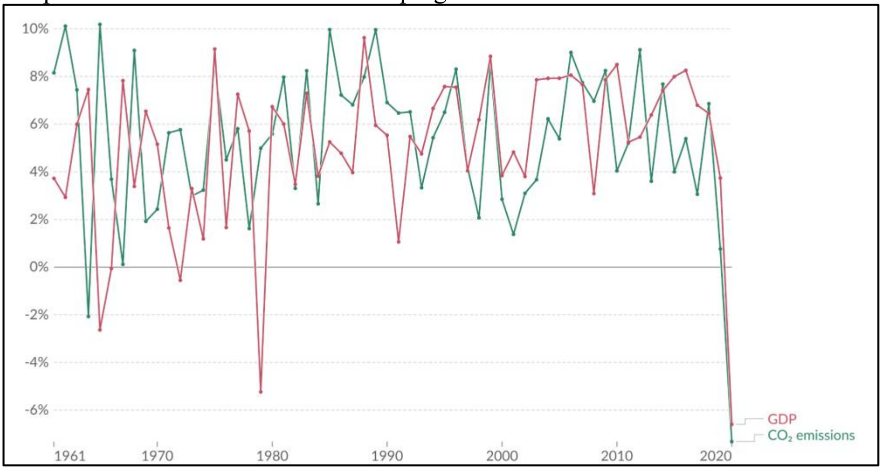

Figure 2. Annual change in GDP and CO2 emissions, India, (Percentage change in gross domestic product and carbon dioxide emissions), Source: World Bank and OECD; Global Carbon Budget (2023)

One answer is to suggest that the problem lies in 'promoting' an energy-hungry consumerist economy for the sake of 'economic growth', and that we should reduce our energy consumption. This 'degrowth' position must only be stated to be rejected. Energy richness is the most clear measure of socio-economic well-being. It cannot be denied to the billions of people who have transitioned away from endemic precarity in the last century. Indeed, it is not the case that any given set of national or international policies is 'promoting' higher energy consumption- it is more apt to say that higher energy consumption is the revealed preference of people whenever their budget increases! (Costa-Campi, del Rio, Trujillo-Baute 2017).

If degrowth is not politically, socially or economically feasible (assertions we believe are all true), it is inevitable that to reduce emissions we will incur the higher non-emission environmental costs associated with non-carbon emitting sources of energy. It is a crucial first step to acknowledge this trade-off, even if no universal formula for comparing environmental harms of different sorts can be given.

Thus, to stick to any reasonable emission reduction agenda (in the sense of non-catastrophe), countries must be willing to relax environmental safeguards, paradoxically. The insistence on the transition being 'just' across all politically salient dimensions is simply unworkable.

8 The Balancing Act in India

In India, this is indeed what has happened functionally speaking (ie, when the law touches the reality of renewable energy projects). But there has been scarce acknowledgement of the trade-off. It is pertinent to mention the outline of the legal architecture for regulating environmental harm to further our argument.

The overarching framework legislation that occupies the field is the Environmental Protection Act, of 1986, which is a barebones enabling statute, which purported to implement the United Nations Conference on the Human Environment, 1972. This international element allowed the Centre to legislate (via Article 253 of the Indian Constitution) matters which ordinarily would have fallen in State or Concurrent jurisdictions. The EPA provided the authority for the Central Government to, belatedly in 2006, institute an Environmental Impact Assessment requirement through delegated legislation (Hanibal, Tariq and Kelly, 2023).

Measures to address Climate Change have on the other hand mostly been ‘Schemes’ and Policy plans. The legislation most directly addressed to reducing GHG emissions became law only in 2022 and has not been operationalised, though very recently there has been governmental action to do so (Tyagi and Ghosh, 2024).

GHG emissions reduction and the Environmental Protection regimes have been at cross purposes often. There are of course huge differences between the different types of renewables involved- nuclear is in the ‘red’ category in the 2016 categorisation of industries by the MoEFCC, while solar power plants are exempted from Environmental Impact Assessment since 2011. Several renewable energy projects such as ‘small’ hydro (less than 25 MW), waste-to-energy, wind power (on-shore) and biomass energy do not require EIA at all. This ‘blanket’ exemption is problematic because even if it is assumed that in terms of noxious gaseous emissions or water run-off, the risks are low, EIA envisages the social and biodiversity impact of the project, which even these supposedly ‘clean’ projects could have. Indeed even the assumption that they are non-toxic is not true everywhere and always- it has been seen for instance that some solar PV cells have cadmium, which accumulates in bones and is carcinogenic (UNEP, 2016). The water required for daily cleaning of solar projects is also estimated to be high and has an impact on water availability for adjoining areas of the project.

More worryingly, protections for marginalised communities in other environmental protection legislations have been diluted to a large degree for renewable energy projects. Some high-profile examples are the installation of wind energy projects inside the Koyna Wildlife Sanctuary, the deleterious impact on indigenous peoples by the Kasargod solar energy project, and the wind projects undertaken in the Bhima Shankar Wildlife Sanctuary, which resulted in land acquisitions which were not ultimately built and resulted in long years of struggle for the communities from whom land was acquired. The mandatory requirements under the Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act 2006 for consent from Gram Sabhas have also been ignored in several renewable energy project cases (Mongabay, 2023).

Another eyebrow-raising trend has been for mega-solar energy projects to rely not on acquisition of land under the 2013 Right to Fair Compensation and Transparency in Land Acquisition, Rehabilitation and Resettlement Act (a major protection for the millions of landless and marginal agriculturalists and pastoralists in the country), but to use Executive authority (via the District Collector usually) to get long-term leases of agricultural land, thereby bypassing the compensation and protection provided under the 2013 Act. Indeed, this was encouraged by the NITI Aayog (the Central Government's in-house think tank) and developed at their behest, and such fast-track procedures are increasingly being made the rule rather than the exception (WRI, 2022).

One key concrete step that has been taken to encourage renewable energy projects has been through the imposition of Renewable Purchase Obligations on power distribution companies (predominantly State-run). These have been steadily increasing over time (ORF, 2024).

The root problem of the issues highlighted above is that Climate Change, a *univariate* problem has been dealt with in India not by the economically sound policy of increasing the price of emissions, but by making unprincipled exceptions within the environmental protection regime, and the legal safeguards for those most vulnerable to environmental degradation (Jolly and Lamba, 2022).

Balancing harms from GHG emissions and 'every other type of environmental harm' is necessarily fraught because the former is posed as urgent to avoid catastrophe. GHG emissions are 'quantifiable' to a much larger extent than the latter category. But, they are also so deeply enmeshed in our energy and manufacturing supply chains that shutting them down by fiat will without doubt be a catastrophe right here and right now. As we have seen above, non-carbon-emitting sources of energy can and do have their environmental concerns. Because the GHG emission does not cause local environmental damage but is contributing to a global problem, it is politically costly to convince citizens to care about it.

The most suitable option to balance these is to send the price signal that emissions are costly- this will have a cascading effect across the economy. Other environmental harms are local and can be negotiated by the local democratic unit. But GHG emissions are best tackled not by including them in the determination of local environmental harms, but by increasing their cost.

The exact contours of how to increase this cost, and how to send the right price signal, can vary- taxation has been suggested, as have carbon credits (a cap and trade mechanism). Practically speaking, since India's Energy Conservation Act already stands amended but not implemented, a 'first step' is the implementation of at least a partial carbon credit trading scheme which can be expanded later.

The Green Transition should not have to depend upon a state of exception for selected technologies in any nation's environmental regime- such an approach will dent the credibility of both the technologies (which are inevitably tied to actual companies when the 'rubber meets the road') perceived to be beneficiaries as well as the environmental protection regime itself. After all, if an exception can be made for carbon emissions because it is urgency, then exceptions will (and indeed have been) demanded for 'national energy security', 'national energy self-sufficiency' etc.

Another crucial step to the sense-making apparatus in balancing harms is the ability to visualise and track the environmental impact of expanded mining in the country. For instance, Maus et al have contributed a novel way to track the impact of mining worldwide through satellite image tracking (Maus et al, 2023). A more 'zoomed-in' and data-rich project for mining projects in India will contribute to a better overall appreciation of the ecological footprint of mining, which tends to get hidden away from policymakers in State capitals.

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