



中國傳媒大學
COMMUNICATION UNIVERSITY OF CHINA



Institute for a Community
with Shared Future
人類命運共同體研究院



GREEN CPEC 2.0

Powering Pakistan's Industrial & Energy Resilience

Through Advanced Clean Technology & Bilateral Innovation



By Mr. Imran Bhatti, Member Board of Experts,
Pakistan Research Center for a Community with Shared
Future (PRCCSF), Islamabad

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Executive Summary

The China-Pakistan Economic Corridor (CPEC) has undergone a fundamental transformation. What began as a \$62 billion infrastructure commitment — roads, ports, and coal-fired power plants — is evolving into something far more consequential: a platform for clean energy technology transfer, green industrial policy, and bilateral climate finance. This is Green CPEC 2.0.

This paper argues that Pakistan stands at an inflection point. The choices made in the next 24 to 36 months regarding energy storage infrastructure, electric vehicle ecosystems, and advanced battery supply chains will determine whether Pakistan becomes an industrial power capable of competing in the 21st-century green economy — or remains a captive importer of technologies it lacks the capacity to manufacture or maintain.

The strategic opportunity is real and time-sensitive.

China has achieved global dominance in battery technology, solar manufacturing, and electric mobility. Green CPEC 2.0 offers a credible pathway for technology transfer, joint manufacturing, and industrial co-investment that could redefine Pakistan's economic trajectory.



<p>\$62B+ Original CPEC Investment</p>	<p>36% Pakistan Energy Access Gap</p>	<p>2030 Green CPEC Target Horizon</p>	<p>85% China Global Battery Market Share</p>
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1. The Hook: Why the Old Model Is Broken

Pakistan's energy crisis is not a secret. With circular debt exceeding PKR 2.5 trillion, electricity theft rates above 20% in several distribution zones, and load-shedding that costs manufacturers billions annually in lost output, the conventional model of centralised, fossil-fuel dependent power has reached its structural ceiling. CPEC 1.0, for all its ambition, was partly responsible for deepening this crisis. Agreements that locked Pakistan into capacity payments for idle thermal plants now cost the national exchequer over \$1.5 billion per year in obligations that produce no electricity.



This is the paradox Pakistan must escape: a country rich in solar irradiance, wind corridors, and hydropower potential, yet chronically energy-deficient and industrially stunted. The transition to Green CPEC 2.0 is not a luxury or an ideological preference for clean energy. It is a structural economic necessity.

"Pakistan cannot afford another decade of paying for capacity that does not generate electricity. Green CPEC 2.0 is not an environmental agenda — it is a fiscal survival strategy."

The global energy transition is also altering the geopolitical calculus. As the European Union implements carbon border adjustments from 2026, Pakistani exports — textiles, leather goods, agricultural produce — face a competitive tax unless their production footprint is demonstrably cleaner. Green CPEC 2.0 thus becomes a trade competitiveness issue, not merely a development finance conversation.

2. The Strategic Architecture of Green CPEC 2.0

2.1 From Megawatts to Molecular Manufacturing

The first iteration of CPEC built capacity. Green CPEC 2.0 must build capability. This distinction is critical. Building a coal plant requires procurement, construction, and an operating contract. Building a battery gigafactory or solar cell manufacturing cluster requires IP licensing, workforce development, supply chain localisation, and regulatory alignment. The former creates jobs for five years. The latter creates an industrial sector for five decades.

China's BYD, CATL, and Ganfeng Lithium are not simply battery manufacturers — they are the custodians of the most strategically important industrial knowledge of the 21st century. Green CPEC 2.0 creates a formal bilateral framework through which Pakistan can negotiate not just product imports, but knowledge partnerships, joint ventures, and long-term technology licensing arrangements.

2.2 The Battery Imperative

Advanced battery technology sits at the intersection of every major clean energy objective: renewable integration, electric mobility, grid stability, and distributed energy access. Pakistan's renewable energy targets — 60% of electricity from clean sources by 2030 — are technically unachievable without significant battery storage deployment. Without storage, solar and wind remain intermittent contributors to an unstable grid, not foundational pillars of a reliable energy system.



The market opportunity is substantial. Pakistan's electric vehicle market is nascent but accelerating, with two- and three-wheeler EV adoption growing at over 40% annually. The off-grid energy storage market, particularly in rural Sindh and Balochistan, represents demand for hundreds of megawatt-hours of battery capacity. Industrial UPS systems, telecommunication towers, and data centre backup power collectively represent a multi-billion rupee market currently served almost entirely by imported lead-acid batteries — a technology that is both environmentally hazardous and economically inefficient.

Substituting this with locally manufactured or assembled lithium-iron phosphate (LFP) batteries under a Green CPEC 2.0 technology partnership would simultaneously address trade imbalance, create skilled employment, and provide a platform for Pakistan's integration into global clean energy supply chains.

Technology Pillar	Strategic Rationale & Impact
LFP Battery Manufacturing	Localises the highest-value component of the clean energy ecosystem; reduces import dependency; creates 15,000–25,000 skilled jobs per GWh of installed capacity
Solar Cell & Module Assembly	Leverages Pakistan's solar irradiance advantage; reduces panel costs 30–40% vs imports; aligns with EU carbon border adjustment readiness
EV Powertrain Co-development	Positions Pakistan as a regional EV assembly hub for South & Central Asia; anchors Chinese OEM investment in Pakistan's industrial zones
Grid-Scale BESS Deployment	Enables 60%+ renewable penetration; eliminates need for new peaking gas capacity; reduces circular debt accumulation from idle thermal plants
Green Hydrogen Pilot Projects	Long-term export opportunity to Gulf states and Europe; leverages cheap renewable electricity; positions Pakistan in the hydrogen economy

3. Bilateral Tech Cooperation: The China Factor

3.1 Why China Is the Indispensable Partner

The global clean energy technology landscape is not evenly distributed. China manufactures approximately 85% of the world's solar panels, controls over 70% of global lithium-ion battery production capacity, and dominates the supply chains for rare earth elements critical to wind turbines and EV motors. This is not a transitional market position — it reflects a decade of

deliberate industrial policy, state-directed R&D investment, and supply chain vertical integration that Western economies are only now beginning to replicate.

For Pakistan, the strategic implication is clear: the fastest, most cost-effective path to clean energy industrialisation runs through Beijing. This is not an ideological statement — it is a market reality. The question is not whether to engage China on clean technology transfer, but how to structure that engagement to maximise Pakistan's industrial benefit rather than simply accelerating import dependency in a new technology category.



3.2 Structuring Equitable Technology Transfer

The failures of earlier industrial cooperation agreements offer instructive lessons. Partnerships that prioritised speed of deployment over depth of local capability consistently left Pakistan as an assembler of foreign components rather than a manufacturer of integrated systems. Green CPEC 2.0 must be architecturally different.

Effective bilateral technology cooperation under Green CPEC 2.0 requires four structural elements:

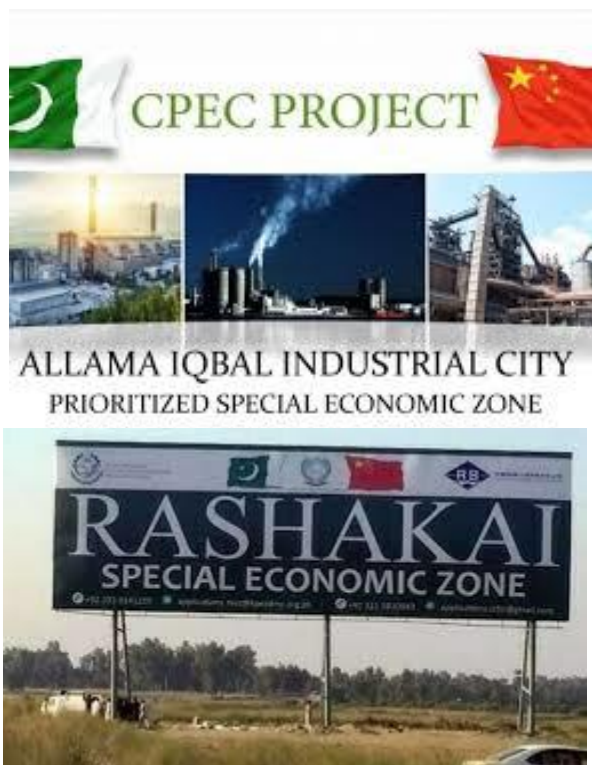
- **Joint Venture Requirements with Mandatory Local Equity:** Chinese clean tech firms operating in Special Economic Zones (SEZs) should be required to establish joint ventures with Pakistani industrial partners holding minimum 30% equity stakes, ensuring wealth accumulation occurs domestically.
- **Progressive Localisation Mandates:** Technology transfer agreements should include binding localisation schedules — beginning with final assembly, progressing to component manufacturing, and ultimately achieving local R&D capability within defined timelines, modelled on South Korea's successful technology absorption frameworks of the 1970s–1990s.
- **Workforce Development Co-investment:** Every major Green CPEC 2.0 project should include co-funded vocational and tertiary training programmes, linking Pakistani technical universities directly with Chinese manufacturing partners for knowledge transfer that outlasts any individual investment cycle.
- **Intellectual Property Licensing Frameworks:** Pakistan must negotiate favourable IP licensing terms for technologies deployed under Green CPEC 2.0, enabling local firms to

innovate on top of transferred technology platforms rather than remaining permanently dependent on continued Chinese licensing arrangements.

3.3 The Special Economic Zone Opportunity

Pakistan's SEZs — particularly those at Rashakai, Allama Iqbal Industrial City (Faisalabad), and Dhabeji — provide ready infrastructure for clean technology manufacturing clusters. Locating battery assembly, solar module production, and EV component manufacturing in these zones creates agglomeration effects: shared logistics infrastructure, co-located supplier ecosystems, and proximity to Pakistan's largest industrial consumer markets.

Chinese anchor investors in clean tech SEZs can catalyse broader industrial ecosystems. When CATL or BYD establishes a manufacturing presence, it invariably attracts its Tier-1 and Tier-2 suppliers — electrolyte producers, separator manufacturers, battery management system developers — creating a supply chain cluster that generates far more economic activity than any single anchor investment.



"The SEZ model works only when Pakistan negotiates depth, not just presence. A battery factory without a supplier ecosystem is a dependency trap wearing the mask of industrialisation."

4. Climate Finance: Unlocking the Green Premium

Green CPEC 2.0 opens access to a fundamentally different category of capital. Traditional CPEC financing was predominantly government-to-government concessional lending for infrastructure. Green CPEC 2.0 projects — battery storage, renewable generation, energy efficiency — are eligible for multilateral climate finance instruments, green bonds, carbon credit mechanisms, and blended finance structures that can dramatically reduce the cost of capital.



Pakistan's ratified NDC commitments under the Paris Agreement provide a credible policy signal to international climate investors. The country's Climate Change Authority and the State Bank of Pakistan's Green Banking framework create regulatory scaffolding for green finance products. What remains underdeveloped is the pipeline of bankable projects that can absorb this capital at scale.

Green CPEC 2.0 projects represent exactly this pipeline. A grid-scale battery storage facility in Sindh can be structured to attract a blended capital stack: concessional lending from the Asian Development Bank's Clean Energy Financing Partnership, equity from a Chinese technology partner, and a carbon credit revenue stream from avoided emissions — with the combination bringing the effective cost of capital below 6%, a threshold at which the project becomes commercially viable without sovereign guarantees.

4.1 Carbon Credit Architecture

Pakistan is an underutilised participant in voluntary carbon markets. Its renewable energy projects, reforestation programmes, and cookstove distribution initiatives generate legitimate Verified Carbon Units (VCUs) that remain largely uncertified and therefore uncapped. Green CPEC 2.0 energy projects, if properly structured under Gold Standard or Verra certification frameworks, could generate hundreds of thousands of carbon credits annually — providing recurring dollar-denominated revenue streams that partially service project debt.

More strategically, Pakistan's engagement in Article 6 mechanisms under the Paris Agreement — bilateral carbon trading with purchasing countries — could see Green CPEC 2.0 battery and renewable projects generating credits that China, Japan, or European buyers acquire to meet their own nationally determined contributions. This transforms Pakistan from a passive recipient of climate finance into an active participant in the global carbon economy.

5. Industrial Resilience: Beyond the Energy Sector

5.1 Decarbonising Pakistan's Export Industries

Pakistan's textile sector — responsible for over 60% of the country's export earnings — faces an existential threat from the EU's Carbon Border Adjustment Mechanism (CBAM) and increasing ESG scrutiny from major Western buyers. Factories running on captive diesel generation or grid electricity from coal-fired plants face a measurable carbon disadvantage versus competitors in countries with cleaner grids or greater access to renewable industrial power.

Green CPEC 2.0 industrial energy solutions — rooftop solar, battery-backed microgrids, and green hydrogen for high-temperature industrial processes — directly address this competitive vulnerability. A textile cluster in Faisalabad or Karachi that can credibly document its renewable energy consumption rate becomes a preferred sourcing destination for Patagonia, H&M, or Marks & Spencer as those brands pursue science-based emissions targets. The commercial premium for provably green manufacturing is growing — and Pakistan's manufacturers risk ceding market share if they cannot demonstrate credible decarbonisation pathways.

5.2 The Digital Energy Stack

Modern energy systems are inseparable from digital infrastructure. Battery management systems, smart grid controls, demand response platforms, and energy trading algorithms are as critical to a functioning clean energy economy as the physical hardware. Green CPEC 2.0 must include explicit provisions for digital technology transfer — not just physical plant.

Pakistan's growing technology sector, centred in Lahore, Karachi, and Islamabad, provides a genuine foundation for digital energy innovation. Collaboration between Pakistani software talent and Chinese hardware expertise — in battery management systems, predictive grid analytics, and EV fleet management platforms — could produce export-competitive products for South Asian and Central Asian markets. This is the highest-value potential of Green CPEC 2.0: not just manufacturing commoditised hardware, but co-developing intelligent energy systems with regional export potential.



6. Risks, Mitigations, and Policy Prerequisites

No strategic opportunity exists without commensurate risk, and intellectual honesty demands a clear-eyed assessment of the constraints facing Green CPEC 2.0.

Risk Factor	Mitigation Strategy
Debt Sustainability	Structure Green CPEC 2.0 financing through grant-eligible multilateral climate instruments and revenue-sharing JVs rather than sovereign-guaranteed loans; maintain IMF programme discipline

Technology Lock-in	Negotiate open-architecture technology standards; avoid proprietary battery chemistries or grid software that create permanent vendor dependency
Governance & Corruption	Establish an independent Green CPEC 2.0 Authority with transparent procurement processes, international audit rights, and public project dashboards
Political Discontinuity	Anchor Green CPEC 2.0 commitments in parliamentary legislation and long-term bilateral frameworks that transcend electoral cycles
Geopolitical Signalling	Communicate Green CPEC 2.0 as a climate and industrial agenda, not a geopolitical alignment; actively engage Western multilaterals, Gulf sovereign funds, and EU climate finance in project co-financing
Skills Gap	Launch a dedicated Green Technology Workforce Development Programme, integrating Chinese partners, Pakistani universities, and TVET institutions in a coordinated national skills strategy

7. A Forward-Looking Conclusion: The Decade Pakistan Cannot Afford to Waste

The global energy transition is not waiting for Pakistan to be ready. Every year of delay in building domestic clean technology manufacturing capacity is a year of growing import dependency, a year of foregone industrial employment, and a year of compounding carbon disadvantage in export markets. The window for Pakistan to position itself as a clean energy industrial power — rather than a clean energy import market — is open but will not remain so indefinitely.

Green CPEC 2.0 is the most credible available framework for accelerating this transition. It combines established bilateral trust, existing SEZ infrastructure, a Chinese partner with unmatched clean technology capabilities, and a growing global appetite for climate finance to support exactly the kind of transformation Pakistan needs. The framework is there. The question is whether Pakistan's policymakers, industrialists, and financial institutions have the strategic clarity and institutional discipline to execute it.

Three imperatives stand above all others:

- Negotiate for capability, not just capacity. Every Green CPEC 2.0 agreement must include binding technology transfer, localisation milestones, and workforce development provisions. Pakistan must not repeat the mistake of importing solutions when it could be building the industrial ecosystem to produce them.
- Stack the capital intelligently. Green CPEC 2.0 projects should be structured to access multiple capital sources simultaneously — Chinese concessional finance, multilateral



climate instruments, carbon revenues, and private equity — reducing sovereign debt exposure while maximising project viability.

- Govern with transparency. The credibility of Green CPEC 2.0 with international partners — climate financiers, technology companies, and bilateral donors — depends entirely on Pakistan's governance track record. An independent oversight architecture, with genuine accountability mechanisms, is not optional; it is the precondition for the framework's success.

Pakistan's energy and industrial challenges are severe. But they are not unique, and they are not insurmountable. South Korea, Malaysia, and Vietnam — countries that faced comparable structural constraints at comparable moments in their economic histories — built industrial powerhouses through deliberate technology absorption strategies anchored in strategic bilateral partnerships. Pakistan has the geographic advantage, the demographic potential, and with Green CPEC 2.0, the partnership framework to do the same.

"The age of coal is ending. The age of batteries, solar, and intelligent grids is beginning. Pakistan must choose which side of this transition it occupies — and act now with the urgency that choice demands."

The transformation will not happen by itself. It requires political will at the highest levels of government, industrial ambition from Pakistan's private sector, and technical rigour from the country's engineering and financial institutions. But the strategic logic is compelling, the opportunity is genuine, and the cost of inaction — economic, environmental, and geopolitical — is too high to ignore.

Green CPEC 2.0 is not the future Pakistan hopes for. It is the future Pakistan must build.