RENEWABLES FIRST

Leader of One or Leader of None –

China's choice for clean over coal in Pakistan

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Disclaimer

All the information and analysis provided in this document are accurate and to the best of our knowledge and understanding, in case you identify any error, please email: info@renewablesfirst.org

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Preface

The onset of climate change is fast outpacing even the direst expert predictions. Over the past two decades, what were once considered worst-case scenarios have become business-as-usual realities. The long-standing idea of viewing the world through two separate lenses, one focused on climate change, the other on national and economic interests, does not hold anymore, as climate realities manifest. Addressing this crisis is now a matter of shared security and collective prosperity. It is a race where there are no individual winners; the finish line only matters if everyone, the leaders, and the laggards alike, cross it together.

The energy transition needed to address climate change requires robust supply systems that can deliver affordable, accessible clean energy on a scale. It demands not just technological innovation, but entire ecosystems of manufacturing, financing, and deployment that can serve billions of people across the developing world.

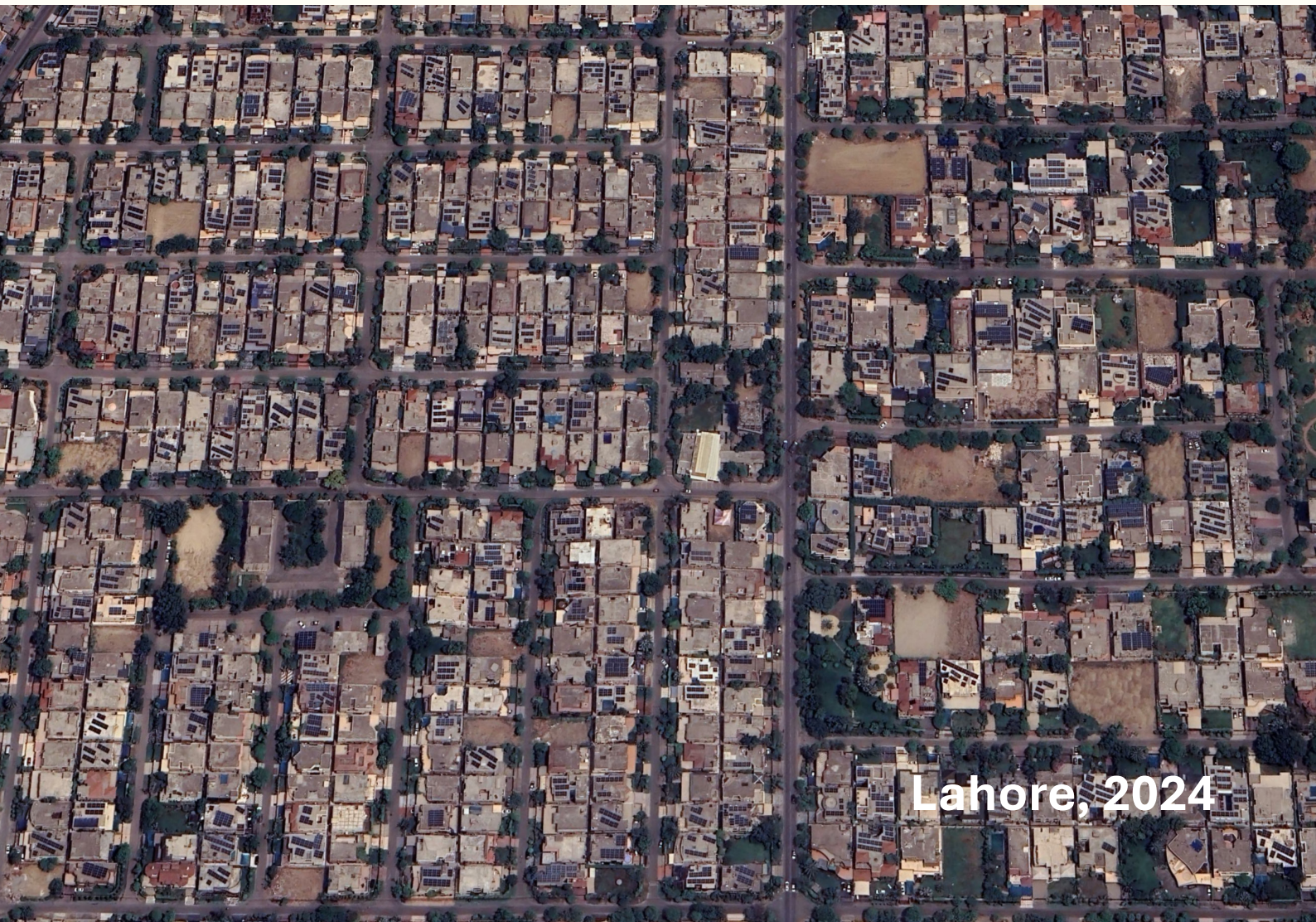
In this race, China is widely expected to be among the frontrunners, and with that comes the opportunity, even the responsibility, to help pull others forward. It has already done so, whether by design or by circumstance, by equipping one of the laggards, namely Pakistan, to leapfrog ahead in its energy transition journey. In doing so, it helped create a, people-led transition model that offers profound lessons for replication across the Global South. This was not a top-down, government-mandated shift, but a market-driven revolution where millions of consumers chose affordable Chinese solar panels over expensive grid electricity, enabling one of the world's fastest energy transitions.

Today, Pakistan stands at the forefront of this race, piercing through traditional notions of transition pathways and rapidly surpassing COP29 tripling pledge, effectively within a single year, through the sheer volume of solar PV capacity imported. Renewables First captured the domestic story behind this phenomenon in its earlier report, The Great Solar Rush in Pakistan, which explored the key internal drivers of this transition.

This brief shifts the focus outward. It looks at the regional factors that shaped this transition model, examining what China and Pakistan collectively did to unlock such rapid change and what lessons might be drawn for other countries in the region. This evolving regional cooperation between the developed and emerging economies may signal a shift toward more inclusive, multi-polar development models aligned with global goals. The China-Pakistan energy transition offers a timely opportunity to strengthen cooperation and trade in a divided world. It aligns state and market interests for both profit and climate action and must be seized for a cleaner, and more cooperative energy future. This brief looks ahead: What should the next phase of China-Pakistan energy cooperation look like to sustain this momentum? Where are the new opportunities, and how can they be shaped around what Pakistan needs most now?

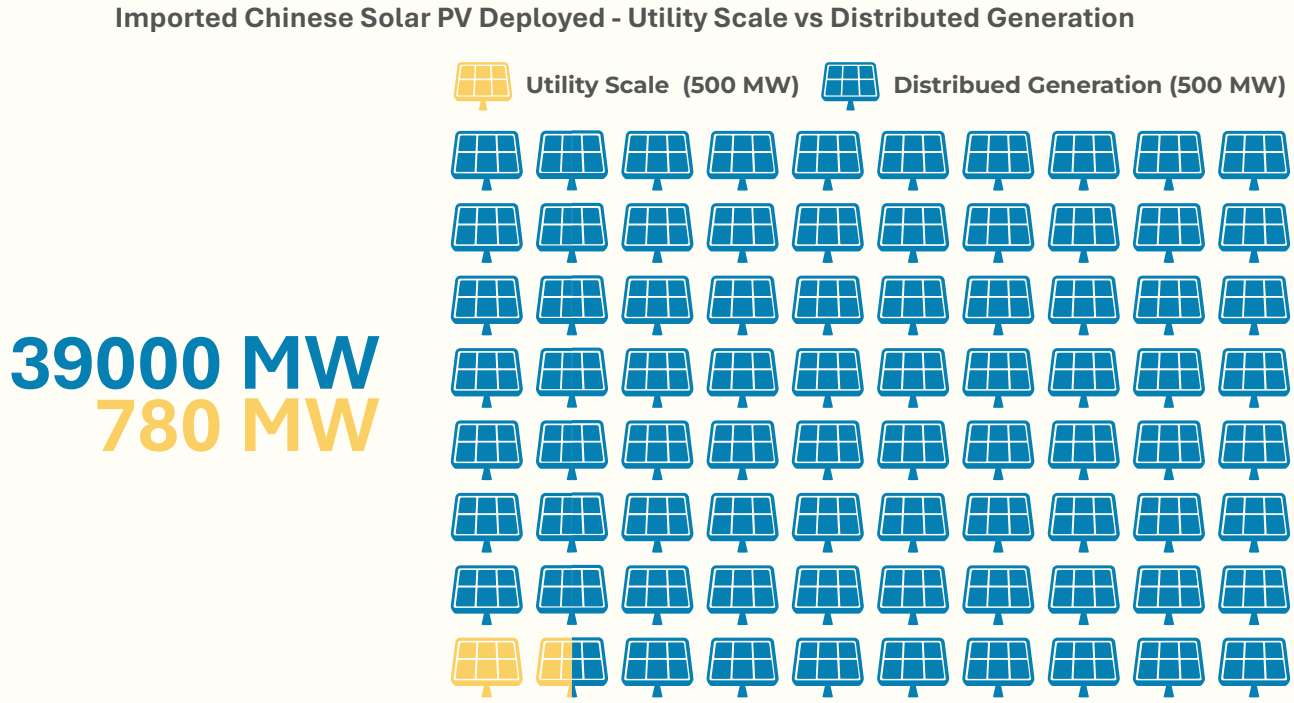
More fundamentally, it examines China's opportunity to assume greater climate leadership by thinking beyond simple import-export relationships to develop comprehensive energy systems that benefit the masses while materializing its commitments to the Global South. This means providing robust mechanisms of support for renewable energy that go far beyond equipment supply to encompass technology transfer, manufacturing ecosystems, innovative financing, and transition pathways that can transform entire economies. In Pakistan, where Chinese solar panels are actively displacing Chinese coal plants, this choice becomes particularly stark and urgent.


Lahore, 2019
Image © 2025 Maxar Technologies


Lahore, 2024

Unbundling the solar rush

Pakistan's people-led solar transition surged to unprecedented heights in fiscal year[1] 2024 with 16 GW of solar PV imports worth USD 2.1 B and continues to accelerate with 12.7 GW imported in just the first three quarters of fiscal year 2025. By March 2025, total imports in the last 5 years reached an impressive 39 GW, more than three-fourths of Pakistan's entire national generation capacity.[1] Despite the massive import volumes, only 780 MW has been installed at the utility scale, as the majority of solar deployment has taken place through distributed generation systems both on and off grid.



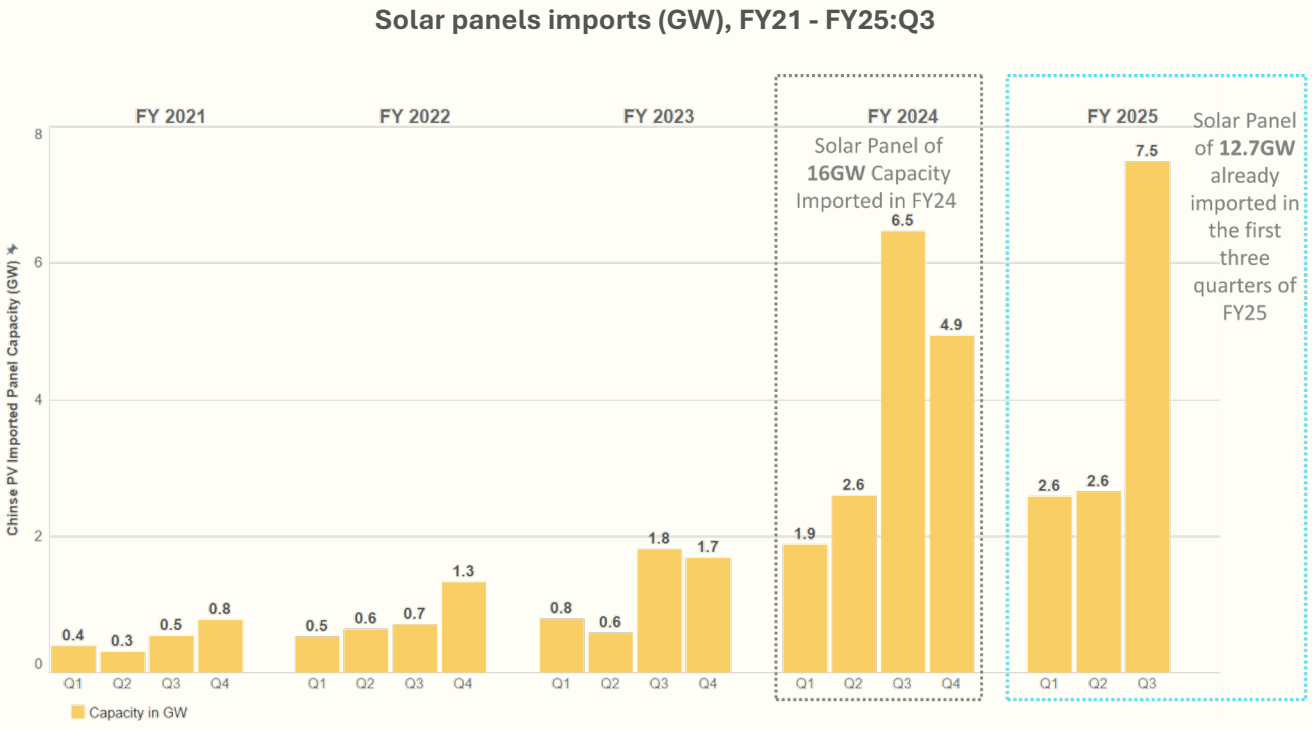


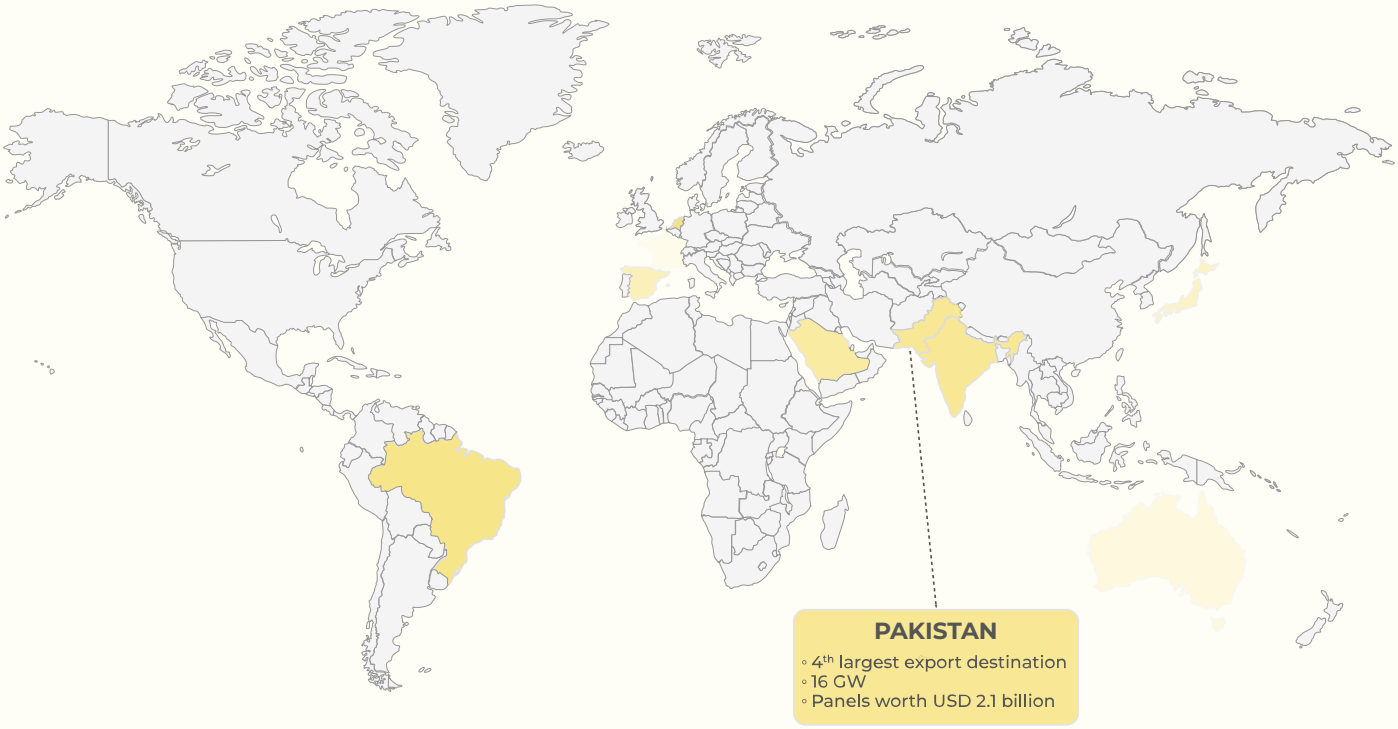
Figure 1: Chinese Solar PV exports to Pakistan by Capacity (GW)

[1] Fiscal year represents 12 months from 1st July, 2025 to 30th June, 2024

The numbers tell a story of perfect market alignment. This surge was driven by two complementary forces: skyrocketing domestic grid electricity costs and plummeting panel prices due to a global solar PV supply glut led by Chinese manufacturers. With grid electricity tariffs surging 155% over three years in Pakistan, households and businesses were driven to seek affordable sources of electricity.[2] Chinese suppliers captured Pakistan's market due to highly competitive pricing, primarily driven by state-led supportive industrial policies, R&D investments, and economies of scale. Domestic solar PV prices in Pakistan halved in fiscal year 2024 alone, creating a domino effect that led to wider proliferation of PV systems across the country.

The solar rush represents more than just a response to high tariffs; it emerges from the synergy between Pakistan's supportive policy environment for Chinese imports and China's commanding position in the global solar market, creating ripe grounds for unprecedented growth. While western economies, including the U.S. and those in the EU, unleashed a series of tariffs against Chinese imports, Pakistan maintained a zero-rated tax regime coupled with a supportive environment for solar and Chinese businesses, leading to high penetration of solar in the country. As a result, Pakistan emerged as a frontrunner among the Global South countries by allowing affordable Chinese PV modules to enter its market, enabling massive deployment of renewables in the country. This shift, fueled by enabling domestic trade policies, Chinese trade dominance, market competitiveness and Pak-China favorable relations, sets Pakistan apart as a unique case study whereby the country ranking 30th in global annual electricity generation, emerged as the 2nd largest destination for Chinese solar panels in the first three months of 2025.[1]

Top 10 destinations for China solar PV exports in FY 2024 (GW)



Netherlands	Brazil	India	Pakistan	Saudi Arabia	Spain	Japan	Australia	France	Greece
41	23	21	16	13	11	7	7	6	5

Figure 2: Chinese Solar PV exports to the world by Capacity (GW)

Pakistan's zero-duty advantage created extraordinary market conditions that set it apart from regional and economic peers. While India and Brazil imposed 20-25% protective tariffs on Chinese solar imports, Pakistan maintained a zero-rated tax regime throughout the period, allowing consumers to access panels at true market prices while others paid premiums. This led to payback periods of solar systems as low as 2 years; lower than similar East Asian economies like Vietnam, Philippines and Indonesia.[3] The importance of this tariff-free policy cannot be overstated. According to the World Bank's "High Tariffs, High Stakes" report, low import duties typically reduce component costs across solar value chains, hence enabling faster scaling of green technologies.[4]

While the government of Pakistan in 2022 announced the withdrawal of exemption from 17% sales tax and 3% additional sales tax on import of solar power equipment in a mini budget, aimed at appeasing the IMF for a new program, the move faced significant backlash in a nascent market, resulting in its reversal within the year. [5] This proposition would've meant a 30% increase in the market price of solar panels; a move that could've effectively strangled the nascent RE market in the country.[6] Duty-free solar imports continued in Pakistan, in one of the most challenging macro-fiscal environments the country had faced. In 2023, Pakistan faced a severe balance of payments crisis, with foreign exchange reserves dwindling to just USD 4.3 B, barely enough to cover one month of the country's

import bill.[7] To stabilize the economy, Pakistan secured a USD 3 B IMF bailout, which came with stringent conditions, including fiscal tightening and revenue-enhancing measures. This is particularly significant given that revenue shortfalls have been a matter of grave concern for the national treasury in recent times, with Pakistan's tax-to-GDP ratio remaining below 10% and the Current Account Deficit standing at USD 0.5 B in fiscal year 2024.[8][9] At the same time, panels worth USD 2.09 B were imported, representing approximately 22% of Pakistan's total foreign exchange reserves at the time. Consumers managed to fund these purchases primarily through their personal savings and private resources.[10]

While net metering remains the only trackable deployment of the solar rush, the real revolution has happened behind the meter and grid deprived areas. The combination of low cost solar systems and lucrative net metering rates that surpass most regional peers, created a multiplier effect to the real revolution, that strengthened the business case for distributed prosumers. In past five years, the number of net-metered systems installed grew exponentially, with cumulative capacity reaching 4.9 GW. During this period, the number of net metering consumers increased from approximately 5,000 to over 293,000, reflecting the success of the policy in driving solar adoption at scale.[11] The current net-metering regime, offering attractive buyback rates, has led to lower payback periods of 2-4 years for grid-connected distributed solar PV installations.[12] Although, the net-metered capacity represents the only statistically visible and less than one-eighth of the total panels imported, the regime allowed for incentivized deployment in domestic and commercial consumer segments, where those that could afford net-metered systems, reduced their reliance on the expensive grid through solar installations.

Country	Regime Type	Average Buy back rate for Distributed Generation (cents/kWh)
Pakistan	Net Metering	9.6 c/kWh
India	Gross Metering	2.3 – 4.6 c/kWh
Vietnam	Feed in Tariff	2.6 c/kWh
Australia	Feed in Tariff	3.3 c/kWh (time varying rate is 2.1 – 8.4 c/kWh)
Philippines	Net Metering	4-5 c/kWh
Indonesia	Net Metering (Abolished)	0 c/kWh

Table: Buyback rates for distributed PV in Pakistan and similar economies [13] [14] [12]

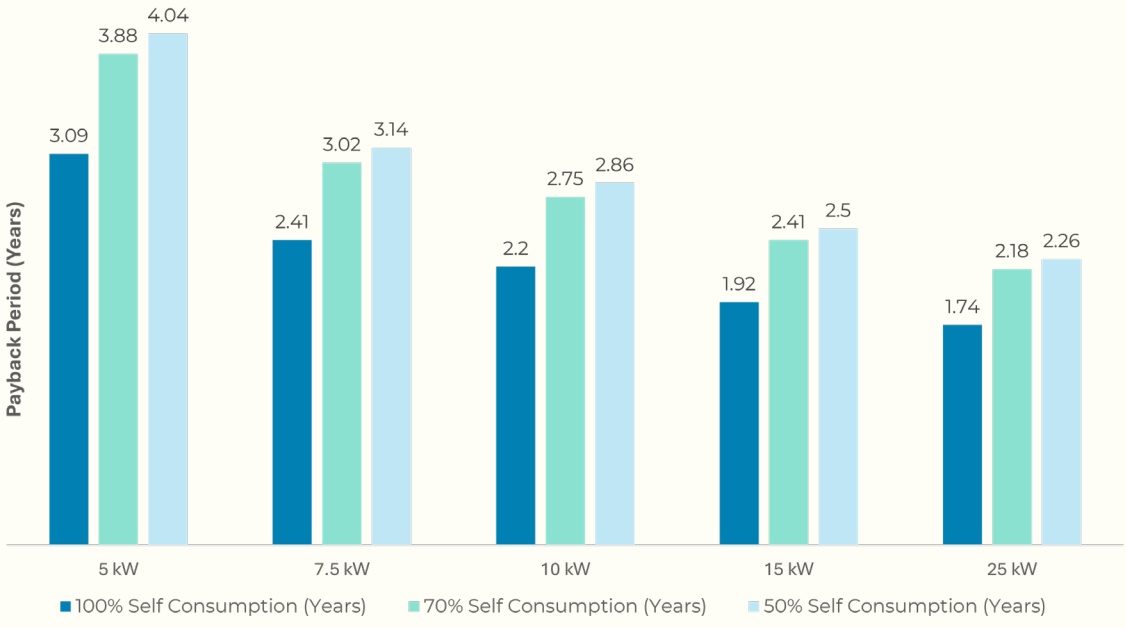


Figure 3: Solar systems payback periods in Pakistan by system size and self consumption [12]

This rapid transition has caught the government off-guard, as the current grid infrastructure and utilities struggle to absorb the quantum of solar. As solar adoption accelerates, ensuring grid stability, fair capacity payments, and tariff sustainability have become increasingly important. Distribution companies have underscored the need to manage infrastructure demands and ensure equitable cost distribution across all consumers. The real struggle remains to increase the demand on the grid, to ensure that the shift in consumers utilization does not negatively affect those that remain on the grid. Electrification of transportation, cooking and heating as well as setting up data and AI Mining centers, all remain potential avenues for increasing demand through the grid, by better management and proactive planning.

Grid enhancement needs amid distributed generation influx

The distribution generation systems account for more than three-fourths of total imported PV capacity, leading to falling demand and technical challenges on the grid. As such, the strengthening of the grid is immediately needed to cope up with incoming solar. This means that the grid needs more investments, innovation, updating power system planning and to adapt with higher renewables integration. Following are some of the key requirements for grid strengthening:

- **Reactive Power Compensation:** Distributed solar generation often leads to low power factor issues, particularly during peak production hours when surplus power is injected back into the grid. To stabilize the power factor, the grid needs reactive power compensation devices at feeder levels. Prosumers can also play a crucial role by upgrading to advanced inverters capable of providing reactive power support, which would reduce stress on the distribution network.
- **Transformer Resilience:** The influx of surplus solar power is overloading distribution transformers, causing overheating and failures. The grid requires investment in technologies like Battery Energy Storage Systems (BESS) at substations to absorb excess energy during peak solar production and release it during demand peaks. This would alleviate transformer stress and mitigate the risk of reverse power flow.
- **Voltage Regulation:** Reverse power flows are now affecting higher voltage levels, including 132kV transformers, causing voltage instability. The grid must adopt voltage regulation devices and upgrade system infrastructure to ensure stable voltage levels across all tiers of the network.
- **Enhanced Power Quality:** The proliferation of substandard inverters for net metering has led to harmonic distortions and degraded power quality. The grid needs stricter quality standards for inverters and increased deployment of smart inverters. Additionally, capacitor banks or other reactive power compensation devices should be installed to address harmonics and enhance overall power quality.
- **Advanced Monitoring and Control:** The grid lacks real-time visibility into the impact of distributed solar integration. To transition from reactive to proactive grid management, advanced monitoring systems such as Supervisory Control and Data Acquisition (SCADA), IoT-enabled sensors, and data analytics platforms must be deployed. These systems would allow grid operators to predict issues, manage distributed generation efficiently, and ensure grid stability.
- **Flexibility Assets:** As Variable Renewable Energy (VRE) grows, grid flexibility must be enhanced. This includes integrating storage, demand-side management, and fast-ramping plants to manage renewable intermittency. Dynamic control mechanisms are needed for real-time adjustments to balance supply and demand.
- **Improved Forecasting Techniques:** Accurate forecasting of wind and solar energy is critical for grid stability. AI and machine learning, like NREL's Second Wind Forecast. Improvement Project (WFIP2) system, improve short-term forecasting. Countries like India and Germany are leveraging AI for better renewable integration and grid optimization.

China's investment strategy in Pakistan: Renewables vs. fossil fuels

China's energy investments across the globe, reflect a shift from coal dominance to renewable energy leadership. Within China, while coal production reached a record high in 2023, the country also added as much solar PV capacity as the entire world did in 2022 and achieved an 18% year-on-year growth in wind energy.[15] [16] Despite the dual approach; maintaining coal for baseline security while aggressively expanding renewables, China has positioned itself as the world's clean energy manufacturing powerhouse, accounting for one-third of global clean energy investments and dominating renewable supply chains with 72% of solar panel and 50% of wind turbine production.[17] Despite coal's continued prominence in its domestic energy mix and legacy overseas investments, China's 2021 pledge to halt new coal investments abroad, coupled with rapid renewable expansion at home, signals a fundamental shift in its global energy strategy.

China's USD 818 B investment in energy transition is reshaping Asia's energy landscape, with Pakistan emerging as a critical test case for this transformation.[18] Chinese Development Finance Institutions (DFIs) have deployed an estimated USD 209 B in energy sector financing through 367 loans globally, with Asia capturing 31% (USD 65 B) of this capital, resulting in 55 GW of installed capacity; nearly half of the 113 GW financed globally by China.[19] [20] Within this Asian portfolio, Pakistan ranks seventh among top recipients of Chinese energy financing, making it a strategic market for China's evolving energy diplomacy.[21]

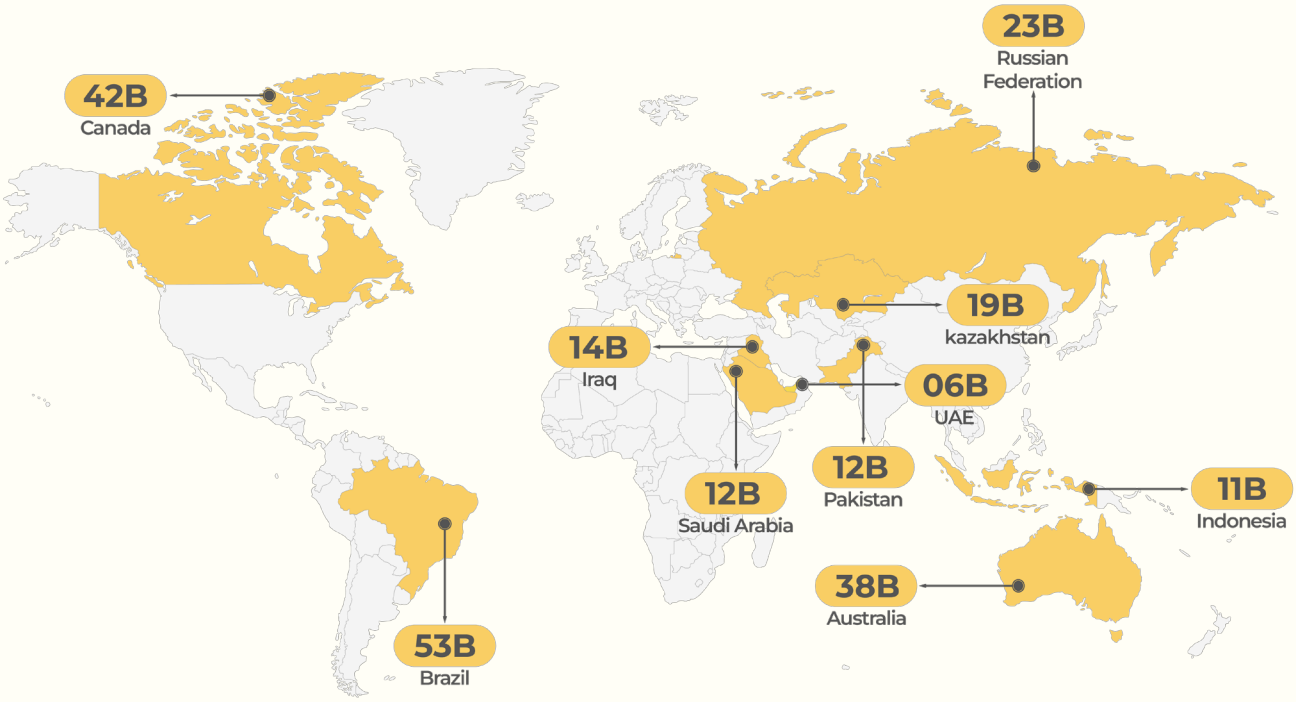


Figure 4: Energy sector financing and investment by China in the world - USD B

Despite China's global renewable leadership, its investment footprint in Pakistan remains paradoxically concentrated in Coal-Fired Power Projects (CFPPs), creating a collision between old investments and new market realities. China's USD 13.7 B investment portfolio commands 28% of Pakistan's installed power capacity, with a staggering 89% concentrated in coal-based generation[2]. This coal-heavy portfolio stands in stark contrast to China's renewable energy leadership globally. Most notably, despite China's dominance in global renewable deployment, no new Chinese-financed utility-scale renewable energy projects have materialized in Pakistan over the past four years, even as the country experiences an unprecedented solar revolution driven by Chinese panels.

[2] Renewables First assessment as of March, 2025

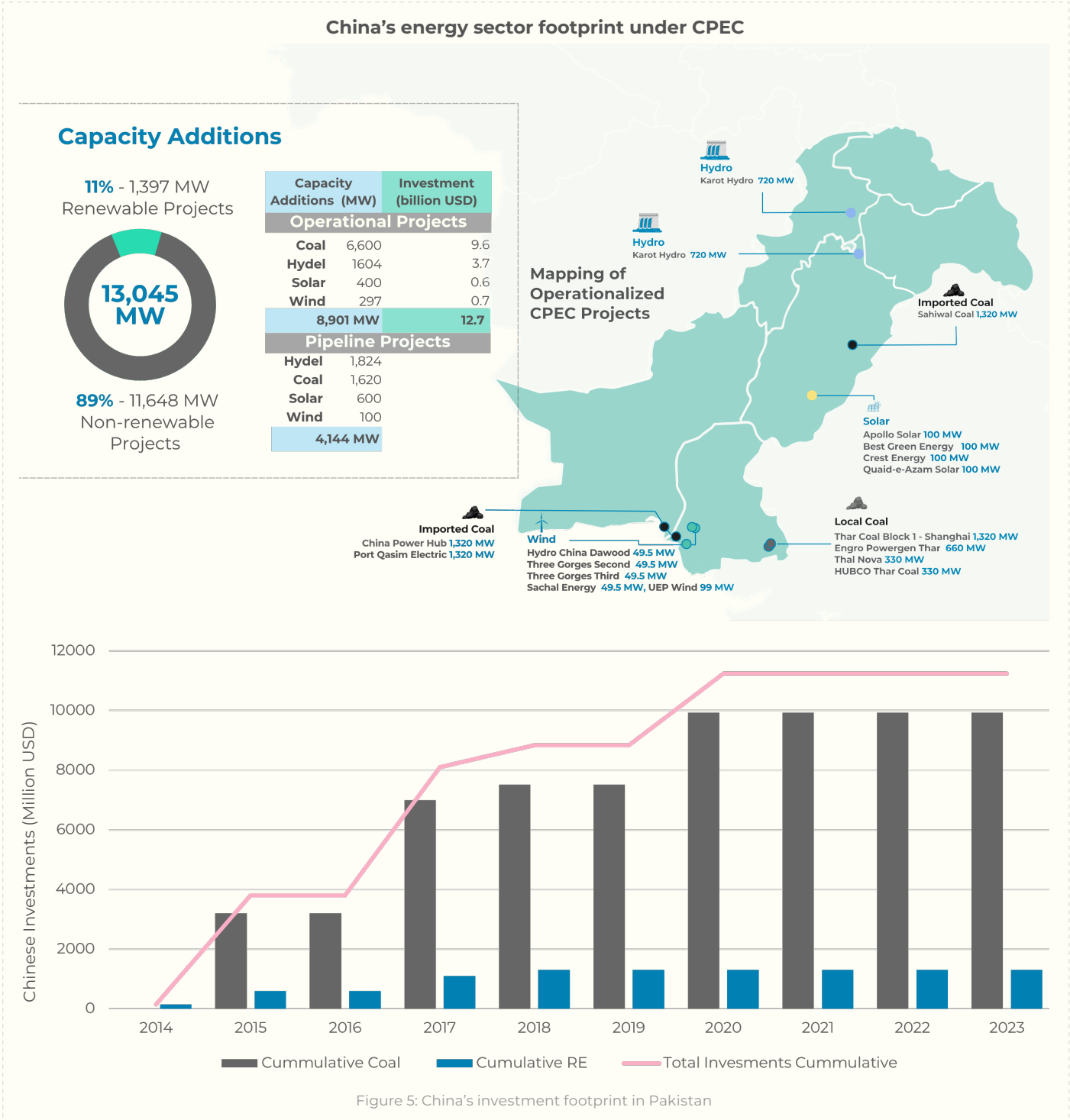


Figure 5: China's investment footprint in Pakistan

The influx of low-cost Chinese solar panels is now cannibalizing demand from the very coal plants China financed, creating a vicious cycle of stranded assets. Of the 39 GW of solar panels imported over the past five years, only 4.9 GW has been connected to the grid through net metering, with the vast majority deployed in off-grid applications across residential, commercial, industrial, and agricultural sectors. This massive off-grid adoption, along with increasing electricity tariffs, has triggered a historic decline in grid electricity consumption—dropping by 10% in FY2023 and a further 3% in FY2024.[11] The phenomenon, documented in detail in "The Great Solar Rush in Pakistan" report, represents consumers voting with their feet, abandoning expensive grid electricity for affordable solar alternatives as tariffs increased by 155% over three years. The trend has since continued into FY24-25, as it looks to surpass the import volume of Chinese solar panels compared to last year, with 15 GW imported already in this fiscal year, with two months still to go.[1]

Electricity sales continued to struggle

- Domestic: With a 6% YoY increase in the number of domestic consumers, electricity sales grew by only 1% YoY. In FY24, more households adopted rooftop solar contributing to the decline in overall electricity usage.
- Industry: Electricity sales in the industrial sector declined from 31 TWh in FY23 to 28 TWh in FY24, reflecting a significant 11% YoY drop. This decrease highlights both economic challenges and the industry's transition toward more competitive energy sources.
- Agriculture: Electricity sales in the agriculture sector declined by 11% YoY, dropping from 10 TWh in FY23 to 9 TWh. This decline also indicates a growing shift toward solar adoption in the sector.
- Commercial: With consumer growth of 3%, commercial sector saw a positive increase of 2.04% YoY increase in electricity sales.

Electricity units sold, FY20 - FY24

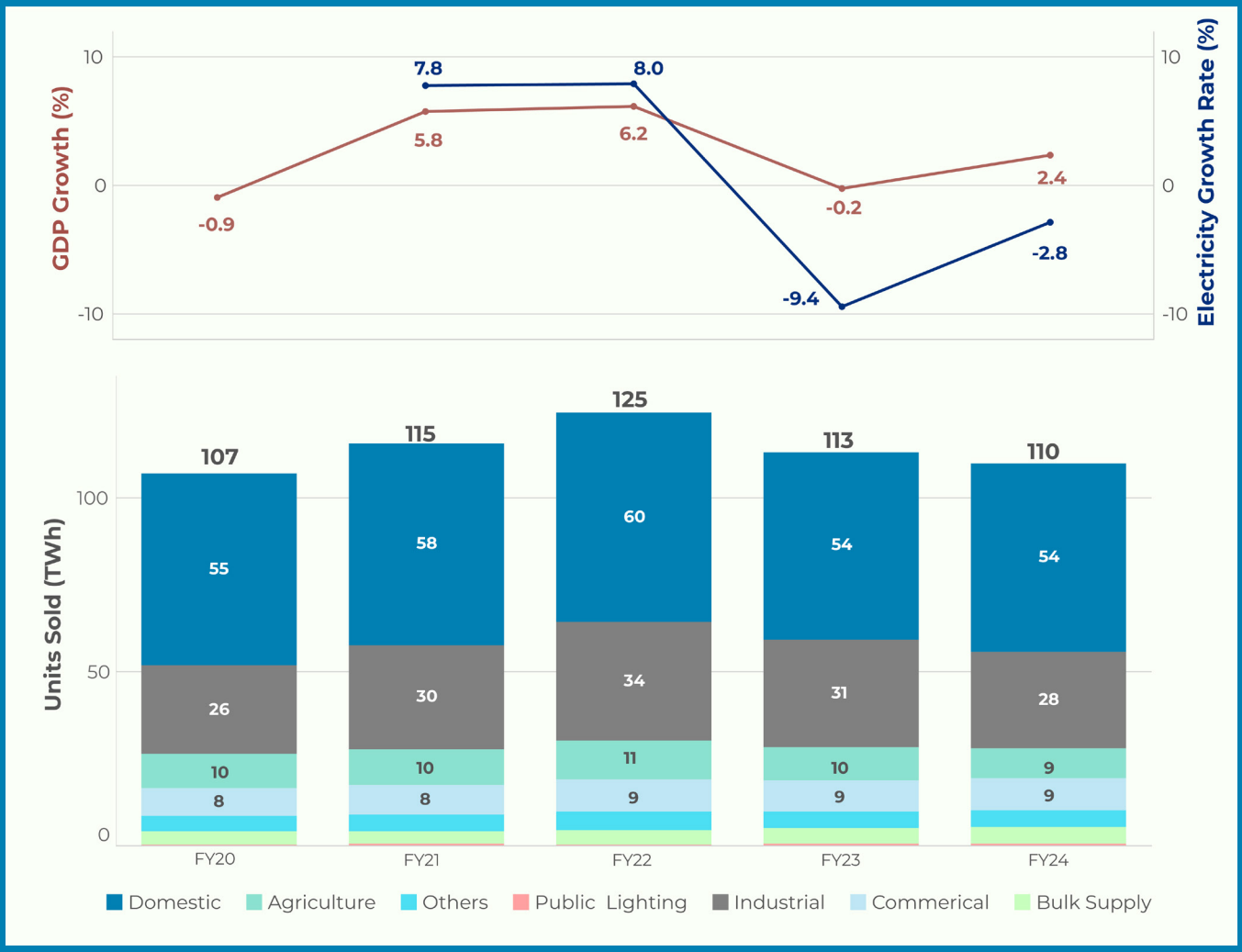


Figure 6: Electricity Sales Trend Vs GDP Growth rate. [11]

The resulting demand squeeze has led to severe underutilization of Chinese CFPPs, transforming what were intended as profitable baseload assets into financial millstones. Chinese coal plants are experiencing catastrophic underutilization, with imported coal-based projects operating at a mere 11% average capacity factor in 2024, while domestic coal plants averaged 70%. These facilities, originally conceived and financed as baseload plants with expected utilization rates above 80%, now face an existential crisis. China Hub Power Company exemplifies this disaster, operating at just 4% annual utilization.[3] This severe underutilization reflects not just temporary market conditions but a fundamental shift in Pakistan's energy landscape, where distributed solar is permanently displacing centralized thermal generation.

[3] State of Industry report and author's assistant

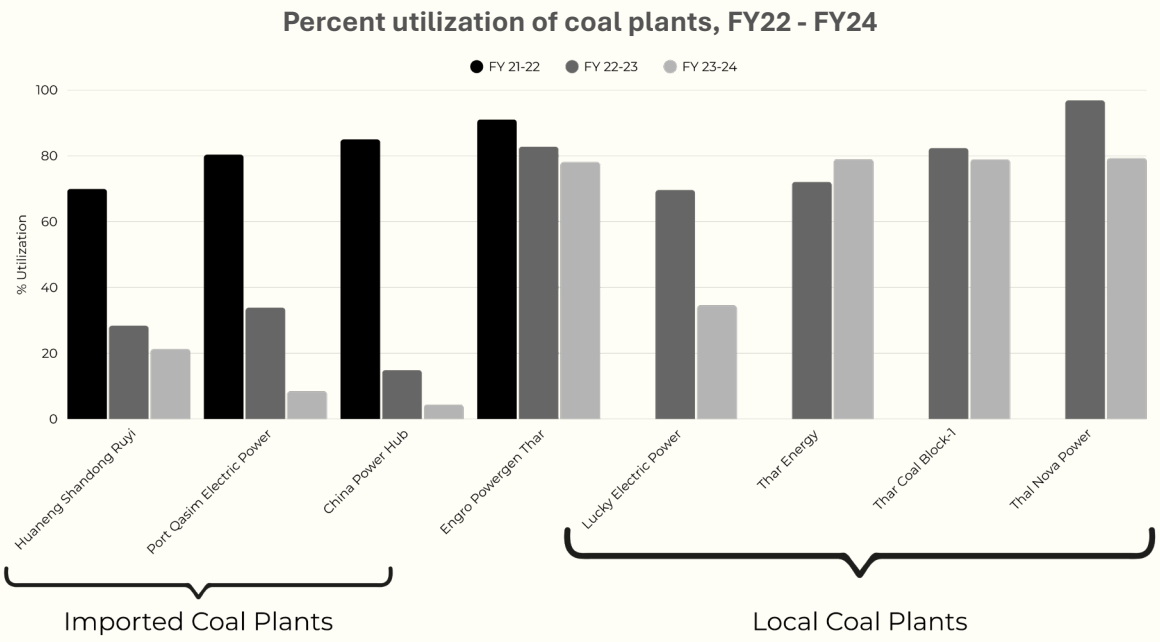


Figure 7: Utilization rates of Chinese financed CFPPs

The underutilization of these assets adds to capacity payments, further increasing tariffs and suppressing demand, a cycle that risks rendering these thermal assets stranded and increase the grid electricity costs. In FY 2024, Capacity Purchase Price (CPP) for National Grid connected Generators (excluding K-Electric systems) surged to PKR 1,902 B, raising their share in the base tariff to an all-time high of 61%. Out of this, PKR 792 B is the portion of capacity payments to Chinese power plants. While the CPP rose by 46% year-on-year (YoY) in FY 2024, the electricity sales on the grid reduced (Figure 5).[11] This growing imbalance between reduced energy consumption and increasing capacity payments driven by underutilized Chinese CFPPs, reinforces the unsustainable burden it places on the grid and its consumers. This paradoxical dynamic, where reduced consumption leads to higher per-unit costs, accelerates grid defection, and further undermines the viability of thermal assets.

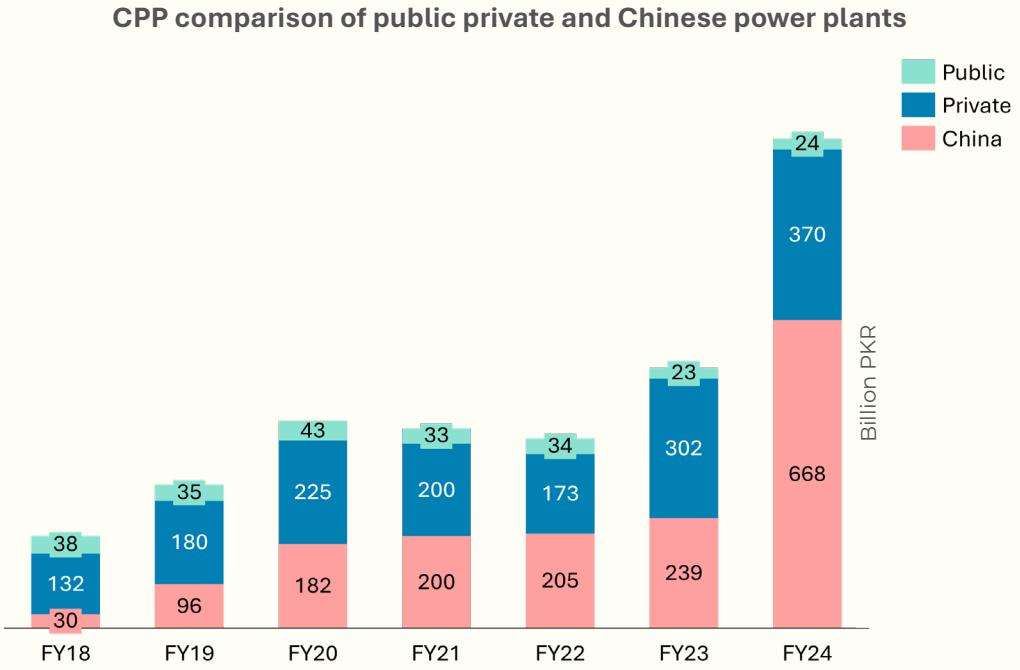


Figure 8: CPP comparison of public, private and Chinese power plants

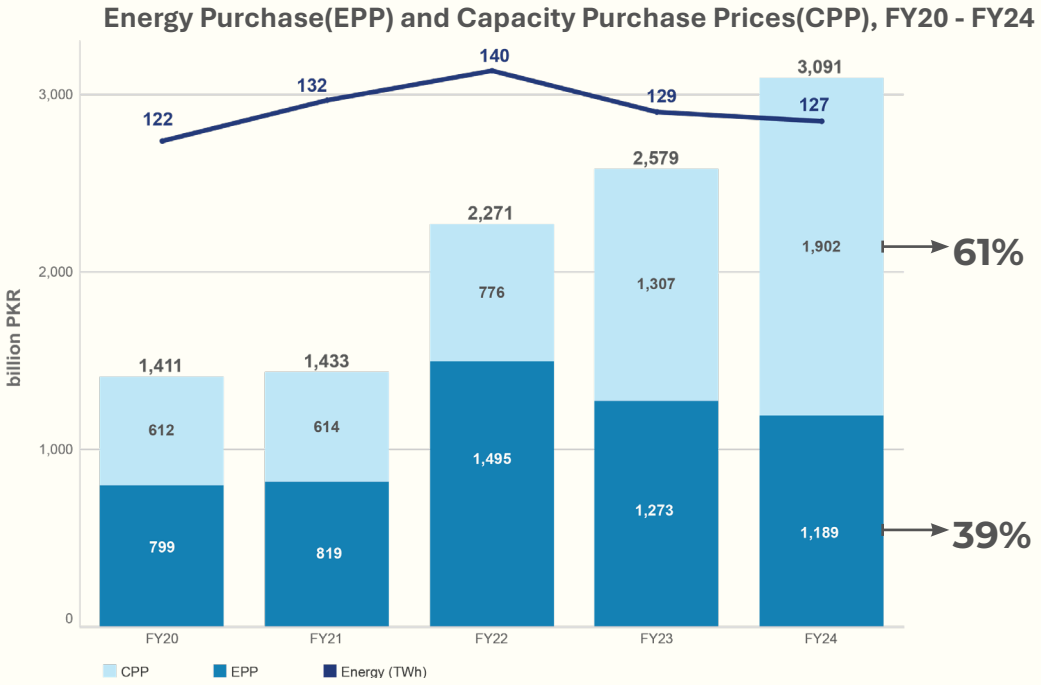


Figure 9: CPP & EPP trend for power plants Vs national energy generation (excluding K-Electric)

The mounting financial burden on the power sector is also spilling over to project sponsors and lenders, as repeated payment delays by national power purchasers disrupt cashflows and erode investor confidence. Out of Pakistan's USD 126 B external debt, USD 30 B is owed to China, including USD 7.56 B for Chinese power sector loans.[22] Pakistan's ongoing fiscal constraints have hindered timely repayments, leading to a build-up of outstanding dues linked to these coal power projects. As of June 2024, Chinese Independent Power Producers (IPPs) have accumulated receivables totaling PKR 550 B, due to the government's inability to clear dues amidst a worsening circular debt crisis. IPPs like Port Qasim Electric Power Company (PQEPC) have already warned the government that they may suspend plant operations due to payment delays.[23] This situation has necessitated repeated debt rollovers and rescheduling, straining bilateral relations and undermining investor confidence.

Despite mounting challenges, CFPPs under CPEC continue to receive preferential treatment that insulates them from market realities. Chinese IPPs secured extraordinary Return on Equity (ROE) rates of 27-34%, nearly double the 15-18% offered to pre-CPEC and government-owned plants.[24] When the Government of Pakistan renegotiated contracts with IPPs in 2024, securing PKR 1,300 B in lifetime savings, Chinese IPPs, accounting for 63% (PKR 668 B) of thermal capacity payments, remained conspicuously exempt from renegotiation.[4] [25] This protection, while shielding Chinese investors from immediate losses, perpetuates the fundamental mismatch between guaranteed returns and actual market conditions, effectively subsidizing stranded assets at the expense of Pakistani consumers.

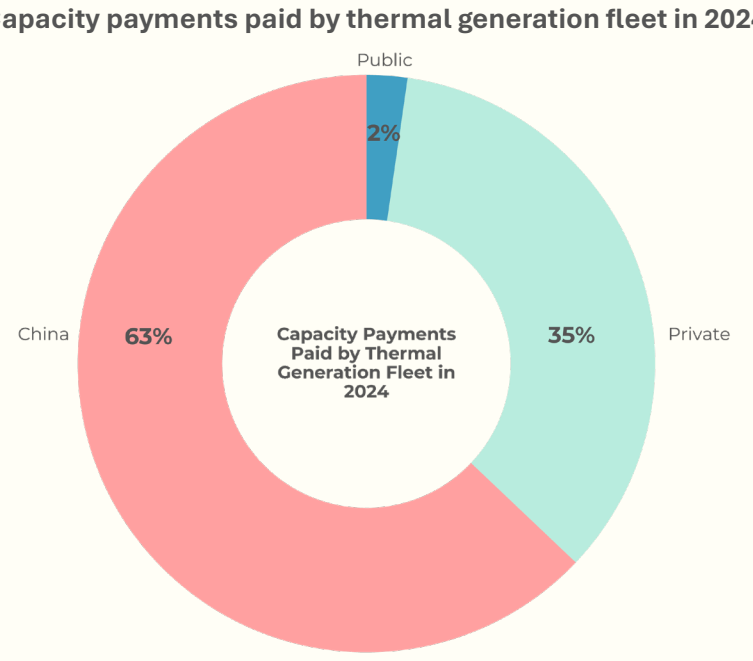


Figure 10: CPP paid by thermal power plants in FY24

The Gwadar coal plant saga epitomizes the broader crisis, with Pakistan's last pipeline Chinese CFPP stuck in limbo as market realities overtake planning assumptions. The 300 MW Gwadar project, originally conceived as an anchor investment for the port city's development, remains stalled without financial closure after years of delays. Rising construction costs and plummeting solar PV prices have rendered the project economically unviable under any realistic scenario. The plant fails to appear in the government's latest Indicative Generation Capacity Expansion Plan (IGCEP) on least-cost criteria. While the government explores alternatives; including conversion to local coal, transitioning to solar-plus-storage, shifting to LNG, or abandoning the project entirely, the Chinese developer continues pressing for the original plan. This impasse symbolizes the broader challenge: Chinese coal investments conceived in an era of growing demand and centralized generation now face a Pakistani market transformed by distributed solar and declining grid consumption. The prudent path forward, transitioning to renewables with storage, remains blocked by contractual obligations and sunk cost fallacies.[24]

Gwadar project timeline:

- Tariff determined in Dec 2018
- Tariff revised in May 2019.
- Land acquired in Feb 2020.
- Implementation Agreement (IA) and Power Purchase Agreement (PPA) signed on 8th April 2021.
- NEPRA revised tariff in July 2023.
- NEPRA revised tariff in September 2023.
- NEPRA revised tariff in May 2024.
- Financial Close under process

The collision between China's legacy coal investments and its flood of cheap solar panels exposes a fundamental strategic contradiction that demands resolution. Chinese manufacturers have equipped Pakistan with over 39 GW of solar capacity in just five years, enabling rapid transition, while simultaneously undermining the economics of Chinese-financed coal plants.[5] This inadvertent competition between Chinese products; coal plants requiring steady demand versus solar panels enabling grid independence, highlights the urgent need for a coherent, forward-looking energy partnership that aligns with both countries' stated climate goals and economic realities.

China's strategic choice: Lead the clean energy transition or cling to fossil fuels

China's domestic energy transformation, where clean energy additions are now displacing coal for the first time, is inadvertently replicating in Pakistan through market dynamics rather than policy design. In 2023, China added 293 GW of wind and solar capacity, sufficient to meet all electricity demand growth and displace the need for additional coal-fired power generation, marking a historic inflection point where CO_2 emissions entered structural decline.[26] This same dynamic is now playing out in Pakistan, where Chinese-manufactured solar panels are flooding the market and displacing demand from Chinese CFPPs. The irony is profound: China's success in driving down solar costs to achieve domestic coal displacement has created the very market conditions that are stranding its coal investments abroad. Expecting both technologies, legacy coal plants and disruptive solar, to emerge as winners in the same market defies both economic logic and China's own domestic experience. Just as China cannot sustain both coal growth and renewable expansion at home, Pakistan cannot support both centralized thermal generation and distributed solar adoption. The Chinese government's recognition that "the amount of newly added renewable power has exceeded the consumption growth for the first time" at home should inform its approach to Pakistan, where the same fundamental disruption is underway, only accelerated by the country's acute affordability crisis.

The U.S. absence from climate diplomacy creates space for China to champion the global energy transition. The U.S. withdrawal from the Paris Climate Agreement under President Trump leaves a significant leadership vacuum in global climate diplomacy as well, paving the way for China to take on a more prominent role in driving the energy transition. With its unmatched position as the largest installer and financier of renewables, the leading manufacturer of renewable energy components, and home to the most extensive raw material sourcing and processing industries, China is uniquely positioned to lead the global energy transition. Moreover, China has already enabled Global South economies to access affordable renewable energy technologies, its exports to these countries now surpass those to the Global North, underscoring its growing influence in shaping the global energy landscape.[27] Some of the technology transfer ventures by China are given in table below.

Pakistan as a strategic test case

China stands at a strategic inflection point in Pakistan, where its coal and renewable investments collide most dramatically in a market transformed by the very solar panels it manufactures. This collision is not merely a bilateral concern, it represents a litmus test for China's global climate leadership. By treating Pakistan as a proving ground for managing stranded fossil assets while scaling renewable ecosystems, China has the opportunity to develop and validate transition models that could be exported across the Global South. The stakes extend beyond bilateral relations: success here would cement China's credibility as the architect of pragmatic climate solutions, while failure would expose the contradictions in championing clean energy while protecting legacy fossil investments.

China has already emerged as the inadvertent catalyst for Pakistan's energy transformation, equipping the country with the tools for its own quiet revolution. By supplying over 28 GW in just 18 months, China has enabled Pakistan to reduce an estimated 14 Mt CO_2-eq emissions annually. Yet this transformation remains incomplete without China's support on developing the ecosystem including storage, grid enhancement, manufacturing capacity, or financing mechanisms, needed to sustain and deepen this transition. As Pakistan absorbs this unprecedented solar capacity, its needs are rapidly evolving from simple panel imports to comprehensive partnership to support whole ecosystem for energy transition.

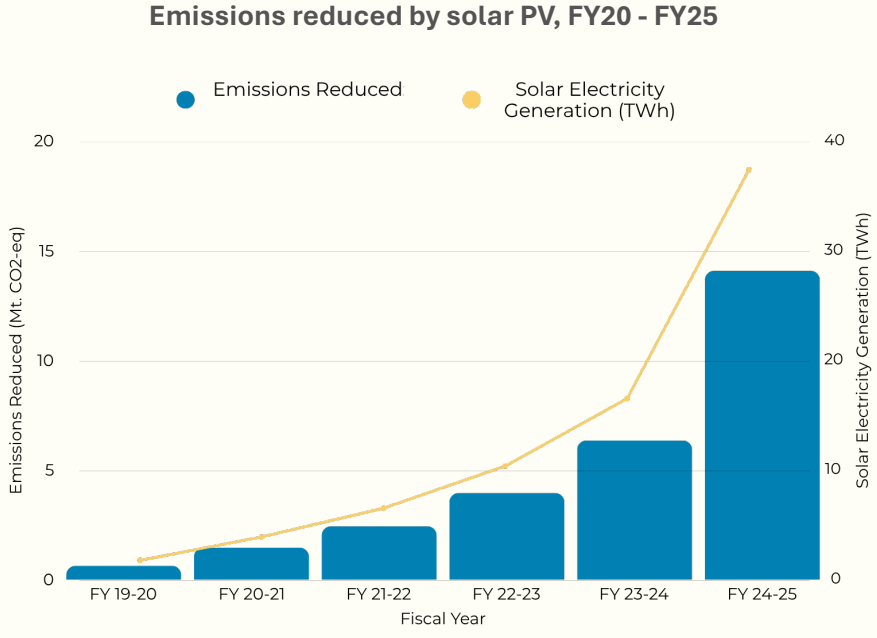


Figure 11: Emission reductions from Chinese PV panels

It now faces a clear choice: double down on a unified clean-energy vision or maintain a bifurcated approach that props up both the health of the coal assets and the renewables exports. In the first scenario, China can cement its role as the champion of a clean-energy economy by orchestrating a holistic ecosystem for Pakistan's energy transition: enhancing access to green finance, forging strategic technology-transfer partnerships, strengthening local innovation, and deploying instruments such as coal-to-clean credits and early-retirement mechanisms to manage stranded thermal assets while expanding renewables deployment. Alternatively, if China opts for the status quo, limited to trade and existing investments, the result will be a fragmented partnership in which Chinese solar exports compete with under-utilized Chinese fossil projects, undermining both financial returns and climate goals.

The renewable energy sector offers China a fundamentally different value proposition than its narrow coal investments, promising broader economic returns, and deeper market penetration. Chinese CFPPs in Pakistan operate through limited G2G contracts under CPEC, involving a handful of state-owned enterprises with minimal downstream linkages or technology spillovers. These projects function as isolated islands of Chinese capital, generating power but not economic dynamism. In stark contrast, the solar ecosystem catalyzes a vibrant commercial environment encompassing thousands of businesses: battery suppliers, inverter manufacturers, installation companies, maintenance providers, financing institutions, and training academies. This distributed model creates multiple entry points for Chinese companies across the value chain, from tier-one manufacturers to small-scale service providers. The contrast is striking: where coal offers narrow returns to few players, renewables enable broad-based commercial engagement that deepens China-Pakistan economic integration while building local capacity.

	Sponsors/Lenders			EPC/ Infrastructure/ Equipment Manufactures/Suppliers		
Fossil Fuels	China Development Bank	China Construction Bank	Agricultural Bank of China	NORINCO	Power China International (+ Investor)	Dongfang Turbine Co. Ltd
	ICBC	China Minsheng Bank	China Bohai Bank	SEPCO1 Electric Power Construction Corporation	Tianjin Electric Power Construction Company Limited	CCCC Second Harbor Consultants Limited
	China Exim Bank	China Zheshang Bank	CMBC	Northwest Electric Power Design Institute (NWEEPDI)	China Energy Engineering Corporation	Shanghai Electric Group
	Hunaneng Shandong Ruyi Energy Pvt Ltd.	Shanghai Electric Group Company Limited	Sinohydro Resources Limited	Shanghai Electric Engineering Consulting Company Limited	China Machinery Engineering Corporation (CMEC) (+ Investor)	
	China Power International Holding Company	Shandong Ruyi Science & Tech. Group		China Gezhouba Group Company Limited		
	Novatex					
Renewable Energy	ZTE Energy	Bank of China	China Development Bank	REPT	Sunwoda	BYD
	China Exim Bank	Bank of Jiangsu Bohai	Power China	Longi Solar	Trina Solar	GHRE Wind
	China Energy Engineering Corporation	China Three Gorges Corporation	China Three Gorgers (CSAIL)	Jinko Solar	Hexing Group	Harbin Electric
	China National Machinery Industry Corporation	Orient Group Investment Holdings Co. Ltd.	Zonergy	Canadian Solar	Gold Wind	MinYang
	China Hydropower Consulting Group International Engineering Co. Ltd.	Gezhouba Group		Aiko Solar	Chint Solar	CSSC
	China Shipbuilding Industry Corporation	Zhenfa Energy		JA Solar	Yingli Soalr	Envision Group
				Zonergy	Sany Renewable Energy Limited	China Huaneng Group
				Growatt	CATL	NORINCO
				Inverex	Gotion	Xingzhong Renewable Energy
				Fronus	GoodWe	Hydrochina International Engineering Ltd.
				Ziewnic	Kstar	
				Sungrow	EVE Energy	CALB

Figure 12: Chinese enterprises/institutes in Pakistan – Renewables Vs Coal

To champion RE economy, a strategic pivot is required to support Pakistan in building comprehensive ecosystems for energy transition, by robust technology transfer agreements that can drive local industrial development. Currently, Pakistan's reliance on imported Chinese solar modules, which account for over 99% of its solar PV installations in the past five years, underscores the need for such agreements to develop indigenous manufacturing capabilities for solar panels, wind turbines, and energy storage systems. China's experience in Vietnam, where renewable energy foreign direct investment surged to $106.8 B between 2015 and 2022, demonstrates how strategic partnerships can stimulate local value creation and manufacturing.[28] Moreover, given the global trade tensions and China's recent export restrictions on critical minerals essential for solar technology, developing indigenous manufacturing is also vital for resilience against supply chain disruptions. China and Pakistan need to evolve from an importer-exporter relationship to co-creators of a homegrown clean-energy innovation ecosystem.

To meet Pakistan's energy-transition financing gap, both countries must transcend the limitations of state-to-state CPEC frameworks and mobilize private capital at scale. Current government-to-government mechanisms, while important for strategic projects, cannot match the speed and scale required for comprehensive energy transformation. Private capital is projected to constitute 60% of clean energy investments in emerging markets by 2030, yet Pakistan remains largely excluded from these flows due to perceived risks and limited investment vehicles. [29] Several innovative financing instruments, including Panda Bonds, debt-for-climate swaps, foreign-exchange hedging instruments would be crucial in unlocking this capital. To realize these opportunities, Pakistan must amplify its investment visibility, address high-risk perceptions in the power sector and pivot toward direct cross-border joint ventures on purely commercial terms, thereby transforming from a state-led CPEC trading partner into a high-reward market for solar, wind and storage investments. To address stranded coal assets, China could pioneer transition credits, as an exit strategy for its coal fleet and monetize emission reductions from early retirement and convert these investments to new RE projects. Additionally, debt-for-climate swaps under a "Shanghai Model" framework, conceived by Zhou Chengjun, Director of the Financial Research Institute of the People's Bank of China, could help Pakistan manage part of its USD 25 B in Chinese debt through tradeable, equity-like instruments. A joint pivot toward these tools could support energy cooperation that is shaped by financial innovation and private sector led solutions. [30]

Technology transfer must evolve from rhetoric to reality if China genuinely intends to lead global energy transition rather than merely dominate panel exports. Pakistan's near-total dependence on Chinese imports, accounting for over 99% of solar installations, represents both an achievement and a vulnerability. China's successful technology transfer experiences offer proven models: Thailand developed a thriving EV ecosystem through Chinese joint ventures in battery production; Malaysia built integrated solar manufacturing from wafers to modules through technology-sharing agreements. Pakistan needs similar arrangements that go beyond assembly to include: cell and wafer production capabilities, inverter and controller manufacturing, battery pack assembly and eventually cell production, and R&D centers focused on local conditions (high temperatures, dust, grid instability). This evolution from importer to co-creator would insulate both countries from growing global trade tensions while building Pakistan's industrial base.

The battery revolution presents the next frontier where China's choices will determine whether Pakistan's solar transformation succeeds or stalls. With global energy storage markets projected to exceed 400 GWh by 2030 and China controlling 75% of global battery production capacity through USD 13.9 B annual investments, the partnership potential is obvious.[31], [32] Yet current approach of simply exporting finished batteries replicates the limitations of the panel-only model. Pakistan needs localized solutions addressing its unique challenges: extreme temperature variations requiring specialized thermal management, frequent grid instabilities demanding robust battery management systems, and cost constraints necessitating innovative second-life applications for used EV batteries. India's trajectory, targeting 50 GWh of domestic production by 2030 through joint ventures and technology transfer, demonstrates the feasibility of building local capacity.[33] Pakistan could follow a similar path with Chinese partnership, focusing initially on pack assembly, then cell production, while developing specialized applications for grid stabilization and agricultural use.

The spontaneous, uncoordinated nature of Pakistan's solar revolution creates both opportunity and urgency. China can either harness this momentum through comprehensive ecosystem development or watch its coal investments become stranded while its solar exports enable unmanaged grid defection. The choice is binary and time sensitive.

China's domestic experience, where renewable additions now exceed demand growth and displace coal generation, provides the roadmap for Pakistan's transformation. Just as China cannot sustain both coal expansion and renewable growth at home, it cannot expect both its coal plants and solar panels to thrive in Pakistan. The fundamental disruption underway in Pakistan mirrors but accelerates China's own transition, compressed by acute affordability pressures and enabled by China's manufacturing scale. Recognizing this parallel, China should apply lessons from its domestic transition: the inevitability of coal displacement, the importance of storage and grid flexibility, and the economic superiority of distributed generation. These insights, translated to Pakistan's context, argue for immediate pivot toward comprehensive renewable ecosystem development.

Conclusion: The moment of truth

Ultimately, China's choice in Pakistan will reveal whether it is a 'Leader of One'-championing global cooperation and collective energy transformation, or a 'Leader of None' by protecting its narrow interests, with little input to the needs of its recipient countries. Leadership means accepting short-term losses on stranded coal assets to build long-term renewable markets. It means sharing technology rather than just selling products. It means pioneering innovative financing that unlocks private capital rather than relying solely on state lending. Most crucially, it means recognizing that in an interconnected world, enabling partners' energy independence strengthens rather than threatens China's position. The alternative, clinging to contradictory investments while expecting different outcomes, ensures China remains a 'Leader of None,' watching its coal plants fail while its solar panels enable unmanaged transition, undermining both its financial returns and climate credibility.

This choice in Pakistan will signal whether China truly embraces its role as the world's clean energy champion or defaults to a status quo that leaves its biggest investments at risk and its global leadership unfulfilled. In Pakistan, where Chinese solar displaces Chinese coal in real-time, this choice cannot be delayed. The window for decisive action is closing, and with it, China's opportunity to define the future of global clean energy cooperation.

Glossary

Balance of Payments: A statement of all financial transactions made between entities in one country and the rest of the world over a defined period.

Baseload Power: The minimum level of electricity demand required over a period, typically supplied by power plants that can run continuously.

Battery Energy Storage System: A technology that uses batteries to store energy from various sources for use when production is low or demand is high.

Buyback Rate: The price at which utilities purchase excess electricity from distributed generators like rooftop solar systems.

Capacity Payments: Fixed payments made to power generators regardless of whether electricity is produced, designed to cover fixed costs and ensure investment returns.

Circular Debt: The accumulation of unpaid bills in the energy sector, where distribution companies cannot pay generators due to low recovery rates, government subsidies, or inefficiencies.

Coal-to-Clean Credits: Financial instruments designed to incentivize the transition from coal power to clean energy sources.

Current Account Deficit: A measurement of a country's trade where the value of goods and services it imports exceeds the value of those it exports.

Debt-for-Climate Swap: A financial transaction in which a portion of a developing nation's foreign debt is forgiven in exchange for commitments to invest in environmental and climate-related projects.

Distributed Generation: Electricity generation at or near the point of consumption, such as rooftop solar panels.
Early-Retirement Mechanisms: Strategies and financial tools to facilitate the decommissioning of fossil fuel power plants before the end of their operational life.

Energy Purchase Price (EPP): The cost of actual energy generated and consumed, as opposed to capacity payments.

Feed-in Tariff: A policy mechanism where renewable energy producers are paid a fixed price for each unit of electricity they inject into the grid, designed to accelerate investment in renewable energy technologies by offering long-term contracts.

Financial Closure: The stage in a project where all the conditions of a financing agreement have been met and the borrower can access the funds.

Foreign Exchange Reserves: Assets held by a central bank in foreign currencies, used to back liabilities, manage balance of payments, and influence monetary policy.

Foreign-Exchange Hedging: Financial instruments used to mitigate potential losses caused by fluctuations in exchange rates between currencies.

Green Finance: Financial investments in projects and initiatives that promote environmentally sustainable development.

Grid Stability: The ability of an electrical grid to maintain reliable and steady voltage/frequency despite fluctuations in supply and demand.

Gross Metering: A system where all electricity generated by a consumer's system is fed into the grid and purchased at a predetermined tariff, separate from consumption billing.

Independent Power Producer (IPP): A private entity that owns and operates facilities to generate electricity for sale to utilities and end users.

Indicative Generation Capacity Expansion Plan (IGCEP): A long-term plan that outlines future electricity generation needs and the optimal mix of power sources in Pakistan.

Load Shedding: The deliberate shutdown of electric power in parts of a power-distribution system to prevent the failure of the entire system when demand exceeds supply.

Net Metering: A billing mechanism that credits solar energy system owners for the electricity they add to the grid, allowing consumers to offset their electricity usage and sell excess generation back to the utility.

Off-Grid Systems: Energy systems that operate independently from the national electricity grid.

Panda Bonds: RMB-denominated bonds issued by non-Chinese entities in Chinese markets.

Power Purchase Agreement (PPA): A long-term contract between an electricity generator and a buyer, typically a utility or large consumer.

Prosumer: An individual who is both consumers and produces electricity, typically through solar panels or other small-scale generation systems.

Renewable Energy Credits: Tradable, non-tangible certificates representing proof that electricity was generated from a renewable energy resource.

Tax-to-GDP Ratio: The ratio of tax collection to the gross domestic product of a country, indicating the size of tax revenue relative to the economy.

Utilization Rate: Gross Generation / (Dependable Capacity * Available Hours)

Abbreviations

AI	Artificial Intelligence
B	Billion
BESS	Battery Energy Storage System
CFPP	Coal Fired Power Plant
COP	Conference of Parties
CPEC	China-Pakistan Economic Corridor
CPP	Capacity Purchase Price
DFI	Development Finance Institutions
EMDE	Emerging Market and Developing Economies
EPC	Engineering, Procurement, and Construction
EPP	Energy Purchase Price
EU	European Union
EV	Electric Vehicles
FX	Foreign Exchange
FY	Fiscal Year
G2G	Government-to-Government
GDP	Gross Domestic Product
GoP-IA	Government of Pakistan Implementation Agreement
GW	Gigawatt
GWh	Gigawatt-hour
IEA	International Energy Agency
IGCEP	Indicative Generation Capacity Expansion Plan
IMF	International Monetary Fund
IoT	Internet of Things
IPP	Independent Power Producers
kWh	Kilowatt-Hour
LNG	Liquefied Natural Gas
Mt. CO2-eq	Million Metric Tons of Carbon Dioxide Equivalent
MW	Megawatt
NREL	National Renewable Energy Laboratory
PKR	Pakistani Rupees
PPA	Power Purchase Agreement
PQEPC	Port Qasim Electric Power Company
RMB	Chinese Yuan
ROE	Return on Equity
SCADA	Supervisory Control and Data Acquisition
TSEP	Transmission System Expansion Plan
UEP	United Energy Pakistan Limited
USD	United States Dollar
VRE	Variable Renewable Energy
WFIP2	Second Wind Forecast Improvement Project
YoY	Year-on-Year

References

1. "China's Solar PV Exports," Ember. Accessed: May 31, 2025. [Online]. Available: https://ember-energy.org/data/china-solar-exports-data
2. "The_Great_Solar_Rush_in_Pakistan_38157451a3.pdf." Accessed: May 31, 2025. [Online]. Available: https://uploads.renewablesfirst.org/The_Great_Solar_Rush_in_Pakistan_38157451a3.pdf
3. S. Cheng, "Breaking down the world's tariffs against China's tech industry," Rest of World. Accessed: May 31, 2025. [Online]. Available: https://restofworld.org/2024/china-tech-tariffs-which-countries-will-impose/
4. S. Rosenow, A. Espitia, and A. M. Fernandes, "High Tariffs, High Stakes: The Policy Drivers behind Firm-Level Adoption of Green Technologies".
5. "Solar association protests 17pc tax on solar panels - Profit by Pakistan Today." Accessed: May 31, 2025. [Online]. Available: https://profit.pakistantoday.com.pk/2022/01/21/solar-association-protests-17pc-tax-on-solar-panels/
6. K. Hasnain, "Businessmen decry 20pc tax on solar panels, equipment," DAWN.COM. Accessed: May 31, 2025. [Online]. Available: https://www.dawn.com/news/1670749
7. "Pakistan foreign exchange reserves drop to lowest since 2014 | Business and Economy News | Al Jazeera." Accessed: May 31, 2025. [Online]. Available: https://www.aljazeera.com/news/2023/1/13/pakistan-foreign-exchange-rates-drop-to-lowest-since-2014
8. "Pakistan Tax Revenue: % of GDP, 2000 – 2025 | CEIC Data." Accessed: May 31, 2025. [Online]. Available: https://www.ceicdata.com/en/indicator/pakistan/tax-revenue--of-gdp
9. "economic_update_June_2024.pdf." Accessed: May 31, 2025. [Online]. Available: https://www.finance.gov.pk/economic/economic_update_June_2024.pdf
10. "forex.pdf." Accessed: May 31, 2025. [Online]. Available: https://www.sbp.org.pk/ecodata/forex.pdf
11. "Pakistan_Electricity_Review_2025_80753f62aa.pdf." Accessed: May 31, 2025. [Online]. Available: https://uploads.renewablesfirst.org/Pakistan_Electricity_Review_2025_80753f62aa.pdf
12. "IEEFA - updated - The Future of Net-metered Solar Power in Pakistan_August 2024.pdf." Accessed: May 31, 2025. [Online]. Available: https://ieefa.org/sites/default/files/2024-08/IEEFA%20-%20updated%20-%20The%20Future%20of%20Net-metered%20Solar%20Power%20in%20Pakistan_August%202024.pdf
13. "Department of Energy Philippines," doe-parent. Accessed: May 31, 2025. [Online]. Available: https://doe.gov.ph/sites/default/files/pdf/announcements/03-remb-net_metering_energy_summit_final2-%20baguio.pdf
14. T. I. government has ended net metering for rooftop solar installations T. J. I. for E. S. R. says this could make it harder for the country to meet its solar deployment targets, as P. installations will become more expensive for households, and small businesses P. Jowett, "Indonesian government abolishes net metering," pv magazine International. Accessed: May 31, 2025. [Online]. Available: https://www.pv-magazine.com/2024/02/28/indonesian-government-abolishes-net-metering/
15. "我国风电太阳能发电装机超14亿千瓦_部门动态_中国政府网." Accessed: May 31, 2025. [Online]. Available: https://www.gov.cn/lianbo/bumen/202501/content_7001210.htm
16. "China's 2023 coal output hits record high | Reuters." Accessed: May 31, 2025. [Online]. Available: https://www.reuters.com/markets/commodities/chinas-2023-coal-output-hits-record-high-2024-01-17/
17. Z. Ma and Y. Ma, "What's After Coal? Accelerating China's Overseas Investment in Renewables," Jan. 2023, Accessed: May 31, 2025. [Online]. Available: https://www.wri.org/insights/whats-after-coal-accelerating-chinas-overseas-investment-renewables
18. A. Cheung, "Energy Transition Investment Trends 2025".
19. "'Small' Belt, 'Beautiful' Road: China's Cautious Return to Global Energy Finance | Global Development Policy Center." Accessed: May 31, 2025. [Online]. Available: https://www.bu.edu/gdp/2024/11/05/small-belt-beautiful-road-chinas-cautious-return-to-global-energy-finance/
20. "China's Global Power Database." Accessed: May 31, 2025. [Online]. Available: https://www.bu.edu/cgp/
21. "China Global Investment Tracker," American Enterprise Institute - AEI. Accessed: May 31, 2025. [Online]. Available: https://www.aei.org/china-global-investment-tracker/
22. M. Desk, "From game-changer to bailout: The troubled journey of CPEC," Profit by Pakistan Today. Accessed: May 31, 2025. [Online]. Available: https://profit.pakistantoday.com.pk/2023/03/11/from-game-changer-to-bailout-the-troubled-journey-of-cpec/
23. "Overdue payment issue: PQEPC threatens to suspend plant operations - Business Recorder." Accessed: May 31, 2025. [Online]. Available: https://www.brecorder.com/news/40353450/overdue-payment-issue-pqepc-threatens-to-suspend-plant-operations
24. "NEPRA | IPPs." Accessed: May 31, 2025. [Online]. Available: https://nepra.org.pk/tariff/Generation%20IPPs.php
25. "Savings from IPP deal revisions top Rs1.3 trillion." Accessed: May 31, 2025. [Online]. Available: https://tribune.com.pk/story/2535131/savings-from-ipp-deal-revisions-top-rs13-trillion
26. "Analysis: Clean energy just put China's CO2 emissions into reverse for first time - Carbon Brief." Accessed: May 31, 2025. [Online]. Available: https://www.carbonbrief.org/analysis-clean-energy-just-put-chinas-co2-emissions-into-reverse-for-first-time/
27. C. B. Staff, "Guest post: Saudi Arabia's surprisingly large imports of solar panels from China," Carbon Brief. Accessed: May 31, 2025. [Online]. Available: https://www.carbonbrief.org/guest-post-saudi-arabias-surprisingly-large-imports-of-solar-panels-from-china/
28. "FDI Drives Green Growth in Vietnam." Accessed: May 31, 2025. [Online]. Available: https://www.phonggiagroup.com/en/news/fdi-drives-green-growth-in-vietnam-g95hd1vw109taxd56riu1k3k
29. "Key findings – Scaling Up Private Finance for Clean Energy in Emerging and Developing Economies – Analysis - IEA." Accessed: May 31, 2025. [Online]. Available: https://www.iea.org/reports/scaling-up-private-finance-for-clean-energy-in-emerging-and-developing-economies/key-findings

30. "IDS Online Tables_Analytical." Accessed: May 31, 2025. [Online]. Available: https://datatopics.worldbank.org/debt/ids/countryanalytical/pak/counterpartarea/730
31. "China's Electric Vehicle Supply Chain and Its Future Prospects," China Briefing News. Accessed: May 31, 2025. [Online]. Available: https://www.china-briefing.com/news/chinas-electric-vehicle-supply-chain-and-its-future-prospects/
32. "How China is driving the world's advanced energy solutions," World Economic Forum. Accessed: May 31, 2025. [Online]. Available: https://www.weforum.org/stories/2025/01/china-driving-advanced-energy-solutions-deployments/
33. "Press Release:Press Information Bureau." Accessed: May 31, 2025. [Online]. Available: https://www.pib.gov.in/PressReleasePage.aspx?PRID=2114919

Renewables First (RF) is a think tank for energy and environment. Our work addresses critical energy and natural resource issues with the aim to make energy and climate transitions just and inclusive.

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