

Financing the green industrial policy for a sustainable and just transition

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Abstract

Green industrial policies and climate finance are both essential tools for meeting the sustainable and just transition challenge – and they must be used together. Green industrial policy integrates climate change mitigation into social welfare goals (Tagliapietra, 2022), becoming imperative as society commits to decarbonization. The reallocation of capital and labour from low- to high-productivity activities is essential for boosting income and productivity; however, this process must now also prioritise environmental preservation (Altenburg & Rodrik, 2017). This necessitates a new industrial strategy, distinct from past approaches, aimed at fostering greener, more inclusive, and resilient economies. However, financing green industrial policy is a pivotal issue in achieving a sustainable and just transition that aims to preserve social welfare, foster innovation, and accomplish structural change towards a sustainable economy. This paper explores the nexus between finance and green industrial policy, seeking to align sustainability goals with economic imperatives to steer growth toward a sustainable future. Many climate investments, particularly in adaptation, lack attractive cash flows for private investors, despite their immense societal benefits. Hence, the state must incentivize green private finance to facilitate green industrial policies, climate innovations, and technology advancements. Development banks have a key role in this process. The article begins by outlining the principles of just transition and sustainability in green industrial policy. It will then explore financing options, focusing on the state's role in achieving a sustainable transition, emphasizing the critical role of financial sector policies in enabling green industrial policies.

Keywords: Green Industrial Policy; Green Sustainable Transition; Development Banks; Central Banks.

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1. Introduction

From heatwaves to floods, extreme weather events are not only costly but also causing increasingly widespread disruption around the world, prompting governments and sectors to strive to reduce greenhouse gas emissions (GHG) and mitigate climate change. Humanity is nearing multiple ecological tipping points,¹ beyond which abrupt and irreversible environmental changes on a large scale are likely to occur. Urgent action is imperative to overhaul our economic systems.

States and institutions globally argue that turning the imperative of decarbonisation into an opportunity for green growth requires stronger, smarter policies to foster job creation and industrial development. The United Nations' Sustainable Development Goals (SDGs) also support this green growth agenda, combining economic growth with deep decarbonisation and environmental protection. According to the UN's definition, green growth means fostering economic growth and development, while ensuring that natural assets continue to provide the resources and environmental services on which our well-being relies. A key challenge for governments is decoupling economic growth from GHG emissions effectively, necessitating robust green industrial policies to create good jobs and sustainable growth. Failure to replace 'brown' jobs with 'green' ones could jeopardise the overall decarbonisation process and the achievement of a just transition.² This necessitates innovation in green technologies to optimise resource use and reduce GHG emissions, thereby mitigating social costs associated with the transition (Rodrik, 2014).

The primary objective of this article is to explore the role of green industrial policy in addressing the climate, social, and environmental crises by promoting sustainable economic development. It aims to demonstrate how financial institutions, particularly development banks and central banks, can facilitate the green sustainable transition. Furthermore, it addresses the necessary alignment of macroeconomic policies to foster long-term structural transformation, emphasising the need for state planning to guide investment towards sustainable growth.

¹ The world is approaching at least nine tipping points, where small changes in the climate system can trigger large, irreversible shifts. The list includes the West Antarctic ice sheet, the Arctic sea ice, the Wilkes basin, Amazon rainforest, Atlantic Circulation, Boreal forest, Coral reefs, the Permafrost and Greenland ice sheets.

² However, it is important to point out that a just transition does not refer solely to the re-allocation of employees. It evolves a broader transformation in other social indicators as inequality, de-commoditized access to energy, health and education, as well as ending poverty and hunger.

The article is divided into four sections besides this introduction. The second section, 'What does it mean to integrate "Green" into Industrial Policy?', explains how environmental sustainability must be incorporated into green industrial strategies, balancing decarbonisation with social welfare objectives. The following section discuss the role of innovation, public-private partnerships, and financial systems in supporting the green sustainable transition. Section 4 explores the restructuring of financial system to accommodate the green sustainable transition, proposing new approaches like green quantitative easing and rethinking the mission of central banks. The last section concludes the article.

2. What does it mean to integrate 'Green' into Industrial Policy?

Achieving development and increasing wealth without the overexploitation of natural resources is a challenge posed by climate change. The reallocation of capital and labour from low- to high-productivity activities is essential for boosting income and productivity. However, this process must now also prioritise environmental preservation, as humanity is nearing multiple ecological tipping points, beyond which abrupt and irreversible environmental changes on a large scale are likely to occur (Altenburg and Rodrik, 2017). Therefore, it is necessary to implement a new kind of industrial strategy, distinct from those of previous decades. This strategy should not only stimulate growth and productivity but also steer it towards creating greener, more inclusive, and more resilient economies. That is, integrating 'green' into industrial policy refers to incorporating environmental sustainability and climate considerations into the planning, development, and implementation of industrial strategies.

Before classifying the green industrial policy, a common factor in the definition of industrial policy highlighted by the established literature is the goal of targeting economic activities for long-term societal benefits (Ambroziak, 2017). Recent literature (Aiginger and Rodrik, 2020; Lane, 2020; Rodrik, 2014) emphasises multi-dimensional objectives beyond short-term competitiveness and growth, aiming for long-term social welfare. A green vein into the industrial policy definition becomes necessary once decarbonisation is set as a societal goal. While climate policy focuses on reducing GHG emissions and industrial policy on social welfare, green industrial policy integrates both, aiming to decarbonise the economy while enhancing social welfare. Therefore, green industrial policy does not focus solely on decarbonisation, as climate policy would, nor should it seek only social welfare and economic growth, as traditional industrial policy does. It serves as a key policy to mitigate the effects of the climate crisis while also increasing social welfare. Thus, green industrial policy can be defined as an industrial policy where

climate change mitigation is a mandatory component of the social welfare objective (Tagliapietra 2022).

The importance of green industrial policies is paramount considering the massive reallocation of assets that will occur during the transition to a sustainable green economy. This shift is driven by both physical and transition risks stemming from the climate crisis. Physical risks refer to the direct impacts of climate change, such as extreme weather events, rising sea levels, and heatwaves, which can damage infrastructure, disrupt supply chains, and lead to significant financial losses. Transition risks arise from the economic and policy changes required to move toward a low-carbon economy. As governments and markets implement stricter environmental regulations and shift toward sustainable alternatives, industries reliant on fossil fuels and carbon-intensive processes will experience reduced demand and profitability, leading to asset devaluation (Carney, 2018; Feijó et al., 2024).

Furthermore, 'brown' activities face a high likelihood of stranded assets, which are assets that suffer from unanticipated or premature devaluations, write-downs, or even conversions into liabilities due to the transition away from fossil fuels. The rapid loss of value in these assets can destabilise industries, leading to job losses, reduced investments, and capital shortages (Ansari and Holz, 2020; Caldecott et al., 2016).

In this context of climate, social, and environmental crises, green industrial policy is not only essential for ensuring the decarbonisation of the economy but also for maintaining economic productivity and growth considering social welfare. By fostering innovation in sustainable technologies and guiding the reallocation of assets toward green sectors, green industrial policies can support a smoother transition, mitigate the risks associated with stranded assets, and ensure that economies continue to thrive in a low-carbon future. These policies are crucial to aligning economic development with environmental sustainability, preventing systemic shocks, and ensuring a resilient, inclusive, and competitive economy.

Regarding changes and improvements in infrastructure, it is necessary that such transformations seek to coordinate environmental, social, and economic development as a strategy to achieve sustainable development (Ying et al., 2022). It places considerable importance on the coordination between human construction and environmental protection, playing a crucial role in adapting to climate change. Historically, adaptation to climate change has received less attention than mitigation. However, there has been a growing interest in adaptation interventions, which have already become necessary in

many contexts, particularly until GHG emissions are stabilized (Geneletti and Zardo, 2016).

This presents a significant opportunity for countries to engage in green industrial policy, as infrastructure investments are necessary regardless. Whether creating new infrastructure or upgrading existing ones, it is better to undertake these projects sustainably from the start. This is especially important considering that ‘brown’ projects will lose value over time. The International Monetary Fund estimates that the multiplier associated with investments in renewable energy is higher (1.1-1.5) than that associated with fossil fuel energy (0.5-0.6), demonstrating that stabilising the climate and reversing biodiversity loss can coexist with ongoing economic progress (IMF, 2021), as a sustainable and just transition takes place.

Therefore, the climate, social and environmental crisis imposes the necessity to re-shape not only infrastructures but also markets to decarbonize in a way that is inclusive and sustainable, and the public sector has the tools to do it. Governments can leverage green industrial policy (Mazzucato, 2023). The [green] industrial policy should be designed in an outcomes-oriented, cross-sectoral, and bottom-up way with a view to catalysing new public and private investment, and galvanizing economy-wide innovation (Mazzucato, 2022; Semieniuk and Mazzucato, 2018). To design, implement, and govern mission-oriented industrial policy, governments should consider all tools and institutions at their disposal, build public sector capacity, and rethink the deal between the public and private sectors to become more reciprocal.

3. State-Led Green Transitions: Innovation, Public-Private Partnerships, and Green Industrial Policy

The green sustainable transition involves the evolution of green technologies, requiring innovations to produce techniques that economise on exhaustible resources and emit fewer GHG. The development of green technology enables the reduction of the social costs of the transition to green growth and helps achieve a satisfactory rate of material progress along that path (Rodrik, 2014). As Mazzucato (2014) puts it, the State has an entrepreneurial role that enables this process, making public investment a crucial element in achieving this objective.

That is, the deliberate promotion of the green industrial policy through the green sustainable transition necessitates the alignment of investment and macroeconomic policies towards this objective. State planning, along with its institutions and strategies – covering fiscal, monetary, exchange rate, industrial, and credit policies – must ensure the

long-term success and sustainability of the catching-up process. The effectiveness of the transition relies on the integration of traditional macroeconomic policies aimed at fostering growth (Feil, 2021).

Innovation is a core pillar of green economy strategy, central to addressing the global and national environmental challenges of the 21st century. It makes environmental targets more affordable while stimulating productive investment and new growth paths necessary for a sustainable transition. Innovation is recognised as a key driver of economic growth, crucial for long-term prosperity (Solow, 1956). However, this process is marked by significant risks, public goods, and environmental impacts. Enterprises frequently encounter challenges due to insufficient resources and incentives for green innovation, compounded by the prevalent issue of structural market failure. Public investment in innovation, along with measures to stimulate private investment, is essential for fostering the innovation that drives growth.

The green sustainable transition requires cleaner technologies, establishing a clear link between innovation policy and environmental policy to achieve ambitious decarbonization and sustainable development (UCL, 2014). Current production technology and consumer behaviour can only yield positive results to a certain extent; beyond this threshold, the depletion of natural capital adversely affects overall growth and exacerbates global warming, contradicting the goals of the green sustainable transition. Innovation can extend this threshold, facilitating the separation of growth from the depletion of natural capital. The potential spillovers resulting from green innovation may surpass those of other forms of innovation since the market is still underdeveloped. Overcoming the dominance of existing technologies could pave the way for a new series of innovations comparable to those witnessed during other major technological revolutions (OCDE, 2011).

To foster green innovation among enterprises, it is essential for non-market entities to actively engage in encouraging and directing innovation while offering resources and market insights. Among the diverse non-market influences, state intervention stands out as the most impactful. Given the pressing environmental issues in today's economic landscape, sustained government support through long-term, sustainable policies is essential to address the green sustainable transition. Green industrial policy is forward-looking and aimed at fostering sustainable development by encouraging green innovation among enterprises (Zhu & Tan, 2022).

The literature poses that integrating the state with markets is crucial for guiding necessary investments, promoting sustainable structural transformation, and engaging

social actors under a unified development plan (Mazzucato and McPherson, 2018). Public-private policy structuring is one of the most important mechanisms through which this integration can occur. From the perspective of climate goals, it is possible to direct private decisions with public incentives through joint projects, thereby maximising public value (Rodrik, 2014). In this way, policies that might initially conflict become aligned towards the common goal of the green sustainable transition.

Public-private collaboration is important for pooling financing, sharing skills, knowledge, and information (Rodrik, 2014). High levels of synergy and interaction are required to develop joint actions, something not known in advance. Additionally, these partnerships can take various forms, such as deliberation councils, investment advisory councils, roundtables, public-private venture funds, and smart development banks. The most important aspect is that policies outlined in these partnerships prioritise an outcomes-oriented, cross-sectoral, and bottom-up approach to promote industrialisation, aiming to catalyse new public and private investments and galvanise economy-wide innovation.

Government alliances should aim to tackle large-scale issues that span entire value chains across relevant clean markets, rather than addressing isolated problems (Tagliapietra, 2022). Generally, green industrial policy promoted by governments should aim to enhance the integration of more complex value chains that can increase their production scale, as well as new value chains that require technological boosts and market space to expand their operations. Although this type of activity involves higher risks of failure, it is fundamental for generating innovative effects on the economy. Consequently, they also have significant impacts on maintaining long-term growth.

The coordination and implementation of public-private partnerships require strong governance capacity based on competence, ownership, and political independence (Tagliapietra, 2022). In other words, it is desirable to have an independent public institution capable of controlling, auditing, and ensuring accountability of projects, with clear goals and performance reporting. Moreover, this institution should foster cooperation and resolve impasses between state bodies and private companies, ensuring they work for the common good, with clear incentives and pre-established penalties when necessary.

It is very important to establish rules that guide the behaviours of economic agents in this context. Establishing balanced, transparent, credible, and feasible commitments is essential for the successful development of partnerships (Tagliapietra, 2022). To manage projects, it is also necessary to set clear and realistic intermediate goals that reduce

uncertainties and provide greater security in taking larger risks. Finally, policy flexibility is an essential requirement to make objectives achievable. It allows for accommodation of unexpected events, uncertainties related to the development and application of new green technologies, and more efficient management regarding the delivery of results, with intelligent monitoring over time.

In the collaboration between the State and private agents, the implementation of conditionalities can significantly aid in maximizing the public value derived from private enterprises (Mazzucato and Rodrik, 2023). The empowerment of the State and the interests of the private sector work hand in hand towards a common interest. On one side, the public agency provides benefits to firms, such as loans, grants, tax incentives, training, knowledge, technical support, or other types of assistance. On the other side, firms commit to engaging with public objectives and transforming their behaviours accordingly. Conditionalities serve as a regulatory framework that establishes responsibilities, commitments, and counterparty obligations among the involved agents, especially regarding the duties of firms. This framework ensures that while firms receive support from the State, they also contribute to achieving broader public goals, such as sustainability, innovation, and social equity.

Thus, the establishment of a new social contract between mission-oriented governments and purpose-driven businesses necessitates rethinking the fundamental agreements that shape their collaborations. It is essential that these partnerships prioritise people and communities at their core, as the green sustainable transition cannot succeed without also being a just transition. Despite high global profit margins, investment rates remain low, largely due to the growing financialisation of both the finance and business sectors. Instead of being reinvested into the economy, a large extent of profits is going to shareholders – deepening the gap between individuals who possess capital and those who do not (Lazonick, 2014). In the United States and the United Kingdom, merely 20% of financial resources are channelled into the productive economy, with the majority being absorbed by finance, insurance, and real estate (FIRE) sectors (Mazzucato, 2021). Additionally, from 2008 to 2017, 466 companies within the S&P 500 index returned US\$4 trillion to shareholders through buybacks, representing 53% of profits, alongside US\$3.1 trillion distributed as dividends (Lazonick and Jacobson, 2018). This prevailing economic model incentivises profits without corresponding production. Consequently, there is mounting pressure on global businesses to consider stakeholder value rather than solely focusing on shareholder value (Mazzucato, 2018).

It is crucial that the notion of ‘purpose’ be integrated not only within corporate governance but also at the nexus of government and the State. Imposing conditions on

public sector investments can serve several key objectives: (1) enhancing consumer access to goods and services, (2) steering investments towards climate-friendly initiatives, (3) broadening profit-sharing to include a wider array of stakeholders, such as workers, (4) reinvesting in productive business activities like research and development and worker training, and (5) curbing share buybacks and other financialisation practices (Mazzucato and Rodrik, 2023). Crucial to a fresh perspective on industrial policy is ensuring that the trajectory of growth (reducing inequality, enhancing sustainability) is integrated into the mechanisms that bridge public-private partnerships – such as subsidies, loans, grants, public investments, and intellectual property rights. Industrial policies can be proactively crafted to increase public value, incorporating provisions that optimize societal benefits. Conditions fostering fair access and equitable distribution of rewards play a pivotal role in shaping the economy for the collective welfare (Mazzucato and Rodrik, 2023; Mazzucato, 2022).

The need to redesign industrial policy with sustainability at its core is closely linked to the debate on how its financing will be managed. The method of financing and the green sustainable transition is a central issue in this debate and is equally crucial when discussing green industrial policy. This discussion involves the pivotal role that development banks play in processes of structural change in general, and in the transition specifically, as well as the debate surrounding the integration of environmental concerns into the mandates of central banks and other financial institutions. These issues will be explored in greater detail below.

4. Financing Green Industrial Policy

Financial services are fundamental in providing liquidity to the economy, which is crucial for financing investment and, consequently, for supporting the green sustainable transition. Industrial policies are enabled by financial systems capable of channelling resources into the productive process. Financial institutions serve as key actors in facilitating the shift from lower to higher productivity levels and, in the context of the climate, environmental, and social crises, driving the green sustainable transition. Therefore, it is the financial institutions, through their provision of liquidity, rather than savers, that will ultimately determine the success of this transition (Kregel, 2017; Mazzucato and Wray, 2015; Minsky, 1992).

According to Keynes, the behaviour of financiers – credit providers operating in a scenario of high uncertainty – contributes to the instability of the economic system and hinders its progress. This reality becomes more pronounced in long-term productive investments, which are characterised by greater uncertainty, as is the case with the green

sustainable transition. Therefore, State intervention is justified to provide liquidity to the system, either through public institutions or direct expenditures (Feil and Feijó, 2022).

The inherent instability of the financial system can limit investors' ability to foster sustainable growth. In this context, the private financial sector is inadequate in addressing the financing needs of the green sustainable transition. Its inherent focus on short-term profitability—particularly in the current stage of financialisation—prevents it from effectively allocating credit to specific economic sectors, geographic regions, and targeted service modalities (Ocampo, 2013).

The green sustainable transition requires the involvement of state-owned financial institutions, particularly development banks, to enhance resource allocation efficiency and accelerate the transition. These institutions, as an extension of public policy, are crucial for financing and supporting long-term investments aligned with green industrial policy objectives. The theoretical discussion around state-owned financial institutions highlights their diverse functions. This article argues that, in the anthropogenic era, their primary role should be to expand policy space to promote structural transformation towards a more sustainable, complex, and technologically advanced economy, with a special focus on green industrial policy and the financing of the green sustainable transition.

In this context, development banks should serve as an arm of public policy, embedded within a broad investment promotion framework that functions as an instrument for the green sustainable transition. They are vehicles of credit policies that guide the State's intentionality in promoting green sustainable transition and directing long-term funding to the green industrial policy. Consequently, they should be part of the macroeconomic policy toolkit, as essential as monetary and fiscal policies, which can finance peripheral countries' catching up (Feil and Feijó, 2021).

Therefore, beyond long-term State planning anchored in green industrial policy, a new financial framework must be developed. The uncertainty surrounding financial risks related to climate change—driven by political and regulatory shifts, technological innovations, transformations in the real economy, and the interconnected global financial system that propagates and amplifies risks—is likely to permeate all sectors. As such, these risks cannot be managed through conventional approaches (Mendonça et al., 2024).

In this process, the green industrial policy must guide the expectations of economic actors, signalling that the green sustainable transition is a societal priority, thereby anchoring these expectations. Development banks are the key conduits for the green

sustainable transition financing. These institutions must operate without interference that prioritises profit over sustainability, focusing instead on investments that support a broad restructuring of economic sectors. In this new framework, development banks function by executing the directives of green industrial policy, acting as intermediaries between the market and the state. Beyond their role as financial agents, they serve as intelligence entities closely aligned with the state's mission to drive the green sustainable transition. Adapting Minsky's concept, these institutions can be seen as 'big smart government banks,' playing a crucial role in both financing and strategising for sustainable development (Deos and Mendonça, 2010; Feijó et al., 2024; Feil and Feijó, 2021; Fernández-Arias et al., 2019; Mendonça and Deos, 2017).

These measures demand a deep and coordinated commitment across various governmental and financial levels to ensure that the green sustainable transition is not only efficient but also fair and equitable, minimising economic and social challenges while securing sustainable changes in resource use and green industrial production (Dafermos, 2023). This restructuring goes beyond merely replacing technologies or practices; it represents a profound transformation that will inevitably affect the global distribution of wealth and reallocation of capital. Therefore, effectively manage this transition and mitigate its negative impacts, in addition to the support of public financial institutions, central banks must also coordinate their actions with the green sustainable transition process (Campiglio et al., 2018).

In this new financial structure, strengthening the partnership between development banks and central banks will be essential. Beyond regulatory incentives, development banks will require new forms of financing and larger volumes of resources, free from the constraints of private market logic. The green sustainable transition necessitates a financial system that redirects investments toward cleaner projects, while simultaneously addressing the losses in highly leveraged, carbon-intensive sectors, ensuring that the transition does not jeopardise financial stability (Crocco and Feil, 2020).

It becomes essential for central banks to take a proactive approach by configuring financial markets to promote sustainable practices. The role of central banks has been increasingly integrated into the sustainable finance agenda, with growing recognition of the serious risks that climate change poses to the financial system (Cahen-Fourot et al., 2020, 2021). Central banks have made considerable strides, particularly in regulatory aspects, by aiming to measure, standardise, and incorporate climate risks into financial operations. However, fewer advances have been made in steering financial investments directly toward green sectors (Mendonça et al., 2024).

Given that financial markets are not inherently efficient, and that monetary policy can influence real economic variables in the long term, the adoption of 'green quantitative easing' policies is recommended. These policies would exclude carbon-intensive assets from central bank asset purchase programmes and require financial institutions to present transition plans towards a low-carbon economy to access monetary operations. Additionally, they would include targeted refinancing operations to support green projects and the purchase of green bonds on secondary markets (Oman et al., 2024). Central banks should adopt the role of 'lender of last resort' not only to maintain financial stability but also to support the green sustainable transition (Sokol, 2022). A potential strategy for central banks is to rethink their mission. Like development banks, they must collaborate with the state to ensure the success of the green sustainable transition, acting as an arm of public policy. This redefinition would involve central banks taking on a state-driven mandate, acting as 'Big Monetary Banks' in support of sustainable development (Sokol, 2022).

Minsky argued that free markets do not promote stability, and the inherent instability of the financial system requires an active, interventionist, and efficient government capable of acting swiftly in the face of crises. Given the dynamic nature of capitalism, institutions and regulations must evolve with its stages of development, underscoring the importance of adapting public policies to each country's specific conditions, historical context, and developmental stage (Papadimitriou and Wray, 1997). In this context, the success of development banks in driving growth, and central banks in maintaining financial stability and preventing crises, should be measured by their ability to foster structural transformation toward more complex and sustainable productive systems.

The reordering and disruption required to drive a successful green sustainable transition can be likened to a war effort, albeit with a fundamentally different dynamic. While war traditionally pits nations against one another, the fight against the triple crisis demands a unified global partnership. This challenge transcends national borders and necessitates unprecedented cooperation among countries, sectors, and communities.

5. Final remarks

The climate crisis requires coordinated action to decarbonize all sectors of our economy - including agriculture, energy, manufacturing, mining tourism, transportation, and water, to name a few. The market will not find the required direction nor drive the required transformation on its own.

This article has emphasized the urgency of addressing the climate, social, and environmental crises through green industrial policy. The transition to a sustainable economy requires a coordinated, systemic approach that integrates decarbonization with long-term economic growth and social welfare. Green industrial policies, supported by innovation and public-private partnerships, are critical to driving this transformation.

Central to this transition are State-owned financial institutions, particularly development banks, and central banks, which must play proactive roles in reallocating capital toward greener industries and managing the inherent risks of the green transition. The introduction of innovative financial tools, such as green quantitative easing, and the redefinition of central banks' missions are vital steps in this process.

Ultimately, the success of the green sustainable transition depends on the active role of the State as a long-term planner and facilitator, guiding markets toward sustainability. By aligning macroeconomic policies with environmental objectives, fostering innovation, and ensuring that the transition is inclusive and equitable, State and financial institutions can create a more resilient and sustainable economic system. This effort, akin to a global cooperative mission, must transcend national borders, involving all sectors and stakeholders in the pursuit of a low-carbon, sustainable future for generations to come.

The State, acting as a long-term planner, holds a central role in this process. As a collective project of transformation, this journey toward a sustainable future demands a strong commitment to innovation and a reconfiguration of existing economic and social structures. Instead of operating in a competitive environment, the climate emergency requires a collaborative effort where success is measured by the collective ability to build a sustainable world for future generations.

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