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ASSESSING THE NEED FOR UTILITY-SCALE SOLAR DEVELOPMENT IN PAKISTAN

A comprehensive analysis of barriers, financing mechanisms, regional lessons, and a strategic roadmap for large-scale solar deployment

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List of Abbreviations

GW	Gigawatt
kWh	Kilowatt-hour
kWh/m²/day	Kilowatt-hours per square metre per day
LCOE	Levelised Cost of Energy
MW	Megawatt
MWh	Megawatt-hour
TW	Terawatt
AEDB	Alternative Energy Development Board
CPPA-G	Central Power Purchasing Agency – Guaranteed
DISCOs	Distribution Companies
KE	K-Electric
MTML	Master Textile Mills Limited
NEPRA	National Electric Power Regulatory Authority
NJTF	National Just Transition Fund
NTDC	National Transmission and Despatch Company
PPIB	Private Power and Infrastructure Board
PRIED	Policy Research Institute for Equitable Development
PSX	Pakistan Stock Exchange
PSX	Quaid-e-Azam Solar Park
SBP	State Bank of Pakistan
SECP	Securities and Exchange Commission of Pakistan
ARE Policy	Alternative and Renewable Energy Policy
BOOT	Build, Own, Operate, and Transfer
CPEC	China-Pakistan Economic Corridor
CTBCM	Competitive Trading Bilateral Contract Market
IGCEP	Indicative Generation Capacity Expansion Plan
NCBTR	National Competitive Bidding Tariff Regulations
NDC	Nationally Determined Contribution
PAP	Power Acquisition Plan
4P	Philanthropic-Public-Private Partnerships
BER / BERs	Bid Evaluation Report(s)
BESS	Battery Energy Storage System
GCF	Green Climate Fund
GFANZ	Glasgow Financial Alliance for Net Zero
GSSS	Green, Social, Sustainable, and Sustainability-linked (bonds)
InvIT	Infrastructure Investment Trust

IPP / IPPs	Independent Power Producer(s)
IRP	Integrated Resource Plan
MDB / MDBs	Multilateral Development Bank(s)
MoU	Memorandum of Understanding
NPMV	Non-Project Missed Volume
PKR	Pakistani Rupee
PPA / PPAs	Power Purchase Agreement(s)
RFP	Request for Proposal
ROE	Return on Equity
SEZ	Special Economic Zone
USS	Utility-Scale Solar
WACC	Weighted Average Cost of Capital
ADB	Asian Development Bank
BII	British International Investment (formerly CDC Group PLC)
CDB	China Development Bank
ECO	ECO Trade & Development Bank
FMO	Dutch Entrepreneurial Development Bank
IFC	International Finance Corporation
IEA	International Energy Agency
ILO	International Labour Organization
IRENA	International Renewable Energy Agency
NREL	National Renewable Energy Laboratory (U.S.)
SECI	Solar Energy Corporation of India
WRI	World Resources Institute
GHI	Global Horizontal Irradiance
LNG	Liquefied Natural Gas
PV	Photovoltaic
RFO	Residual Fuel Oil
RMB	Renminbi (Chinese Yuan)
UAE	United Arab Emirates
USD	United States Dollar
VRE	Variable Renewable Energy

CONTENTS

Executive Summary

Pakistan possesses some of the highest solar irradiance levels in Asia, averaging around 5–6 kWh/m²/day, yet utility-scale solar contributes less than 2 percent to the country's grid-connected electricity. As a result, the country remains heavily dependent on imported fossil fuels, exposing electricity costs to exchange-rate fluctuations and global fuel price volatility. Rising capacity payment obligations have further increased electricity tariffs to unsustainable levels, frequently exceeding 40–50 rupees per kilowatt-hour, placing a significant burden on households and businesses. This has driven a fragmented, consumer-led surge in distributed rooftop solar of over 33 GW by 2025, creating an equity gap for lower-income consumers who remain dependent on increasingly unaffordable grid electricity while also threatening the financial sustainability of electricity distribution companies (DISCOs).

This energy monitor argues that utility-scale solar power offers one of the main keys to untie this Gordian knot of the power sector. The case for utility-scale solar is premised not merely on an energy transition argument but on a macroeconomic one as well. Every unit of solar electricity generated domestically is a unit that no longer needs to be purchased with scarce US dollars through imported fuel, directly easing pressure on Pakistan's foreign exchange reserves. It will also reduce the fiscal burden of capacity payments and diminish Pakistan's vulnerability to global energy price and supply shocks. Globally, economic logic already supports this transition, with solar auction prices falling by over 90 percent in the past decade, while countries such as India, the United Arab Emirates and Saudi Arabia have successfully attracted large-scale private investment through competitive public procurement.

Our study lays out the specific mechanisms, sequenced steps and responsible actors required to make this transition a reality. It advocates three strategic shifts in Pakistan's power sector: institutionalizing competitive reverse auctions as the primary mechanism for procuring solar energy; shifting the state's role from directly owning and building power plants towards strategic risk mitigation through transmission infrastructure, project preparation, payment security mechanisms and first-loss guarantees; and deploying a coordinated blended finance architecture combining concessional and commercial capital, including the Green Climate Fund, Green Bonds, Green Sukuks and aggregation platforms modelled on Infrastructure Investment Trusts (InvITs), to reduce the Weighted Average Cost of Capital (WACC) to levels that make solar power commercially attractive without relying on US dollar-indexed tariffs.

1. Background of the policy problems

Pakistan's solar resource is abundant, with Global Horizontal Irradiance (GHI) averaging 5.0 kWh/m²/day in Karachi and Lahore. This average exceeds 6.0 kWh/m²/day across Balochistan and south Punjab. These latter numbers are comparable to Saudi Arabia and the UAE, two of the world's largest utility-scale solar markets.[1] On the contrary, as per the State of the Industry Report 2025 by the National Electric Power Regulatory Authority (NEPRA), utility scale solar deployment in Pakistan has remained sluggish with only 680 MW having become a part of the national grid since 2014. This limited deployment is notably low, particularly when compared with that of countries that have used competitive procurement and coordinated grid planning to scale solar power more rapidly.

In sharp contrast to utility-scale solar development, however, Pakistan has experienced one of the fastest distributed solar power expansions. Between 2020 and 2025, an estimated 30-33 gigawatts (GW) of solar photovoltaic panels were deployed across Pakistan -- around 18 percent of it connected to the national grid through net-metering/net billing system. The remaining was installed either to supplement the grid-connected electricity supply or completely off-grid. Due to this deployment, net-metered/net-billed solar power capacity alone surged from 1.3 GW in 2023 to over 6 GW by 2025, driven mainly by high tariffs of the grid electricity, its unreliable power supply and falling solar panel prices.[2] Fueled by the import of over 50 GW of solar panel modules, predominantly from China, this consumer-led revolution, however, has created new systemic challenges that include declining demand for the grid electricity, increased financial stress on the electricity distribution companies (because their electricity sales are either stagnating or declining) and growing pressure by Pakistan's development partners, particularly IMF, for the removal of cross-subsidies that support lower-income electricity consumers.

This situation could have been avoided if utility-scale solar deployment had gone hand in hand with the deployment of distributed solar power. They cannot substitute each other for the simple reason that distributed solar power benefits only those who can afford its high upfront costs while utility-scale solar power can reduce the overall cost of the grid electricity for all consumers provided it is procured competitively and integrated into the grid effectively.

The history of utility scale solar deployment in Pakistan is one of high ambition and low implementation. The country's very first utility-level solar power generation facility was conceived as a part of the investment package called China-Pakistan Economic Corridor (CPEC). Known as Quaid-e-Azam Solar Park (QASP) and located in Punjab's Bahawalpur district, it was originally planned to have 1000 MW capacity but only 400 MW have been installed in it by August 2016 while another 100 MW are in the pipeline. The fate of the other 500 MW still remains ambiguous.[3] Subsequent to this project, many private investors applied to install cumulatively more than 5000 MW of solar power capacity and their applications did reach different stages of development[4] but, in the end, 4500 MW of this potential

1. globalsolaratlas.info/map?c=30.375,69.345,5
2. priedpk.org/wp-content/uploads/2025/11/Energy-Monitor-PRIED-R01-1.pdf

capacity never materialized due regulatory and administrative delays and hurdles.[5]

In 2024, the federal government made another push for utility scale solar power and sought land for three large scale private projects with a collective capacity of 2,400 MW on a build-own-operate and transfer (BOOT) model for 25 years.[6] Yet, only one of them, a 600 MW solar park in Muzaffargarh district, made some headline even though it, too, failed to garner the interest of local or international investors despite multiple extensions in the deadline for submitting its requests for proposal (RFP) and several favorable changes in its terms and conditions. No update is available on the rest of the projects.

In another significant development, a Solar Panels Manufacturing Policy (for 2026-2035) was also initiated by the federal government's Engineering Development Board for the local manufacturing of solar panels and for easing the process for installation of solar power projects.[7] The government, however, has never publicly announced if this policy was ever approved.

The utility scale solar development potential is also not harnessed at the level of provincial governments. The Constitution of Pakistan, through article 157, gives provinces the autonomy to set up their own electricity generation, transmission and distribution. However, provinces led renewable energy transition has been limited at utility scale particularly in Baluchistan and Sindh, which are rich in solar GHI.

3. cpec.gov.pk/project-details/10
4. https://www.priedpk.org/wp-content/uploads/2024/08/Situation-Brief-Financial-Analysis-of-Utility-Scale-R05-1.pdf
5. Ibid
6. dawn.com/news/1821914
7. https://engineeringpakistan.com/wp-content/uploads/2022/07/Industrial-Bulletin-January-April-2022.pdf

2. Problem Statement

Pakistan's utility-scale solar deployment remains far below its irradiance and economic potential. The constraint is not the availability of solar resources or the cost of solar technology. What Pakistan lacks is financing and procurement mechanisms for solar power projects, required grid-planning, and the institutional architecture within which power sector investments are made.

Large-scale solar deployment is further constrained by contracts with thermal power generation companies that have already resulted in the installation of more power capacity than Pakistan can gainfully utilize. Without changing those clauses in the contracts that bind the government to pay capacity payments to power companies regardless of whether the power generated is used or not, it is almost impossible to make space for new utility-scale capacity additions. Additional barriers include off-taker risk, whereby the distribution companies or the Central Power Purchasing Agency (CPPA-G) may either not purchase solar-generated electricity because of existing power purchase agreements or may not be in a position to pay due to their weak financial position; currency exposure arising from the dollar-linked imports of utility-scale solar equipment, which places pressure on Pakistan's foreign currency reserves; and electricity transmission bottlenecks and regulatory uncertainty.

2.1. Financial and fiscal 'capacity trap'

The primary obstacle to utility-scale solar deployment is no longer the cost of solar technology (which has fallen by 90 percent between 2010 and 2024 as per IRENA).[8] That obstacle comes from the financing architecture within which Pakistan procures and pays for power sector investments. Although utility-scale solar power can offer some of the lowest generation costs, its procurement is constrained by Pakistan's existing capacity-payment obligations under legacy power purchase agreements with thermal power generators. These obligations require payments to Independent Power Producers (IPPs) regardless of actual electricity dispatch, drastically reducing fiscal and financial space for new renewable energy procurements. The result is a paradox: the new but cheapest sources of power generation may be difficult to procure because the system is already financially locked into paying for expensive legacy capacity.

Currency risk further weakens the bankability of solar power projects. Project developers and lenders often seek dollar-linked returns to protect against rupee depreciation (which has depreciated over 60 percent against US Dollar between 2021 and 2024). The state and the consumers, on the other hand, operate within a rupee-based tariff system, making electricity costlier with each round of devaluation. This mismatch raises the cost of capital required for investment in solar deployment and can erode the apparent cost advantage of solar power.

8. https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2025/Jul/IRENA_TEC_RPGC_in_2024_2025.pdf

2.2. Technical and grid infrastructure barriers

Pakistan's transmission and dispatch systems were designed around large, centralized power plants and are not yet flexible enough to handle high levels of renewable energy such as solar and wind. Weak coordination in energy planning, limited grid flexibility and insufficient investment in energy storage and other balancing solutions increase the risk that electricity generated by utility scale solar power projects will not be fully utilized.

In solar-rich regions such as Sindh and south Punjab, limited electricity transmission capacity becomes another barrier, forcing even the operational solar power plants to fail in delivering all the electricity they generate to consumers. Now project developers are disincentivized by this 'curtailment', fearing that some of their electricity generation may be curtailed without compensation. They will either factor this risk into the project's cost, making it expensive, or choose not to invest at all, hampering or halting solar power capacity additions.[9]

Table 2.1. Mapping Technical Barriers to Policy Responses

Barrier	Why it matters	Policy implication
Weak evacuation capacity in solar rich corridors	Projects may be delayed or generated solar power will be curtailed	Investments in power transmission network before auctions for utility scale solar power projects
Limited system flexibility to add new generation capacity	Solar power output may not match demand patterns	Make investments in battery storage, improve in forecasting and demand response, ensure flexible dispatch commensurate with different generation technologies at different times of the day
Lack of integrated planning	Generation projects are approved without system-level coordination	Devise, publicize and update an Integrated System Plan
Curtailment risk	Project developers raise tariffs to compensate for lost revenue as a result of their curtailed generation	Enhance evacuation capacity to avoid curtailment, compensate developers through non-project missed volume (NPMV), and defined grid-access rules

9. sciencedirect.com/science/article/pii/S2590123025045815

2.3. Regulatory and institutional barriers

The power sector's regulatory environment has been marked by policy uncertainty, delayed implementation and ambiguous long-term capacity targets. Cumulatively, these problems have eroded the investors' confidence. Variable Renewable Energy (VRE) targets – that include solar power deployment in the indicative generation capacity expansion plans (IGCEPs) have fluctuated significantly over the years, often contradicting the 2025 and 2030 VRE integration targets given in the Alternative and Renewable Energy (ARE) Policy 2019. This continued inconsistency has increased perceived investor risk and can raise the cost of capital for them.

Outdated power-grid rules and the absence of clear ways to integrate battery energy storage systems that can support grid stability make solar-plus-battery projects complicated and harder to implement, both technically and legally.[10]

10. sciencedirect.com/science/article/pii/S2590123025045815

Table 2.2 Political economy risks and strategic engagement measures for utility-scale solar power reforms

Actor	Reasons for Resistance to Structural Change	Mitigation Measures
Thermal IPP owners	• Under existing PPAs, they are entitled to guaranteed capacity payments – an arrangement that stands in the way of new RE-based capacity additions. • Their power generation has dispatch priority if any new solar plant competes with their IPPs.	• Targeted renegotiation of PPAs where legally feasible • Voluntary retirement or repurposing of high-cost plants • Introducing compensation mechanisms linked to avoided fuel costs
Fuel importers and traders	• Earnings from gas, coal, and Residual Fuel Oil imports • Large-scale commercial and industrial shares and interests in the energy market	• Incentives for diversification into renewable energy supply chains, logistics, storage and grid service • Participation in green bond or sukuk-financed infrastructure
DISCOs (Distribution Companies)	• Rooftop solar power connected with the grid undermines the tariff base and impacts revenue streams • Utility scale solar requires grid upgrades at the DISCOs' cost	• Performance-linked financing for loss reduction and grid upgrades • Regulatory incentives to procure least-cost solar power • Carefully regulated participation in distributed or utility scale solar power to manage conflicts of interest
NTDC (Transmission)	• Grid expansion is capital-intensive • VRE increases operational complexity	• Concessional financing for renewable-ready transmission upgrades • Technical assistance for grid integration, forecasting, dispatch protocols, and evacuation planning
Provincial governments	• Undermining of provincial authority to generate, transmit, and distribute electricity within their territorial jurisdictions due to the presence of the centralized grid • Reluctance to acquire land and approve amenities for federal projects including the VRE ones	• Federal-provincial coordination framework for land acquisition (which ensures community participation/consultation during the acquisition process and establishes a robust grievance redressing mechanism), permitting, revenue-sharing, local employment, and provincial equity participation where appropriate

2.4. The equity gap and utility death spiral

Rooftop solar primarily benefits consumers who can afford it, either through direct investment of their own savings or through access to banks or other modes of financing. Lower-income households and renters often do not have suitable roof space or the financial resources to install solar systems. As a result, they remain dependent on grid electricity and are exposed to rising tariffs. It is the failure to develop utility scale solar power that has created this equity gap since that is one of the most significant means for low income consumers to have access to cheap renewable energy.

As higher-income consumers reduce their grid consumption by switching to solar power or other renewable energy sources, revenues of power distribution companies (DISCOs) may decrease. This decrease will raise the financial burden of the consumers remaining on the grid since they must bear a larger share of the system's costs. These additional costs, in turn, may encourage even more consumers to leave the grid. This creates what is called a utility death spiral, a self-reinforcing financial risk for the distribution system.

Utility-scale solar power can reduce the cost of grid electricity for all consumers, including those who cannot install their own rooftop systems. It is, therefore, not only an energy policy tool but also a matter of social equity.

2.5. Analysis of Pakistan's current utility-scale solar portfolio

Pakistan's documented utility-scale solar portfolio is spread across 14 projects and has a totals electricity generation capacity of about 1,030 MW. Out of this capacity, however, only 780 MWs were commercially operational before 2024. This low level of operational capacity shows that Pakistan is significantly behind in meeting the targets of the 2019 Alternative and Renewable Energy (ARE) Policy, which aims for the induction of 30 percent variable renewable energy, including solar power, in the power mix by 2030.

As shown in the table below, utility-scale solar projects are quite concentrated geographically, with five of them located in Quaid-e-Azam Solar Park, in Bahawalpur district. The five projects have a combined electricity generation capacity of about 500 MW. Several others are located along Sindh's coastal belt.

As is obvious from the table below, Pakistan's overall utility scale solar portfolio remains too small to meet the country's renewable energy needs. This shortfall reflects regulatory and financing challenges rather than a lack of solar resources.

To assess the current status, financial structures and broader implications of utility scale solar power, below we have compiled data on all utility scale solar projects in Pakistan using project information supplemented by publicly available data from NEPRA and the Private Power and Infrastructure Board (PPIB). [11]

11. Capacity factor is the ratio between the actual energy output of a solar power plant over a period of time and the theoretical maximum energy it could produce if it operates at full nameplate capacity continuously during that period.

Table 3.1. Utility Scale Solar Projects in Pakistan

Project Developer	Latest Tariff (Rs/kWh) (Apr-Jun 2026)	Plant Size	Location	Commis-sioning Date	Project Cost (US Dol-lars)	Debt-Equity Ratio	Financing / Major Lenders	Designed Capacity Factor (in percent-age)***
Atlas Solar Limited	12.220	100 MW	Rakh Choubara, Layyah District	2022	57.39 million	80:20	CDC Group PLC (BII), Habib Bank Limited	21.51
AJ Power (Private) Limited	28.7755	12 MW	Adhi Kot, Khushab, District	13 December 2017	15.62 million	75:25	Bank of Punjab, MCB Bank Limited UAE, MCB Bank Limited Bahrain	17.00
Apollo Solar Development Pakistan Limited (ASDPL)	50.3075	100 MW	Quaid-e-Azam Solar Park, Bahawalpur District	August 2016	151.43 million	75:25	China Exim Bank, China Development Bank (CDB)	17.21
Best Green Energy Pakistan Limited	46.7597	100 MW	Quaid-e-Azam Solar Park Bahawalpur District	31 July 2016	151.43 million	75:25	China Exim Bank, Bank of Jiangsu Co. Ltd.	17.99
Crest Energy Pakistan Limited	47.3260	100 MW	Quaid-e-Azam Solar Par, Bahawalpur District	31 July 2016	151.43 million	75:25	China Exim Bank, China Bohai Bank Tianjin Pilot Free Trade Zone Branch	17.99
Gharo Solar Limited	16.8142	50 MW	Deh Ghairabad, Mirpur Sakro, Thatta District	23 December 2019	37.5 million	75:25	FMO (Dutch Entrepreneurial Development Bank), Bank Alfalah, Bank of Punjab	22.21
Harappa Solar (Pvt.) Limited	29.0090	18 MW	Harappa, Sahiwal District	14 October 2017	23.43 million	75:25	Bank of Punjab, Askari Bank Limited, ECO Trade & Development Bank, Pak-Oman Investment Company Ltd.	17.22

Helios Power Limited	10.9953	50 MW	Goth Gagrwra, Saleh Pat, Sukkur District	01 February 2024	30.34 million	80:20	Faysal Bank Ltd., Bank of Punjab, Pakistan Kuwait Investment Company, Bank Islami, Dutch -FMO	22.33
HNDS Energy Limited	10.9953	50 MW	Goth Gagrwra, Saleh Pat, Sukkur District	10 January 2024	30.34 million	80:20	Faysal Bank Ltd., Bank of Punjab, Pakistan Kuwait Investment Company, Bank Islami, Dutch-FMO	22.23
Meridian Energy Limited	10.9953	50 MW	Goth Gagrwra, Saleh Pat, Sukkur District	19-Jan-2024	30.34 million	80:20	Faysal Bank Ltd., Bank of Punjab, Pakistan Kuwait Investment Company, Bank Islami, Dutch-FMO	22.33
Quaid-e-Azam Solar Power (Pvt.) Limited	17.7179	100 MW	Quaid-e-Azam Solar Par, Bahawalpur District	15 July 2015	151.43 million	75:25	The Bank of Punjab, Lahore	18.30
Oursun Pakistan Limited	29.8454	50 MW	Gharo, Thatta District	30 November 2018	62 million	75:25	United National Bank Ltd. (UK), Bank of Punjab, Askari Bank Limited	17.50
Zorlu Solar Pakistan Ltd	Tariff decision awaited from NEPRA	100 MW	Quaid-e-Azam Solar Par, Bahawalpur District	December 2026*	38–42 million	65:35	IFC, ADB, ECO Trade & Development Bank	22.97
Siachen Energy Ltd	Tariff decision awaited from NEPRA	100 MW	Taluka Mirpur Sakro, Thatta District	June 2028**	77.51 million	80:20	International commercial facilities backed by Sinosure (China Export & Credit Insurance Corporation)	22.06

The above table shows that not a single new project was commissioned in 2025 and that the two projects still in the pipeline, Siachen Energy and Zorlu Solar at 100 MW each, remain stuck in regulatory midpoint with tariff approvals still pending. Their projected commissioning dates are almost certainly unrealistic. Every year that these projects sit idle, Pakistan forgoes roughly 175–200 gigawatt hours of fuel-free electricity per project and continues burning imported fuel it could have avoided.

The portfolio, however, reveals something deeper than just administrative delays. The per unit tariff of these projects ranges from a low of 10.99 rupees to a very high of 50.3075 rupees, highlighting a fourfold difference for the same technology, in the same country and sometimes within the same district. Three projects commissioned in Bahawalpur in 2016 carry tariffs that differ from that of an earlier project in the same district by almost a factor of three. Obviously, this difference has nothing to do with the availability of sunlight or variations in technology.

This is also proven by another factor. The difference between the designed capacity factors of the projects listed above (varying between 17 percent and 22.97 percent) highlights a narrow inter-project spread -- roughly 5-6 percentage points – even when the projects are geographically dispersed. This indicates that Pakistan's horizontal solar irradiance is broadly adequate and fairly uniform across major solar power deployment zones. The solar resource quality, therefore, is not the binding constraint on utility scale solar deployment.

The tariff differences, instead, are entirely a product of how these projects have been financed and how their governing contracts have been designed. Differences in financing modes, tariff determination methodologies, dollar indexation mechanisms, exchange-rate adjustments, and project commissioning periods rather than differences – these are the reasons why their tariffs differ so widely.

High debt to equity ratio (75-80 percent), too, is an important reason why tariffs for most of these projects are high. Given Pakistan's poor credit rating, the dollar part of their debt attracts as high an interest as 7-12 percent. When translated into tariff, this high borrowing cost ends up determining to a large extent what consumers ultimately pay. Rupee depreciation makes this cost worse over time. A project that was paying 100 rupees in 2015 for every dollar of interest on its foreign exchange borrowing is now paying 280 rupees for the same dollar. These costs are likely to increase in the future with further devaluation of the rupee. Given that older solar panels produce lower electricity than the new one, the combined cost of their borrowing and decreased productivity also leads to increases in their consumer tariff.

The project development costs in rupee have also gone up by the same rate due to devaluation. For instance, if a project cost 13.4 billion rupees in 2015 it will cost 20 billion rupees in 2025-26 even though its actual hardware is 53 percent cheaper in dollar terms nowadays. Ultimately, it is the consumer who pays for these changes.

Meanwhile, wealthier households have been increasingly installing rooftop solar systems and reducing their reliance on the grid. This makes the remaining grid consumers, predominantly low-income families, renters, and rural households, to shoulder the grid's financial obligations that were never designed with them in mind. Consequently, household electricity bills have risen fivefold since 2015 for consuming the same amount of electricity.

The contract structures are another major problem. The long-term value to be retained by the state at the expiry of a contract varies depending on contractual arrangements, residual asset condition and rehabilitation requirements. Under most of the solar power contracts mentioned above, Pakistan gets nothing of lasting value when a 25-year contract expires. Either the developer walks away with a worn-out asset or the state inherits a plant that needs expensive rehabilitation or repurposing.

While all these factors have contributed significantly both to the project-level and consumer-level costs of utility scale solar projects in Pakistan, the biggest factor hindering further solar deployment at the same level is the unavailability of finance. Since Pakistani banks alone cannot arrange all the money required to finance solar power projects, this leaves Pakistan dependent on foreign banks and multilateral lenders in general and Chinese banks in particular both of which have grown wary of the fact that Pakistan's power sector is plagued by capacity payment delays and overridden by circular debt. This explains why financing was only possible through sovereign guarantees or multilateral lending for every project in the table above, a sign that private capital simply does not trust the system on its own terms.

The absence of energy storage across the entire solar portfolio compounds the financial problem further. Since solar power without storage cannot serve evening peak demand or provide the grid services the system increasingly needs, prospective investors find it less attractive than other investments in the energy sector.

The planned shift to competitive procurement -- under Competitive Trading Bilateral Contracts Mechanism (CTBCM) for bulk electricity consumers such as industries, shopping malls and gated residential neighborhoods -- could have changed this picture but it has already been delayed for years beyond its original kickoff date in 2020. Even though it is being operationalized now, it will cover only 200 MW in its first phase and a collective total of 800 MW in the next three years, creating little room for the deployment of new renewable energy projects.

And then there are the system costs. Whatever cheaper electricity the new and competitive auctions for setting up solar power projects will eventually deliver, its consumers will still be paying for the previous utility scale solar and other contracts for years to come. This also brings transmission into the equation as well. While existing transmission lines are seriously inadequate and weak to carry variable renewable energy -- such as solar and wind power – to consumers without the risk of creating blackouts and new investments in transmission are being entirely planned for large-scale hydropower projects, investors will remain wary of betting their money on solar projects. Many investors who helped develop wind power projects between 2013 and 2025 are already ruing their losses because the national grid's inadequate transmission network has failed to evacuate all the electricity that these projects can produce.

The evidence, thus, shows that Pakistan's utility-scale solar challenge is not one of resource availability or technology's cost and performance. The existing projects demonstrate adequate solar resource quality and operational viability. The principal constraints, as explained above, are financing costs, off-taker risk, regulatory uncertainty and insufficient transmission planning.

3. Mechanisms and policies required to accelerate utility scale solar development

Regional and domestic experience shows that utility scale solar power can be deployed when competitive procurement is combined with credible payment security, transmission planning, and targeted financial de-risking instruments. The solar power policy package should, therefore, be sequenced around three priorities: first, making projects bankable through competitive auctions, payment security, and standardized contracts; second, reducing project risk through transmission readiness, solar parks development, and grid-integration planning; and third, mobilizing long-term domestic capital through Green Sukuks, GSSS bonds, and regulated financial aggregation platforms.

3.1. Conducive policies for utility scale solar – regional experience

Pakistan's utility-scale solar power capacity is estimated at 780 MW. India, in comparison, is expected to commission approximately 32,500 MW of new utility-scale solar capacity by the end of 2026. China, meanwhile, had already installed approximately 1.18 million MW (1,180 GW) of cumulative solar power capacity by the end of 2025. Based on China's National Energy Administration data, cumulative installed solar capacity reached approximately 1.25 million MW (1,250 GW) by April 2026.[12] [13] [14] [15] [16] [17] This comparison demonstrates that resource availability alone

12. https://www.pv-magazine-india.com/2026/02/27/india-expected-to-install-about-42-5-gw-of-new-solar-capacity-in-2026-jmk-research
13. https://www.pv-magazine.com/2026/01/20/pakistans-installed-pv-capacity-estimated-above-27-gw
14. https://www.pv-magazine.com/2026/01/28/china-adds-315-gw-of-solar-in-2025
15. https://english.www.gov.cn/archive/statistics/202602/12/content_WS698d93cbc6d00ca5f9a091bb.html?utm_source=chatgpt.com
16. https://news.metal.com/newscontent/103920517-national-energy-administration-new-pv-installations-in-april-reached-952-gw
17. https://english.scio.gov.cn/m/pressroom/2026-04/24/content_118460594.html

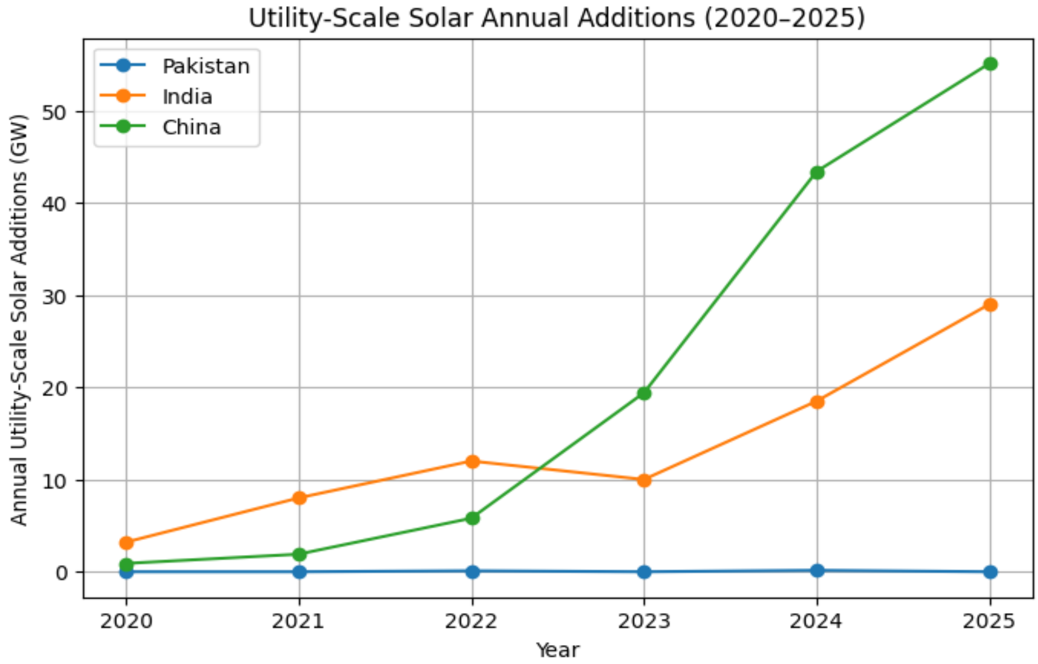


Figure 3.1. Annual Utility-Scale Solar Additions (GW per year) [18][19][20]

does not guarantee large scale renewable energy deployment. Rather, successful utility scale solar power expansion depends on a combination of enabling policies, investment certainty, competitive procurement mechanisms, transmission infrastructure, and institutional readiness.

3.1.1. India's experience of competitive auctions and institutional capital mobilization

India's example demonstrates that policy clarity, competitive procurement and publicly enabled project preparation can mobilize large scale private investment in solar power without requiring the state to act as the direct owner of the power generation projects. Its use of competitive auctions through the National Solar Mission and the Solar Energy Corporation of India helped reduce solar power tariffs significantly by creating transparent price discovery, scale, and investor confidence. The framework of its Infrastructure Investment Trusts (InvITs) has enabled it to refinance operational renewable assets, recycling capital into new projects and attracting institutional investors such as pension funds, insurance companies and sovereign wealth funds that are entirely absent from Pakistan's renewable energy financing landscape.[21]

18. https://www.iea.org/data-and-statistics/charts/global-utility-scale-installations-in-selected-countries-and-regions-2020-2025
19. https://www.ppib.gov.pk/commisioned_ipps.html
20. https://mnre.gov.in/
21. climatepolicyinitiative.org/mobilizing-institutional-investment-in-indian-renewables

The key lesson for Pakistan is that competitive auctions work best when they are supported by pre-developed sites, clear grid-connection arrangements, standardized contracts and credible off-taker/payment structures. Auctions alone will not deliver low tariffs if investors have to price in payment delays, currency risk and/or curtailment risk.

3.1.2. China's state-enabled and finance-driven experience

China illustrates a different pathway in which state-enabled low-cost capital, coordinated industrial policy and grid-scale planning have driven rapid solar power expansion. Through central bank interventions such as green re-lending facilities and the acceptance of green bonds as eligible collateral, China has embedded variable renewable energy investments within its financial system. Its installed utility scale solar power capacity surpassed 700,000 MW by mid-2025, more than the rest of the world combined.[22] Critically, Its model is not purely premised on state ownership of solar power projects. It is premised upon a state-enabled, finance-driven expansion yet it is the private sector that owns and operates power projects. The state only manages and regulates the financial ecosystem.

Pakistan cannot replicate China's fiscal capacity, its state-owned banking system or its manufacturing scale. It, however, can adopt their underlying principle of using public financial instruments to reduce projects costs and perceived risks for the private capital.

3.1.3. Bangladesh and Sri Lanka: The South Asian comparison

Bangladesh and Sri Lanka may offer more directly relevant comparisons for Pakistan because they face similar constraints around fiscal space, imported energy exposure, grid limitations and dependence on foreign development-finance. Bangladesh achieved its first utility scale solar power auction tariff of 7.5 cents/kWh in 2020 through a World Bank-backed competitive procurement framework. This tariff subsequently declined to 4.8 cents/kWh by 2023 through successive bidding rounds.

Despite macroeconomic crisis conditions, Sri Lanka, too, maintained its solar power pipeline and pushed toward a 70 percent renewable electricity generation target by 2030 through blended finance instruments and guarantees provided by the Asian Development Bank (ADB).

Both these countries demonstrate that competitive auctions and targeted de-risking instruments can generate bankable projects even in challenging macroeconomic environments similar to Pakistan's. The lesson to be learnt from them: when procurement is transparent, risk allocation is clear and development finance is used to crowd in rather than replace private capital, other constraints come down substantially.

3.1.4. K-Electric 2025: Pakistan's first competitive renewable energy auction

The most directly relevant evidence comes from within Pakistan itself. In 2025, K-Electric (KE), Karachi's vertically integrated electricity company, conducted the country's first competitive renewable energy auctions under the National Competitive Bidding Tariff Regulations (NCBTR) 2017, following NEPRA's

22. globalenergymonitor.org/report/chinas-solar-and-onshore-wind-capacity-reaches-new-heights
23. Electricity prices update for 2025

approval of KE's Power Acquisition Plan (PAP 2024–30).[23] The competitive process produced three projects, with a total capacity of 370 MW. Subsequently, NEPRA duly approved their respective Bid Evaluation Reports (BERs). The details of the bids are as follows:

- A 220 MW site-neutral hybrid project at Dhabeji attracted a bid price of approximately 3.09-3.1 cents/kWh (PKR 8.91/unit); the bid was submitted by JCM Power, a Canadian firm, and is set to result in 200 million US dollars in foreign investment. [24] [25]
- Two 150 MW solar power projects to be set up in Balochistan (on the outskirts of Karachi) attracted a bid price of 4.0363/kWh (Rs 11.6508/unit; these are two be set up in Winder (50 MW) and Bela 100 MW) [26] by Master Textile Mills Limited. These projects are estimated to displace expensive existing generation and thus generate annual foreign exchange savings of 17.01 million US dollars which will amount to 425.2 million US dollars over their lifespan. [27]

These auction results suggest that significantly lower renewable energy tariffs are achievable even in Pakistan when procurement process is competitive, project terms are clear, evaluation criteria is transparent and off-taker risk is perceived to be manageable. Their success is derived by three factors absent in most other federal government procurements: clear and stable contractual terms, creditworthy off-taker status (with KE's private ownership and regulated revenue stream reduced investor risk), and a streamlined permitting process. Adapting these conditions at the federal level will require transparent auction designs, bankable standardized contracts, credible payment security, and clear grid-access arrangements either through Central Power Purchasing Agency (PPA-G) or through DISCO-backed procurement. Also, the federal level utility-scale solar power deployment has lagged because procurement has remained fragmented and project-specific while grid planning, payment security and local-foreign currency financing have not evolved into a coherent framework for large-scale solar power integration.

24. K-Electric Advances 220 MW Renewable Energy Project
25. K-Electric's $2 Billion Power Sector Modernization Plan Unveiled | Nukta
26. Nepra clears KE's BERs for two solar, one hybrid projects - Business Recorder
27. Consumers to bear burden as K-Electric allowed to build recovery losses into tariff - Business - DAWN.COM

Table 3.2. Illustrative comparison of policy and financing models for USS development [28] [29] [30] [31] [32] [33]

Feature	Pakistan (Federal)	KE (Pakistan)	India	China
Procurement model	Negotiated IPP PPAs	Competitive reverse auction	Competitive auctions (SECI)	State-directed + market
Latest solar tariff	3.95 -16.99 ¢ents/kWh (2026)[34]	3.4–3.7 ¢ents/ kWh (2025)	1.9–2.5 ¢ents/kWh (2023)	1.5–2.0 ¢ents/kWh (2024)
Off-taker risk	High	Low (private, regulated)	Medium (state DISCOMs)	Low (state utilities)
Currency indexation	US Dollar-indexed PPAs	Local PKR + hedging	INR-denominated	RMB (Yuan) -denominated
Capital market role	Minimal	Limited	InvITs, Green Bonds	Green bonds, re-lending
Grid planning	Project-by-project	Integrated local plan	Solar parks model	Centralized IRP
Pakistan applicability	Status quo — must change	Model could be replicated	Adapt auction + park model	Adopt de-risking tools only

Note: Tariff comparisons are indicative and should be interpreted with caution, as auction results vary by project size, financing structure, currency, off-taker risk, land acquisition and grid arrangements, tax treatment, and contract terms.

28. https://www.sciencedirect.com/science/article/pii/S0140988323001949#:~:text=Based%20on%20an%20ROE%20of%2015%25%2C%20cost%2Dof%2Ddebt,of%20USS%20in%20Pakistan%20averages%20around%207.86%25
29. https://www.transitionzero.org/shedding-light-on-pakistans-distributed-solar-revolution
30. https://ieefa.org/wp-content/uploads/2020/05/Indias-Utility-Scale-Solar-Parks-Success-Story_May-2020.pdf
31. https://globalenergymonitor.org/report/chinas-solar-and-onshore-wind-capacity-reaches-new-heights-while-offshore-wind-shows-promise/#:~:text=As%20of%20May%202025%2C%20China,demand%20of%20Luxembourg%20in%202023.&text=Wind%20power%20has%20followed%20a,gigawatt%20hours%20(GWh)%20annually.
32. https://www.atlanticcouncil.org/blogs/energysource/china-builds-more-utility-scale-solar-as-competition-with-coal-ramps-up/
33. https://ke.com.pk/kes-220-mw-hybrid-project-marks-a-milestone-in-pakistans-renewable-energy-transition/#:~:text=Karachi%2C%20February%204%2C%202025:,energy%20to%20its%20generation%20mix.
34. https://nepra.org.pk/tariff/Generation%20IPPs%20Solar.php

3.2. Easing financing mechanisms

The cost of capital is a central obstacle to utility scale solar power deployment in Pakistan. High perceived risk — including off-taker risk, currency risk, regulatory uncertainty, and curtailment risk — raises the need for high required returns on investment and can offset the positive effects of decline in solar technology costs in recent times.

To address this problem, Pakistan needs a sequenced financing architecture that consists of the following three pillars:

- Blended finance to overcome near-term bankability gaps
- Public finance to provide enabling infrastructure and risk mitigation
- Domestic institutional capital to supply the long-term funding engine after projects are operationalized and risks are better understood.

3.2.1. Pillar A: Blended finance

Blended finance can be used strategically to mobilize private investment by absorbing risks that commercial lenders are currently unwilling to bear. In Pakistan's case, it should be targeted at specific bankability constraints: power price payment risk, currency risk, early-stage project preparation risk and power curtailment risk.

The core logic of blended finance is simple. It is meant to absorb the 'first-loss' risk that has to be absorbed by the core investors of a project and is, therefore, seen by commercial investors as prohibitive. Concessional public financial instruments can help avoid this risk, making the projects bankable without requiring inflated tariffs.[35] Pakistan can deploy the following suite of targeted instruments through the Green Climate Fund (GCF), Asian Development Bank (ADB), and GFANZ-affiliated institutions to overcome that risk:

- **Concessional loans and grants (GCF/ADB):** Direct injections of below-market rate capital into project financing structures to reduce the weighted average cost of capital (WACC). A first-loss covering tranche from concessional lending sources such as GCF or multilateral development banks (MDBs) could reduce the risk to be borne by core lenders and help lower the overall capital cost.
- **Risk-sharing facilities and guarantees:** MDBs-backed payment guarantees that absorb off-taker risk -- that is, the risk that power purchasing entities will not be able to pay for it), the single most cited barrier by international solar developers in Pakistan. [36] [37]

35. https://illuminem.com/illuminemvoices/42-concessional-capital-is-the-unsung-hero-of-green-finance
36. chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://ppp.worldbank.org/sites/default/files/2021-10/A%20Solar%20Developer%E2%80%99s%20Guide%20for%20Pakistan.pdf
37. https://courtingthelaw.com/2018/12/15/commentary/challenges-of-mainstreaming-renewable-energy-in-pakistans-generation-mix

- **Debt-for-climate swaps:** Debt-for-climate swaps could be explored as a medium-term instrument to convert portions of bilateral debt-service obligations into domestic renewable-energy investments but these should be strictly subject to creditor interest, fiscal transparency and credible project pipelines. Egypt converted its =1.3 billion US dollar debt under European sovereign lending into climate finance commitments, a mechanism that can be directly applicable to Pakistan's 7+ billion US dollars bilateral debt owed to UAE and Saudi Arabia.[38] [39]
- **Philanthropic-Public-Private Partnerships (4P):** These partnerships could play a limited but useful role in funding early-stage project preparation, feasibility studies, community engagement and technical assistance.

3.2.2. Pillar B: Public finance

Given Pakistan's fiscal constraints and the existing financial stress of its power sector, public finance should be used selectively to unlock private investment rather than to expand direct state ownership of power projects. Historically, state-owned power plants have been marred by inefficiencies, having exacerbated the public debt burden. The state's role must, therefore, change from 'developer' to 'enabler', concentrating public investments in enabling infrastructure and risk mitigation that unlocks private investment.[40] Such investments could go into:

- developing transmission infrastructure as a public good. Transmission upgrades in priority solar corridors should be planned and financed as enabling infrastructure before auctions are carried out. Passing these costs entirely to project developers risks increasing bid tariffs and weakening project economics. Publicly financed transmission networks remove the single largest technical barrier to utility scale solar power in Pakistan.[41] [42]
- solar parks development. PPIB and provincial governments should prepare pre-approved solar park sites where land acquisition, permits, environmental clearances and grid-connection arrangements are in place before competitive auctions are carried out. While doing all this, it must be ensured that communities to be affected by the projects are consulted to their satisfaction during the land acquisition process and a robust grievance redressing mechanism is established to register and resolve their complaints.
- payment security mechanisms. New utility scale solar power projects should be supported by credible payment-security structures, such as escrow accounts, payment security funds, partial risk guarantees, or MDBs-backed instruments to reduce off-taker risk.
- a revived or expanded green refinancing facility by the State Bank of Pakistan. It could support local-currency lending for utility scale solar power projects, particularly if combined with clear eligibility criteria, tenor support and safeguards against excessive fiscal exposure.

38. https://www.dawn.com/news/1929887#:~:text=ISLAMABAD:%20Pakistan%20has%20a%20significant,prepare%20projects%20to%20benefit%20first
39. https://english.ahram.org.eg/NewsContent/3/12/541902/Business/Economy/IMF-approves--bln-loan-to-support-Egypt%E2%80%99s-Climate-.aspx#:~:text=Ahram%20Online%20%2C%20Wednesday%2012%20Mar,National%20Climate%20Change%20Strategy%202050.
40. pide.org.pk/research/pakistans-power-sector-woes-part-iii
41. https://www.adb.org/projects/48078-006/main#:~:text=Sovereign%20Project%20%7C%2048078%2D006&text=In%20October%202022%2C%20ADB%20received,%2C%20EU%2C%20and%20the%20UN.
42. https://www.dawn.com/news/1634908#:~:text=NTDC%20secures%20Rs6.-,4bn%20loan%20for%20grid%20station%2C%20transmission%20lines'%20construction,while%20speaking%20on%20the%20occasion.

3.2.3. Pillar C: Domestic institutional capital

Pakistan's renewable energy financing remains heavily dependent on bilateral and multilateral development finance which is useful for demonstration and de-risking but insufficient for systemic scaling up of energy projects. Long-term growth of these projects requires mobilizing the country's own institutional capital -- from pension funds, insurance companies, mutual funds and the Islamic finance sector.[43] The instruments to do so can include:

- Sovereign and corporate green, social, sustainable and sustainability-linked (GSSS) bonds that can aggregate fragmented solar power projects into large, tradable instruments that match institutional investors' risk appetites.[44] They need to be supported by credible project pipelines, transparent use-of-proceeds frameworks and independent verifications.
- Green Sukuks (Islamic bonds) then can provide a Shariah-compliant channel for mobilizing domestic and regional capital into verified renewable-energy assets since Pakistan's Islamic banking sector commands over 25 percent of total banking assets and is growing at 20 percent plus per year.[45] The State Bank of Pakistan's Islamic Banking Bulletin (2024) identifies renewable energy as a priority sector for Islamic finance expansion yet no utility-scale solar sukuk has been issued to date. PPIB, working with the Securities and Exchange Commission of Pakistan, should develop a standardized Green Sukuk framework for financing utility scale solar power projects by the end of 2026.
- Infrastructure Investment Trusts,[46] that, drawing from India's experience, can refinance mature solar power projects and recycle their developers' capital into new projects through stock exchange. For this to happen, projects must first become operational and demonstrate stable cash flows.
- A gradual shift towards rupee-denominated or partially hedged tariff structures that can reduce fiscal exposure to exchange rate depreciation. This will require longer-tenor local-currency debt, credible hedging instruments, and risk-sharing support from public finance or development-finance institutions.

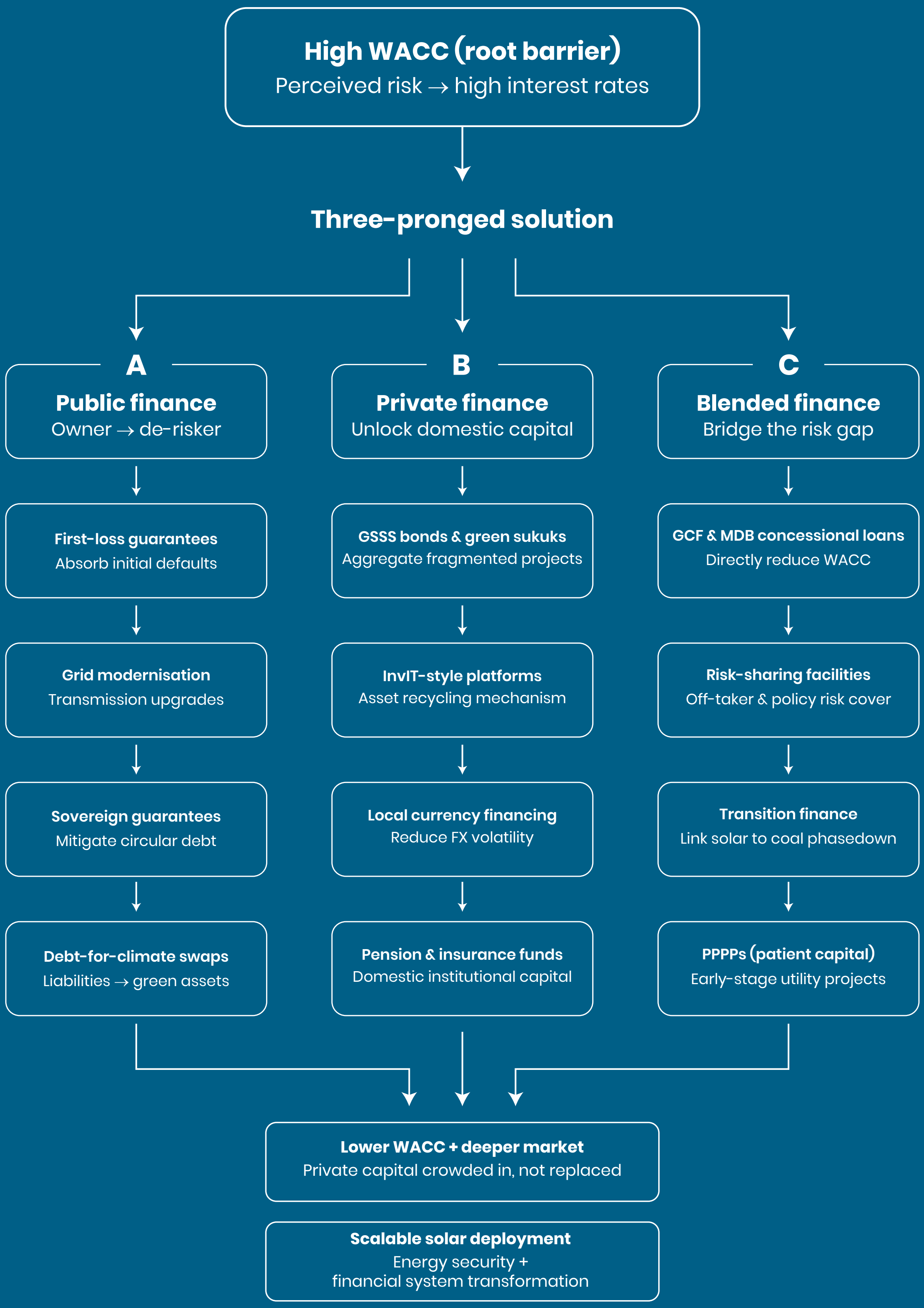
43. undp.org/sites/g/files/zskgke326/files/2023-09/policy_brief_-_greening_the_financial_system_of_pakistan_2023.pdf
44. https://creit.com.ph/press-room/blogs/what-are-green-bonds/#:~:text=Support%20for%20Local%20Sustainability%20Goals,impact%20of%20green%20bond%20investments
45. sbp.org.pk/ibd/Bulletin
46. climatepolicyinitiative.org/mobilizing-institutional-investment-in-indian-renewables

Table 4.1. Priority Mechanisms to Support Utility Scale Solar Development

Timeframe	Priority mechanism	Purpose	Lead institutions
Immediate	Competitive auctions with standardized PPAs	Transparent price discovery and investor confidence	PPIB, NEPRA, CPPA-G
	Payment security mechanism	Reduce off-taker risk	Ministry of Finance, CPPA-G, MDBs
	Transmission and solar park preparation	Reduce evacuation and curtailment risk	NTDC, PPIB, provincial governments
Short to medium term	Blended finance/ first-loss facilities	Decrease WACC and crowd in private capital	GCF, ADB, World Bank, Ministry of Finance
Medium term	SBP green refinancing / local-currency lending	Reduce currency mismatch	SBP, commercial banks
	Green Sukuk and GSSS frameworks	Mobilize domestic institutional capital	SECP, SBP, stock exchange, Ministry of Finance
Long term	InvIT-style aggregation/asset recycling	Refinance operational assets and scale market depth	SECP, stock exchange, institutional investors
Exploratory	Debt-for-climate swaps	Convert sovereign debt relief into renewable investments	Ministry of Finance, creditors, MDBs

Pakistan Solar **Financing Architecture**

Evolving the state from “owner” to “risk-guarantor”



State role: competitive auctions + integrated grid planning

Hybrid model: state manages risk • private sector manages operations

Neither full state ownership nor unmitigated private investment achieves scale

4. Risk landscape and strategic mitigation

As explained above, utility scale solar power deployment in Pakistan is constrained by a set of interconnected technical, commercial, regulatory and institutional risks. For solar power projects to become bankable, these risks must be identified, allocated to the actors best able to manage them, and mitigated through credible policy, financing, and grid-planning instruments.

Table 4.2. Risks and Mitigation Measures

Risk category	Why it matters	Main impact	Proposed mitigation
Grid evacuation risk	Solar-rich areas may lack adequate transmission capacity	Project delays, curtailment, higher tariffs	Transmission upgrades before auctions; preparing solar parks with ready grid access
System balancing risk	Solar output varies during the day and may not match demand peaks	Curtailment, reliability concerns	Improved demand forecasting, flexible dispatch, demand-based response, storage where justified
Off-taker/ payment risk	Payment delays reduce investor confidence	Higher WACC, limited private participation in project financing	Payment security fund, escrow accounts, MDBs guarantees
Currency risk	US Dollar-linked obligations become costly after rupee depreciation	Fiscal stress, tariff increases	Rupee financing, partial hedging of the currency risk, blended local-currency debt
Regulatory risk	Policy reversals or unclear timelines increase uncertainty	Higher bid prices, project delays	Standardized PPAs, binding auction calendar, CTBCM roadmap
Political economy risk	Incumbent interests may resist reform	Delayed implementation	Stakeholder transition plans, contract renegotiations, just transition measures

4.1. Technical risks: Balancing power generation and grid absorption

A central technical challenge for utility-scale solar power is the mismatch between renewable generation potential and the grid's current ability to evacuate, dispatch, and balance the variable power generated by solar power projects. The reason is obvious. Previous planning has focused heavily on increasing generation capacity while transmission expansion, grid flexibility, demand forecasting, electricity dispatch protocols and storage planning did not advance at the same pace. This mismatch creates curtailment risk where variable renewable energy generators may be unable to dispatch their power because of transmission constraints, system inflexibility or low demand during peak solar hours.

The power purchase agreements of most of the existing upfront tariff-based renewable energy power plants contain a clause called non-project missed volume (NPMV) under which the projects are compensated for curtailment. The new developers pitching their projects through competitive bidding may price this risk into their bids, raising their tariffs – as wind power projects in the Jhimpir region in Sindh province have done due to the fact that they frequently face curtailment [47] [48].

To mitigate this, the state must shift its approach from approving isolated projects to an 'infrastructure-first' model, establishing solar parks where transmission and site-enabling infrastructure are provided as public goods. Storage and hybridization should be introduced where grid studies show their clear value for the system, particularly in areas with curtailment risk or evening peak demand. Rather than applying a blanket Battery Energy Storage System (BESS) mandate, Pakistan could acquire storage-readiness for large projects and procure solar-plus-storage competitively where it reduces total system costs.

4.2. Commercial, financial and regulatory risks: Market cancellations and regulatory volatility

Renewable energy projects are delayed, cancelled or 'frozen' less by technology failure and more by unresolved commercial risks. These include off-taker payment concerns, currency exposures, unclear procurement timelines and regulatory uncertainties.

Currency mismatch is a major commercial risk. US dollar-linked tariff obligations can become increasingly costly due to rupee depreciation. Fully rupee denominated returns may be unattractive to foreign investors unless they are supported by hedging, concessional finance or risk-sharing mechanisms.

This financial fragility is exacerbated by policy instability, with abrupt shifts in subsidies or the repeal of contracts leading to project abandonment and protracted international litigation.[49] Mitigation of these

47. https://www.brecorder.com/news/40412286/cheapest-wind-power-unjustified-curtailment-pushes-projects-toward-collapse-fpcci
48. https://www.dawn.com/news/1521088
49. https://www.researchgate.net/publication/400578317_Renewable_Energy_Integration_Challenges_in_Pakistan's_Power_Sector#:~:text=dropped%20but%20in%20Pakistan%2C%20capital,rtainty%20regarding%20power%20purchases

problems should focus on gradually reducing currency mismatch through local-currency lending, partial hedging instruments, blended finance and tariff structures that balance investor protection with consumer affordability. MDBs-backed guarantees, escrow accounts and payment security funds can reduce off-taker payment risk for new projects. These instruments would not solve the problem of circular debt on their own but they could ring-fence payment security for new utility scale solar procurement while broader power sector reforms proceed.

4.3. Policy credibility and implementation risk

Beyond technical and financial risks, a policy credibility gap can also deter investment. When official commitments to renewable energy are not matched by clear policymaking and policy implementation, investors may price this uncertainty as an additional risk premium. For international and domestic capital, this misalignment is not merely a communication failure, it is a financial metric that increases the cost of every project. [50]

On procurement: transparent competitive auctions and standardized contracts can reduce uncertainty and improve investor confidence.	**On grid readiness:** public investment in transmission, improved forecasting, and targeted storage or flexibility services can reduce curtailment and integration risk.
On commercial risk: local-currency financing, partial hedging, payment security mechanisms, and blended finance can reduce exposure to currency and off-taker risk.	**On institutional gaps:** project pipelines must be addressed through standardized taxonomies and targeted technical assistance.

Ultimately, policy credibility will depend on whether Pakistan can align its renewable energy ambitions with fiscal, regulatory and grid-related reforms. Without this alignment utility scale solar power will continue to be perceived as a high-risk infrastructure asset class.

50. uploads.renewablesfirst.org/Capitalizing_on_Green

Table 4.3. Alignment Between Policy Commitments and Implementation Requirements

Government narrative	Operational market reality	Required alignment action
'Pakistan is open for investments in renewable energy'	Circular debt and delayed payments to project developers weaken off-taker credibility, leading lenders to require additional payment security or guarantees.	Establish a transparent payment security mechanism for new utility scale solar PPAs, potentially combining escrow accounts, payment security funds and MDBs-backed guarantees.
'CTBCM will deliver competitive tariffs'	CTBCM implementation timelines remain uncertain, and DISCO-level metering, settlement and billing systems may require further strengthening for its comprehensive application.	Prepare a phased CTBCM implementation roadmap with clear milestones, institutional responsibilities and progress reporting.
'Solar manufacturing policy will reduce costs'	Domestic manufacturing targets of solar panels and other related equipment may not reduce costs unless supported by realistic milestones, quality standards, scale, and competitive input costs.	Introduce gradual incentives for domestic manufacturing rather than setting strict early-stage requirements, ensuring that localization goals do not undermine least-cost procurement.
'Grid is ready for large-scale solar'	Grid readiness varies across solar corridors and additional transmission planning, evacuation studies and flexibility measures are required before large scale auctions are carried out.	Prepare an Integrated Resource Plan and conduct grid-impact studies for large projects; procure storage or flexibility services where system studies show clear value.

4.4. Phased implementation roadmap (2026–2032)

A phased implementation roadmap can help translate this research report's recommendations into sequenced actions. The first phase should focus on the project bankability and the grid readiness; the second on scaling procurement of solar power projects and arranging domestic finance; and the third on market consolidation, asset recycling, and long-term system integration. The final phase should aim to deliver bankable projects, lower tariffs, and a stable, solar-ready grid while minimizing implementation risks.

Table 4.4. Phased Implementation Roadmap (2026-2032)

Reform area	**Phase 1: Foundation (2026–2027)**	**Phase 2: Scaling (2028–2030)**	**Phase 3: Consolidation (2031–2032)**
Policy & regulation	• Prepare a binding CTBCM roadmap • Carry out grid-impact studies and ensure storage-readiness for projects above 100 MW capacity; competitively procure battery energy storage system where its value for the system is demonstrated. • Prepare and periodically update an Integrated Resource Plan aligned with transmission planning, demand forecasts and Nationally Determined Contributions (NDCs) targets. • Enact a provincial coordination MoU for setting up four solar corridors	• Full CTBCM operationalization • SECP makes regulatory framework for Green Sukuk • Requirements are devised for the inclusion of domestic manufactured components in auction criteria	• Review and update Nationally Determined Contributions (NDCs) targets • Evaluate Solar Manufacturing Policy milestones • Integrate carbon markets with power markets
Financing	• Establish a payment security mechanism for solar PPAs, potentially supported by the Ministry of Finance, MDBs, CPPA-G, and SBP where legally appropriate. • Create a GCF/ADB blended finance facility • Pilot Green Sukuk issuance	• Issue sovereign GSSS Bonds • Launch InvIT-style aggregation platform I on the stock exchange • Explore debt-for-climate swap feasibility with bilateral creditors, subject to creditor appetite and project pipeline readiness.	• Increase the share of domestic institutional capital in renewable-energy financing as project track records and regulatory frameworks mature. • Allow asset recycling through InvIT platform

Grid infrastructure	• Commence NTDC transmission upgrades in Bahawalpur and Sukkur corridors • PPIB should carry out solar park site preparation for three locations	• Complete transmission upgrades in all four solar corridors • Procure 500 MW battery energy storage system • Operationalize Gharo/ Jamshoro corridor solar park	• National grid BESS capacity >1,000 MW • Smart grid pilots in 3 DISCOs • Reduce transmission and distribution losses through targeted grid investment and DISCO performance reforms.
Procurement	• Announce competitive auction for a 600 MW solar power project • Review and adapt KE's auction model	• Carry out auction for an 800 MW solar power project • Carry out first solar auction that includes requirements for locally manufactured equipment • Issue solar parks tenders for Layyah and Jhang	• Establish an annual auction cycle • Operationalize 3,000 MW new utility scale solar power capacity • Bring Levelized Cost of Energy (LCOE) below 4 cents/kWh
Manufacturing	• Activate incentives for module assembly of solar panels in line with incentives for Special Economic Zones • Identify and partner with tier-2 module suppliers	• Operationalize the first domestic solar module assembly plant with 200 MW per year capacity) • Ensure 20 percent locally manufactured components in new solar power projects	• Assess localization progress against realistic cost, quality, and competitiveness benchmarks. • Enact solar panel recycling framework • Initiate local inverter manufacturing
Just transition	• Commission National Just Transition Plan • Sign technical assistance agreement with ILO	• Capitalize national just transition facility with 10 billion rupees • Retrain the first batch of 5,000 thermal sector workers	• Enroll all the workers of retired RFO power plants in transition programs • Operationalize economic diversification funds for the districts affected by energy transition

5. Policy Recommendations and Way Forward

5.1. Immediate priorities: make projects bankable

1. **Adopt transparent competitive auctions with standardized PPAs.** Auctions should include clear rules on tariff indexation, curtailment, payment security, land acquisition and grid connection. Local communities should be consulted to their satisfaction, including through a robust grievance redressing mechanism, so that their problems do not remain unheard and unresolved before, during and after the land acquisition process. acquisition process.
2. **Establish payment security for new solar PPAs.** Use escrow accounts, payment security funds, MDBs guarantees or other risk-sharing instruments to reduce the risk of non-payment to solar developers by CPPA-G or DISCOs.
3. **Prioritize transmission readiness before procurement.** National Transmission and Dispatch Company (NTDC) and relevant provincial authorities should prepare electricity evacuation infrastructure in solar corridors before projects auctions are held.
4. **Use blended finance to reduce specific risks.** Concessional finance should be arranged to mitigate payment risk, currency risk, project preparation risk and electricity curtailment risk.

5.2. Grid and system-readiness reforms

5. **Prepare and regularly update an Integrated Resource Plan (IRP).** This plan should align power generation procurement, transmission expansion, demand forecasts, and renewable-energy targets in a single document with clear targets and timelines and clearly assigned powers and responsibilities to different stakeholders.
6. **Use grid studies to determine storage requirements.** The government should carry out detailed studies to ensure storage-readiness for large projects. These studies must also be used for competitive procurement of battery energy storage system where it can reduce total system costs.
7. **Develop solar parks with federal-provincial coordination and a meaningful, participatory and inclusive consultation with local communities.** The two levels of the government should coordinate smoothly and effectively with each other to ensure that the problems of land acquisition, permitting, environmental clearance and grid connection are addressed before auctions are held for solar power deployment. They must also engage the communities to be affected by the projects in a thorough, meaningful, participatory and inclusive consultation process so that their problems before, during and after the project development are not just duly heard but also addressed to their satisfaction.

5.3. Financing and capital-market reforms

8. **Develop local-currency financing pathways.** In order to facilitate and promote local-currency financing of utility scale solar power projects, State Bank of Pakistan (SBP), commercial banks and multilateral development banks (MDBs) should support longer-tenor rupee financing, partial hedging and concessional refinancing.

9. **Create Green Sukuk and GSSS bond frameworks.** Securities and Exchange Commission of Pakistan (SECP), State Bank of Pakistan (SBP), Pakistan Stock Exchange (PSX) and the Ministry of Finance should develop verified frameworks to mobilize Islamic and institutional capital to finance utility scale solar power projects.

10. **Explore aggregation platforms after operational track records emerge.** The policymakers should consider using InvIT-style or yield-vehicle structures once projects demonstrate stable cash flows in order to recycle the investors' money into other projects.

5.4. Medium-term industrial and transition measures

11. **Support gradual domestic manufacturing without undermining least-cost procurement.** The government should initiate a phased localization of solar panel manufacturing, linking it with quality, competitiveness and scale.

12. **Develop a just transition plan.** Workers and communities affected by the reduced use of thermal power generation should be supported through retraining and economic diversification.

13. **Carry out broader circular debt reforms while protecting new solar projects.** Payment security for new solar power projects should be ring-fenced even as the government must carry out a wider power sector financial reform in order to get rid of circular debt and its related problems.

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