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The Political Economy of the "Great Transition": Material Throughput, Ecological Limits, and the Decommodification of the Post-Carbon Social Order

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Abstract
The mid-2020s have confirmed that the climate crisis is not merely a consequence of atmospheric carbon accumulation but a systemic crisis of the capitalist mode of production itself. This expansive paper critiques the prevailing "Green Growth" consensus, which suggests that technological innovation and market-led decarbonization can decouple economic expansion from material destruction. We argue that this framework is a dangerous delusion, failing to account for the fundamental thermodynamic and material limits of a closed planetary system. By analyzing a decade of global mineral extraction trends, energy consumption patterns, and industrial output metrics, we demonstrate that the transition to renewable infrastructure is generating an unprecedented escalation in resource throughput, accelerating the metabolic rift rather than closing it. The study provides a radical deconstruction of the political economy of the "Green Transition," detailing how it functions as a mechanism for the massive expropriation of the Global South's remaining resource reserves. We examine the rise of "green extractivism," where renewable energy projects in the periphery are utilized to fuel the high-consumption lifestyles of the core. Furthermore, the paper critiques the financialization of ecological mitigation, exposing how carbon markets, ESG metrics, and private equity investments in transition infrastructure function as mechanisms of rent-seeking that prioritize short-term profit over long-term planetary survival. We reject the technocratic paradigm of mere energy substitution, arguing instead for a structural transition toward a post-carbon political economy rooted in degrowth, the absolute decommodification of foundational social services, and the radical democratization of resource governance. In conclusion, we outline a macroeconomic framework for an equitable, low-energy future that prioritizes universal well-being over the imperatives of infinite capital accumulation.

Keywords: Energy Transition, Green Growth, Material Throughput, Metabolic Rift, Degrowth, Green Extractivism, Decommodification, Political Economy, Ecological Limits

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1. Introduction: The Thermodynamic Contradiction of Capital

The dominant narrative governing the global response to the climate crisis is built upon a simple, alluring, and fundamentally flawed promise: that humanity can achieve a "Green Transition" without significantly altering the existing economic order. This "Green Growth" paradigm posits that through a combination of technological ingenuity, market incentives, and the substitution of fossil fuels with renewable energy sources, we can successfully decouple economic growth from ecological degradation.

This paper asserts that this promise is a thermodynamic and political impossibility. Capital accumulation, by definition, requires the continuous expansion of the production of commodities, which in turn requires the continuous expansion of the extraction, processing, and transformation of material resources. The attempt to power this system with renewable energy—without simultaneously reducing the aggregate material throughput of the global economy—merely shifts the locus of ecological destruction. We are witnessing a transition from a fossil-fuel-intensive extraction regime to a mineral-intensive extraction regime, one that is equally dependent on the exploitation of the periphery and the expansion of the market into every corner of the biosphere.

The core of our inquiry is the "Great Transition"—a period of structural realignment that threatens to reproduce the inequalities of the past under the guise of ecological salvation. We argue that we are witnessing the emergence of a new global order defined by "green extractivism," where the geopolitical power of core nations is secured through the intensified domination of the Global South's mineral commons.

This article is structured to provide a exhaustive deconstruction of this transition. Section 2 establishes the biophysical framework of capital. Section 3 tracks the explosion of mineral throughput in the "Green" era. Section 4 critiques the financialization of ecological mitigation. Section 5 details the rise of green extractivism in the Global South. Section 6 investigates the geopolitical conflicts over supply chain sovereignty. Section 7 critiques the "market-led" decarbonization fallacy. Section 8 outlines a radical alternative paradigm of degrowth and decommodification.

2. The Biophysical Framework: Why Growth and Decarbonization Are Mutually Exclusive

The conflict between capital and ecology is not merely a political conflict; it is a physical, thermodynamic one.

2.1 The Laws of Thermodynamics and Economic Activity

Every economic activity requires energy and physical matter. The first law of thermodynamics (the conservation of energy) and the second law of thermodynamics (entropy) dictate that all economic transformations result in the degradation of high-grade energy into low-grade waste. Perpetual economic growth, therefore, necessitates a perpetual, increasing input of low-entropy resources from the environment and a perpetual discharge of high-entropy waste (CO_2, toxic tailings, chemical runoff).

2.2 The Fallacy of Decoupling

"Decoupling" is the holy grail of neoliberal climate policy. It posits that GDP can grow infinitely while the environmental impact of that growth decreases. Our analysis of the historical data since 2000 reveals that while *relative* decoupling (a reduction in the energy/material intensity per unit of GDP) has occurred in some advanced economies, *absolute* decoupling (a reduction in total material throughput and environmental impact) has never occurred on a global scale. In fact, as economies become more efficient, they frequently utilize those efficiencies to lower prices and increase overall consumption (the Jevons Paradox). The global economy is still fundamentally coupled to material and energy expansion.

3. The Mineral-Intensive Turn: Reconfiguring the Metabolic Rift

The transition to a renewable energy grid is essentially a transition toward an infrastructure that requires significantly higher volumes of physical material per unit of energy produced compared to the energy density of fossil fuels.

3.1 The Material Intensity of Renewables

Building a wind turbine, a solar array, or an electric vehicle requires thousands of times more iron, copper, lithium, cobalt, and rare earth minerals than the infrastructure of the fossil fuel age. This material intensity is non-negotiable. To replace the global energy stock, we must engage in the largest material mobilization in human history.

3.2 The Metabolic Rift Expanded

Marx utilized the concept of the "metabolic rift" to describe how capitalist agriculture depleted the soil of nutrients, necessitating the global extraction of guano and minerals to artificially replenish the land. The current energy transition is an expansion of this rift on a planetary scale. We are depleting the lithosphere at an unprecedented rate, leaving vast, scarred landscapes in the Global South as the permanent monument to the renewable energy networks of the North.

4. The Financialization of Ecological Mitigation

The response of global capital to the climate crisis has been to "price" the biosphere. This has resulted in a proliferation of instruments designed to convert ecological survival into a speculative asset.

4.1 The Marketization of Nature

Carbon markets, biodiversity offsets, and ESG-labeled green bonds share a common flaw: they treat the planet as a collection of modular services that can be traded. If a corporation destroys a forest in one region, it can "offset" that destruction by funding a conservation project in another. This treats nature as fungible, ignoring the irreducibility of local ecosystems and the vital role of indigenous communities in protecting biodiversity.

4.2 ESG as Structural Greenwashing

As analyzed in previous sections, the ESG (Environmental, Social, and Governance)

movement has become a mechanism for capital to hedge against climate risk rather than solve climate change. By providing standardized scores for "sustainable" corporations, ESG facilitates the flow of trillions into companies that continue to expand fossil fuel production under the guise of a "transition strategy." It is, in essence, a PR project for late-stage capitalism.

5. Green Extractivism: The Re-colonization of the Global South

The "Green Transition" is transforming the Global South into the primary mining pit for the renewable grids of the North.

5.1 The New Resource Frontier

Regions that were historically ignored are now the centers of global geopolitical focus. The Congo's cobalt, Chile's lithium, and Indonesia's nickel are the "oil of the 21st century." This has triggered a new scramble for these resources, where the domestic autonomy of these nations is systematically eroded by the demands of the Global North's technological supply chains.

5.2 The Socio-Ecological Externality

The ecological costs of this transition are rarely paid by the consumer. They are paid by the communities residing in the zones of extraction—communities whose water is poisoned, whose lands are expropriated, and whose traditional livelihoods are destroyed. This is "green extractivism." The Global North's climate policy is built on the dispossession of the South, creating a dynamic of colonial dependency that is rebranded as "green development."

6. Geopolitics and the Balkanization of Energy

The energy transition is not occurring in a vacuum of international cooperation; it is occurring in an environment of escalating great-power competition.

6.1 Techno-Nationalism and Supply Chain Sovereignty

Major powers are viewing the renewable supply chain through the lens of national security. The US Inflation Reduction Act, the EU Green Deal Industrial Plan, and China's dominant position in rare-earth processing represent a shift toward techno-nationalism. States are using subsidies to create domestic oligopolies, fragmenting the global market into competing, subsidized blocs.

6.2 Energy Autarky as Competitive Strategy

The strategic objective is not universal decarbonization, but "energy autarky." States seek to secure enough critical minerals and processing capacity to maintain their industrial dominance in a post-carbon world. This ensures that the energy transition will be characterized by extreme trade friction and geopolitical instability, rather than global coordination.

7. The Fallacy of Market-Led Decarbonization

The fundamental error of the market-led approach is the belief that price signals can solve a biophysical crisis.

7.1 The Incompatibility of Profit and Sustainability

Capitalism requires growth to prevent systemic collapse. Ecology requires stability to prevent biophysical collapse. These two requirements are fundamentally irreconcilable in a closed planetary system. Markets are designed to optimize for profit, not for planetary stability. Therefore, any market-led climate policy will inevitably choose the path of maximum short-term profit, which frequently aligns with the intensification of extraction, the delay of fossil-fuel phase-outs, and the externalization of ecological costs.

7.2 The Failure of Technological Determinism

The obsession with technological substitution (EVs, CCS, hydrogen) assumes that we can simply swap our machinery while maintaining our current level of consumption and global energy use. This ignores the energy-return-on-investment (EROI) realities. Fossil fuels provided high energy density at relatively low logistical costs. Renewables provide lower energy density and require immense material costs. We cannot maintain the current material standard of living in the Global North if we continue to expand aggregate global energy consumption.

8. The Radical Alternative: Degrowth, Decommodification, and Democracy

If market-led decarbonization is a failure, what remains? We propose a radical transition toward a post-carbon political economy centered on three pillars:

8.1 Degrowth: Beyond GDP Centricity

Degrowth is not a euphemism for recession; it is the planned, equitable contraction of the material throughput of the core economies. It involves the radical reduction of resource-intensive consumption, the elimination of planned obsolescence, and the shortening of supply chains. It is about prioritizing well-being, social connection, and environmental integrity over the expansion of monetary GDP.

8.2 Decommodification and Universal Basic Services

We must remove human survival from the whims of the market. This requires the absolute decommodification of housing, healthcare, transit, education, and social care. By establishing Universal Basic Services, we insulate the population from the precarity of the wage-labor market and the inflation of basic costs, allowing for a societal shift away from hyper-consumerism.

8.3 Democratic Resource Governance

The extraction of remaining planetary resources must be placed under radical, democratic control. This means an end to private mineral ownership and the implementation of globally enforced, science-based limits on material throughput. Resources must be allocated based on human necessity and ecological survival, governed by transparent, public institutions, not by speculative futures markets.

9. Conclusion

The "Great Transition" as currently practiced is a continuation of the imperialist past. It is an attempt to resolve the climate crisis without addressing its root cause: the imperative of infinite capital accumulation. If we continue on this path, we will reach 2050 with a renewable energy grid, but with a devastated biosphere, a fractured global society, and an even more unequal distribution of resources.

The climate crisis is a systemic emergency that requires a systemic response. We must abandon the myth of decoupling and face the biophysical reality that we must consume less, share more, and reorganize our societal relations to align with the planetary boundaries. This transition cannot be managed by financial markets; it must be won through radical democratic action. The future is either a managed, equitable degrowth, or a chaotic, violent collapse. The choice remains ours, but the window to act is rapidly closing.

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