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Economic and Industrial Development Strategies in Pakistan – Environmental Trade-Offs

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ABSTRACT

Rapid industrialization, driven by flagship initiatives such as the China-Pakistan Economic Corridor (CPEC) and the dominance of textile exports, has generated foreign exchange and employment in Pakistan; however, it has also intensified air, water, and carbon externalities. This article employs a mixed-methods desk review, institutional SWOT/EETH analysis, and comparative case studies (Bangladesh and Germany) to examine the trade-offs between growth and ecological integrity. Evidence shows that (i) 8.2 GW of CPEC coal capacity now accounts for roughly two-thirds of corridor power output, (ii) Lahore ended 2024 as the world's most polluted city, and (iii) brick-kiln crack-downs remain episodic despite 209 kiln demolitions in 2024. Structural drivers include fiscal incentives that overlook externalities, chronic underfunding of environmental agencies (≈ approximately 0.003 % of GDP), and fragmented compliance systems. A green industrialization framework is proposed, centered on energy diversification, circular economy incentives, independent Environmental Impact Assessment (EIA) audits, and targeted finance for SMEs.

Key Words: *Ecological Modernisation, Path-Dependent Carbon Lock-In, SWOT/EETH, Institutional Diagnostics, Continuous Emissions Monitoring Systems (CEMS), Carbon Border Adjustment Mechanism (CBAM)*

INTRODUCTION

Manufacturing remains the backbone of Pakistan's economy, contributing just under one-quarter of the national GDP and providing broad employment across both large-scale and small-scale units (State Bank of Pakistan [SBP], 2024). Within that sector, the textile value chain alone accounts for 55–60% of Pakistan's annual merchandise exports, highlighting its significant role in foreign exchange earnings and job creation (Pakistan Textile Council [PTC], 2023; fibre2fashion, 2025).[1] Meanwhile, major infrastructure initiatives—most notably the "early-harvest" energy projects of the China-Pakistan Economic Corridor (CPEC)—have added 17 priority power projects totaling approximately 11 GW, with three-quarters (8.22 GW) being coal-fired, which ties the corridor into a carbon-intensive energy baseline (Dialogue Earth, 2021). These projects were intended to reduce chronic load shedding and enhance logistics connectivity, but their high reliance on coal demonstrates how growth-focused policies can embed long-term ecological costs.

The environmental impact of this growth trajectory is becoming increasingly apparent. On December 22, 2024, Lahore recorded an average Air Quality Index (AQI) of 266, peaking above 500, making it—for that day—the most polluted major city in the world (The News International, 2024).[3] Such levels surpass the World Health Organization's 24-hour PMguideline of 15 µg m³ by more than 30 times (WHO, 2021),

indicating serious public health risks. This incident underscores a broader trade-off: while policies like CPEC provide much-needed power and export-led manufacturing that generate foreign currency, weak environmental protections and carbon-intensive energy sources are pushing urban air, water, and climate indicators beyond safe limits. Addressing this imbalance will require harmonizing industrial incentives with green investments, strengthening independent Environmental Impact Assessments, and integrating real-time emissions monitoring — all of which are discussed in later sections of this study.

This study investigates three questions:

i. How have recent industrial- development strategies altered Pakistan's energy and production mix?
ii. What environmental externalities materialize at sectoral and regional scales?
iii. Which governance, financial, and technological levers could decouple growth from degradation?

LITERATURE REVIEW AND THEORETICAL FRAMING

Environmental Kuznets Curve (EKC) and Ecological Modernization

A key part of environmental economic theory is based on the Environmental Kuznets Curve (EKC) hypothesis, which suggests that environmental degradation initially increases and then decreases as income grows, creating an inverted U-shaped curve. In the early phases of economic growth, industrial expansion often leads to increased pollution; however, once a certain income level is reached, societies tend to prioritize cleaner environments and adopt greener technologies (Grossman & Krueger, 1995).

However, the importance of EKC for South Asia—and Pakistan specifically—is debated. Recent research indicates that for key pollutants like PM (particulate matter), the income level required to start seeing pollution decline is significantly higher than Pakistan's current per capita GDP. For example, Ahmed and Long (2023) find that the turning point for PM levels in South Asian countries is well above USD 10,000 per capita, while Pakistan's GDP per capita in 2024 is less than $1,700. This suggests that relying solely on income growth to mitigate environmental damage is insufficient. Active policy measures, such as emission standards and pollution control investments, are necessary to "bend the curve" sooner.

In parallel, Ecological Modernization Theory (EMT) presents a more optimistic perspective on the relationship between industrial development and ecological health. Unlike the EKC, which assumes environmental degradation is a necessary stage of development, EMT argues that modern industries can become catalysts for environmental innovation—if supported by appropriate regulatory frameworks, market incentives, and knowledge systems (Mol & Sonnenfeld, 2020). In this perspective, industries are not just polluters but also potential agents of technological advancement and green transition. For example, Germany's Energiewende (energy transition) demonstrates how industry can remain competitive while transitioning to renewables.

Thus, while EKC explains past pollution trends, ecological modernization offers a plan for separating growth from environmental damage—a vital goal for Pakistan as it manages industrial expansion under CPEC.

Political Economy Lens

Understanding Pakistan'sindustrial and environmental trajectory also requires a political economy perspective, particularly about state–business relations. The country's political settlement—the informal distribution of power among elites—has long favored export-oriented sectors such as textiles and leather. These sectors benefit from fiscal incentives, weak enforcement of environmental laws, and minimal compliance with pollution control standards (Yousaf, 2024).

Furthermore, the China-Pakistan Economic Corridor (CPEC) has introduced a new layer of strategic rent-sharing, where Chinese investors receive sovereign guarantees, tax holidays, and relaxed environmental

standards in exchange for investments in infrastructure and the power sector. This results in environmental concerns often being overlooked in favor of geopolitical and economic interests (The News, 2024). For example, several CPEC coal power projects—such as Sahiwal and Port Qasim—advanced without comprehensive Environmental Impact Assessments (EIAs), raising concerns among environmental NGOs.

Nevertheless, Pakistan has seen pockets of environmental accountability, mainly through judicial activism. The ban on illegal stone crushers near Thandiani forests, led by the Abbottabad bench of the Peshawar High Court, demonstrates how courts can serve as protectors of environmental justice when regulatory agencies fall short (Dawn, 2024). However, these efforts are isolated and lack a comprehensive enforcement system.

In this context, both structural incentives (rent-sharing and lax regulation) and institutional weaknesses (underfunded Environmental Protection Agencies, or EPAs, and political capture) contribute to the gap between environmental policy and practice in Pakistan.

METHODOLOGY

This study employs a qualitative meta-analysis approach to synthesize various data sources and critically evaluate the environmental trade-offs associated with industrial development in Pakistan. Key datasets include official records such as the Private Power & Infrastructure Board's (PPIB) list of CPEC energy projects (retrieved March 2025), the 2022 annual environmental audit by the Khyber Pakhtunkhwa Environmental Protection Agency (KP EPA), and federal budget allocations for the fiscal year 2025–26. Additional materials, such as media investigations, judicial rulings on compliance violations, and enforcement actions, were also reviewed to understand the real-world implementation dynamics and regulatory challenges. International best practices were sourced from entities such as the LEED-certified Green Industry Registry and Germany's Energiewende documentation, via Agora Energiewende.

To ensure analytical rigor, the study incorporates a SWOT and EETH (Economic, Ecological, Technological, and Human) framework to map institutional capacities and structural gaps. This multidimensional approach enables the evaluation of how industrial policies align with sustainability goals. Additionally, emissions assessments utilize IPCC default values, including an emission factor of 0.82 tonnes of CO_2 per megawatt-hour (MWh) for sub-critical coal-fired plants, which provides a standardized benchmark for comparing environmental impacts across energy projects. This triangulated method allows for a comprehensive examination of Pakistan's development strategy from environmental, economic, and policy perspectives.

Evolution of Industrial Policy

Import Substitution to CPEC: Evolution of Industrial Policy Trajectories

Pakistan's industrial policy has experienced a significant transformation over the past fifty years. After independence, the country adopted an import substitution industrialization (ISI) strategy, emphasizing domestic production to reduceits reliance on imports. This strategy helped establish key industries, such as textiles, cement, and steel. However, by the late 1980s and early 1990s, guided by the International Monetary Fund (IMF), Pakistan began to move toward economic liberalization and privatization, dismantling many state-owned enterprises and removing regulations in industrial sectors to encourage private investment.

This trajectory was further developed under Pakistan Vision 2025, which focused on regional connectivity, energy security, and trade integration, primarily through the China-Pakistan Economic Corridor (CPEC). CPEC now serves as a key part of Pakistan's economic plan, with its energy projects

alone requiring an investment of over US$21 billion. According to official data from the Private Power & Infrastructure Board (PPIB), as of March 13, 2025, CPEC includes 12.95 GW of energy capacity, consisting of 8.22 GW of coal-fired power (divided between 4.26 GW from imported coal and 3.96 GW from domestic Thar coal), 3.43 GW of hydropower, 0.9 GW of solar, and 0.4 GW of wind energy (PPIB, 2025). While this diverse energy mix has helped reduce persistent energy shortages, the heavy dependence on coal has created serious environmental and health externalities, harming long-term sustainability goals.

Sector-Targeted Fiscal Incentives and Environmental Oversight Gaps

To enhance industrial competitiveness and increase exports, the Government of Pakistan has offered extensive sector-specific fiscal incentives, especially for export-driven manufacturing. The most significant of these is the Export Finance Scheme (EFS), which provides concessional credit lines through the State Bank of Pakistan. Historically, the textile sector—which makes up over 60% of Pakistan's export revenue—has received the majority of these funds (The Friday Times, 2023). These incentives have supported industrial growth, job creation, and foreign exchange earnings.

However, a significant flaw in this policy framework is the lack of environmental conditionalities. The absence of mandatory resource efficiency standards, emissions benchmarks, or green financing criteria means that industries are rewarded for volume growth without being held responsible for their ecological impact. For instance, water-intensive textile units continue to benefit from subsidized energy and export credit, despite their documented role in groundwater depletion and chemical effluent discharge, particularly in regions such as Faisalabad and Karachi. This regulatory gap not only encourages unsustainable industrial practices but also disadvantages Pakistan in global markets where eco-compliance is increasingly linked to trade access and preferential tariffs.

To address these systemic gaps, fiscal incentives need to be adjusted to support green industrial transformation. Implementing environmental performance-based disbursements that reward industries investing in clean technologies, water recycling systems, and emissions control equipment can shift the incentive structure from volume-based expansion to sustainability-driven competitiveness.

Sectoral Environmental Footprint

Energy and Climate: Coal Lock-In, Hydrological Volatility, and Grid Inflexibility

One of the most significant environmental trade-offs associated with Pakistan's industrial strategy is its continued dependence on coal-fired power under CPEC, particularly from imported sources. The three major imported coal plants—Sahiwal, Port Qasim, and Hub—operate at a high-capacity factor of 85%, emitting an estimated 28 million tonnes (Mt) of CO_2 equivalent annually. This amount exceeds the total emissions from Pakistan's transport sector, according to the authors' calculations, indicating a troubling pattern of carbon lock-in that conflicts with global decarbonization efforts. Pakistan's absence of a carbon pricing system effectively shifts the environmental and health costs of these emissions outside the country, undermining both the

Although CPEC and subsequent investments have helped diversify Pakistan's energy mix—particularly through run-of-the-river hydropower projects like Karot and Suki Kinari—the system remains susceptible to climate-related hydrological variability. The 2022 monsoon floods, which devastated large parts of the country, disrupted power supply chains and exposed the dual risks of flooding and extended droughts. During low-flow periods, hydropower output drops markedly, risking the potential for stranded generation capacity and increasing dependence on fossil-fueled peaking plants(Khan et al. 2025). Furthermore, integration issues affect renewable energy: the Quaid-e-Azam Solar Park in Bahawalpur

frequently faces grid curtailments due to the absence of smart grid infrastructure and energy storage systems, resulting in underutilized clean energy capacity and economic inefficiencies.

Textile Region Nexus: Water Extraction, Toxic Effluents, and Regulatory Deficits

The textile sector, a key part of Pakistan's export economy, also causes significant environmental harm, especially in Punjab, where most dyeing and finishing clusters are located. Water-intensive processes, such as bleaching and dyeing, use approximately 169 cubic meters of groundwater per ton of finished fabric (Naqvi et al., 2023). This unsustainable water use has already led to aquifer depletion in southern Punjab, resulting in increased competition between agriculture and domestic water needs.

Furthermore, the chemical composition of textile wastewater presents a serious threat to ecosystems and human health. Reactive dyes, frequently used in fabric manufacturing, release azo dyes, sulfates, and heavy metals, which often surpass the National Environmental Quality Standards (NEQS). Recent sampling by the Pakistan Council of Research in Water Resources (PCRWR, 2023) revealed chromium levels in some Faisalabad discharge points exceeding NEQS limits by eight times. This toxic pollutant contaminates both canals and groundwater, with potential long-term carcinogenic effects. Despite this, enforcement remains disorganized, and treatment methods such as Zero Liquid Discharge (ZLD) and closed-loop dyeing systems remain uncommon. Environmental experts now advocate for the mandatory adoption of waterless dyeing technologies and the development of public-private partnerships to co-finance effluent treatment plants, especially for small and medium enterprises (SMEs).

Brick Kilns and Seasonal Smog: Incomplete Conversion and Enforcement Cycles

The brick kiln industry remains an area where environmental costs stay high despite efforts to reform. Punjab's well-publicized 2020–2024 zigzag kiln conversion policy aimed to cut particulate matter (PM) emissions by 60%, mainly by upgrading combustion technology. While the plan is technically solid, efforts to implement it have been inconsistent. Enforcement data shows that between April and August 2024, the Punjab Environmental Protection Agency (EPA) took punitive actions against 945 kilns that did not comply, filed 1,070 FIRs, demolished 209 illegal units, and collected Rs 81.6 million in fines (The News, 2024). However, these actions tend to be seasonal—spiking during winter smog episodes and decreasing afterward—leading to temporary pollution displacement rather than permanent reduction.

The broader issue is that structural incentives for kiln owners to upgrade remain weak. Many continue to burn toxic fuels, such as used rubber, plastic, and low-grade coal, which emit carcinogens and ultrafine particulate matter. Without access to low-interest green financing and in the absence of a regulatory compliance culture, many operators prefer paying fines over upgrading infrastructure, undermining long-term air quality goals.

Other High-Impact Sectors: Overlooked Emitters and Regulatory Blind Spots

Beyond the headline sectors, several other industries contribute significantly to Pakistan's environmental burden, yet remain under-regulated or outside emerging mitigation frameworks.

Cement and steel: These two sectors together account for about 9% of Pakistan's total CO_2 emissions. However, they are not yet included in Pakistan's emerging voluntary carbon credit trading systems. This oversight misses an opportunity to incorporate carbon costs and attract global climate finance, particularly through mechanisms such as Article 6 of the Paris Agreement.

Marble mining in Buner: This localized but significant activity causes aerosolized particulate pollution, water contamination, and reduced agricultural productivity due to dust settling on farmland. The Deputy Commissioner of Buner has suggested measures, including mechanical cutting, repurposing waste blocks,

and installing dust capture systems. However, progress has been slow due to limited administrative capacity and a lack of resources.

Transport Sector: Pakistan still depends on Euro II fuels—a standard phased out in many parts of the world—and uses aging, poorly maintained vehicle fleets that emit high levels of nitrogen oxides (NO_x) and PM2.5 particles. The establishment of a "Smog War Room" in Lahore in 2024 indicates an increasing political focus, but it remains a reactive approach. Without robust vehicle inspection systems, stringent clean fuel standards, and substantial investment in public transportation, air quality is unlikely to improve sustainably.

Governance and Compliance Gaps

Legal Architecture

The Pakistan Environmental Protection Act (1997) mandates EIAs for Category A projects and grants authority to tribunals. Provincial laws enacted after the 18th Amendment are supposed to reflect these powers, but only the Punjab tribunal is fully functioning; the backlog in other regions exceeds 1,700 cases (KP-EPA, 2022).

Institutional Capacity

Budgetary constraints. Federal PSDP allocates Rs 2.78 billion (≈ USD 10 million) to the Ministry of Climate Change for FY 2025/26—roughly 0.003 % of GDP, significantly less compared to defense (1.97 % of GDP). geo.tv

Staff shortages. KP EPA's expansion into tribal districts stalled after only Rs 10 million (8% of the forecast) was released in FY23. tnn.com.pk

Monitoring deficits. An audit found that PakEPA failed to classify industrial units by emission categories, which hampered the creation of a database for Islamabad's 270 industries. The post-approval project monitoring at thenews.com.pk is similarly absent. minutemirror.com.pk

Judicial Interventions

In June 2025, the Peshawar High Court ordered KP-EPA to shut down unapproved stone crushers, citing the constitutional right to a clean environment. dawn.com While beneficial, court-led enforcement remains inconsistent.

Comparative International Experiences

Bangladesh's Green Garment Leap

Bangladesh has become a global leader in sustainable textile manufacturing, with 217 garments and ready-made garment (RMG) factories now certified under the LEED (Leadership in Energy and Environmental Design) framework, including 83 facilities rated at the highest "Platinum" level (BGMEA, 2024). This shift has been driven by a strategic mix of market incentives and climate-friendly financing. International apparel buyers such as H&M, Uniqlo, and Marks & Spencer have increasingly required compliance with environmental and social standards, offering price premiums and long-term contracts to certified suppliers (IFC, 2023). Additionally, the International Finance Corporation (IFC) and other financial institutions have provided concessional loans, technical support, and performance-based grants under the Green Buildings program, allowing factory owners to upgrade or build eco-efficient infrastructure without excessive upfront costs(Jan et al.2025).

Importantly, Bangladesh's regulatory and industry groups have supported this green initiative through policy alignment and industry cooperation. The Bangladesh Garment Manufacturers and Exporters Association (BGMEA) has promoted green branding and expedited the approval process for green factories. Additionally, the country's focus on energy efficiency, water reuse systems, and solar integration within industrial parks demonstrates how environmentally conscious upgrades can complement export growth. This approach highlights that environmental improvements, when combined with access to finance and buyer pressure, can enhance international competitiveness rather than hinder it.

Germany's Energiewende

Germany's flagship energy transition, Energiewende, has made significant progress in reducing carbon emissions from the power sector. In 2023, the country's total CO_2 emissions reached a 70-year low of 673 million tonnes, primarily due to the rapid growth of renewable energy, which now accounts for 56% of electricity generation. At the same time, the share of coal-fired power plants declined to just 26%, down from over 40% a decade ago (Guardian, 2024; AP News, 2024). Wind and solar, supported by feed-in tariffs and grid integration methods, have become key technologies, while the shutdown of nuclear and coal plants continues according to strict schedules.

However, Germany's progress also shows the complex trade-offs involved in industrial decarbonization. High electricity prices—partly caused by surcharges, transmission costs, and carbon levies—have raised concerns among energy-heavy industries, such as chemicals and steel, about losing competitiveness in global markets. In response, the government has suggested transitional support measures, including electricity tariff rebates for electro-intensive companies and strategic subsidies for green hydrogen. These efforts highlight the broader reality that even in developed economies, clean energy transitions require carefully planned market reforms to prevent deindustrialization.

Germany's experience demonstrates that ambitious climate goals must be balanced with robust social and economic safety nets, particularly for manufacturers subject to global price competition. It also highlights the importance of grid flexibility, innovative storage solutions, and demand-side management as renewable energy sources near a majority share.

SWOT / EETH Diagnostic

Dimension	Strengths	Weaknesses	Opportunities	Threats
Economic	Export scale in textiles; CPEC logistics	Energy tariffs are volatile; carbon border adjustment is looming	Green- product premiums; climate finance	Loss of EU GSP+ without compliance
Ecological	Vast solar & hydropower potential	Air & water pollution hotspots; coal lock-in	Nature-based solutions; carbon markets	Accelerated climate hazards (floods)
Technological	Growing solar manufacturing base	Limited wastewater ZLD, poor CEMS coverage	Digital MRV platforms; water- less dyeing	Technology obsolescence, stranded assets
Human / Governance	Active judiciary; rising civil- society scrutiny	Under-resourced EPAs, data opacity	Youth climate activism; ESG investor pressure	Institutional capture; enforcement

Dimension	Strengths	Weaknesses	Opportunities	Threats
				fatigue

DISCUSSION: DECOUPLING GROWTH FROM EMISSIONS

Currently, Pakistan's development path shows economic growth increasing alongside high pollution levels. Projects like CPEC have helped expand industries and increase electricity generation, but they have also contributed to rising carbon emissions. This trend presents serious risks to the environment and public health. For example, Lahore's deadly winter smog continues to cause significant health issues. At the same time, export industries—especially the textile sector—now face challenges under the EU's Carbon Border Adjustment Mechanism (CBAM), which could tax Pakistani goods based on their carbon emissions.

Some experts believe that as Pakistan becomes wealthier, pollution will decrease naturally—a concept known as the Environmental Kuznets Curve (EKC). However, in countries like Pakistan, where environmental laws are weak and enforcement is limited, this theory does not apply well. Merely waiting for income levels to increase will not resolve pollution issues quickly enough, especially as climate change worsens floods, droughts, and air quality.

To decouple growth from emissions, Pakistan needs to adopt more innovative and environmentally friendly strategies. Four key steps are necessary:

Firm and Fair Regulations: Environmental laws must be adequately enforced. All major projects should undergo independent Environmental Impact Assessments (EIAs), and their results should be made public to build trust and ensure accountability.

Use of Market Tools: Pakistan has implemented a small carbon tax (Rs 2.5 per liter) in the 2025–26 budget, but it is too low to create a substantial change. A stronger and gradually increasing carbon price can motivate industries to adopt cleaner technologies. The revenue collected can support green projects and assist low-income groups during the transition.

Support for Small Industries: Many small businesses lack the financial resources or expertise to transition to cleaner processes. The government should offer low-interest loans, credit guarantees, and subsidies for technologies like Zero Liquid Discharge (ZLD) water treatment plants and solar energy systems.

Better Data and Monitoring: Currently, it is not easy to track who is polluting and by how much. The government should establish real-time pollution tracking systems that utilize both ground sensors and satellites, enabling individuals to pinpoint which factories or areas are causing environmental harm. This kind of transparency has helped countries like China and South Korea improve their pollution management.

There are good examples Pakistan can learn from. Bangladesh's textile sector has become more competitive globally by making over 200 factories LEED-certified, demonstrating to buyers that they adhere to green practices. Similarly, Germany supports its industries during the energy transition by offering rebates to high-energy users that comply with climate rules, demonstrating that clean growth is possible with the right policies.

In short, Pakistan can develop economically without damaging its environment. However, it must move away from business-as-usual thinking. Clean industrial growth is achievable when laws are enforced,

technology is supported, and pollution is taken seriously. Without this shift, Pakistan risks harming its environment, public health, and long-term economic prospects.

POLICY RECOMMENDATIONS

Make CPEC Projects Cleaner

Cancel the planned coal power plant in Gwadar and instead build solar and battery systems.
Accelerate work on the Azad Pattan hydropower project, which can help reduce pollution from coal.

Better Pollution Checks

Utilize independent experts to review major projects and ensure that regulations are adhered to.
All factories should have real-time pollution monitors that report data to government websites.

Recycle Waste in Industries

Offer tax benefits to industries that utilize waste heat or convert waste into energy.
Try waste-sharing projects—for example, use textile waste in cement factories in Faisalabad.

Support Small Businesses

Help small factories get low-interest loans (at 6% interest) to switch to cleaner technologies like:
Zig-zag brick kilns
Water recycling plants (ZLD systems)

Make the Government Stronger

Spend more money on pollution control—at least 0.1% of GDP by 2028.
Hire more staff in the Khyber Pakhtunkhwa Environment Department and create mobile courts to handle pollution cases quickly.

Share Pollution Data and Involve the Public

Create a public "Smog Dashboard" displaying air quality data from sensors, satellites, and government reports. Incorporate environmental education into schools so students can help monitor air, water, and noise pollution in their communities.

CONCLUSION

Pakistan's industrial future hinges on striking a balance between growth objectives and environmental constraints. CPEC's coal increase, textile water use, and kiln emissions illustrate unsustainable paths, but international examples show workable alternatives. By integrating green requirements into industrial financing, investing in monitoring systems, and utilizing global supply chain incentives, Pakistan can transition from a pollution-intensive growth model to a green industrialization approach that prioritizes public health, maintains export markets, and enhances climate resilience.

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