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NIBAF Pakistan

Solar Financing

Landscape for Retail and SME Segments in Pakistan

Market Diagnostic Study 2025

Table of Contents

List of Figures

List of Tables

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Acknowledgements

We also acknowledge the contributions of National Institute of Banking and Finance (NIBAF), Pakistan Banks Association (PBA) and Karachi School of Business and Leadership for their support as the official knowledge partners throughout the development of this publication.

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, feel free to reach out to us at: info@renewablesfirst.org

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Acronyms & Abbreviations

AEDB	Alternative Energy Development Board
CPPA-G	Central Power Purchasing Agency Guarantee
DISCO(s)	Distribution Companies
GENCO(s)	Generation Companies
IGCEP	Indicative Generation Capacity Expansion Plan
ISMO	Independent System and Market Operator
KE	K-Electric
NEPRA	National Electric Power Regulatory Authority
NTDC	National Transmission & Despatch Company
PPIB	Private Power & Infrastructure Board
SBP	State Bank of Pakistan
AT&C Losses	Aggregate Technical & Commercial Losses
BESS	Battery Energy Storage System
C&I	Commercial & Industrial
DG	Distributed Generation
EPC	Engineering, Procurement & Construction
IPP(s)	Independent Power Producer(s)
kW/kWh/MW/GWh	Kilowatt / Kilowatt-hour / Megawatt / Gigawatt-hour
PV	Photovoltaic
ADR	Advances-to-Deposits Ratio
CDMP	Circular Debt Management Plan
EFS	Export Finance Scheme
EPP	Energy Purchase Price
CPP	Capacity Purchase Price
GDP	Gross Domestic Product
IMF	International Monetary Fund
MDR	Minimum Deposit Rate
MFB	Microfinance Bank
MFI	Microfinance Institution
NBFC/NBFI	Non-Banking Financial Company/Institution
NPL	Non-Performing Loan
ARE Policy 2019	Alternative & Renewable Energy Policy 2019
CTBCM	Competitive Trading Bilateral Contract Market
NDC	Nationally Determined Contribution
NEP 2023-27	National Electricity Plan
RE	Renewable Energy
ESG	Environmental, Social & Governance
PPP	Public-Private Partnership / Power Purchase Price
PPA	Power Purchase Agreement
LGD	Loss Given Default

Executive Summary

The dawn of Pakistan's solar transformation

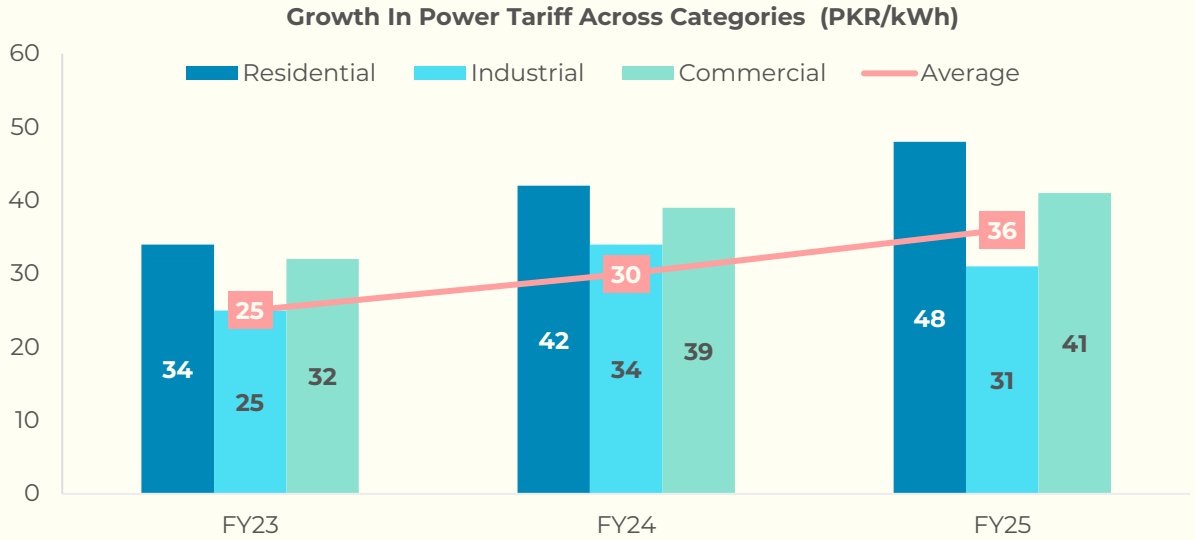
Pakistan's energy landscape has undergone a profound transformation in recent years, driven by a perfect storm of economic necessity, technological advancement, and market dynamics. The nation's energy sector, historically burdened by heavy dependence on imported fuels, faced a critical juncture during the 2022 energy crisis that sent shockwaves through the economy. This crisis, coupled with subsequent economic fallout, catalyzed an unprecedented shift toward distributed solar energy that has fundamentally altered the country's energy paradigm.

The distributed solar revolution in Pakistan represents both a remarkable success story and a cautionary tale about equitable energy transition. While the country has witnessed explosive growth in solar adoption, with net-metering exports increasing by 148% in 2024 and 194% in 2025, this transformation has primarily benefited those with access to capital, leaving vast segments of the population unable to participate despite strong willingness and economic rationale. The missing link in this equation is not technology or demand, but rather the absence of appropriate financial intermediation that could democratize access to solar energy.

The scale of the opportunity is substantial: the distributed solar market in Pakistan's three major cities alone, Karachi, Lahore, and Islamabad, represents approximately PKR 800 billion (USD 2.8 billion) in near-term lending potential under our base-case scenarios. This figure only scratches the surface of the nationwide opportunity, particularly when considering the untapped potential in secondary cities, rural areas, and the now rapidly evolving battery storage market.

The response to converging forces

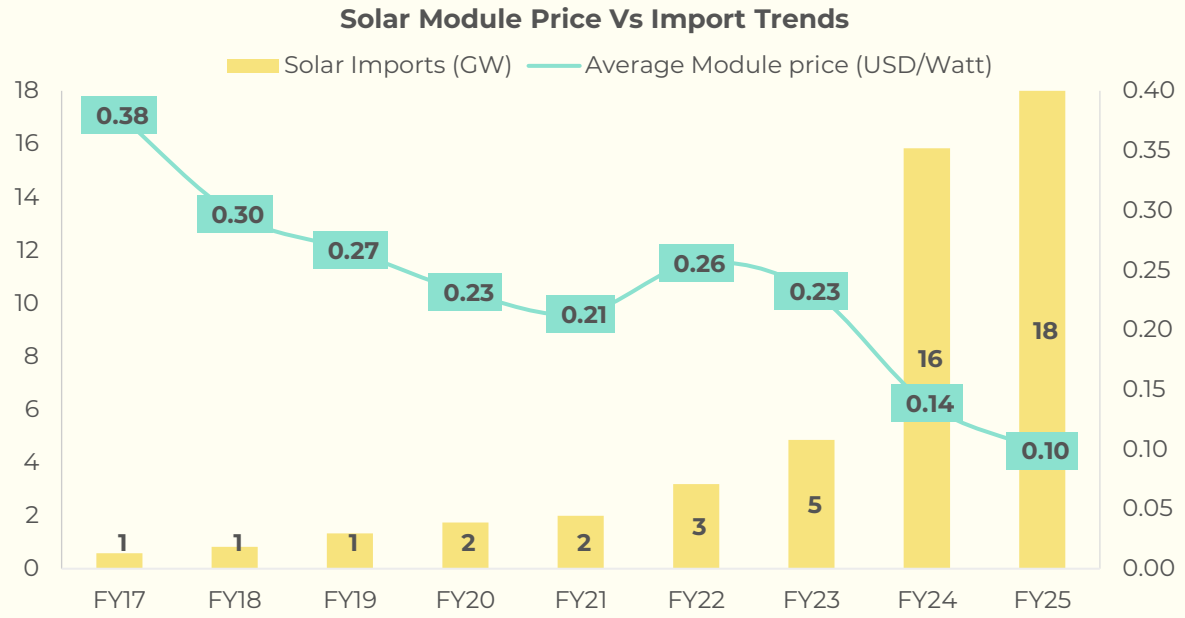
The explosive growth of distributed solar in Pakistan emerged from a confluence of factors that created the perfect conditions for rapid market expansion. At the heart of this transformation lies the dramatic divergence between rising electricity tariffs and falling solar technology costs. Between 2012 and 2025, NEPRA-determined average tariffs surged from PKR 11.89/kWh to PKR 35.5/kWh, representing an almost 200% increase. This rise far outpaced income growth, with GDP per capita increasing by only 51% during the same period. The acceleration was particularly severe between 2023 and 2025, where average tariffs jumped by 43% in just two years.



Source: NEPRA Tariff Updates, Renewables First PMI 2025

Simultaneously, the global solar market underwent its own revolution. A manufacturing glut in China flooded Asian markets with affordable panels, causing average prices in Pakistan to plummet by 73% from USD 0.38/Watt in 2017 to USD 0.10/Watt by 2025, the lowest in history. This price collapse transformed solar from a niche technology to a mainstream consumer product. By early 2024, major

Pakistani cities had become installation hubs, with solar kits marketed with the same accessibility as household electronics.



Source: Renewables First - Solar Import data

The regulatory environment also evolved to facilitate this transition. The 2015 Net Metering Regulations created a crucial pathway for small producers to feed electricity back to the grid, transforming consumers into prosumers. Subsequent amendments, including the extension of license tenure and exemption of systems under 25 kW from licensing requirements, simplified participation and unlocked a new wave of adoption. These regulatory changes, combined with the economic pressures and technological affordability, created an environment where distributed solar became not just viable but essential for many consumers.

The shift in Pakistan's energy generation mix tells a compelling story of structural transformation. The country moved from hydro-dominance in the 1980s to heavy reliance on imported thermal fuels by the 2010s and now stands at the threshold of a renewable energy transition. By 2024, the power sector alone accounted for 62% of total RLNG and 69% of total coal consumption, highlighting the vulnerability of the traditional energy model. The rupee's depreciation from approximately PKR 159/USD in 2019 to PKR 278/USD in 2024 further magnified capacity payments and fuel-cost adjustments, making imported fuel-based generation increasingly unsustainable.

While utility-scale renewable generation has stagnated, distributed solar has surged to fill the gap. Installed capacity expanded by a remarkable 362% between 2023 and 2025. Although net metering exports represented only about 1% of total generation in 2024, the scale and pace of expansion signal a fundamental transformation in consumer behavior and energy consumption patterns.

The financial market's structural constraints

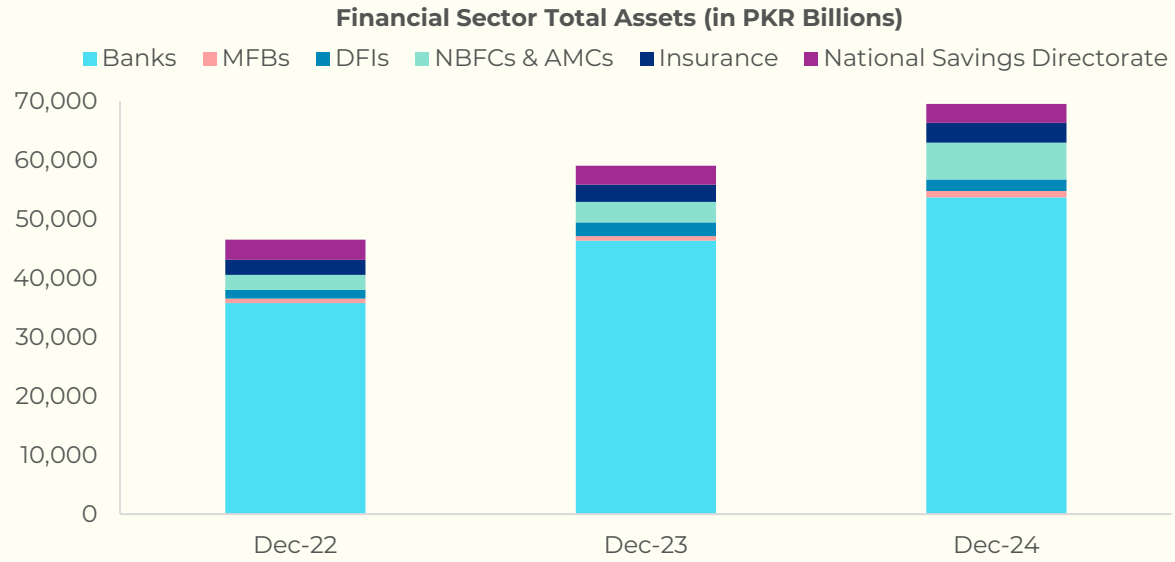
Despite the remarkable growth in distributed solar adoption, Pakistan's financial sector has failed to keep pace with this transformation, creating significant barriers to equitable access. The country's financial landscape presents a paradox: abundant liquidity exists within the system, yet it fails to reach the segments with the strongest economic rationale for solar adoption, mid-tier industries, SMEs, and organized households.

Pakistan's financial sector is dominated by commercial banks, which constitute approximately 77% of the sector's total assets and remain central to lending activities. However, private sector credit has historically been extremely low compared to peer countries and has suffered significantly during the recent economic crisis. This deterioration stems from a pronounced "sovereign-bank nexus," with Pakistan's banking sector holding the largest proportion of government securities relative to total

assets globally, increasingly funded through short-term central bank liquidity using bonds as collateral.

The microfinance banking sector, which serves approximately 10 million borrowers – three-fourths of all retail borrowers nationally – operates through 12 microfinance banks. Despite this extensive reach, the sector remains marginal in rupee terms, representing less than 2% of total financial sector assets due to characteristically small ticket sizes. The sector's trajectory shifted dramatically with the COVID-19 pandemic in 2020, when loan rescheduling and rollover options led to aggressive portfolio restructuring that exceeded genuine distress levels.

The 2022 floods necessitated another restructuring wave, compounding existing vulnerabilities, while the 2023 economic downturn further strained portfolios. The implementation of IFRS-9 accounting standards in 2024 intensified these challenges, while soaring interest rates devastated borrower affordability, triggering widespread defaults as financing costs exceeded repayment capacity.



Source: *State Bank of Pakistan Financial Stability Review 2024*

The core limitation facing solar finance in Pakistan is the fundamental misalignment between cashflow-based solar assets and a credit system optimized for collateralized lending. Solar installations offer predictable savings and stable repayment profiles but have limited collateral value, creating a structural mismatch that leads to persistent under-lending despite manageable risk profiles. Banks and development finance institutions continue to operate primarily as liquidity protectors, prioritizing secured lending and regulatory comfort over their intended role of financial intermediation and support for productive sectors of the economy.

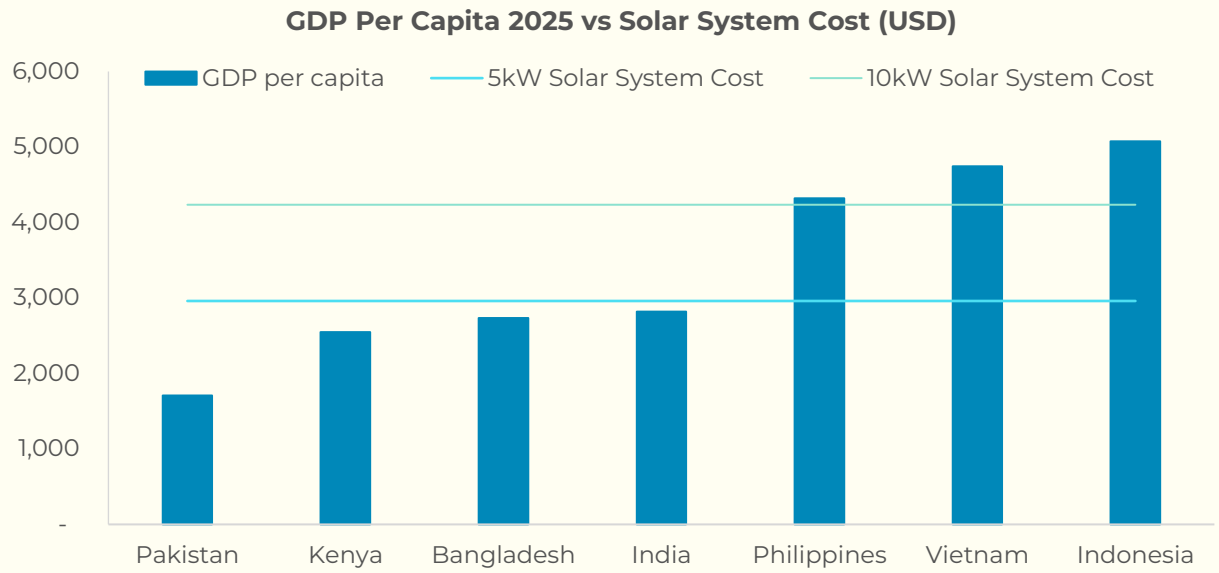
The solar financing equity gap

Pakistan's distributed solar revolution has accelerated rapidly, but its benefits remain unevenly distributed across society. The 'equity gap' captures the critical divide between users who can convert their willingness to adopt solar into actual installations, versus segments where willingness exists but constraints such as upfront capital requirements and lack of credit access prevent adoption. This gap represents not just a market failure but a fundamental challenge to equitable energy transition.

Early adoption has been dominated by affluent households and larger enterprises able to self-finance or access traditional credit channels. These segments have captured the lion's share of benefits from the solar boom, while other segments remain unable to bridge the upfront investment gap despite having strong economic rationale for adoption. The emergence of hybrid solar-plus-battery systems represents the next stage of Pakistan's distributed energy transition, initially driven by load-shedding and tariff shocks.

Early adoption was led by industrial and commercial users seeking power reliability and cost control. As battery pack prices nearly halved between 2023 and 2025, hybrid systems became viable for both

enterprises and high-income households, enabling energy arbitrage and peak-shaving during expensive evening hours.



Source: IMF GDP per Capita 2025, USD Solar System Costs from Industry Sources

Despite the dramatic fall in global solar prices, affordability remains a binding constraint on widespread adoption. The cost of installation, while significantly reduced, still represents a substantial upfront investment that many potential adopters cannot afford without financing. This creates a vicious cycle where those who would benefit most from reduced electricity costs – lower-income households and small businesses facing the greatest burden from tariff increases – are least able to access the technology.

The data reveals striking patterns in consumption changes that underscore the unregistered solar revolution. Between 2022 and 2024, national electricity sales declined by nearly 15 TWh while net-metering barely added 1% to the grid. The industrial and domestic sectors together accounted for more than 12 TWh of that fall. While domestic users' per-household solar uptake remains modest compared to industry, their sheer numbers magnify the effect: total domestic demand dropped by 6.8 TWh, significantly higher than the units generated by net metered systems, implying that unregistered residential PV now substantially offsets daytime consumption.

Testing the market sentiment

Extensive stakeholder consultations revealed critical insights into barriers and opportunities shaping Pakistan's solar finance landscape. These consultations brought together commercial banks, microfinance institutions, digital platforms, EPCs, and credit enhancement agencies.

Financial institution perspectives

Commercial banks controlling USD 131 billion in deposits consistently emphasized collateral quality over transaction pricing. Solar assets are not viewed as reliable security due to insurance depreciation and settlement practices. Islamic banks showed slightly greater cashflow tolerance through Shariah-compliant structures but remain limited to SBP-backed schemes.

Microfinance banks emerged as most adaptable, using behavioral scoring and maintaining sub-2% delinquencies. Institutions like Easypaisa have built massive portfolios through digital channels adaptable for solar. However, these institutions face liquidity mismatches between short-term funding and 5-7 year solar tenors.

Developer and market insights

Industry leaders reported market adjustment following 2023-24's exceptional growth. Panel prices declined 40-50% year-on-year, yet payback periods remain attractive at 1.5-2 years for solar-only and 3-4 years for hybrid systems. Vendors advocate treating solar as bankable through structured partnerships with performance guarantees. Demand remains robust for 2-3 year installment plans.

Consultants highlighted untapped opportunities in lower-income urban areas, referencing successful African PAYG models. These aggregated EPC-led models achieve viability through scale rather than collateral.

Policy and regulatory perspectives

SMEDA identified priority segments: medium enterprises with PKR 200+ million turnover, hospitality and education services, and six industrial clusters including aluminum utensils, agriculture implements, and pharmaceuticals. NCGCL outlined flexible guarantee structures for underserved SMEs and residential segments with stable cashflows but limited formal finance access.

PCRET noted implementation gaps despite 30% renewable targets, with flagship projects facing operational challenges. Battery storage remains a 'major policy blind spot' lacking formal investment plans despite global integration trends.

The market financial opportunity

The untapped potential of Pakistan's solar finance market represents one of the most significant opportunities in the country's financial sector, with quantifiable near-term lending potential exceeding PKR 800 billion in just three major cities. Our market sizing exercise for Karachi, Lahore, and Islamabad reveal substantial addressable markets across multiple segments, with commercial establishments, urban households, and SMEs showing varying degrees of readiness for solar adoption.

The analysis applies conservative eligibility criteria, assuming 15-25% adoption rates for commercial segments, 10-20% for residential customers with net-metering capability, and 25-45% for SME/industrial categories. System sizes were calibrated to typical load patterns: 5-10 kW for residential users, 200-600 kW for SMEs and light industrial facilities, 60-100 kW for schools, and 120-200 kW for hospitals. Capital costs range from PKR 90,000-125,000 per kW for basic installations to PKR 150,000-200,000 per kW for systems including batteries.

Market size estimation

(PKR Bn)	Karachi	Lahore Base Case	Islamabad	Total
Residential	248	253	30	531
Commercial	26	16	4	46
SME	72	387	78	536
Total	**346**	**655**	**111**	**1,113**
Low Penetration				
Residential	120	122	14	257
Commercial	16	10	3	28
SME	24	128	26	178
Total	**160**	**260**	**43**	**462**
High Penetration				
Residential	532	542	64	1,138
Commercial	44	27	7	78
SME	147	782	157	1,086
Total	**722**	**1,352**	**228**	**2,302**

The total addressable market calculation reveals that distributed solar represents approximately PKR 320-350 billion in lending volume over the next three years under conservative scenarios. This figure could expand significantly under more aggressive adoption assumptions or with the inclusion of

secondary cities and rural markets. The market dynamics strongly favor expansion, with demand significantly exceeding supply capacity, industry stakeholders suggest the market could easily absorb manifold increases in financing availability.

With demand, liquidity, and technology readiness already in place, the market awaits only the development of appropriate financial intermediation mechanisms to unlock massive value creation. The constraint is not financial capacity – Pakistan's banking system holds USD 131 billion in deposits against only USD 50 billion in gross advances, operating at a mere 35% advances-to-deposits ratio. Rather, the limitation is institutional design, with banks increasingly parking liquidity in government securities (which now constitute 62.9% of total banking assets) instead of productive lending.

The market's most investable clients, mid-tier industries with turnovers exceeding PKR 200 million, service SMEs, and organized residential users are caught in a structural blind spot within the current financial system. Their credit behavior is observable through energy payments, consumption patterns, transaction data, and digital footprints, yet these indicators are not recognized as valid proxies in formal credit scoring mechanisms. This information friction, rather than actual credit risk, represents the primary barrier to market development.

Financing Potential for Segments

Segment	Total Investment (PKR Bn)	Debt Share (%)	Financing Potential (PKR Bn)
Residential	531	75	398
Commercial	46	60	28
SMEs	536	70	375
Total	**1,113**	-	801

The economic rationale for solar finance is compelling across multiple market segments. For industrial and commercial users, solar offers predictable cost savings that directly improve competitiveness and operational margins. For SMEs, reduced energy costs can mean the difference between profitability and loss in an increasingly challenging economic environment. For households, solar represents not just cost savings but energy security and protection against future tariff increases.

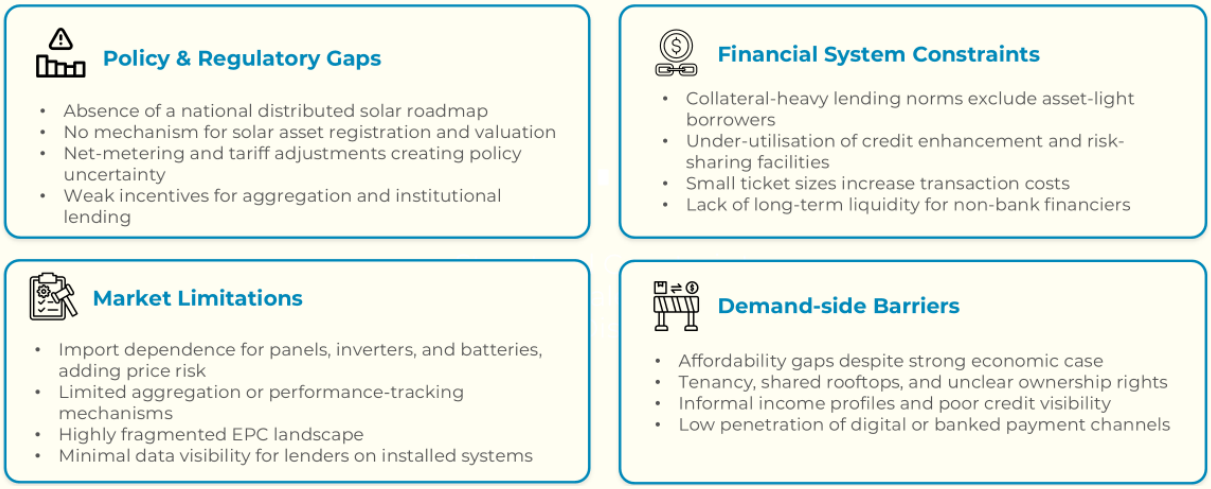
Vendors and anchors who have real repayment visibility sit outside the regulated credit perimeter, creating a fragmented ecosystem where origination occurs in one layer, underwriting in another, and risk absorption in yet another. This structural inefficiency produces high friction and low throughput, preventing the market from reaching its natural scale. The report's findings make clear that Pakistan's constraint is informational, not financial. Solar finance will scale when repayment visibility replaces collateral as the organizing principle of credit design.

The opportunity extends beyond direct solar financing to encompass broader financial innovation. The predictable cashflows generated by solar installations could serve as the foundation for new financial products, including asset-backed securities, green bonds, and specialized investment vehicles. These innovations could attract both domestic and international capital, creating a virtuous cycle of investment and market development.

Pathways and products for market development

Addressing Pakistan's solar finance gap requires a multi-faceted approach that combines financial innovation, regulatory reform, and market infrastructure development. Based on extensive consultations and market analysis, several specific product architectures and implementation pathways have emerged as most promising for immediate deployment.

Structural Constraints Preventing Scale and Financial Inclusion in Distributed Solar



Priority financial products by segment

For Urban Households: Consumer finance products with average loan sizes of PKR 700,000 for 7kW net-metered systems, requiring 20-30% equity contribution and offering 3-5 year tenors. These products should leverage standardized 5-15kW equipment packages, incorporate smart meters for remote monitoring, and utilize existing electricity bill or payroll deduction mechanisms for repayment. First-loss guarantee coverage of 10-30% from development finance institutions could enable banks to extend credit to households without traditional collateral.

For SMEs and Light Industrial Users: Working capital-linked solar loans for 50-500 kW systems with ticket sizes averaging PKR 7.5 million for 100kW installations. These facilities should recognize energy savings as additional cashflow in debt service coverage calculations, accept moveable asset registration through SECP's Secured Transactions Registry, and provide grace periods aligned with installation timelines. Structural protections should include tripartite agreements among lenders, borrowers, and EPCs, with performance insurance covering technical risks.

For Microenterprise and Lower-Income Segments: Digital finance solutions leveraging mobile wallets and fintech platforms, with simplified credit scoring based on utility payment history and e-wallet transactions. Loan sizes should be capped at 3-5 times average monthly credits in e-wallets, with 12-18 month tenors to ensure affordability. Standardized 3-10kW packages pre-approved by lenders can reduce evaluation complexity, while direct disbursement to EPCs ensures proper use of funds.

Anchor-based and aggregator models

Consultations revealed strong support for anchor-based financing, where large corporations, government entities, or development organizations facilitate solar adoption among their employees, suppliers, or communities. This model leverages existing relationships and payment channels while reducing credit risk through salary deductions or supply chain offsets. Banks favor this approach as it simplifies due diligence and fits existing supply chain financing systems.

EPC aggregator financing represents another high-potential model, with wholesale credit lines of PKR 500-600 million extended to vetted solar companies for on-lending to end customers. EPCs act as credit underwriters based on their customer knowledge while banks maintain portfolio oversight. This structure has already shown success, with companies like SkyElectric maintaining sub-2% default rates on multi-billion rupee portfolios. Key success factors include maintaining 30% equity requirements from EPCs, creating escrow accounts for collections, and implementing portfolio-level insurance.

Innovative risk mitigation instruments

Portfolio guarantees from institutions like NCGCL can unlock lending to segments currently deemed unbankable. These guarantees should be structured with graduated coverage – starting at 25-30% for

initial portfolios and tapering to 10-15% as performance history develops. Coverage should be automatic for pre-qualified segments and products, with simplified claim procedures completed within 30 days.

Performance-linked insurance products specifically designed for distributed solar can address lenders' concerns about technical risks. These policies should cover system underperformance, equipment failure, and installation defects, with coverage linked to certified EPCs and original equipment manufacturer warranties. Premium costs of 1-2% of system value can be built into financing structures.

Digital platform integration

Technology platforms that combine customer acquisition, credit assessment, installation management, and payment collection can dramatically reduce transaction costs. These platforms should leverage alternative data including utility payment patterns (accessible through DISCO partnerships), mobile phone usage data, and transaction histories from digital wallets. Integration with the State Bank's Raast instant payment system can enable real-time collections while reducing payment friction.

Blockchain-based energy credit systems could enable peer-to-peer trading of excess generation, creating additional revenue streams for prosumers while building transparent performance records for future financing. Smart contracts could automate payment splitting between loan servicing and energy trading proceeds.

Securitization and capital market development

The development of secondary markets through securitization can transform market dynamics. Solar loan portfolios from microfinance institutions and EPCs can be packaged into rated securities yielding 14-16% against underlying portfolio rates of 30-36%. This spread provides sufficient margin for credit enhancement, servicing costs, and investor returns. Initial securitizations should focus on seasoned portfolios with 12+ months of performance history, targeting institutional investors including insurance companies, pension funds, and ESG-focused investment vehicles.

Green bonds specifically backed by distributed solar assets could attract both domestic and international climate finance. These instruments should be structured with clear impact metrics, third-party verification of installation quality, and regular performance reporting. Development finance institutions can provide partial guarantees or anchor investments to achieve investment-grade ratings.

Implementation through existing schemes

Before creating new subsidy mechanisms, priority should be given to increasing utilization of existing State Bank schemes including SAAF (SBP's Alternative Energy Financing), the Refinance Facility for Modernization of SMEs, and the Risk Coverage Scheme. These facilities already provide concessional funding at rates below 10% but suffer from low uptake due to procedural barriers.

Immediate steps to improve access include issuing detailed standard operating procedures for registering solar assets, accepting landlord consent letters for rooftop installations, and enabling utility-based repayment channels. Banks need operational flexibility in collateralization and faster processes for claim realization. Such adjustments could unlock billions in concessional funding already available in the system without introducing new subsidy layers.

Strategic implementation framework

The transition from concept to execution requires coordinated action across multiple stakeholders. Financial institutions need ready-to-use instruments including standard documentation, risk-sharing templates, and monitoring dashboards. Development partners should focus concessional support on portfolio guarantees sharing first-loss risk, refinancing windows offering long-term capital, and digital registries tracking installations and performance.

A national solar finance facility could serve as market maker, piloting innovative models and providing technical assistance to financial institutions. Capacity building programs for bank staff on solar evaluation and risk assessment would build internal expertise. Market infrastructure development should proceed in parallel, establishing quality standards, certification programs, and performance monitoring systems to reduce technical risks and increase lender confidence.

Product	Capital Availability	Complexity	Cost to Consumer	Development Impact	Mitigation Potential
Anchor-based Finance	High	Low	Low	Medium	Medium
Consumer Finance	Medium	Low	Medium	Medium	Medium
Commercial/SME Finance	Medium	Low	Medium	Medium	High
Installer Finance	Low	Medium	Medium to High	Medium to High	Low
Securitization	Low	High	Medium	Medium	Medium
BNPL	Low	Medium	High	High	Low

Capital Availability refers to willingness of financiers to participate based on the perceived risk of the financial product

Complexity depends on the number of stakeholders and approvals required to execute

Cost to consumer refers to credit spreads built in a financial product (< 3% low, 3%-7% medium, 7%-15% high)

Development Impact refers to improvements in energy affordability and energy access for the target segment

Mitigation Potential refers to the quantum of grid energy displacement

From fragmentation to scale

Pakistan stands at a critical juncture in its energy transition. The distributed solar revolution has demonstrated tremendous potential, yet the persistent equity gap highlights the urgent need for inclusive financial solutions. The path forward is clear: Pakistan must move from fragmented initiatives to a coherent, scalable solar-finance ecosystem.

The market opportunity is quantifiable and substantial, PKR 800 billion in three major cities alone, with national potential far exceeding this figure. Liquidity exists within the financial system, with banks holding USD 131 billion in deposits against limited productive lending. The technology is proven, with payback periods of 1.5-2 years making solar economically compelling across segments.

Success requires aligning incentives, reducing friction, and strengthening market infrastructure. Key priorities include: operationalizing existing State Bank schemes through simplified procedures; deploying graduated portfolio guarantees to de-risk early-stage lending; developing standardized products for different market segments; leveraging digital platforms and alternative credit scoring; and building secondary markets through securitization.

The transformation extends beyond energy access to encompass broader economic benefits: reduced fuel import dependence, improved industrial competitiveness, job creation, and climate change mitigation. Each day of delay perpetuates inequities and missed opportunities. The building blocks are in place, what remains is the collective will to transform these elements into a functioning market that serves all Pakistanis.

The distributed solar revolution in Pakistan is simultaneously an energy story, a development story, a finance story, and fundamentally an equity story. By addressing the financial intermediation gap, Pakistan can ensure that clean, affordable energy becomes accessible to all, driving inclusive growth and sustainable development for millions of citizens.

1. Introduction & Background

1.1 Context: Pakistan's Solar Financing Landscape

Pakistan's distributed solar story looks like an unqualified success at first glance. Rooftops are filling with panels because grid power is expensive, unreliable, and volatile, and because technology costs have fallen while local EPC capability has deepened. But the balance sheets carrying this transition are largely private, not institutional. Households and businesses with savings or internal cash flows are paying to exit the grid, while the formal financial system mostly watches from the sidelines. The result is growth that reinforces, rather than eases, existing inequalities in access to reliable power.

The pattern of financing reflects Pakistan's broader credit architecture. The financial system continues to serve a narrow, collateral-backed core of borrowers: large corporates, established SMEs with banked cashflows, and upper-income households. These groups can access credit for solar or mobilize internal funds, so adoption accelerates where capital already exists. For the majority of households and smaller enterprises, access to finance remains limited, informal, or absent altogether, even when the economic case for solar is clear.

This creates a structural divergence between demand and the channels through which finance is delivered. Distributed solar is financially sensible for far more users than the credit system currently reaches. But risk evaluation practices, data visibility, and product design still mirror traditional lending norms rather than the needs of small-ticket, performance-based assets. As a result, scalable institutional financing has not yet emerged, and most of the market continues to rely on personal balance sheets.

This diagnostic starts from that disconnect. It examines where adoption potential sits, how lending behaviors shape access, and which product, origination, and risk-sharing models can bridge the gap between viable demand and the limited reach of formal finance.

1.2 Purpose and Scope of the Study

This study develops an analytical foundation and practical design framework to support the transition of Pakistan's distributed solar sector to a structured, credit-enabled ecosystem.

Its core objective is to identify commercially viable yet 'credit-invisible' market segments particularly SMEs, commercial users, and middle-income households, and design financing pathways that enable financial institutions to lend based on verifiable cash flows, system performance, and borrower behavior.

The scope encompasses:

- Demand-side analysis: Energy consumption patterns, economic viability, and repayment capacity across customer segments
- Supply-side assessment: Credit practices, risk perceptions, product structures, and operational constraints within financial institutions
- Enabling environment review: Regulatory frameworks, policy conditions, and institutional capacity that shape lending decisions
- Market failure diagnosis: Identifying where barriers originate and where de-risking or standardization can lower credit barriers

The study is grounded in current market realities and evaluates what can function within Pakistan's existing prudential and operational frameworks. It integrates market analytics, regulatory assessment, and practical product design to support a more inclusive and scalable distributed solar market, with a focus on expanding access to formal credit.

1.3 Objectives of the Market Diagnostic

The market diagnostic seeks to shift Pakistan's distributed solar market from fragmented, self-financed deployment toward an institutionalized financing ecosystem. Specifically, it aims to:

- Quantify the market opportunity and financing gap: Identify economically viable but underfinanced segments across retail, SME, and commercial categories.

- Assess borrower credit visibility: Analyze income proxies, energy usage patterns, documentation levels, and payment behavior relevant to lender underwriting.
- Map the credit intermediation chain: Document how banks, NBFIs, MFBs/MFIs, leasing companies, EPCs etc. currently participate in solar financing, and identify bottlenecks in origination, due diligence, monitoring, and product delivery.
- Diagnose binding constraints: Evaluate collateral-dependance, asset bankability challenges, risk-perception gaps, liquidity mismatches, and operational frictions that hinder scaling.
- Develop implementable financing structures: Propose segment-specific financing products, and risk sharing mechanisms, aligned with existing institutional mandates.

Together, these objectives focus on expanding credit participation, without requiring fundamental changes to institutional risk appetite.

1.4 Approach & Methodology

This study adopts a market-systems and financial-ecosystem diagnostic approach to assess Pakistan's distributed solar financing landscape. Rather than focusing on individual transactions or isolated policy gaps, the analysis maps the interaction between demand-side segments (households, SMEs, commercial users) and the supply-side ecosystem (banks, leasing companies, microfinance providers, government and donor-backed programs).

The approach is deliberately practical. It focuses on identifying bankable demand within underserved but credit-worthy borrower segments, then works backward from institutional and regulatory constraints to identify interventions that can turn economically viable propositions into bankable transactions. The emphasis is on adjacencies: segments close to existing borrower profiles where lending can expand with limited structural change.

Data Sources and Research Design

The study combines three streams of evidence:

1. Secondary research draws on regulatory publications and policy documents (NEPRA, SBP, AEDB, IGCEP, Power Division, Ministry of Finance etc.) to establish market context, pricing structures and institutional frameworks.
2. Primary stakeholder inputs were gathered through:
    a. Multi-stakeholder group consultations with 15 plus institutions across banking, microfinance, development finance, solar developers, and policy bodies.
    b. Structured one-on-one interviews with senior decision-makers from commercial banks, MFBs, NBFCs, EPCs, guarantee institutions, and regulatory agencies.
    c. Targeted exploratory surveys used selectively to test specific assumptions.

3. Financial ecosystem mapping analyzed lending practices, credit appetite, collateral requirements, and operational bottlenecks across institution types. This focused on why uptake remains limited and where frictions occur in the origination-to-disbursement chain.

Analytical Framework

The analysis is organized along three diagnostic pillars:

- Enabling environment: capturing policy, tariff, and regulatory conditions that shape economic viability and institutional confidence
- Financial ecosystem: mapping institutions, instruments, risk behaviors, and capital flows that determine credit access
- Demand segmentation: profiling viable borrower groups by income, consumption, credit characteristics, and readiness for scale

Data triangulation across these sources ensures consistency between macro-level policy trends and ground-level financing realities. Findings are used to inform product design and institutional recommendations rather than generic policy reform.

1.5 Limitations and Assumptions

Limitations

Segment exclusions based on existing support structures

Utility-scale projects are excluded as they already attract FI participation. Agricultural borrowers and subsidy-eligible households are also excluded as the government and development partners operate multiple access programs for them.

Accordingly, the study focuses on distributed solar segments where commercial finance can play a meaningful role. Peri-urban and rural households with higher incomes and meaningful energy use remain within scope.

Data availability and verification constraints

Market sizing was constrained by data gaps, including limited visibility on behind-the-meter installations, household income distributions relevant for credit assessment, and geographic dispersion of installations across DISCO territories. Disaggregated data on SBP incentive schemes including solar-specific disbursements, loan sizes, and asset performance was also unavailable. These gaps reduced the precision of segment-level estimates and required reliance on proxies and stakeholder validation.

Assumptions

Macroeconomic Conditions

Interest rate levels, liquidity conditions, exchange rates, and prudential limits are assumed to remain stable during the study and intervention period.

Bank Behavior

Commercial banks are assumed to continue prioritizing government securities, in the absence of regulatory or policy pressure to raise their private sector credit exposure. The prevailing risk-return effort trade-off, where expected yields are not commensurate with credit and administrative effort, is assumed to persist, limiting appetite for smaller borrowers. Bank boards and shareholders are assumed to maintain conservative risk appetites, favoring capital preservation over lending that could raise non-performing loans even marginally. Institutional culture within most banks will continue to discourage risk-taking by client facing teams.

Tariff and policy frameworks

Electricity tariffs are assumed to remain high relative to historical averages and utility-scale generation costs, maintaining the economic rationale for solar adoption. While specific tariff slabs may adjust, the overall cost-competitiveness of solar relative to grid electricity is expected to persist. Net-metering regulations may evolve, but the fundamental legal and technical framework enabling distributed generation is assumed to remain in place.

These assumptions frame the boundary conditions within which financing solutions must operate. Where these conditions shift materially, recommended interventions may require recalibration.

2. Pakistan's Financing and Solar Market Context

2.1 Macroeconomic Environment

The intertwined nature of Pakistan's energy sector and the broader economy have been well established. Understanding the energy context requires an acknowledgment of the structural realities of the country's macroeconomy. Pakistan's import-dependent economy has endured multiple boom-bust cycles over the past three decades, continuously running trade deficits that culminated in its most severe crisis in early 2022. The Russia-Ukraine conflict triggered global commodity price volatility, pushing Brent crude oil to USD130 per barrel[1], significantly impacting Pakistan's import costs and current account balance. Simultaneously, catastrophic flooding devastated approximately one-third of the country's territory, causing substantial infrastructure damage and creating additional fiscal pressures on already strained government resources.

These external and natural shocks were compounded by political uncertainty that hindered effective policy implementation and eroded both domestic and international investor confidence. As economic conditions deteriorated rapidly, the country approached the brink of sovereign default. International credit rating agencies responded by downgrading Pakistan's sovereign rating to its lowest levels in decades, with Fitch lowering the rating to CCC- with a negative outlook in early 2023 and Moody's following suit, signaling substantial default risk to international investors and creditors Pakistan found itself among other emerging economies facing similar sovereign debt difficulties, including Ghana, Zambia, and Ethiopia. Although credit ratings have since improved to B-, fiscal conditions remain tenuous.

The economic crisis manifested in severe currency depreciation as the Pakistani rupee plummeted by 28% in 2023[2], while consumer price inflation surged to 38% and energy costs became among the highest in the region, severely affecting both consumers and businesses.[3] With the government's financing options becoming severely constrained and limited access to international capital markets, the country teetered on the edge of sovereign default by late 2022. During this critical period, bilateral support and International Monetary Fund assistance proved vital, particularly through a short-term, 9-month standby arrangement of USD 3 billion in 2023, followed by the country's 25th IMF program, a 37-month Extended Fund Facility approved in September 2024. Since then, Pakistan has made notable progress with macroeconomic stabilization through fiscal year 2025, achieving declining inflation, rising reserves, and fiscal consolidation. Real gross domestic product growth at factor cost is estimated to have reached 3.0% year-on-year in FY25, slightly improving from the 2.6% achieved in FY24. More dramatically, headline inflation decelerated sharply to 4.5% year-on-year in FY25 from 23.4% in FY24, driven by adequate food supply, lower global commodity prices, and stabilizing electricity tariffs that reduced energy inflation. This remarkable improvement in price stability enabled the State Bank of Pakistan to cut the policy rate from 23% during May 2024, the highest in the country's history, to 11% as of June 2025.[4]

Figure 1: Consolidated Fisal and Primary Balance (excluding grants)

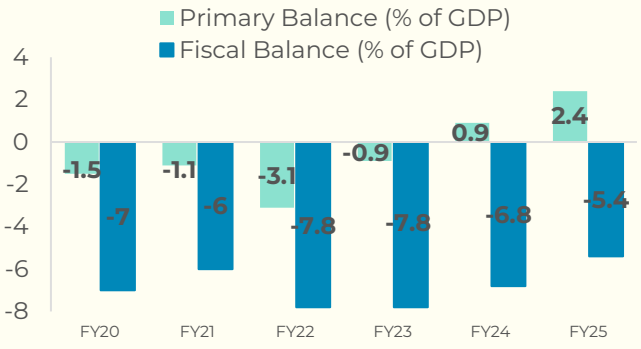
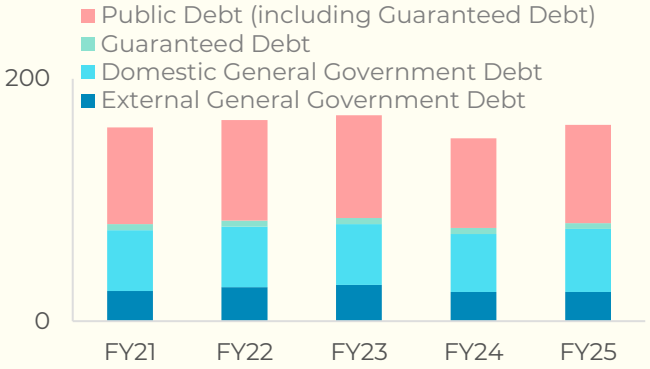


Figure 2: Public and Publicly Guaranteed Debt (in USD)



[1] Profit Magazine June 2025
[2] Business Recorder June 2023
[3] SBP Inflation Monitor 2023 May
[4] World Bank 'Pakistan Development Update', 2025

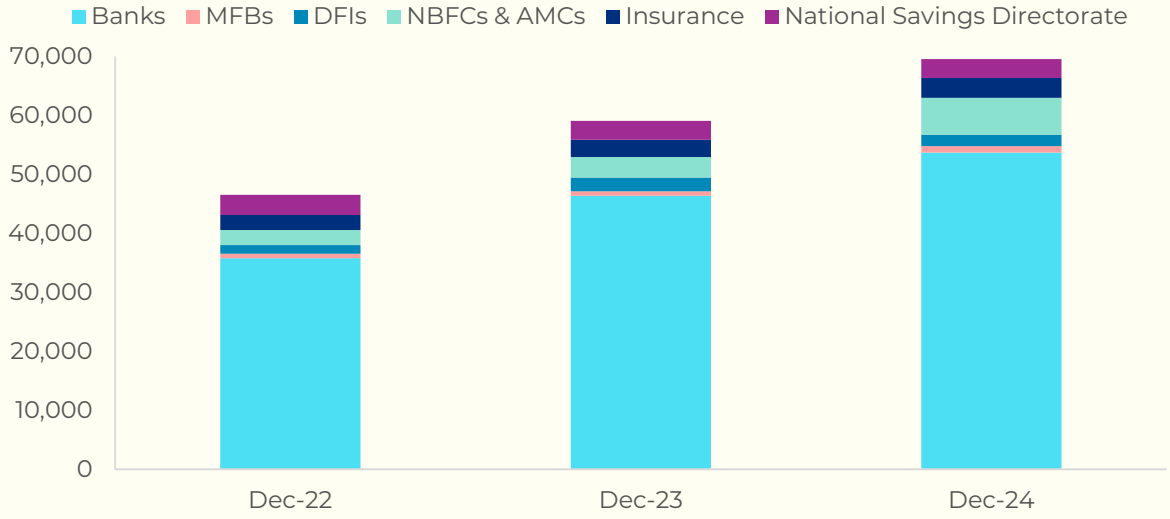
Source: World Bank, Pakistan Development Update October 2025

Economic growth that was initially expected to strengthen further in FY26 is now projected to be lower due to recent floods disrupting agricultural production and incomes. While fiscal consolidation is expected to continue under the ongoing IMF program, flood-related relief and reconstruction needs will add significant spending pressures, keeping the fiscal deficit elevated at 5.4% of GDP in FY26.

2.2 The Financing Landscape

Pakistan's financial sector is dominated by commercial banks, which constitute approximately 77% of the sector's total assets and remain central to the country's lending activities as seen in table 1. However, private sector credit has historically been extremely low compared to peer countries and has suffered significantly during the recent economic crisis. This deterioration stems from a pronounced "sovereign-bank nexus," with Pakistan's banking sector holding the largest proportion of government securities relative to total assets globally, increasingly funded through short-term central bank liquidity using bonds as collateral.

Figure 3: Financial Sector Total Assets (in PKR Billions)



Source: State Bank of Pakistan Financial Stability Review 2024

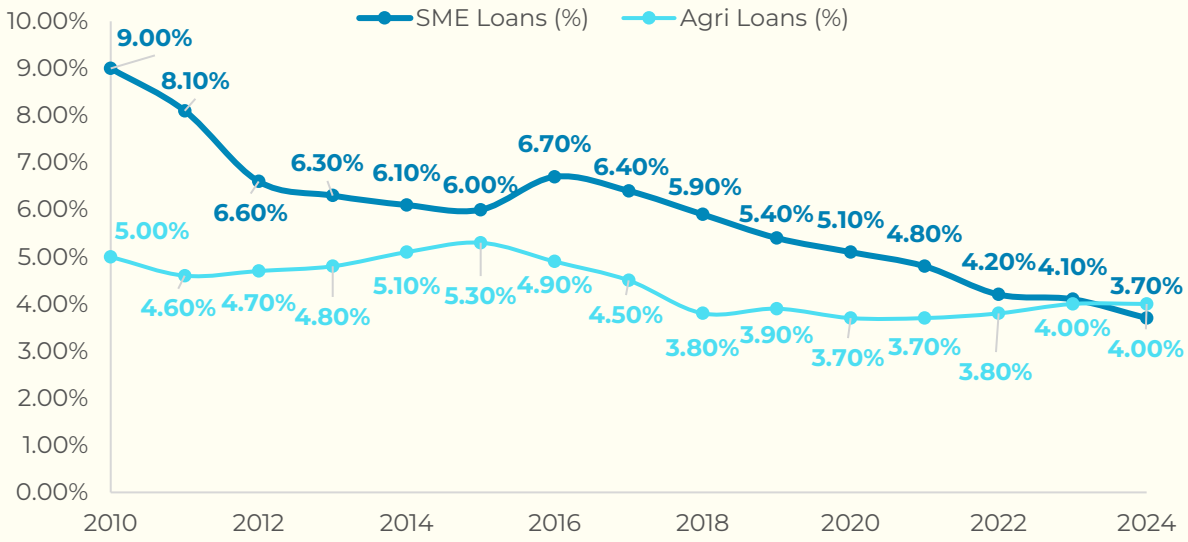
The Sovereign-Bank Nexus[5]

The evolution of government financing reveals a critical shift in Pakistan's monetary landscape. Until 2019, the government relied heavily on direct financing from the State Bank of Pakistan to sustain fiscal deficits, with monetary financing accelerating between 2017 and 2019. By end-2019, government debt held by the SBP reached approximately 20% of GDP, constituting nearly 40% of outstanding domestic debt and severely compromising the central bank's operational independence and inflation targeting capabilities. Recognizing this fiscal dominance, authorities committed in mid-2019 to eliminate new direct SBP financing and gradually reduce government debt on the central bank's balance sheet. These reforms were institutionalized through 2022 amendments to the SBP Act, legally prohibiting direct government lending and primary market purchases of government securities.

This fundamental shift transferred the burden of government financing to commercial banks, even as authorities committed to fiscal consolidation. However, a series of external shocks, including the pandemic, severe flooding, commodity price spikes from the Ukraine conflict, and tightening financing conditions, combined with policy backsliding to push fiscal deficits above 7% of GDP after 2019. Without SBP financing and lacking developed capital markets, commercial banks became the primary purchasers of government debt auctioned at increasing rates. Between 2019 and 2023, banks' sovereign exposure surged from 45% to approximately 60% of assets, while their government bond portfolios quadrupled even as deposits merely doubled, forcing banks to seek alternative liquidity sources to support their expanding balance sheets.

This crowding-out effect fundamentally undermined the banking sector's economic role. When banks primarily funded government operations, their capacity to supply credit to the real economy diminished substantially, creating a vicious cycle where higher borrowing costs, reduced private sector lending, and potential financial instability collectively dampened economic growth prospects.

Figure 4: Loans to Priority Sectors as % of Total Advances



Source: PwC Banking Publication 2024

Many banks have strategically pivoted toward current accounts or Islamic banking products exempt from Minimum Deposit Rate requirements, discouraging small savers from participating in an already under-penetrated banking system.[6]

Combined with Pakistan's extensive informal economy, prolonged political and economic instability, low savings rates, and weak incentives for participation in the documented and regulated sectors,

[5] IMF, The Sovereign-Bank (-Central Bank) Nexus in Pakistan
[6] IMF, The Sovereign-Bank (-Central Bank) Nexus in Pakistan

have sustained high demand for physical currency, keeping substantial funds outside the banking system.

In the shadow of commercial banks, Pakistan's microfinance banking sector stands out as one of the few active lending segments in the country's constrained financing landscape. Serving approximately 10 million borrowers, three-fourths of all borrowers nationally, the sector operates through 12 microfinance banks. Despite this extensive reach, the sector remains

The sector demonstrated impressive expansion over the past five years, with assets growing at an average 19% annually and the gross loan portfolio nearly doubling from PKR 214 billion in December 2019 to PKR 423 billion in September 2024. However, these headline figures mask a deteriorating foundation shaped by successive crises and questionable portfolio management practices.[7]

The sector's trajectory shifted dramatically with the COVID-19 pandemic in 2020, when the State Bank of Pakistan introduced loan rescheduling and rollover options to mitigate economic impacts. Banks responded with aggressive, often excessive, portfolio restructuring that exceeded genuine distress levels. The 2022 floods necessitated another restructuring wave, compounding existing vulnerabilities, while the 2023 economic downturn further strained portfolios. Throughout this period, banks struggling with recoveries repeatedly rolled over loans, incorporating accrued markup into principal at each iteration and artificially inflating balance sheets. This practice continued until SBP audits in late 2022 signaled the end of regulatory forbearance, revealing serious strain at major institutions.

The implementation of IFRS-9 accounting standards in 2024 intensified these challenges. Compounding these structural issues, soaring interest rates devastated borrower affordability, triggering widespread defaults (seen in table 2) as financing costs exceeded repayment capacity. This dynamic proved particularly damaging for microfinance clients operating on thin margins with minimal resilience to cost increases.

Table 1: Financial Soundness Indicators MFBs (%)

	Dec-21	Dec-22	Dec-23	Dec-24
Capital Adequacy Ratio (15% regulatory requirement)	18.3	10.9	7.6	2.6
NPLs to Total Loans	5.2	6.7	6.7	9.7
Provision to NPLs	78.1	78.8	102.3	95.3

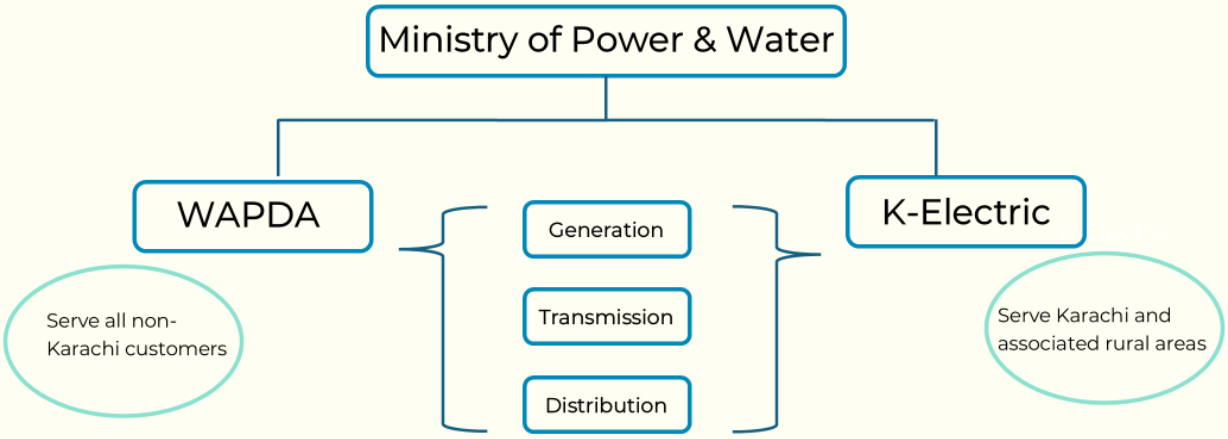
Source: SBP Economic Data

2.3 Power Sector Regulatory Environment

Pakistan's power sector has evolved over several decades, moving from a state-run monopoly to a partially liberalized, regulation-driven system that continues to balance legacy inefficiencies with new market realities and renewable energy growth.

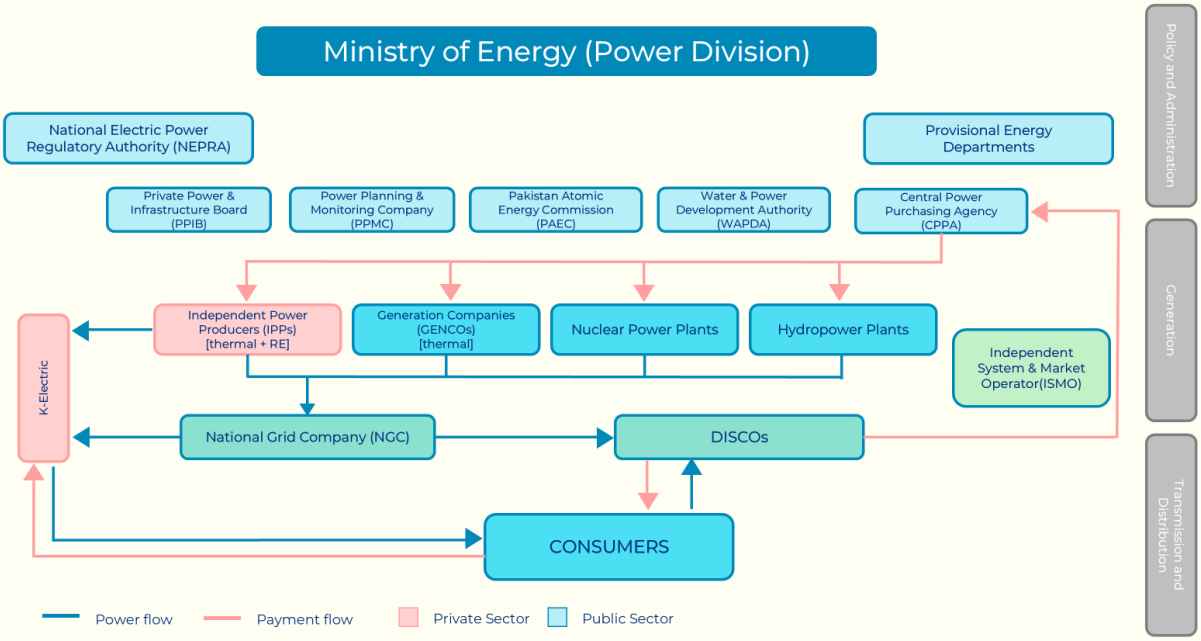
At independence, the sector was dominated by the vertically integrated Water and Power Development Authority (WAPDA) and the Karachi Electric Supply Corporation (KESC). By the 1980s, rising demand, high losses, and aging infrastructure made the structure unsustainable, constraining economic growth.

[7] State Bank of Pakistan, Financial Stability Review 2024



Power Sector Structure Before unbundling of WAPDA (1992)

The 1990s brought the first wave of reform. The 1994 Private Power Policy[8], implemented through the newly established Private Power and Infrastructure Board (PPIB)[9] sought to attract private investment through Independent Power Producers (IPPs) backed by long-term, dollar-linked Power Purchase Agreements (PPAs) with take-or-pay and other favourable clauses. The policy succeeded in adding about 4,500 MW of capacity[10] and reducing shortages in the short term. However, it created lasting financial vulnerabilities, including foreign-exchange exposure and rigid capacity payments that fueled circular debt.



Current Power Sector Structure

Institutional reforms followed. The National Electric Power Regulatory Authority (NEPRA)[11], established in 1997, introduced licensing and tariff regulation. In 1998, WAPDA's unbundling[12] created four Generation Companies (GENCOs), ten Distribution Companies (DISCOs), and the National Transmission and Despatch Company (NTDC). While this restructuring introduced corporate entities with distinct roles, it failed to establish genuine competition or operational autonomy. In practice,

[8] 1994 Private Power Policy
[9] PPIB Website
[10] World Bank Paper 'Learning from Power Sector Reform: The Case of Pakistan', 2019
[11] NEPRA ACT 1997
[12] Khalid & Hussain Paper 'Restructuring of WAPDA: A reality or a myth', 2016

accountability became fragmented across numerous institutions, and inefficiencies persisted as financial and decision-making control remained centralized.

The Power Generation Policy 2002[13], followed by the 2015 Policy[14] under the backdrop of China-Pakistan Economic Corridor (CPEC) framework, revived private investment incentives and expanded generation capacity, largely through imported coal and LNG projects. Though these policies succeeded in improving supply reliability in the short term, they deepened import dependence and embedded long-term legacy contracts within the power sector.

Through the 2000s, public DISCOs remained mired in structural inefficiencies, chronic under-recovery, and persistent failure to meet T&D loss targets. The 2005 privatization of KESC (now K-Electric) delivered some operational gains but entrenched a private monopoly still reliant on federal support and regulatory interventions. Attempts to privatize other DISCOs stalled repeatedly due to political resistance, weak regulation, and limited investor appetite. These inefficiencies persist today.[15]

The uniform tariff policy under earlier regulations, meant to keep electricity affordable, cross-subsidized inefficient utilities and distorted incentives. Tariff freezes between 2003 and 2007 and chronic delays in tariff subsidies created cash-flow shortfalls. Combined with distribution side inefficiency losses and rising capacity payments, these pressures led to Pakistan's most persistent sector crisis; a ballooning circular debt that emerged in 2006 at PKR 111 billion.[16]

In parallel, the 2006 Renewable Energy policy launched by the AEDB laid Pakistan's foundational framework to promote renewable energy.[17] The implementation lagged however, due to overlapping institutional roles, financing delays, and slow project approvals.[18] The Alternative and Renewable Energy (ARE) Policy 2019 set a 30% non-hydro renewable targe by 2030 and introduced competitive bidding, signaling a more coherent renewable framework.[19]

These directions have been further reinforced by the National Climate Change Policy[20] and updated Nationally Determined Contribution (NDC)[21], which placed renewables at the center of Pakistan's low-carbon transition and linked energy diversification with fiscal resilience. Building on this foundation, the National Electricity Policy 2021 integrated renewables into the least-cost generation mix and emphasized privatization, financial discipline, and institutional reform. It introduced the Indicative Generation Capacity Expansion Plan (IGCEP) and Transmission System Expansion Plan (TSEP) to align long-term generation and grid development with national economic and environmental goals.[22] To operationalize this framework, the Ministry of Energy launched the National Electricity Plan (NEP) 2023-27[23] as a five-year roadmap addressing capacity optimization, grid modernization, renewable expansion, tariff rationalization, and overall efficiency improvements across the sector.

On the competitive market front, the 2018 NEPRA ACT amendments[24] laid the legal foundation by introducing new licensing categories for suppliers, traders, and aggregator. Building on this, NEPRA approved the Competitive Trading Bilateral Contract Market (CTBCM) in 2020 to replace the single-buyer model of Central Power Purchasing Agency Guarantee (CPPA-G) and enable large consumers to directly procure power from generators. Ministry of Energy (Power Division) has announced plans to launch the competitive market in the first quarter of 2026, starting with an initial quantum of 800 MW for the first five years.

In parallel, the licensing of the Independent System and Market Operator (ISMO) in 2025, separating system dispatch from market operations, marked an important institutional step toward a

[13] Power Generation Policy 2002
[14] Power Policy 2015
[15] PIDE Paper 'Privatisation of Electricity Distribution Companies - A Way Forward', 2022
[16] World Bank Paper 'Rethinking Electricity Tariffs and Subsidies in Pakistan', 2011
[17] Renewable Energy Policy 2006
[18] Paper 'An Overview of Implemented Renewable Energy Policy of Pakistan', 2017
[19] ARE Policy 2019
[20] National Climate Change Policy Updated 2021
[21] Nationally Determined Contribution (NDC) Updated 2021
[22] National Electricity Policy 2021
[23] National Electricity Plan (NEP) 2023-27
[24] 1.4 NEPRA ACT Amendments

competitive, multi-player power market.[25] The below table shows the current power market structure of Pakistan with key entities and their mandates.

Table 2: Key Power Sector Entities & Their Mandates

Entity	Mandates
Power Division (Ministry of Energy)	Leads power policy, reforms, and oversight of public utilities.
NEPRA	Regulates generation, transmission, and distribution, sets tariffs and ensures performance and cost recovery.
NTDC/NGC	Restructured into National Grid Company of Pakistan (NGC); owns and maintains the national transmission grid.
CPPA-G	Manages legacy PPAs, billing, and settlements for DISCOs; transitioning to contract management under CTBCM.
ISMO	Independent operator for system dispatch and power market administration; oversees CTBCM implementation. Responsible for Integrated System Planning (Includes IGCEP and TSEP)
DISCOs & KE	Handle distribution, metering, billing, and revenue recovery across service areas.
GENCOs	Four public-sector thermal generation companies under PEPCO.
IPPs	Private generation companies supplying power under long-term PPAs or bilateral contracts.
PPIB (includes former AEDB)	One-window federal body for private and renewable power projects, investment facilitation, and approvals.
Provincial Energy Departments	Manage distributed- and off-grid energy programs, including rooftop solar and public-sector projects.

The most transformative change in the power sector has emerged from the consumer side. NEPRA's 2015 Regulations on Distributed Generation and Net Metering enabled rooftop solar installations of up to 1 MW with grid export, catalyzing widespread adoption. While this shift has advanced energy democratization and reduced reliance on centralized utilities, it has also introduced challenges such as declining DISCO revenues and emerging grid-stability risks.

Ultimately, the country's reform trajectory reflects ambition tempered by uneven execution. Each policy from the 1994 private-power initiative to the 2025 net-metering revision sought to solve one crisis but often deepened another. The sector inefficiencies ballooned losses that led to the debt accumulation of PKR 2.4 trillion by June 2024 (20% of country's tax revenues).[26] [27]

The recent Circular Debt Management Plan (CDMP), adopted under IMF conditionality, mandates tariff rationalization, subsidy targeting, efficiency improvements and clearance of payables[28]; aligning sector reforms directly with foreign financing and macroeconomic stability imperatives.

Today, the sector stands between legacy fiscal obligations and fast-moving, consumer-driven energy resources; a transformation driven as much by market forces and consumer behavior as by policy design.

2.4 Energy Transition Landscape in Pakistan

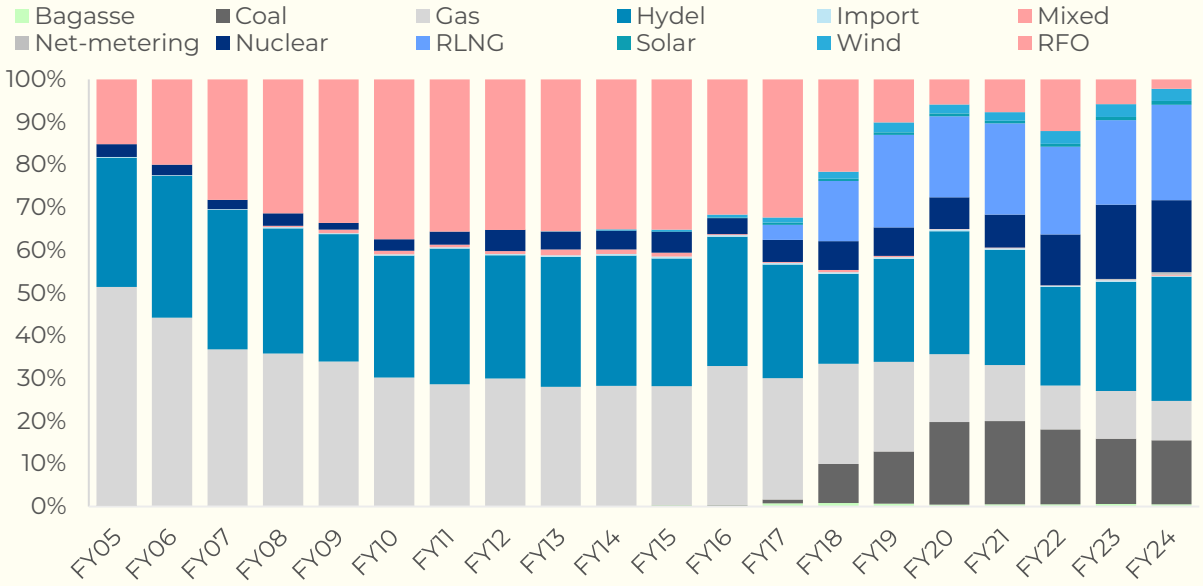
Pakistan's energy transition has unfolded with the backdrop of ambitious policy goals, economic constraints, and rapidly declining technology costs. The generation mix has undergone a structural

[25] NEPRA - ISMO Licensing, 2025
[26] Power Division Circular Debt Report, 2024
[27] SBP Federal Revenue Data, 2025
[28] Business Recorder 2025

shift: from hydro-dominance in the 1980s to heavy reliance on imported thermal fuels by the 2010s and now a slow gradual shift towards distributed renewables.

In the early 1990s, hydropower supplied nearly 60% of total generation[29], offering a low-cost and reliable baseload. However, challenges with dam construction and delays in flagship projects like Dasu and Diamer-Bhasha[30] meant hydropower capacity stagnated, reaching about 10.6 GW by 2024 (26% of installed capacity). Between 2000 and 2015, generation mix transitioned from hydropower dominance to increased reliance on domestic gas and then imported residual fuel oil (RFO). Domestic gas plateaued and declined due to mature fields, slow new discoveries, and pipeline constraints that prioritized protected sector. With gas becoming scarce, RFO went up in fuel mix, inflating the import bill and escalating fuel costs.

Figure 5: Generation Mix By Fuel Type %

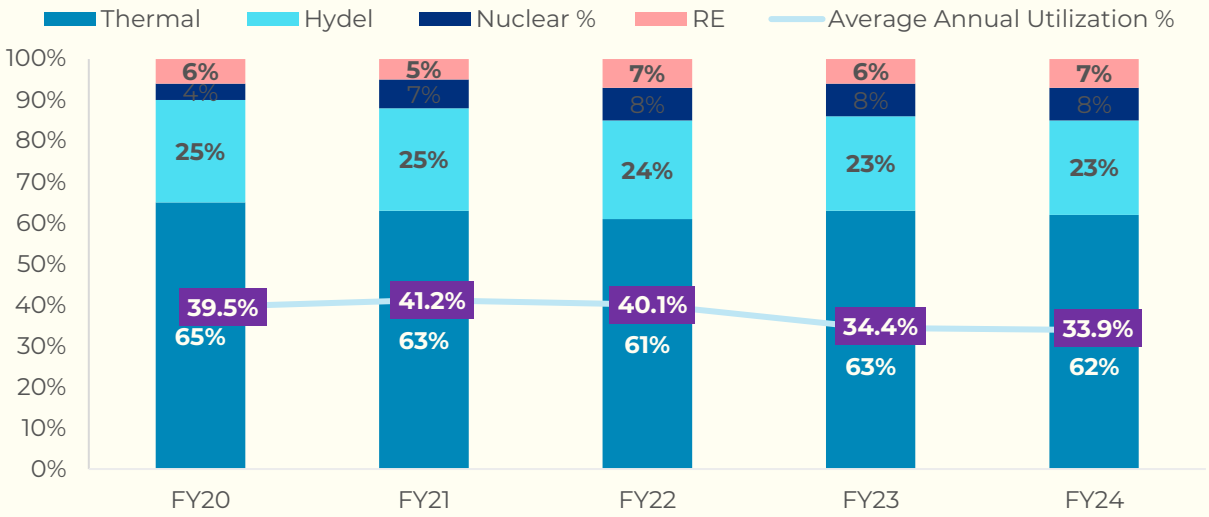


Source: Renewables First, NEPRA 2024 Report

Post 2015, two parallel transitions reshaped Pakistan's energy mix. Under the China-Pakistan Economic Corridor (CPEC), a series of large coal-fired power plants, most using imported coal and later local coal, came online.[31] Simultaneously, the depletion of domestic gas reserves spurred the development of re-gasified liquefied natural gas (RLNG) infrastructure, including import terminals and combined-cycle gas plants.[32]

[29] World Bank Paper 'Regional Electricity Trade for Hydropower Development in South Asia', 2021
[30] Business Recorder, 2012
[31] CPEC Website
[32] PPIB Annual Report 2016-17

Figure 6: Installed Capacity Mix & Utilization %

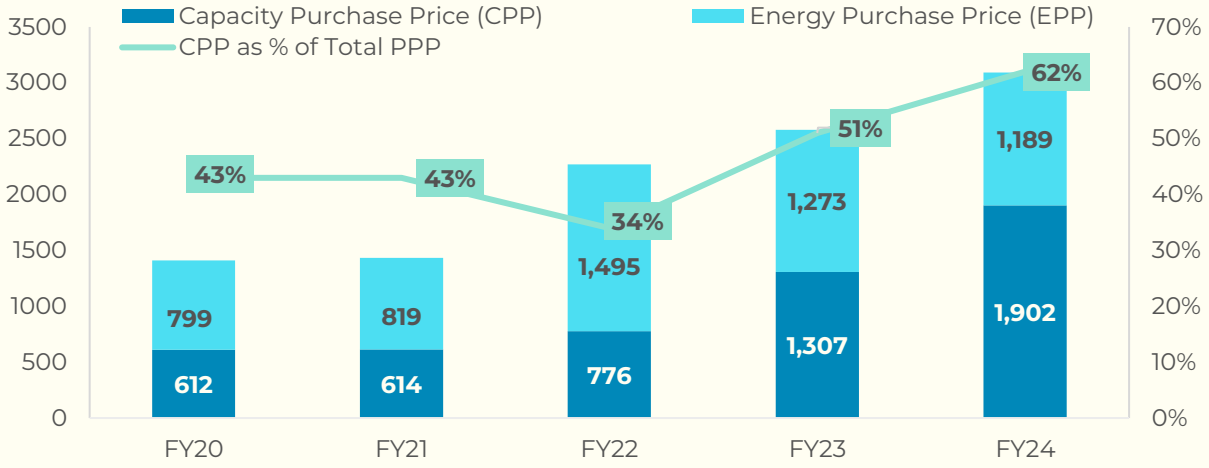


Source: NEPRA 2024 Report

These decisions, to meet the country's immediate electricity shortfall, led to huge capacity additions which exceeded even the peak demand by 2024. NEPRA's latest report[33] shows installed generation capacity of 46.2 GW by 2024 (46.6 GW by 2025[34]) while peak demand remained static near 29-30 GW during the same year.

The table 4 shows the average annual plant utilization factor declined to 34% by 2024, so consumers increasingly pay for electricity generation assets that remained idle for over half the year. Fixed capacity payments rose to PKR 1.9 trillion in FY 2024 (62% of total power purchase costs) as reflected in below chart while actual energy offtake fell, driving up end-user prices.

Figure 7: Capacity Payment Trends

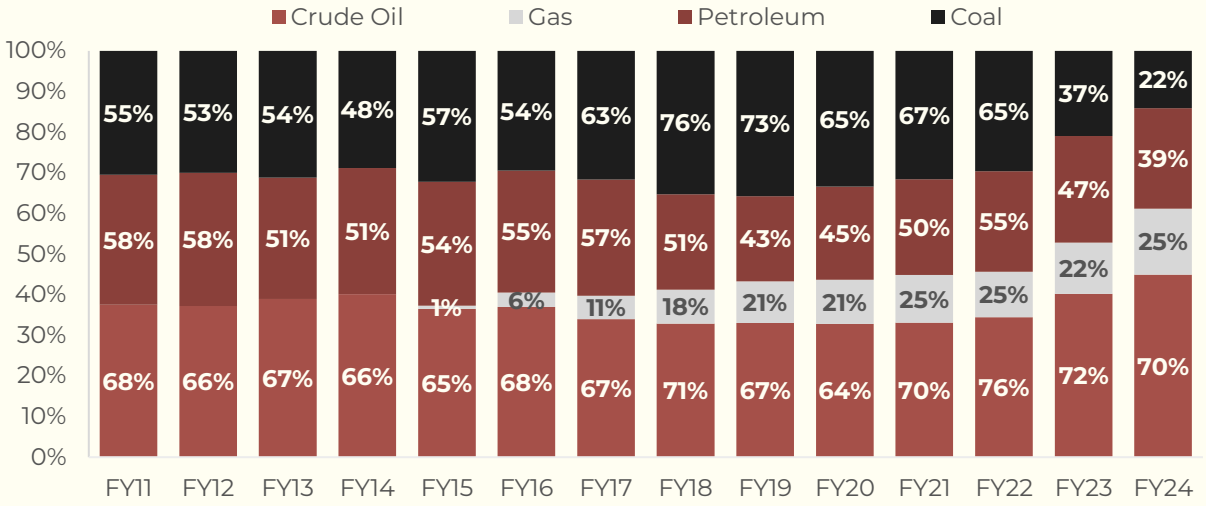


Source: NEPRA 2024 Report

In 2024, the power sector alone accounted for 62% of total RLNG and 69% of total coal consumption.[35] [36] Import dependence across coal, petroleum, and gas rose notably after 2016.[37] The rupee's depreciation from about PKR 159/USD in 2019 to PKR 278/USD[38] in 2024 further magnified capacity payments and fuel-cost adjustments.

[33] NEPRA State of Industry Report 2024
[34] Pakistan Economic Survey 2024-25 Chapter 14
[35] Pakistan Economic Survey 2024-25 Chapter 14
[36] PACRA Coal Mining & Trading Report, 2025
[37] Our World in Data Fossil Fuel Price Index
[38] SBP Conversion Rates

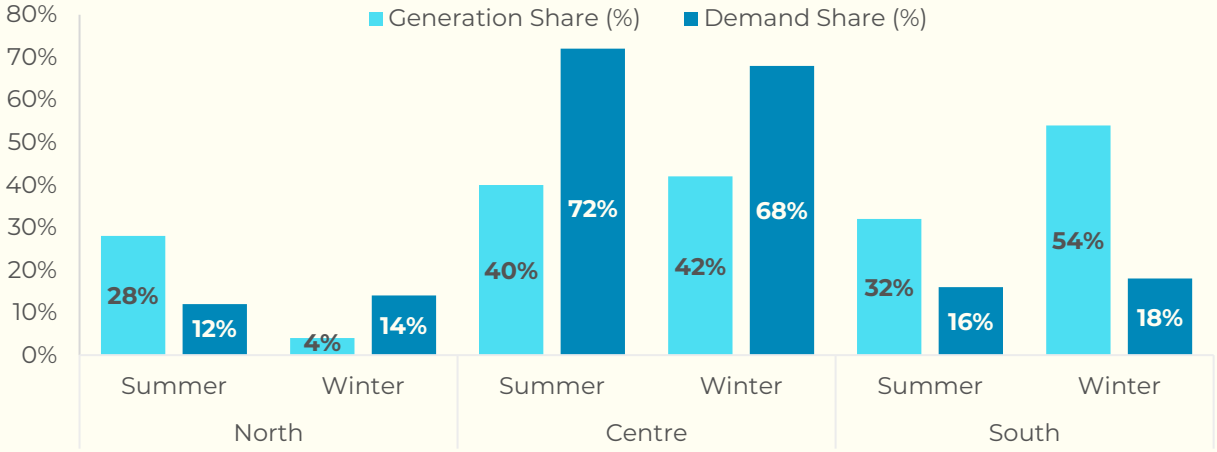
Figure 8: Import Dependence By Fuel Type



Source: Pakistan Economic Survey 2024-25

Geographically, a mismatch persists between where electricity is generated and where it is consumed. Roughly 11 GW of large hydropower is concentrated in the northern river basins and major gas plants in Punjab while most coal capacity and new nuclear units are located in the south. On the demand side, the centre region (primarily Punjab) accounts for 60-70% of national electricity consumption.[39]

Figure 9: Demand vs Generation Patterns 2024



Source: PPIB Report 2024

Limited transmission corridors have hindered least-cost dispatch, constraining south-to-north power flows and forcing heavier reliance on mid-country thermal plants. Despite competitive marginal costs, renewable energy plants remain under dispatched by 37% in 2024 (Table 7) with their overall generation share at just 5%.

Table 3: RE Projected vs Actual Generation 2024

	Projected (TWh)	Actual (TWh)	Shortfall (TWh)	Shortfall (%)
Solar	2.6	1	1.6	62%
Wind	5.2	3.9	1.3	25%
Bagasse	1.1	0.7	0.4	36%
Total RE	**8.9**	**5.6**	**3.3**	**37%**

[39] NEPRA State of Industry Report 2024

Source: NEPRA 2024 Report, Pg 38

While utility-scale renewable generation share has stagnated, distributed solar has surged. Electricity sales dropped 2.8% in 2024 despite GDP growth, signaling increased grid defection. The government estimates PKR 159 billion lost in grid revenues and capacity payments in 2024 alone.[40]

Pakistan's energy transition paradox: excess capacity with unmet demand, vast renewable potential amid fossil fuel reliance, and a centralized grid losing ground to empowered consumer.

The IGCEP 2025-35[41] reorients Pakistan's power planning toward indigenous, least-cost generation, targeting 30% renewables by 2035. It also recognizes distributed generation as a permanent structural shift, reflected in lower peak demand projections. Without accurately integrating distributed solar and storage growth into planning (actual net-metered capacity by 2025[42] surpassed IGCEP's forecast), system planning risks underestimating grid impacts.

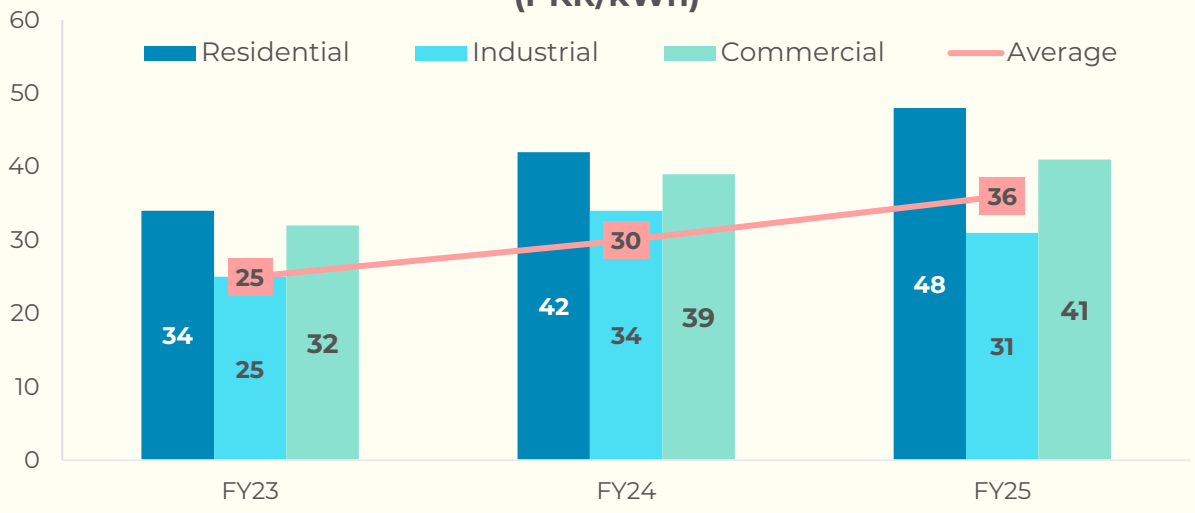
2.5 Growth of Distributed Solar - Trends and Drivers

Pakistan's electricity landscape has undergone a seismic transformation over the past decade. A combination of steep tariff hikes, collapsing global solar prices, and an enabling net-metering framework has propelled distributed solar from the margins into the mainstream of the power mix.

Tariff Inflation and the Erosion of Grid Affordability

Power tariffs have risen far faster than incomes, eroding affordability and reshaping consumer behavior. NEPRA-determined average tariffs climbed from PKR 11.89 per kWh in 2012 to PKR 35.5 per kWh in 2025[43][44], an almost 200% increase, while GDP per capita rose by 51% (USD 1,204 to USD 1,824).[45] Between 2023 and 2025, average tariffs surged from PKR 25 to PKR 36 per kWh with consumer categories seeing hikes between the range of 16-85% in just 2 years.

Figure 10: Growth In Power Tariff Across Categories (PKR/kWh)



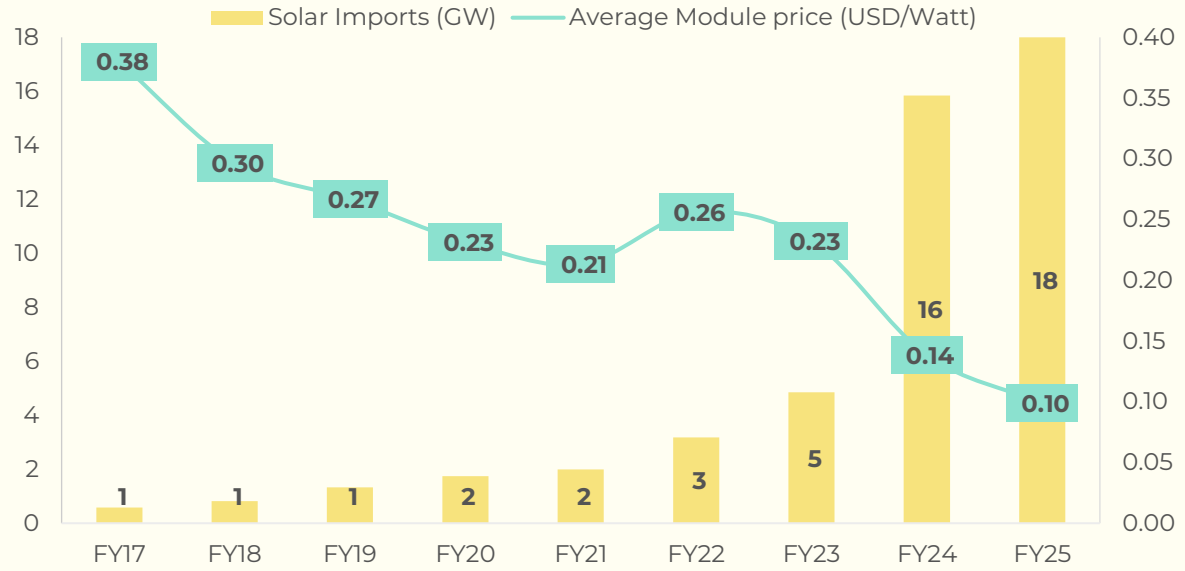
[40] ECC Net Metering Updates, 2025
[41] IGCEP 2025-35
[42] Renewables First - Solar Import Data
[43] NEPRA Notifications
[44] Renewables First Pakistan Electricity Review, 2025
[45] Pakistan Economic Survey 2024-25

Source: NEPRA Tariff Updates, Renewables First PMI 2025[46]

Global Solar Panel Price Collapse

While grid tariffs surged, global solar panel prices collapsed. A glut in Chinese manufacturing flooded Asian markets, and average panel prices in Pakistan fell by 73% from USD 0.38/Watt in 2017 to USD 0.10/Watt by 2025, the lowest in history. The market quickly adjusted: by early 2024, major cities had become installation hubs, and solar kits were being marketed with the affordability of household electronics.

Figure 11: Solar Module Price Vs Import Trends



Source: Renewables First - Solar Import data

By 2025, Pakistan had emerged as one of the top six importers of Chinese PV modules, accounting for roughly 12%[47], alongside much larger markets. This surge in imports was driven not only by economic necessity but also by an enabling policy environment that steadily lowered entry barriers.

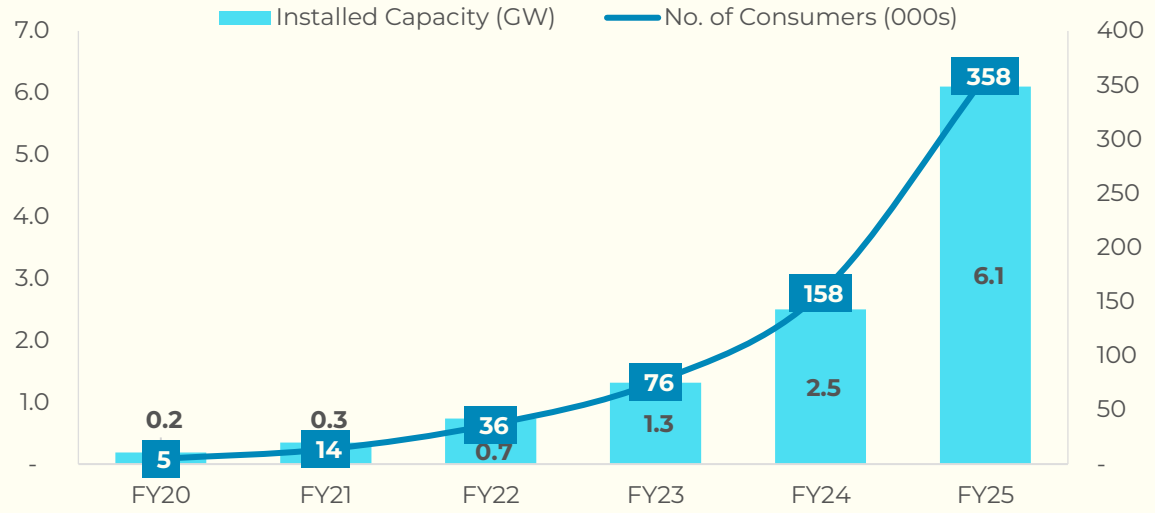
Policy Enabler & the Expansion of Net Metering

The 2015 Net Metering Regulations[48] created a pathway for small producers to feed electricity back to the grid, allowing electricity consumers to become prosumers. Later amendments, such as extension of license tenure and exempting systems under 25 kW, simplified licensing and unlocked a new wave of participation.

By June 2024, more than 157,000 net-metered connections were registered, representing 2.5 GW of distributed capacity.[49] The net metering users reached over 358,000 reflecting a capacity of 6.1 GW in 2025, reflecting an increase of more than 144% in capacity and 130% in users added in one year. An additional capacity of 9 GW is targeted by 2035 under the IGCEP 2025-35.[50] However, actual net-metering uptake has already outpaced the plan's near-term (2025) expectations, highlighting the case for a faster consumer-led transition and the need for more frequent updating of projections to prevent planning risks.

[46] *Tariffs shown: Residential (> 5 kW - Peak), Industrial (< 500 kW - Peak), Commercial (> 5 kW - Peak), Average (NEPRA determined)*
[47] Reuters, 2025
[48] Net Metering Policy 2015
[49] NEPRA State of Industry Report 2024
[50] IGCEP 2025-35

Figure 12: Net Metering Total Capacity & Users



Source: Renewables First, NEPRA 2024 Report

Net-metering exports to the grid have maintained strong year-on-year momentum, with an increase by 148% in 2024 and 194% in 2025. Installed capacity followed a similar trajectory, expanding by 362% between 2023 to 2025. While net metering exports represented only about 1% of total generation in 2024 (Table 8), the scale and pace of expansion signal a structural transformation in consumer behavior.

Table 4: Net Metering: Grid Exports vs Capacity

	FY23	FY24	FY25
Exports (GWh)	177	438	1,428
Capacity (GW)	1.3	2.5	6.1

Source: Renewables First, NEPRA 2024 Report

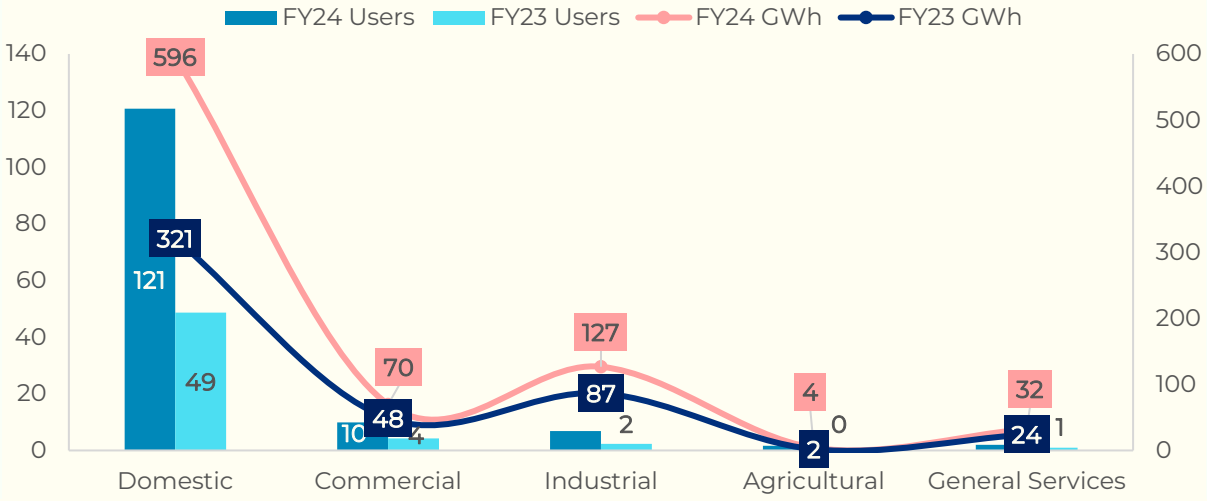
Segment-Wise Net Metering Patterns

In FY24, domestic consumers accounted for nearly half (49%) of total electricity sales, followed by industrial (25%), commercial (8%), and agricultural (8%) users. The remaining consumption is spread across other categories.

However, this energy-weighted composition contrasts sharply with the distribution of users: domestic consumers make up 87%, while commercial and industrial users represent only about 10% and 1%, respectively. Pakistan's demand base is highly skewed: millions of small, low-consumption households coexist with a narrow band of energy-intensive industrial customers. This asymmetry is critical to note for interpreting the scale and concentration of net-metering adoption.

Segment-wise net-metering data shows that domestic consumers now generate nearly three-fourths of total distributed solar exports to the grid. Residential users grew by 148% between 2023 and 2024, while generation rose 86% (from 321 GWh to 596 GWh). Average output per connection declined from roughly 6,588 kWh to 4,937 kWh annually, corresponding to system sizes of about 6 kW to 5 kW. This trend reflects a wave of new entrants from middle- and lower-income households as falling panel prices and turnkey packages made rooftop solar increasingly accessible. It may also suggest that many new users are sizing systems primarily to meet their own consumption needs rather than generate significant surplus for the grid.

Figure 13: Net Metering By Segment in DISCOs



Source: NEPRA 2024 Report

The industrial segment followed, with user numbers rising 197% and generation 46% (from 87 GWh to 127 GWh) while commercial users contributed 8%. The agricultural sector also expanded rapidly, with roughly 650,000 solar-powered tube wells operating across the country[51], driven by diesel substitution, unreliable grid supply, and concessional finance schemes.

Table 5: Net Metering vs Total Grid Pattern (DISCOs excluding KE) in 2024

	Net Metering Generation vs Grid Consumption (GWh)	Net Metering vs Total Users
Domestic	1%	0.38%
Commercial	1%	0.27%
Industrial	0%	1.80%
Agricultural	0%	0.43%
General Services	1%	0.87%

Source: NEPRA 2024 Report

Net metering's footprint may be small, but not trivial in revealing emerging patterns. Table 9 highlights domestic and commercial exports each amount to 1% of total grid sales even though their user base accounts for just 0.38% and 0.27% of all customers in those classes. Industrial and agricultural show the opposite pattern: relatively higher net metering adoption shares but negligible exports, indicating smaller, behind-the-meter systems sized for peak-shaving and self-consumption rather than bulk export.

The Silent Revolution Behind the Meter

In parallel to grid-connected exports, industrial, agricultural and increasingly residential consumers have been driving Pakistan's quiet but far-reaching shift toward non-net-metered solarization.

Between 2022 and 2024, national electricity sales declined by nearly 15 TWh (-12%) while net-metering barely added 1% to the grid. Together, the industrial and domestic sectors accounted for more than 12 TWh of that fall as per NEPRA's latest state of industry report. While domestic users' per-household solar uptake remains modest compared to industry, their sheer numbers magnify the effect: total domestic demand dropped by 6.8 TWh, way higher than the units generated by net metered systems, implying unregistered residential PV now offsets daytime consumption.

In industry, grid sales fell by 6.2 TWh, reflecting the rapid build-out of at least 3 GW captive[52], non-net-metered solar capacity across factories that use solarization as a hedge against high tariffs and supply risk. Agriculture mirrors this off-grid trend. Grid-connected agri-consumption declined by 2.45 TWh

[51] Reuters 2025
[52] Renewables First & Herald Analytics 'Great Solar Rush in Pakistan', 2024

as provinces expanded solar-pump programs, and private farmers converted diesel units. Evidence reflects these trends with 70-90% of industrial and agricultural solarization is non-net-metered and used solely for self-consumption.[53] Together, these non-net-metered systems across households, industries, and farms likely account for three-quarters of the 12 TWh reduction in national grid demand.

The solar transition is unfolding far faster, and far less visibly, than official net-metering data alone can capture. It is also fundamentally reshaping the load curve: grid demand increasingly collapses during daylight hours when solar output and surplus supply are highest, while tariffs remain misaligned with marginal costs. As a result, the system pays for generation capacity it cannot use midday and then struggles to recover fixed costs from fewer units sold. This in turns deepens the emerging duck-curve dynamic and accelerates grid defection through solar and batteries. With capacity charges forming more than half of total system costs and largely insensitive to sales volumes, continuing to recover them through per-unit tariff pricing risks higher tariffs, fiscal stress, and further demand erosion.[54] [55]

Outage Driven Declines Versus Solar Driven Substitution

The table compares decline in consumption over a 5-year period (2019 to 2024) against average Aggregate Technical & Commercial losses (AT&C) losses and the corresponding load-shedding tiers for each DISCO. It shows that similar levels of consumption decline occur for very different underlying reasons depending on the loss tier and reliability conditions.

Table 6: Consumption vs AT&C Pattern

	Change in Average Annual Consumption Per Connection (%)	Average Annual AT&C Losses (%)	Load shedding corresponding with AT&C Tiers (hours)
IESCO	-19	8	0
GEPCO	-29	10	0
FESCO	-14	11	0
LESCO	-16	14	0
MEPCO	-18	16	0
KE	-12	22	2
TESCO	-15	25	2
PESCO	-12	42	8
HESCO	-7	46	8
SEPCO	-26	62	12
QESCO	-16	76	12

Source: Author analysis, NEPRA 2024 Report

In low-loss DISCOs with zero load-shedding, the fall in consumption reflects voluntary behind-the-meter solarization as fully billed consumers face the full impact of tariff inflation and substitute expensive grid units with self-generation.

In high-loss, high-outage DISCOs, the decline is primarily supply-driven: extended feeder shutdowns suppress recorded consumption and reduce the effective hours of grid availability, with small-scale solar acting more as a reliability buffer than a full substitute. Mid-tier networks sit between these two patterns, with demand falling due to a mix of moderate load-shedding and increasing incentives for hybrid solar in pockets that are either tariff-pressured or grid-constrained.

The Next Phase of Solarization

The emergence of hybrid solar-plus-battery[56] systems represents the next stage of Pakistan's distributed energy transition. Initially driven by load-shedding and tariff shocks, early adoption was led by industrial and commercial users seeking power reliability and cost control. As battery pack

[53] Business Recorder, 2024
[54] Dawn 'How to hunt a duck curve', 2025
[55] Business Recorder 'Solar duck curve dictating power dynamics', 2025
[56] IEEFA 'Battery storage and the future of Pakistan's grid', 2025

prices nearly halved between 2023 and 2025, hybrid systems became viable for both enterprises and high-income households, enabling energy arbitrage and peak-shaving during expensive evening hours.

Pakistan imported about 1.25 GWh of battery storage (roughly 5% of peak demand) in 2024, with projections reaching 8.75 GWh by 2030.[57] Despite high taxes and duties on batteries, overall economics on solar with Battery Energy Storage Systems (BESS) systems have improved and represent a payback period of 3-5 years in the residential sector and 4-6 years for the commercial and industrial sectors.[58] Recent global forecasts project battery costs falling by almost 50-56% by 2035, with a further 68% decline by 2050.[59] [60] As battery and solar cost curves converge, system economics increasingly favor behind-the-meter storage and decentralized self-consumption models.

Balcony-solar systems also represent a significant untapped opportunity for apartment dwellers and households under low consumption slabs. These plug-in PV kits typically range from 1-2kW, require minimal installation and provide flexibility for tenants or owners without rooftop access. Countries such as Germany have already seen strong uptake with over one million balcony solar systems registered by mid-2025.[61] Other countries in Europe like Austria and France are beginning to simplify regulations for such systems. For markets like Pakistan, such models could bridge the gap for solar uptake among urban renters and small-load households.

Policy Realignment and Expectations

Policy is now adjusting to these market realities. The new hybridization wave can trigger greater grid defection, especially as power tariff hikes continue. In 2025, policy proposals have discussed revising the net-metering export rate to PKR 10/kWh, compared to the earlier PKR 27/kWh buy-back rate.[62] While this has not been approved yet, such a change may extend solar payback periods and further incentivize users to maximize on-site consumption rather than export surplus (attractive under a higher buy-back rate). Moreover, the IMF-linked fiscal framework has increasingly embedded electricity tariffs as a tool for debt recovery. The continuation of debt service surcharges (from PHL to the circular-debt surcharge) and the possible removal of the 10 percent cap on it are likely to keep tariffs elevated over the medium term. Many stakeholders, particularly industrial users, have expressed concern over the growing surcharge burden. This policy environment strengthens incentives for consumers to prioritize self-consumed solar over grid supply.[63] [64]

These shifts mark not just adoption of a technology, but a reordering of the electricity system itself where consumption is fragmented and the once-centralized model is unraveling.

2.6 The Equity Gap in Solar Adoption

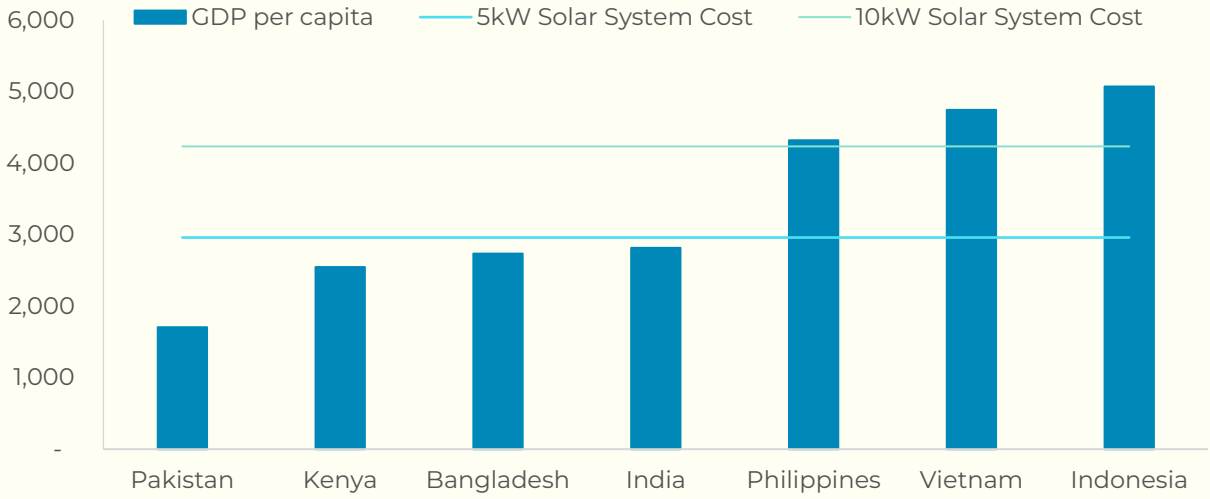
Pakistan's distributed solar revolution has accelerated rapidly, but its benefits remain unevenly distributed. The 'equity gap' captures the divide between users who can convert their willingness to adopt solar into actual installations, versus segments where willingness exists but constraints such as upfront capital and lack of credit prevent adoption.

Early adoption has been dominated by affluent households and larger enterprises able to self-finance or access credit, while other segments remain unable to bridge the upfront investment gap. Despite a dramatic fall in global solar prices, affordability remains a binding constraint on widespread adoption. Presently, the cost of an average 5-kW rooftop solar system is nearly double the country's average annual income as seen in Figure 7. This affordability gap is among the widest in Asia. For comparison, similar systems cost roughly the same in neighboring markets, yet the income baseline

[57] IEEFA 'Battery storage and the future of Pakistan's grid', 2025
[58] IEEFA 'Battery storage and the future of Pakistan's grid', 2025
[59] BloombergNEF, 2025
[60] NREL Cost Projections for Utility-Scale Battery Storage, 2025
[61] Taiyang News, 2025
[62] ECC Net Metering Updates, 2025
[63] PBA Press Release, 2025
[64] Business Recorder 'Govt apprised of Debt Servicing Surcharge', 2025

is substantially higher in regional economies. So, while hardware costs are globally convergent, relative affordability diverges sharply across income levels. For Pakistan, where the system cost exceeds annual earnings, and the savings rate is low, cash adoption remains infeasible for most households and SMEs without access to credit.

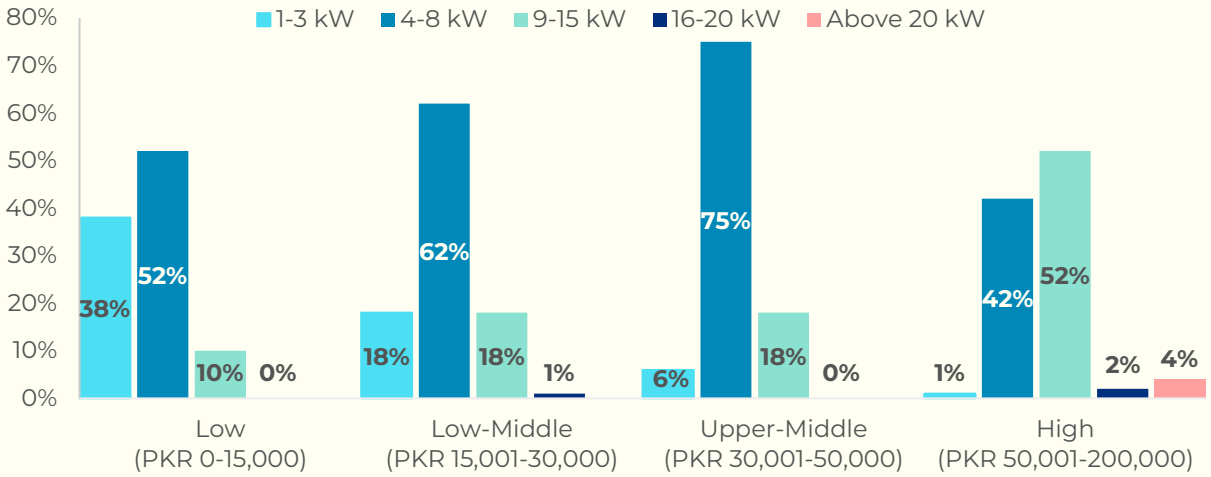
Figure 14: GDP Per Capita 2025 vs Solar System Cost (USD)



Source: IMF GDP per Capita 2025, USD Solar System Costs from Industry Sources

Studies show that adoption closely tracks income levels and electricity expenditure. A joint Transition Zero - PRIED survey[65] found that among households with monthly electricity bills below PKR 15,000, only one-third report to have installed solar systems, whereas adoption exceeds four-fifths among those spending above PKR 50,000. Meanwhile, deployment in agricultural segment was found to be strongest amongst lower-expenditure farmers due to reliability concerns. They concluded that the pattern points to affordability and reliability concerns as key differentiators for each segment.

Figure 15: Solar Capacity by Income/Expenditure Group



Source: TransitionZero-PRIED 2025 survey

We will revisit this gap for low-income, low-energy-intensity households in Section 6 by analyzing the economics of solar and outlining the parameters required to make adoption financially workable for them. At the same time, we do see the overall demand surging with net-metered users and capacity expanded rapidly through 2024-2025, signaling strong willingness to invest where capital is available.

[65] Transition Zero - PRIED 'Quantifying Pakistan's Solar Revolution', 2025

Figure 16: Net Metering Grid Exports vs Capacity

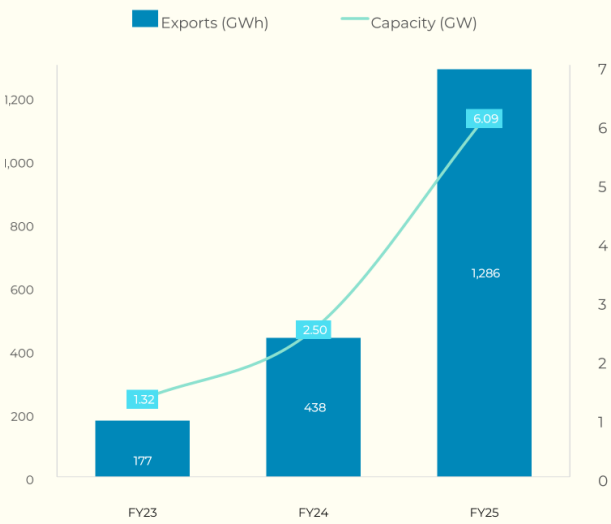
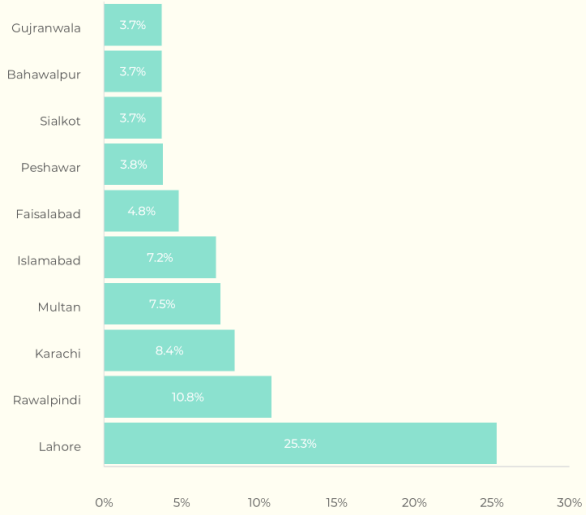


Figure 17: Net Metering Composition by Major Cities



Source: Transition Zero - PRIED 2025 survey

These patterns can be further evidenced in NEPRA's net metering data, where adoption across distribution companies (DISCOs) mirrors the socio-economic geography of their service areas. Urban territories such as those served by KE, LESCO, IESCO, FESCO, and MEPCO include denser clusters of middle- to high-income households, literate populations, and a larger base of commercial and industrial consumers with daytime loads and roof ownership, conditions that favor distributed solar investment.

In contrast, utilities operating in less urbanized or lower-income regions (PESCO, HESCO, SEPCO, QESCO, and TESCO) serve customers with lower purchasing power, weaker grid compliance, and limited awareness or roof access.

The result is a clear divide: areas with more credit-worthy, bill-paying consumers and established urban infrastructure are leading net-metering growth, while solar uptake from high losses, irregular billing, and informal energy areas is not reflected in official numbers.

Table 7: Net Metered Connections as a % of Total Customers (Adoption Map)

	PESCO	TESCO	IESCO	GEPCO	LESCO	FESCO	MEPCO	HESCO	SEPCO	QESCO	KE
Domestic	0.2%	0.0%	1.0%	0.3%	0.7%	0.2%	0.3%	0.0%	0.0%	0.0%	0.4%
Commercial	0.1%	0.0%	0.3%	0.3%	0.3%	0.3%	0.4%	0.0%	0.0%	0.0%	0.1%
Industrial	0.5%	0.1%	2.0%	1.9%	1.3%	2.7%	3.2%	0.2%	0.1%	0.1%	2.5%
Agricultural	0.1%	0.0%	1.0%	0.4%	0.2%	0.8%	0.7%	0.0%	0.0%	0.0%	0.2%
Public Lighting	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Bulk Supply	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
General Services	0.3%	0.1%	1.5%	1.0%	1.9%	1.7%	0.8%	0.0%	0.0%	0.1%	1.2%
Others	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Total	**0.2%**	**0.0%**	**0.9%**	**0.3%**	**0.6%**	**0.3%**	**0.3%**	**0.0%**	**0.0%**	**0.0%**	**0.4%**

Low Adoption
Moderate Adoption
High Adoption

Source: NEPRA 2024 Report

NEPRA's own interpretation of the data suggests that high-loss, unreliable DISCOs see greater behind-the-meter solar uptake. Extended load-shedding in these areas reduces the effectiveness of net-metering because systems cannot export during outages, making grid-tied solar less attractive and pushing consumers toward hybrid or fully off-grid solutions instead.[66] While demand is evident, the financing ecosystem remains shallow. Less than 1% of private-sector credit in Pakistan flows into renewables[67], and most of that goes to utility-scale projects, not distributed solar. There is also an

[66] Section 2.1.2, State of the Industry Report, 2024
[67] SBP Loans to Private Sector Business by type of Finance

absence of any formal reporting on personal solar financing, meaning the true scale of financing, repayment performance, or demand patterns remains invisible. Banks continue to prefer government securities and collateralized corporate loans. For SMEs and households, loan origination remains bureaucratic, turnaround times long, and risk perception high. This is discussed further in Section 4.

When cash-rich users reduce or end their dependence on the grid, the fixed costs of transmission and distribution are distributed among fewer customers who are least able to leave. This cost redistribution loop raises tariffs for remaining consumers and erodes their affordability.

Pakistan's solar surge is real, but it has been powered more by equity capital than by equity of access. Recognizing this as a financing and geography problem, not a technology gap, sets the stage for subsequent sections that model inclusive structures and test whether financial innovation can extend solar's reach to those who want it but cannot yet afford it. Innovative solutions can unlock the latent, bankable demand among mid-income households and SMEs, making solar inclusion a function of financial design rather than just wealth.

2.7 Technology, Financing Architecture, and Digital Integration in Distributed Solar

Technology and financing models for distributed solar in Pakistan are evolving in parallel, with digital tools increasingly enabling risk assessment, performance monitoring, and new ownership structures.

The direction of change is from case-by-case lending and installation contracting toward data-driven, portfolio-based, and service-oriented business models. Digital integration now underpins both the performance assurance of systems and the credit visibility of borrowers.

Digital Monitoring and Asset Integrity

IoT-enabled inverters and energy management systems now allow real-time monitoring of generation, downtime, and consumption. These telemetry feeds can verify borrower behavior and technical performance, improving lender confidence. Energy Service Companies (ESCOs) such as Sky Electric and Reon use predictive maintenance algorithms to manage hybrid systems and mitigate post-installation credit risk. In comparable markets, similar data streams are integrated directly into lender dashboards or insurance platforms to automate disbursement and warranty claims.

Digital Credit and Behavioral Risk Assessment

Banks and fintechs are piloting alternative data-based lending for small-ticket systems. Credit models use utility bill payment histories, e-wallet transactions, and CNIC-linked verification to infer repayment discipline. This behavioral scoring, while nascent, mirrors pay-as-you-go frameworks in Africa and India, where consistent digital payments serve as de facto collateral and credit history.

Asset Tagging and Registries

A key missing layer in Pakistan's ecosystem is asset-level identification. Internationally, distributed assets are digitally "fingerprinted" through serial numbers, QR codes, or IoT-linked IDs tied to geo-coordinates and ownership records. These registries allow lenders and insurers to verify existence, prevent double-pledging, and track performance across portfolios. A national registry integrated with NADRA or SBP digital-credit infrastructure could serve as the foundation for standardized asset traceability and credit history.

Platform Integration and Data Consolidation

Digital workflow tools are beginning to connect vendors, EPCs, financiers, and end-users. Platforms validate quotations, meter readings, and O&M events, then aggregate payment data to feed portfolio dashboards for lenders and guarantee providers. Such standardized datasets can support future securitization or green asset-backed vehicles by offering verifiable performance and repayment information.

Performance-linked Financing Models

Battery price declines and the proliferation of hybrid inverters are enabling performance-linked financing models, including energy-as-a-service and subscription-based storage upgrades. Real-time monitoring and automated billing improve transparency and reduce perceived technical risk. For SMEs and institutions, combining solar, battery, and diesel generation into integrated smart systems is emerging as a pathway to reliability without full grid defection.

Portfolio and Guarantee-Backed Financing

Developers such as Nizam Energy, Shams Power, and GRC Solar increasingly rely on portfolio-based financing. They aggregate SME-scale projects under lease or power-purchase contracts and raise debt with partial guarantees from GuarantCo or InfraZamin. Typical facilities are around USD 10 million, with developers acting as both asset managers and repayment conduits. As datasets on asset performance accumulate, such portfolios can evolve toward securitization-ready products, supported by standardized reporting and credit enhancement.

Leasing, Modarabas, and NBFC Participation

Non-bank financiers and Modarabas are expanding access through conventional and Sharia-compliant leasing models. These products address the 50-500 kW commercial range, where bank credit is scarce. Burj Clean Energy Modaraba's retail-scale program (5-25 kW systems) signals a trend toward distributed asset leasing, supported by digital repayment tracking and residual-value management.

System Configurations and Market Orientation

Solar deployments nationwide fall under these four configurations. Grid-tied, net-metered systems serve daytime loads and export surplus electricity to the grid at the approved tariff. Grid-tied, non-net-metered systems, a much larger category, operate in self-consumption mode, avoiding export and the procedural requirements of net-metering for smaller deployments. This also applies to commercial and SME installations above 1 MW, which are ineligible for net-metering under NEPRA regulations and instead optimize system sizing to align generation with on-site demand. Hybrid PV-plus-storage systems are increasingly adopted by urban households and service facilities seeking backup and partial grid independence. Off-grid and mini-grid systems remain concentrated in peri-urban and rural areas, often donor-financed or deployed through community-based delivery models.

Technology Supply Chain and Quality Assurance

Over 95% of components, modules, inverters, and batteries, are imported, primarily from China. Domestic production is confined to mounting structures, electrical accessories, and limited inverter assembly. This import dependence links equipment cost directly to forex volatility. Quality assurance is uneven: large EPCs serving commercial and industrial clients follow AEDB and NEPRA standards and integrate remote monitoring, while small installers remain informal with limited after-sales capacity.

Together, these developments depict a market transitioning from fragmented installation contracting to an integrated digital-finance ecosystem, where asset identity, operational data, and behavioral repayment patterns form the backbone of solar credit markets in Pakistan.

2.8 Gender and Social Inclusion Considerations

The capture of economic value from distributed solar is not gender neutral. The answers to questions such as 'Who controls the asset?", "Who makes the purchase decision?", and "Whose income grows from the energy produced" determine how benefits accrue for women, children, elderly and vulnerable communities.

Energy reliability directly affects women's time use and livelihood options. In rural and peri-urban areas, improved lighting and appliance use extend productive hours for stitching, food processing, or tutoring work, but these opportunities depend on whether women can access and control the

electricity generated. In some households, hybrid systems reduce reliance on kerosene-based lamps lowering fumes that disproportionately burden women managing domestic work.

Inclusion also intersects with finance and technology channels. Digital credit, mobile-wallet repayment, and pay-as-you-go models can widen women's access only if accounts are registered in their names and linked to verifiable IDs. Evidence from PAYG programs in East Africa shows that default rates among women borrowers are lower when products are bundled with income-generating uses, such as solar sewing machines or cold-chain storage, rather than household lighting alone. Similar targeting could improve both credit performance and gender impact in Pakistan.

For women-led micro-enterprises, high upfront costs and collateral requirements remain major barriers. Partnerships between MFIs, women's chambers, and EPCs could bridge these gaps if coupled with digital identity verification and simplified asset registration that recognizes shared or informal ownership.

2.9 Implications for Financing Action

The priority is to channel existing liquidity within the domestic financial system toward distributed solar rather than seek new funding sources. Financing action should improve both the flow of capital and its accessibility to end users.

Later sections in this report will therefore look at mechanisms needed to align lender risk perception with actual borrower performance, reduce transaction costs, and lower the effective cost of credit for consumers with limited affordability. Standardization of asset valuation, simplified documentation, flexible collateral substitutes, and digital credit verification will be explored as ways to improve borrower access while maintaining portfolio quality for financiers.

We will then find use-cases for instruments such as partial credit guarantees, concessional financing, portfolio refinancing, and vendor-linked finance to translate available liquidity into affordable, scalable solar lending. The goal is not just liquidity mobilization but credit inclusion.

3. Enabling Environment Assessment

3.1 Tariff Design, Allocation of System Losses, and Supply Reliability

Electricity pricing in Pakistan follows NEPRA's cost-of-service model[68], which sets tariffs to recover the full cost of generation, transmission, and distribution, along with approved margins and government surcharges. In practice, this means consumers pay not only for the variable cost of power they actually use, but also for fixed capacity payments tied to generation plants that remain idle due to over-contracting and excess capacity in the system.

On top of that, electricity bills include multiple non-energy components. Various taxes, duties, and surcharges together now account for nearly a third of the total bill. High distribution losses from inefficiency, theft and non-recoveries, averaging 18% nationwide in 2024, are also passed through to paying consumer.[69]

Cross-subsidization further distorts price signals. Industrial and commercial users, along with higher-consuming residential customers, effectively pay inflated tariffs to offset subsidized rates for lifeline and agricultural consumer.

For consumers with sanctioned loads above 5 kW, NEPRA mandates Time-of-Use (ToU) metering, which applies separate rates for peak and off-peak hours to reflect variations in system demand and supply costs.[70] Peak-hour tariffs are typically 15-20% higher than off-peak rates and are meant to discourage consumption during evening demand surges.[71] However, as the overall cost of electricity has risen sharply, many ToU consumers, especially households, reduce their exposure to high tariffs by using battery systems to shift load away from the grid during peak hour.

Reliability issues directly raise the effective cost of electricity for many consumers. Load-shedding is allocated using Aggregated Technical and Commercial losses, which combine technical losses, theft, and non-recoveries. Feeders with higher ATC losses experience longer outages even when individual consumers on those feeders pay their bills. This creates large differences in supply quality across distribution companies and localities. Consumers in high-loss areas end up spending more on batteries, generators, or alternative supply, which makes their actual cost of electricity far higher than the tariff alone suggests.

3.2 Regulatory Framework and Policy Analysis

While policy intent is clear, execution has exposed structural frictions between planners, regulators, and system operator.

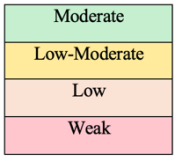
NEPRA and NTDC have repeatedly cautioned that aggressive solar expansion, particularly through net-metered and distributed systems, poses operational risks to a grid designed for centralized dispatch. The NEPRA State of Industry Report 2024 notes that rising reverse power flows, voltage instability, and "duck-curve" load profiles are already emerging in certain distribution networks. The IGCEP plans similarly warns that without parallel investment in Battery Energy Storage Systems (BESS), Flexible AC Transmission Systems (FACTS), and improved forecasting tools, large-scale daytime solar injection could threaten grid stability and increase system losses.

This has produced a divided policy landscape. The Power Division continues to emphasize solarization as part of fiscal and import-substitution strategy, whereas NTDC and CPPA-G advocate for a slower, grid-synchronized rollout. DISCOs remain reluctant to expand distributed-generation connections, citing technical constraints and potential revenue loss. As a result, renewable-energy policy in Pakistan now balances two competing imperatives: accelerating solar adoption to reduce generation costs and emissions, and safeguarding system reliability under legacy infrastructure.

[68] NEPRA Consumer End Tariff Methodology and Process, 2015
[69] NEPRA State of Industry Report 2024
[70] SEPCO Tariff 2025
[71] Renewables First Power Market Insights Jun 2025

3.3 Enabling Environment Scorecard

Dimension	Evidence / Rationale	Implication for Solar Market
Policy Alignment	National frameworks acknowledge distributed solar, but execution is fragmented across Power Division, NEPRA, and DISCOs.	Conflicting priorities between fiscal targets and grid stability dilute policy signals to investors and financier
Regulatory Certainty	Net metering regulations exist, but recent policy reversals and tariff adjustments have created uncertainty. No clear roadmap for BESS or hybrid systems.	Investors hesitate to commit long-term capital without assurance on buyback rates, interconnection standards, and licensing continuity.
Financial Intermediation	SBP refinance and guarantee schemes exist, but inclusion is weak. Banks remain collateral-driven and risk-averse, despite partial guarantees.	Credit supply constrained for SMEs and households; limited flow of concessional capital to decentralized renewables.
Technical Infrastructure	Transmission and distribution networks lack flexibility. Voltage instability and reverse power flow issues already reported by NEPRA.	Technical limits on grid absorption risk curtailing further distributed solar integration.
Market Awareness and Capacity	Awareness of solar economics has improved; EPC and installer base expanding. However, due diligence and documentation standards remain uneven.	High customer interest but limited bankable pipeline; poor quality documentation reinforces lender caution.
Institutional Coordination	NEPRA, NTDC, AEDB, and Power Division operate in silos. No unified framework linking distributed generation to national energy planning or climate targets.	Slow translation of policy into bankable project pipelines; donor and private efforts remain scattered.
Data and Transparency	Limited public data on distributed generation uptake, system performance, and payment defaults.	Restricts risk modelling and portfolio aggregation needed for blended or securitized financing solutions.
Gender and Inclusion Lens	Dedicated SBP schemes exist for women and special persons, but limited outreach and negligible uptake in clean-energy businesses.	Missed opportunity for inclusive financing models and targeted awareness campaigns.



4. Financial Ecosystem Assessment

4.1 Overview of Pakistan's Financial Ecosystem for RE

The banking system in Pakistan has abundant liquidity, with over USD 131 billion (PKR 37,423 billion) in deposits and gross advances of only USD 50 billion (PKR 14,338 billion) as of June 30, 2025. At an advances-to-deposits (ADR) ratio of just over 35%, the sector operates well below its lending potential. Consumers and SMEs represent 8.7% and 6.4% of total private sector credit as of June 2025, highlighting the narrow credit base and persistent concentration of lending among large corporates. However, the low ADR is not due to a lack of liquidity as deposits grew by 17.7% in June 2025 (H1CY25), the fastest expansion since 2014. Instead, banks have increasingly parked liquidity in government securities, which rose by 25.8% in the same period and now constitute 62.9% of total assets, driven by heavy budgetary borrowing and attractive yields.[72]

While this points to an underutilization of available liquidity and a concentration of credit among a limited set of sectors and borrower types, it also highlights untapped lending capacity that Section 6 explores in the context of renewable energy finance.

4.2 Banking Sector Regulation

Prudential Regulations

Pakistan's financial sector operates under a conservative regulatory framework anchored in collateral coverage and exposure limits. The State Bank of Pakistan issues separate Prudential Regulations (PRs) for consumer, corporate, SME and microfinance lending, each with distinct capital adequacy, exposure, and security requirements. While these regulations are intended to safeguard the cohesion of the sector, in practice, many banks apply this lens to narrow credit eligibility by the quality, liquidity, and enforceability of collateral, which tends to constrain appetite for small-ticket or asset-light sectors.

This bias toward collateral with high secondary market value limits credit to sectors like distributed solar, where the economic value of assets lies in their ability to generate savings rather than their resale potential.

Regulation R-8 requires bank exposures to be secured by collateral. Unsecured or "clean" exposure is capped at PKR 10 million per borrower and excludes consumer finance lines, such as credit cards and personal loans, availed by sponsors. The PR for Corporate and Commercial Banking outline the forms of collateral banks may accept. Liquid assets are defined as those that can be converted to cash without court proceedings and include deposits, government securities, listed debt and equity securities, mutual funds, and bank guarantees.

Secured lending may be backed by liquid assets, pledged stock, land and buildings, plant and machinery, trust receipts, inventories, and receivables under contracts. Under SE R-8 and ME R-5, banks are required to make provisions against non-performing loans, with Annexure II specifying which assets may be used to offset these provisions. Only liquid assets, pledged stock, plant and machinery, and property qualify for recognition at their Forced Sale Values (FSV). As a result, assets such as solar equipment, inventories, or receivables, while technically acceptable as collateral, do not qualify for FSV recognition. This reduces their effective collateral value and discourages banks from lending against them.

IFRS 9: Expected Credit Loss Model, and the Prevailing Risk Culture

The transition to IFRS 9 began in 2023 and was applied in phases across commercial banks, microfinance institutions, Modarabas and other NBFIs.

Under IFRS 9, financial institutions are required to adopt a forward-looking approach to credit risk assessment through the 'Expected Credit Loss' model. Unlike the earlier incurred loss model, which recognized provisions only after a default or clear evidence of impairment, IFRS 9 requires lenders to assess expected losses from loan origination by factoring in macroeconomic scenarios, borrower profiles, and sectoral conditions.

[72] SBP Mid-Year Performance Review of Banking Sector, 2025

For distributed solar and other renewable energy portfolios, the absence of established performance history and sector-specific credit data prompts banks to apply conservative assumptions when estimating expected credit losses. Since reliable benchmarks are yet to take shape and proper standardization, exposures are often mapped to higher-risk asset classes, inflating provision requirements. This treatment increases capital allocation costs and tilts credit preferences toward collateral-rich or government-backed exposures, even though repayment behavior in solar loans has been strong in comparable markets.

Enforcement of Collateral & Behavioral Dynamics

Collateral enforcement in Pakistan is slow and litigious. Even where legal recourse exists, recovery periods can take anywhere between one and a half year to fifteen years[73], which deters banks from accepting assets without clear secondary markets. This has created a risk-averse culture where credit committees prioritize recoverability over growth potential, and branch officers lack discretion to innovate beyond policy templates. Hence, credit appraisal remains relationship-driven and centralized, with limited capacity for cash-flow or performance-based lending.

4.3 Institutional Readiness

Institutional readiness within the banking sector remains low for risk-based SME and clean-energy lending. The real constraint is not the availability of capital or regulations, but banks' limited willingness to lend beyond Tier-1 corporates and public sector entities. Credit allocation continues to be driven by relationship banking and concentration within established business groups, leaving most SMEs and new sectors, including distributed solar, outside the formal credit envelope.

The SBP mandates all banks and DFIs to maintain Internal Credit Risk Rating Systems (ICRRS) in line with Basel guidelines. These systems are intended to quantify borrower risk using financial metrics, repayment history, sectoral exposure, and qualitative factors such as governance and management quality. In principle, internal ratings should guide loan pricing, exposure limits, provisioning, and early warning systems, creating a risk-based framework that enables banks to lend confidently to new or undercollateralized segments such as SMEs or renewable-energy businesses.

In practice, however, many institutions treat ICRRS as a regulatory formality rather than a core decision tool. Credit officers continue to rely on collateral coverage and borrower reputation instead of probability-of-default metrics or cash-flow projections due to a conservative approach to banking learnt over the years. Validation and back-testing mechanisms are weak, and few banks make use of historical performance data to calibrate ratings effectively. As a result, the potential of internal rating systems to expand credit beyond traditional corporate borrowers remains unrealized, perpetuating a culture of collateral-driven lending that constrains risk-taking in emerging sectors such as distributed solar.

4.4 Credit Risk in Solar Portfolio and Banking Experience So Far

High-intent Clients

Solar borrowers are generally considered high-intent clients, because their investment in solar directly reduces their energy costs, creating a built-in repayment incentive. Interviews with participating banks indicate that non-performing loans in their solar portfolios are exceptionally low at around 1% and primarily linked to physical damage to assets rather than borrower's willful refusal to repay. In most cases, repayment behavior remains strong because energy needs are essential, and borrowers seek to avoid any disruption to electricity supply.

Collateral Dictates Eligibility for Financing

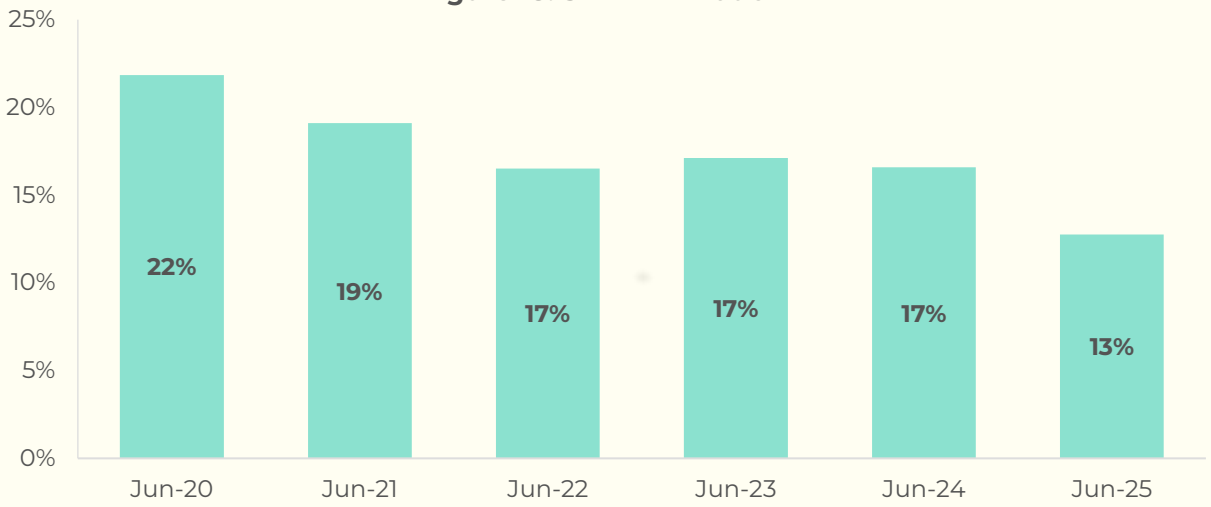
Within the commercial banking sector, healthy borrower cash flows, and the financial feasibility of solar investment, are necessary but not sufficient conditions for securing financing. For most financial institutions, the decisive factor remains the availability and enforceability of collateral, which continues to determine lending eligibility and pricing. Even where energy savings clearly demonstrate repayment capacity, the absence of property or other assets, limits the amounts they can access, if at all. While solar assets are hypothecated, they are considered a poor quality collateral.

[73] World Bank Paper 'Bringing Finance to Pakistan's Poor', 2009

Conservative Lens

The data suggest that credit risk in distributed solar lending is relatively contained when systems are technically sound, installations are verified, and cash-flow savings are transparent to both lender and borrower. EPCs participating in bank schemes usually offer buy-back guarantees for panels, backed by bonds. However, mainstream scaling is still constrained by institutional risk perceptions rather than actual portfolio performance.

Figure 18: SME NPL Ratio



Source: SBP Loans to Private Sector Business

Industry sources report that the stock of NPLs for SME's has barely budged in the past decade. The double-digit numbers in the chart above mainly reflect legacy NPLs that tend to linger on bank balance sheets, due to ongoing litigation with borrowers and delays in enforcement of collateral.

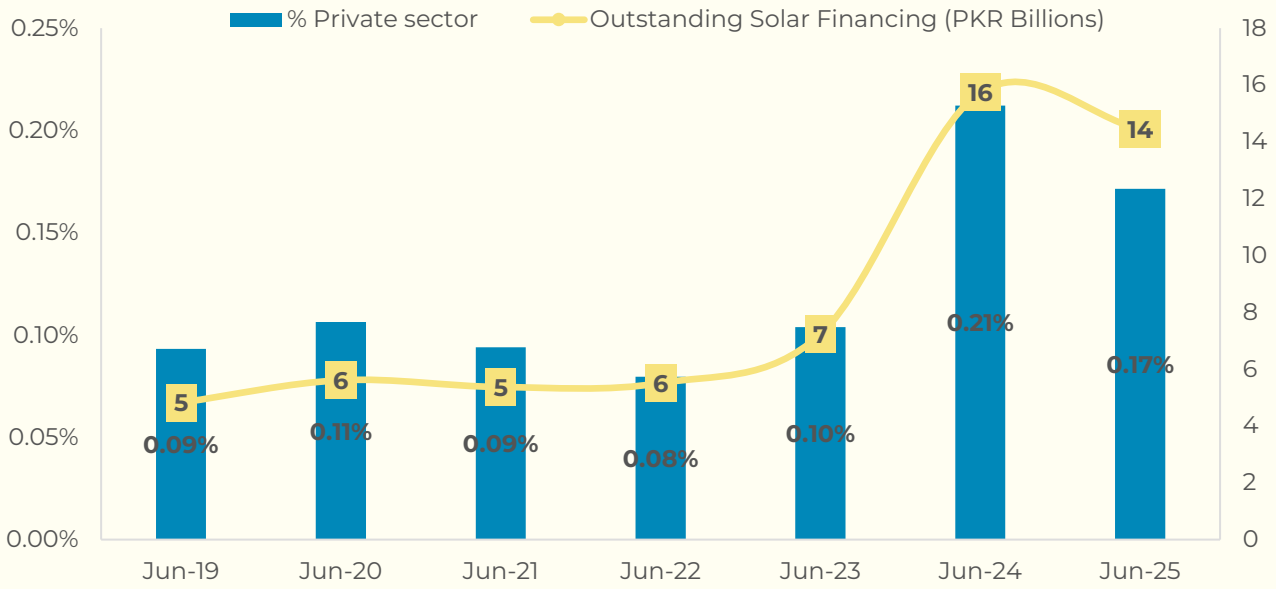
Table 8: SME NPLs 2014-2024

(PKR Bn)	Dec-14	Dec-15	Dec-16	Dec-17	Dec-18	Dec-19	Dec-20	Dec-21	Dec-22	Dec-23	Sep-24
Outstanding SME Finance	288	305	401	442	513	477	482	524	540	543	478
SME NPL (%)	34%	25%	29%	18%	15%	17%	16%	16%	15%	15%	17%
Stock of SME NPL	97	77	116	75	75	80	75	83	79	79	83
Incremental SME NPL	**-**	**-20**	**39**	**-41**	**0**	**4**	**-4**	**8**	**-4**	**0**	**4**

Source: Industry Sources

4.5 Existing Credit Flows and Market Penetration

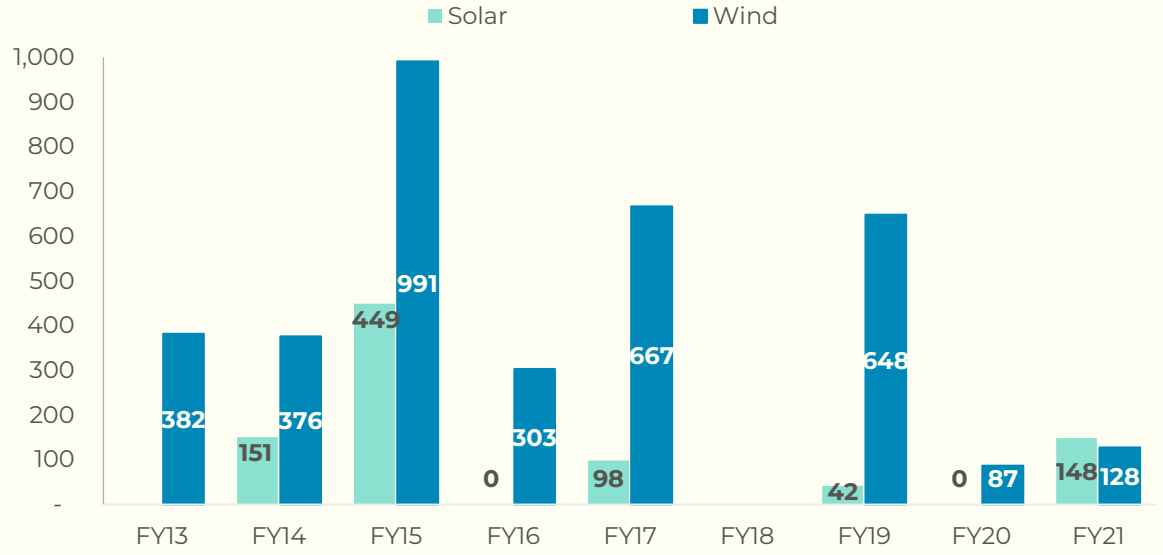
Figure 19: Solar Financing in Private Sector



Source: SBP Loans to Private Sector Business

Solar financing is almost peripheral within Pakistan's credit flows. While overall solar lending in value terms has increased by 300% from 2019 to 2025, only about 0.17% of private sector credit went towards solar lending. Majority of this credit flows towards utility scale solar projects, which stood at almost USD 0.9 billion in 2021. Even with the uptick especially in utility scale lending, solar remains a niche asset class in banks' portfolios rather than a mainstream lending preference.

Figure 20: Renewable Energy Financing (USD Million)



Source: Renewables First working based on NEPRA Tariff Documents

Figure 21: Outstanding SME Financing

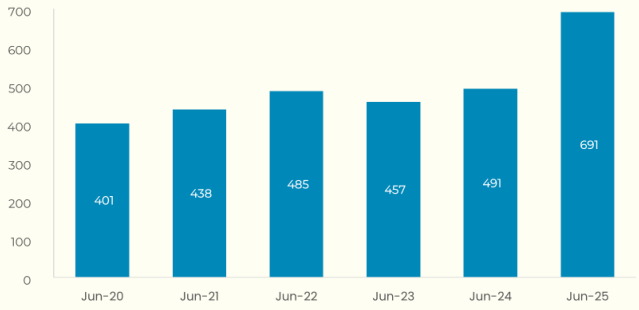


Figure 22: SME Share in Overall Private Sector Financing

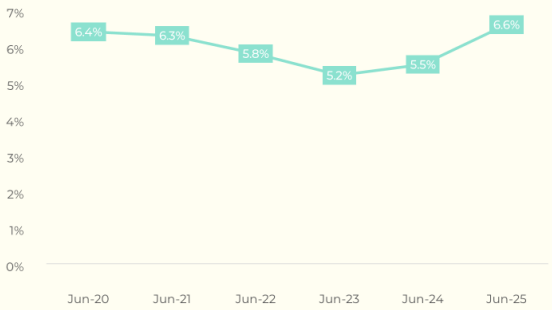


Figure 23: Facility-wise SME Financing

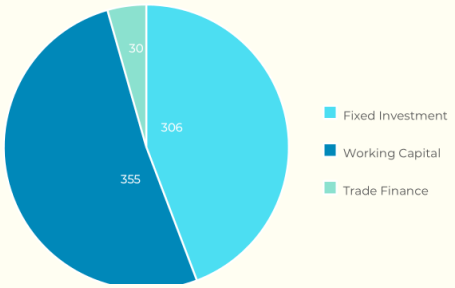
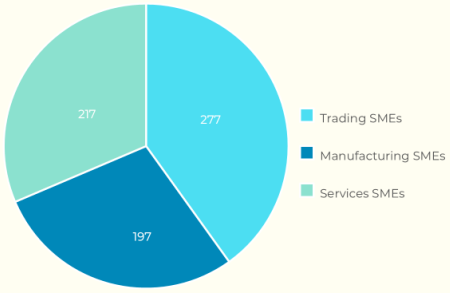


Figure 24: Sector-wise SME Financing



Source: SBP Loans to Private Sector Business, SBP SME Financing Data Tables 2025

SMEs continue to account for less than 7% of private sector credit, with lending skewed toward short-term liquidity rather than fixed investment. In June 2025, 51% of SME credit supported working capital, consistent with the dominance of trading enterprises in Pakistan's SME landscape. Fixed-investment lending comprised approximately 44% of total SME loans, reflecting banks' preference for shorter-maturity exposures over longer-term, asset-heavy financing.

4.6 Institutional Liquidity and Estimation of Investable Capital

This analysis builds on the sectoral asset profile presented in earlier section to estimate how much institutional liquidity could realistically be channeled into distributed solar finance. Using conservative exposure ratios based on balance-sheet structures and regulatory limits, the financial system could sustain a cumulative solar lending volume of roughly PKR 320-350 billion over the next three years. Most deployable liquidity sits with commercial banks, while NBFCs, DFIs, and microfinance institutions represent the next most viable pools for targeted expansion through blended finance and structured products.

Table 9: Estimation of Investable Capital for Solar

Institution Type	Share Of Financial Sector Assets	Total Assets (Dec-24) *(PKR Bn)*	Estimated Private-Sector Exposure	Target Range for Solar Lending	Target Solar Portfolio Size *(PKR Bn)*
	% of Total	*Value*	*% of Assets*	*% of Pvt Sector Assets*	*Value*
Commercial Banks	77%	53,693	35%	1.0%	188
NBFCs / Modarabas	1%	757	60%	5.0%	23
Insurance Companies	5%	3,375	10%	0.5%	2
DFIs	3%	1,979	50%	2.0%	20
Mutual Funds	8%	5,447	10%	0.5%	3
MFBs / MFIs	2%	1,069	80%	10%	86
National Savings Directorate	5%	3,227	0%	0%	0

Source: Author Analysis based on Financial Stability Review 2024

However, redirecting even a fraction of this liquidity toward solar is challenging. As of June 2025, solar lending volumes are negligible, with banking-sector disbursements standing at only PKR 14 billion (dominated by utility scale projects)[74], while outstanding SME financing stands at PKR 691 billion-accounting for just 6.6% of private-sector credit.[75]

As is evident, liquidity abundance does not automatically translate into investable capital for emerging sectors.

[74] SBP Economic Data 'Loans to private sector business by type of finance' archives
[75] SBP SME Financing Quarterly Data Table June 2025

5. The Credit Intermediation Chain for Distributed Solar Finance

Pakistan's distributed solar finance market operates through a layered intermediation chain connecting concessional capital, debt, financial institutions, delivery partners and end-users. This section maps the roles, instruments, and handoffs across that chain, then tests whether the current stack can reach priority segments at scale.

5.1 The Capital Stack for Solar

5.1.1 Upstream Liquidity Providers: Commercial Banks

Ample liquidity but lending remains collateral bound

Commercial banks remain the primary formal financiers of solar projects across consumer types. Activity has historically been anchored by the State Bank of Pakistan's SBP Financing Scheme for Renewable Energy.[76] Introduced in 2016, this facility offered refinancing at concessional rates, with tenors extending up to 12 years, for systems up to 50MW for investors, intermediaries and end-users . The scheme was suspended for fresh disbursements in June 2023.

Outside this scheme, most banks extend solar financing largely to existing corporate or commercial clients. Retail and SME products exist at several institutions but remain narrowly accessible, due to collateral and documentation requirements, as discussed in Sec 5.4. Although Prudential Regulations permit clean (uncollateralized) lending up to prescribed exposure limits, banks apply stricter internal criteria for those.

Typical instruments: Project loans to corporate or institutional end-users, term loans to EPCs and NBFCs for solar portfolio development, consumer finance and SME solar finance.

5.1.2 Mid-Tier Asset Financiers: NBFIs & NBFC

Leasing suits Commercial & Industrial (C&I) clients but scale is limited by tenor and cost

Leasing companies and non-banking financial institutions have partially filled the financing gap for middle market clients unable to meet bank requirements. Their products are medium-tenor (around five years) and asset-backed, targeting systems in the 50kW-500kW range. While leasing provides stronger collateral comfort through asset ownership, their portfolios remain small relative to market potential due to their high cost of funds and limited access to long-term liquidity.

Some NBFCs are affiliated with EPCs or developers, enabling bundled financing and system supply, although portfolio scale remains modest.

Typical instruments: Financial leases, ijarah-based leases, sale-and-lease-back arrangements.

5.1.3 Contractual & Balance Sheet Based Models: ESCOs and EPCs with Financing Arms

Off-balance-sheet models need standard contracts to scale

For larger commercial and industrial users, energy service companies (ESCOs) and EPC contractors have introduced lease-to-own and power purchase agreement models. Under these structures, the developer installs and operates the system, and the client pays a fixed tariff for electricity over a defined term.

Some ESCOs hold NBFC licenses or partner with one to structure these transactions legally. Others operate through special-purpose vehicles, relying on bank lines or investor capital. These arrangements allow off-balance-sheet access to solar power without upfront capital expenditure, now common for systems above 500 kW.

Typical instruments: PPAs, energy service contracts, operating leases.

[76] SBP Financing Scheme for RE

5.1.4 Embedded Short-term Financing: Supplier and Installer Credit

Works for small-ticket sales but constrained by supplier liquidity

Local EPCs and solar distributors frequently offer in-house installment plans of six months to two years, especially for household and small commercial customers. The financing is embedded in the equipment price. These are typically unsecured and depend on supplier cash flows or working capital lines.

5.1.5 Downstream Credit Access for Informal Clients: Microfinance Banks and Institutions

Extends reach to low-income users but affordability remains tight

Microfinance banks and institutions serve the lower end of the distributed solar market, financing solar home systems and small commercial setups. The PMIC-KfW Renewable Energy Initiative (EUR 15 million) remains the only dedicated concessional line, with blended funding and technical assistance to promote certified systems. Since its launch in 2019, the program has provided PKR 268 million financing to 38,000 clients as of mid-2025. This window carries partial subsidies and interest rates below 25%.[77]

Outside such programs, the vast majority of solar lending by MFIs and MFBs is priced commercially. These loans are secured through gold, property, deposits, or equipment liens, tenors are variable.

Typical instruments: Secured loans for solar systems, concessional credit lines under donor-funded programs, supplier-linked consumer finance.

5.1.6 Digital Retail Intermediaries: Fintechs and BNPL Platforms

Expands access but needs institutional financing to be meaningful

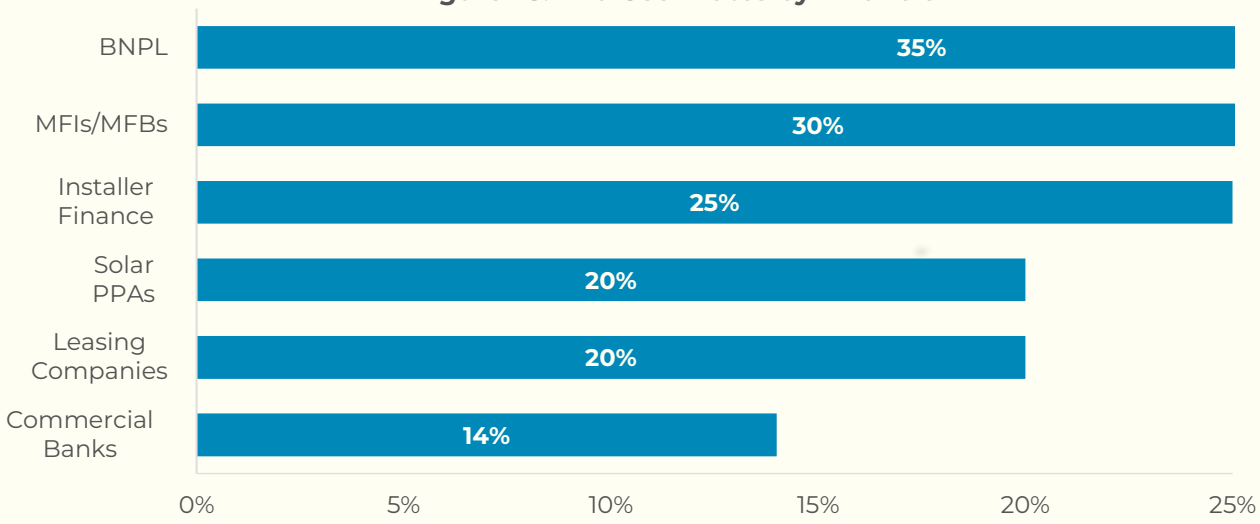
Digital lenders and fintech-linked wholesalers are gradually entering the distributed solar market through *Buy Now Pay Later (BNPL)* and embedded-finance models. These platforms provide short-tenor (6-24 month) consumer or small-business financing, typically in partnership with solar vendors or payment gateways. Credit assessment relies on transaction data, e-commerce history, or mobile wallet activity rather than formal income proof, expanding reach to thin-file customers in urban and peri-urban areas.

Some solar distributors and importers also extend financing through fintech tie-ups or in-house credit subsidiaries. Ticket sizes remain small (PKR 100,000-800,000), but this model is increasingly used for 1-6 kW systems purchased online or via retail partners.

Typical instruments: BNPL loans, vendor-linked installment financing, embedded credit via mobile wallets or e-commerce platforms.

[77] PRIME Website

Figure 25: End User Rates by Financier



Source: Author Analysis based on Industry Sources

5.1.7 Support Layer: Public and Development Capital

External support available but limited mainstreaming

Public and development-backed programs provide concessional and risk-sharing funds intended to expand access to energy, but their overall contribution remains limited. These facilities channel liquidity or subsidies through local institutions and implementing partners, yet most operate at small scale and have not influenced mainstream retail or SME lending.

The Green Climate Fund backed program SAP024 ('Pakistan Distributed Solar Project (PSDP')[78] has introduced partial guarantees to JS Bank, as the executing entity and co-financer, to enable lending to small businesses and households. The facility size is USD 54 million and targets a capacity of 47MW by 2033. However, this still remains to be embedded with existing product programs, and overlays the limitations which the banks might have with small ticket loans.

The Sindh Solar Energy Project[79] is a USD 100 million financing agreement between Pakistan and the World Bank to boost solar deployment in Sindh across utility, distributed, and household levels. The project includes support for solar parks under competitive bidding, rooftop and public-building solar, and solar home systems in off-grid zones.

PMIC-KfW Renewable Energy Initiative through Microfinance, is a EUR 15 million program to enable microfinance for solar home systems, pico-PV, and small solar in off-grid or poor grid areas. The program is now in its 10th year, and so far, approximately 38,000 clients have been served, and KfW has allocated a further EUR 5 million in subsidies to improve affordability of certified systems. Currently, the program is being implemented through 11 partner microfinance institutions working with 23 qualified solar supplier. PMIC provides both on-lending funds and technical assistance to these partners. The microfinance institutions identify and finance eligible customers, while the approved solar suppliers handle system installation and after-sales support.[80] [81]

Previously, ADB has backed a broad scope Access to Clean Energy Investment Program[82] which included decentralized solar plants for education and primary health care facilities in KPK and Punjab.

[78] GCF SAP024 'Pakistan Distributed Solar Project', 2022
[79] WB & GOP-funded Sindh Solar Energy Project, 2018
[80] PRIME Website
[81] PRIME TORs updated, 2025
[82] ADB-funded Pakistan Access to Clean Energy Investment Program, 2016

There are several development-partner-backed schemes for agriculture, such as the UNIDO/NRSP solar tubewells scheme[83], SoLAR Project[84], Punjab Government Subsidy Schemes[85], Rural Aid Pakistan[86] etc.

5.2 Available Instruments Within the Blended Finance Stack

The following programs include both sector-agnostic SME finance schemes introduced by the Government of Pakistan and the State Bank of Pakistan, and renewable-energy-specific facilities such as the GCF-JS Bank program. Most schemes provide blended refinance, partial risk coverage, or both, and can support solar deployment either as business capital for installers or as asset financing for individuals or SMEs adopting self-generation systems.

Prime Minister's Youth Business & Agriculture Loan Scheme (PMYB&ALS)	
Eligible beneficiary	Individuals aged 21-45, small businesses, startups, and agricultural enterprises
Maximum financing amount	Tier 1: Up to PKR 0.5 million Tier 2: PKR 0.5 million - PKR 1.5 million Tier 3: PKR 1.5 million - PKR 7.5 million
Rate / markup	Tier 1: 0% p.a.; Tier 2: 5% p.a.; Tier 3: 7% p.a.
Tenor	Up to 7 years
Risk coverage	50% for Tier 1 and Tier 2, and 10% for Tier 3 loans.
Collateral / security	Tier 1 and Tier 2 are unsecured. Tier 3 is secured as per the discretion of originating bank

Source: SBP

SME Asaan Finance (SAAF) Scheme (Conventional & Islamic)	
Eligible beneficiary	New borrower of the participating bank that meets credit underwriting criteria set by such bank
Financing amount	Up to PKR 10 million per SME
Rate / markup	End-user rate at 9% p.a.
Tenor	Maximum tenor is as per discretion of originating bank
Risk coverage	50% for loans up to PKR 4 million; 40% for those between PKR 4-7 million, and 30% for PKR 7-10 million
Collateral / security	Unsecured loans; personal guarantees taken

Source: SBP

Refinance Facility for Modernization of SMEs	
Eligible beneficiary	SMEs, as defined under Prudential Regulations
Financing amount	For Small Enterprises: PKR 25 million; for Medium Enterprises: PKR 200 million.
Rate / markup	End-user rate at 6% p.a.
Tenor	Up to 10 years
Risk coverage	No risk coverage
Collateral / security	Secured as per the discretion of originating bank

Source: SBP

[83] UNIDO-funded Pakistan's farmers feel the (solar) power, 2024
[84] SDC-funded Solar Irrigation for Agriculture Resilience in South Asia (SoLAR)
[85] ADB-funded Solarization of Drip & Sprinkler Irrigation Systems, 2019
[86] GGP-funded Rural Aid Pakistan Solar-Powered Irrigation Systems, 2025

Risk Coverage Scheme for Small and Medium Enterprises	
Eligible beneficiary	SMEs, as defined under Prudential Regulations
Maximum financing amount	For Small Enterprises: PKR 25 million; for Medium Enterprises: PKR 200 million.
Rate / markup	Commercial rates as per the discretion of originating bank
Tenor	Up to 5 years
Risk coverage	Applies to new loans or increases in loan amounts 20% first loss for SEs, 10% for MEs. Principal-only cover
Collateral / security	Secured as per the discretion of originating bank

Source: SBP

Small Enterprise (SE) Financing and Credit Guarantee Scheme for Special Persons	
Eligible beneficiary	Special persons setting up or expanding a business
Maximum financing amount	PKR 1.5 million
Rate / markup	5% p.a.
Tenor	Up to 5 years
Risk coverage	60%
Collateral / security	As per the discretion of originating bank

Source: SBP

Refinance & Credit Guarantee Scheme for Women Entrepreneurs	
Eligible beneficiary	Women setting up or expanding a business
Maximum financing amount	PKR 5 million
Rate / markup	5%
Tenor	Up to 5 years
Risk coverage	60%
Collateral / security	As per the discretion of originating bank

Source: SBP

Green Climate Fund - SAP024: Scaling Up Renewable Energy in Pakistan	
Implementation Partner	JS Bank Limited
Eligible beneficiary	Households, agribusinesses, and SMEs investing in distributed solar installations
Maximum financing amount	Up to PKR 150 million per borrower, depending on system size and credit profile
Rate / markup*	Market- rates set by JS Bank. **While the original structure anticipated lending under SBP's REEF concessional rates, the termination of REEF in June 2023 led GCF to permit standard KIBOR-based pricing. This demonstrated that solar-financing products can remain commercially viable at market rates; however, adequate portfolio-level guarantee coverage remains key.*
Tenor	Up to 10 years
Risk coverage	USD 9 million first-loss guarantee funded by the Green Climate Fund on a USD 54 million facility
Collateral / security	Standard collateral as per JS Bank policy. GCF guarantee covers initial losses on qualifying portfolios

Source: GCF SAP024

Access Metrics for SBP/GoP Programs

The table below outlines the scale and reach of active concessional and refinance programs implemented through participating financial institutions. While publicly available data is limited, it still provides useful directional insights.

Table 10: Active Concessional and Refinance Programs

Amounts in PKR Million	# of Participating Institutions	Scheme active since	Cumulative disbursements to date *(PKR million)*	Total funding allocation for the scheme *(PKR million)*	Maximum Spread*
PMYB&ALS	15	2022	174,905	NA	7%**
SAAF/ISAAF	8	2021	30,721	NA	8%
Refinance Facility for Modernization of SMEs	20	2010	5,533	165,500	NA
Scheme for Women Entrepreneurs	19	2019		47,500	5%
Risk Coverage Scheme for Small and Medium Enterprises	All Banks	2024	NA	NA	No cap
Scheme for Special Persons	NA	2019	NA	NA	5%

NA = Not Available

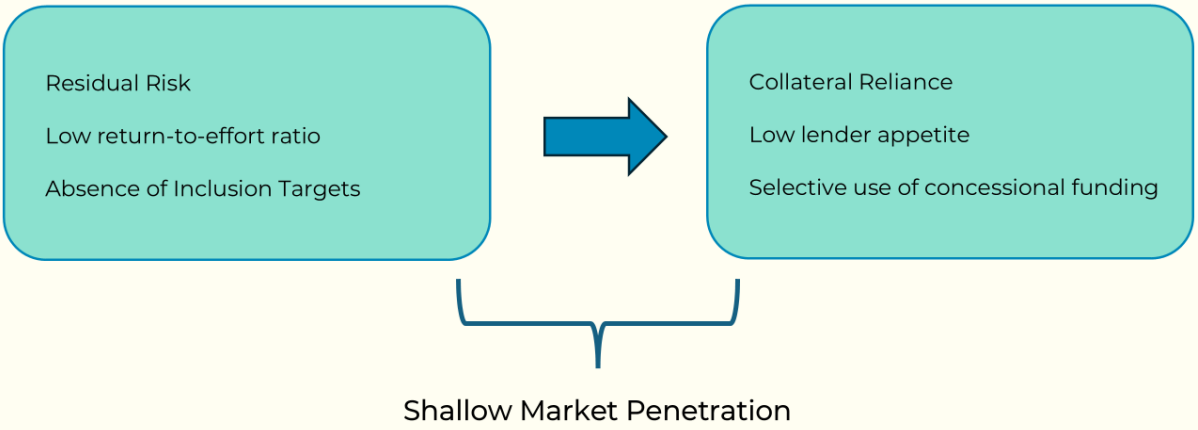
**Maximum Spread is the difference between end-user rate and the rate the FI earns in case of PMYB&ALS or the rate the FI pays to access liquidity.*

***KIBOR-linked*

Source: SBP Quarterly Data 2025, SBP Monthly Statistical Bulletin 2025, SBP APR 2021

5.3 Program Performance Insights and Design Constraints

Despite the availability of concessional credit lines and risk-sharing facilities, disbursement remains limited across retail and SME segments, including solar adopters. The evidence suggests that performance constraints are primarily structural and behavioral, stemming from weak alignment between risk allocation, product design, and operational capacity within financial institutions.



Drivers of Shallow Market Penetration

Subsidized credit flows to comfort zones, not credit gaps.

Residual Risk and Collateral Dependence

Despite multiple refinance and risk-sharing schemes by SBP, lending to SMEs and retail borrowers remains limited because banks still retain most of the underlying risk. First-loss coverage of 10-50% is not enough to materially change behavior when Prudential Regulations require full provisioning on the uncovered portion, as discussed in Section 4.2. Credit officers continue to treat these loans like any other and demand immovable collateral, even for risk-covered portfolios. As a result, concessional credit flows to clients already within the formal banking net, rather than the new borrowers it was designed to reach.

Administrative Burden and Weak Incentives

As of September 2025, the average cost of deposits for banks was 5.3% per annum against an average lending rate of 11.7%, implying a gross spread of 6.4%.[87] Schemes that preserve or enhance this spread, such as PMYB&ALS and SAAF, see stronger uptake. Others offer comparable margins to standard lending but impose heavier compliance and monitoring requirements. Once risk exposure, documentation effort, and reimbursement delays are factored in, concessional portfolios become less attractive than conventional loans or government securities. This reflects a clear misalignment between perceived effort and actual return. Banks therefore prefer to allocate liquidity toward full-spread, low-friction products rather than risk-shared SME or retail solar portfolios.

Scheme Design and Delivery Differences

The relative performance of GoP's PMYB&ALS scheme compared to SBP's refinance and concessional facilities suggests that scheme design may also influence uptake. PMYB&ALS has disbursed PKR 175 billion since 2022 through 15 banks, supported by a digital application platform, standardized processing steps, defined turnaround times and transparent reporting. In contrast, SAAF, active since 2021, has reached PKR 31 billion across eight institutions, while the Refinance Facility for Modernization of SMEs has seen limited utilization despite an allocation exceeding PKR 160 billion. These differences could point to the role of delivery mechanisms in shaping market absorption. Schemes with digital onboarding, structured workflows and clear operational benchmarks have scaled better, while those embedded within traditional credit processes depend more on bank-led origination and thus see slower uptake.

5.4 Eligibility Filters and Lending Terms in Commercial Portfolios

Our analysis looked at conventional and Islamic banks, MFBs, MFIs and specialized refinance or guarantee entities providing solar finance. Eligibility is tightly defined for most lenders, and the following common themes emerge. (Details in 12.4 Appendix)

Access Filters

- **Eligibility:** Consumer banking targets documented, salaried or self-employed urban customers with owned premises and verifiable income. Apartments and rented properties are rarely eligible. Microfinance institutions extend coverage to asset-owning individuals operating in the informal economy, as well as peri-urban and rural customers and unregistered small businesses. SME divisions within banks look for operationally mature firms with turnovers of PKR 200 million and above in banked cashflows for SBP-backed unsecured loans, and collateralization for other categories.
- **Vendor Requirements:** Solar equipment needs to be sourced from bank-approved or AEDB-certified vendors. Site surveys are conducted before disbursement.
- **Geographic Scope:** Many products are limited to Karachi, Lahore, Islamabad, Faisalabad, Multan, and areas within a certain radius of these. Rural and peri-urban borrowers rely on microfinance and NGO-linked programs.

[87] SBP Lending and Deposit Rates

Key Terms and Conditions

Table 11: Solar Financing Parameters

	Consumer Banking	SME Banking	Microfinance
Loan Amounts	PKR 0.3 to 7 million	PKR 25 to 400 million	PKR 0.05-5 million
Tenor	3-7 years	5-8 years	0.5-10 years
Pricing	13% - 16%	12%-15%	30%-40%
Equity*	Downpayment is 20% - 30%	Downpayment is 20% - 30%	Downpayment is 20% - 50%
Collateral for Documented Households	Hypothecation of solar assets, Personal Guarantees Property owner must co-sign with applicant; Additional collateral (property/car/deposits/securities) for loan amounts exceeding a certain threshold	Hypothecation of equipment, Property mortgage, and director guarantees	Property, gold, TDRs, social guarantees

**Equity contribution is higher for self-employed borrowers or off-grid systems*

Source: Author Analysis based on Solar Product Catalog in Appendix

5.5 Credit Visibility By Consumer Categories

Table 12: Credit Visibility for Large Urban Centres (Residential)

Energy Intensity	Documentation	Premise Type	Credit Visibility	Credit Type
High (10 KW+)	Income and asset ownership	Owned home with rooftop access	High	Consumer Finance
		Rented home or apartment with rooftop access	Low	MFI, Installer Finance, BNPL
Medium (5-10KW) (5-10KW)	Documented / Partial	Owned home with rooftop access	High	Consumer Finance, MFBs, Installer Finance
		Rented home/apartment with rooftop access	Low	BNPL & Installer Finance
Low 1-4KW 1-4KW	Informal	Owned home with rooftop access	Medium	MFBs, BNPL & Installer Finance
		Rented home or apartment with rooftop access	Low	BNPL
		Owned/rented apartment	Low	BNPL for balcony

Source: Author Analysis

Table 13: Credit Visibility for Small Town or Peri-Urban (Residential)

Energy Intensity	Documentation	Premise Type	Credit Visibility	Credit Type
Medium (3-10KW) (3-10KW)	Informal or Partial	Owned home/shop, with rooftop access	Moderate	Consumer Finance, MFBs, Installer Finance, BNPL
		Rented home	Low	BNPL
Low 1-3KW	Cash-based or seasonal income	Owned home/shop, with rooftop access	Low	MFBs, BNPL & Installer Finance

Source: Author Analysis

Table 14: Credit Visibility for SME or Commercial in Large Urban Centres / Industrial Clusters

Energy Intensity	Documentation	Premise Type	Credit Visibility	Credit type
High (100-500 KW)	Audited / Banked Cashflows	Owned or long-leased in metropolitan cities	High	Banks, NBFIs, Installer Finance
		Owned or long-leased in smaller towns	Moderate	Banks, NBFIs, Installer Finance
Medium (50-100KW)	Partial or semi-formal records	Owned workshops, small factories, or schools	Moderate	Banks, NBFIs, Installer Finance
Low (10-50KW)	Informal Cashflows	Rented shops, shared spaces, micro SMEs	Low	BNPL & Installer Finance

Source: Author Analysis

6. Market Diagnostic

This section identifies where distributed and hybrid solar can expand commercially and where targeted de-risking is required to include underserved but viable users. The assessment uses a four-part framework covering demand strength, economic viability, installation feasibility, and replicability.

Segments performing well across all dimensions are considered *ready to scale* through commercial finance, while those that are viable in principle but constrained by affordability or access are *primed for inclusion*.

6.1 Market Readiness & Economic Viability

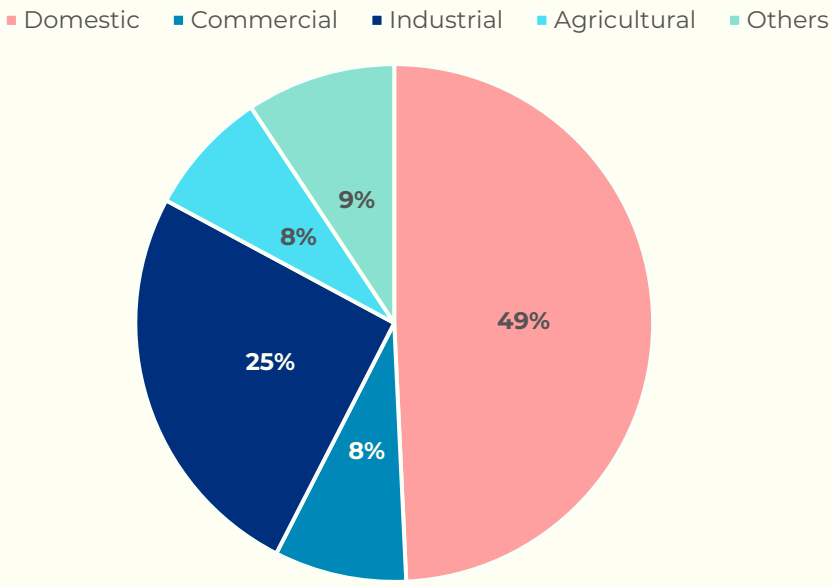
The four components of market readiness are defined as follows:

- **Demand Strength;** measured through energy intensity and consumption patterns
- **Economic Viability;** based on electricity tariffs, potential savings and payback period
- **Installation Feasibility;** determined by roof access, legal readiness, tenure stability, and service network availability
- **Replicability;** ease of scaling across similar users or adjacent users

6.1.1 Demand Strength

Electricity consumption in Pakistan totalled 109,708 GWh in FY24, distributed across five categories: Household, Industry, Commercial, Agriculture, and Others.[88]

Figure 26: Consumption Composition by Segment %



Source: NEPRA 2024 Report

Together, the highest two account for nearly three-fourths of national demand and form the core opportunity space for distributed and hybrid solar deployment. The upper end of commercial segment is also included, as it overlaps with light industrial users in system size and delivery structure and can be financed through similar instruments. Together, these three categories cover about 80% of total electricity use and define the main market for distributed solar solutions.

[88] NEPRA State of Industry Report 2024

Households

NEPRA categorizes domestic users by sanctioned load, below or above 5 kW. These thresholds are weak predictors of actual usage. Meters allow unrestricted current flow, so a large number of high-consumption homes remain billed under slab-based tariffs even when their real loads exceed 5 kW. Many such households already operate hybrid or off-grid systems without formal net-metering, meaning both their energy intensity and level of solar uptake are understated in official data.

To approximate true demand strength, consumption data by tariff slab and sanctioned load are summarized below. Households using 500 units per month or more (i.e. slabs of 300 units and above and ToU users) represent the genuinely energy-intensive segment. Although they constitute just 5% of total domestic connections across all DISCOs, their combined annual consumption exceeds 14,700 GWh, underscoring a high-load but narrow user base.

Table 15: Residential Category Consumption in DISCOs 2025

Category	Number of Consumers	Annual Consumption (GWh)	Monthly Consumption per Customer (kWh)*
Sanctioned Load < 5kW			
0-100 Units	5,954,366	3,211	45
100-200 Units	2,315,675	6,488	233
200-300 Units	2,210,975	10,396	392
300-400 Units	594,066	4,913	689
401-500 Units	193,731	2,508	1,079
501-600 Units	78,418	1,418	1,507
601-700 Units	36,720	861	1,954
Above 700 Units	59,498	2,037	2,853
Sanctioned Load > 5Kw			
ToU Connections	482,232	3,023	522
Total Residential			
Total Consumption Consumption	28,804,861	51,476	149
with Monthly Avg. of 500 units or more	1,444,665	14,760	851

**Monthly Consumption per customer = Annual Consumption / 12 (months) / No. of Consumers*

Source: Author Analysis based on NEPRA Tariff 2025

For K-Electric, disaggregated slab data are not available. However, its 3.1 million domestic customers consumed 6,899 GWh in 2024, confirming comparable intensity to other major DISCOs.

SMEs (Light Industrial)

DISCO data indicates the following consumption profile for industrial users.

Table 16: SME/Industrial Category Consumption in Discos 2025

Category	Number of Consumers	Annual Consumption (GWh)	Monthly Consumption per Customer (kWh)
B1	217,637	2,069	792
B2	61,555	8,606	11,651
B3	2,208	9,679	365,300
B4	109	4,079	3,118,502

TOTAL	**281,509**	**24,433**	**7,233**

Source: Author Analysis based on NEPRA Tariff 2025

Light industrial activity lies primarily in the B2 category, with monthly consumption around 11,600 units which is consistent with small- to mid-scale factories and workshops. In KE's service area, 23,430 industrial consumers recorded an average 18,654 units/month, placing Karachi's SME base within the same B2 bracket of other DISCOs. These firms typically operate on daytime schedules, maintain steady load profiles, and are technically well-suited for 50-200 kW grid-tied or hybrid systems.

Commercial

The commercial segment is broad and heterogeneous, encompassing small retailers, clinics, restaurants, and offices, alongside larger institutions such as schools, hospitals, and service complexes. Energy intensity varies widely, from household-like patterns at the lower end to light industrial SME profiles at the upper end

Table 17: Commercial Category Consumption Patterns in Discos 2025

Category	Number of Consumers	Annual Consumption (GWh)	Monthly Consumption per Customer (kWh)
SANCTIONED LOAD < 5KW	2,770,334	3,015	91
SANCTIONED LOAD >5KW	170,017	4,752	2,329
TOTAL	**2,940,351**	**7,767**	**220**

Source: Author Analysis based on NEPRA Tariff 2025

For Karachi, 532,825 commercial consumers used 1,822 GWh, averaging 285 units per month. Larger users with owned or long-leased premises, typically schools, hospitals, or multi-story offices, represent the most relevant subsegment for distributed solar. Their roof area and daytime load profiles allow system sizes of 50-150 kW, often covering 50-100% of site demand under grid-tied operation.

6.1.2 Unit Economics, Payback and Return on Investment

To evaluate financial attractiveness across system sizes, we conducted payback and ROI analyses based on the following parameters[89]:

- Installed cost: Varies by system size and is at PKR 80,000 per MW for larger deployments and PKR 175,000/kW for the smallest and includes Tier-1 modules, inverter, mounting, wiring, and installation; batteries included for grid-tied, non-net-metered deployments
- Annual generation: 1,500 kWh per kW for systems under formal O&M contracts and 1,250 kWh for systems smaller than 100 kW, due to soilage, shutdowns etc.
- Export rate (buy-back for net-metered units): PKR 11 per kWh (new approvals)
- O&M: 1% of initial capex, per year for systems <100 kW and 3rd party O&M at 2% annual cost for larger systems
- Net-Metering/Ability to Export: For systems between 5kW and 1MW
- Curtailment: 0% curtailment assumed for grid-tied, zero-export installations and cost includes batteries, implying that the system is sized conservatively
- Variation in demand during various seasons of the year was not modelled

The 'net annual benefit' comprises both savings from grid electricity displaced at current tariffs (2025) and revenue from exported units, after adjusting for O&M.

'ROI for self-use' is (Annual Savings - Export Earnings - O&M) / % of capex attributed to self use

[89] Key assumptions were validated with Hadron Solar and Burj Clean Energy Modarba

‘ROI for exports’ is (Annual Export Earnings)/ % of capex attributed to exports

The price/kW for deployment declines as system sizes increase.

Payback period ranges between 20-42 months for most categories.

Table 18: Payback Analysis and ROI for Various System Sizes and Tariff Categories

System Size	Price per kW	Segment	Export Share	Tariff for self-use	Annual Generation	Net Annual Benefit	Simple Payback	ROI on Self-use	ROI on Exports
kW	*PKR*			*PKR/kWh*	*kWh*	*PKR/Year*	*Years*	*Annual %*	*Annual %*
1	175,000	Residential (Protected)	0%	14	1,250	15,750	11.1	9.0%	0%
5	200,000	Residential (Grid-tied, with battery)	0%	49	6,250	296,250	3.4	29.6%	0%
5	130,000	Residential (Net-metered)	30%	43	6,250	202,250	3.2	39.7%	10.6%
10	115,000	Residential (Net-metered)	40%	43	12,500	366,000	3.1	45.1%	12.0%
10	175,000	Commercial (Grid-tied, with battery)	0%	41	12,500	495,000	3.5	28.3%	0.0%
10	115,000	Commercial	20%	38	12,500	396,000	2.9	40.1%	12.0%
24	110,000	Commercial	10%	38	30,000	1,032,600	2.6	42.1%	12.5%
24	110,000	Light Industrial	10%	32	30,000	870,600	3.0	35.3%	12.5%
50	105,000	Commercial	10%	41	62,500	2,322,500	2.3	47.7%	13.1%
50	105,000	Light Industrial	10%	31	62,500	1,760,000	3.0	35.8%	13.1%
100	100,000	Commercial	5%	41	150,000	5,825,000	1.7	59.4%	16.5%
100	100,000	Light Industrial	5%	31	150,000	4,400,000	2.3	44.4%	16.5%
1000	80,000	Commercial/Industrial	0%	31	1,500,000	45,700,000	1.8	56.1%	0.0%

Source: Author Analysis

The longest payback period was faced by the protected user at just over eleven years, as their tariffs are already cross-subsidized, and their upfront capex is disproportionately higher, making solar economically less attractive unless it is used to improve reliability during load shedding.

Key Findings & Insights

- Non-net-metered users who self-consume all generation, without curtailment, achieve faster investment returns, since offsetting grid purchases at the full tariff yields higher value than exporting surplus to the grid at around PKR 26 per kWh.

- Among higher-consumption segments, commercial customers recover investment faster than industrial users despite similar system costs and usage, because commercial tariffs are higher and industrial users benefit from concessional rates.

- For net-metering eligible customers, over-sizing their system is potentially an investment opportunity to deploy excess liquidity, as the returns are higher than those on bank deposits.

- A use-case for smaller system sizes could be in medium to high consumption households where applicable tariff is higher, but installation is not feasible (Section 6.1.3), so a downsized system can provide some relief.

6.1.3 Installation Feasibility

For single-ownership residences and self-occupied commercial or industrial premises, feasibility is high due to clear roof ownership and straightforward installation. Urban bungalows and peri-urban homes typically require 500-1,000 square feet of usable rooftop space, sufficient for 5-10 kW systems, with minimal structural reinforcement requirements.

Feasibility declines for rented properties without rights to roof, or in the case of multi-tenant properties (apartments, offices, retail outlets) with shared roof rights or none, load segregation challenges, and administrative limits from building management. These customers are served by small portable systems, unless organized collective arrangements such as ESCO models are introduced.

In the commercial and SME segment, most medium-sized facilities, schools, hospitals, workshops, and warehouses possess ample unshaded roof or canopy space for 50-200 kW systems.

Rural and small-town users are less served by installers or EPCs working with Grade A panels, and quality components. They may also be affected by an unreliable grid or backlogs in net-metering or interconnection approvals, making plug-and-play or behind-the-meter systems the most practical option for them.

6.1.4 Replicability

Replicability is strongest in institutional, commercial, and SME clusters, where similar load patterns and building structures enable standardization and portfolio aggregation. These clusters are already being used by installers to raise funding.

Among residential users, high-slab urban households are the most replicable segment: they exhibit consistent consumption profiles, predictable daytime loads, and are concentrated in a few large metropolitan areas where EPC networks already operate. By comparison, informal, rural, or rental segments are difficult to replicate due to small ticket sizes, higher cost to serve, fragmented ownership, varying site conditions, and weak after-sales networks.

6.1.5 Segments Readiness Matrix

We ranked key market segments on a scale of 1 (Low) to 3 (High) based on the discussed filters.

Table 19: Market Segment Readiness Matrix

Demand Strength	Economic Viability	Installation Feasibility	Replicability	Overall Market Readiness
1	2	2	1	**1.5 Low**
1	2	1	1	**1.25 Low**
3	3	2	2	**2.5 Medium**
2	3	3	3	**2.75 High**
3	3	3	3	**3 High**

Source: Author Analysis

While the highlighted cohorts are commercially ready or near-ready, the *equity paradox* remains an important consideration.

For lower-income households, the economic logic of solar is inverted. Since they already receive subsidy on consumption through low tariffs, expecting them to self-finance or commercially finance solar, transfers system decarbonization costs to those least able to bear them.

From a feasibility standpoint, their limited consumption means the solar savings are too small to be meaningful. Meanwhile, the unsubsidized capital cost for smaller systems is disproportionately higher on a per kW basis than larger installations, which means their payback period is nearly four times longer than every other segment.

Expanding solar in lower-income segments therefore requires reframing the problem. The inequity isn't in *tariff affordability*, it's in *reliable access*. The poorest consumers pay less per unit but endure the highest cost in lost productivity, discomfort, and service gaps. The solution is to replace subsidized grid power with subsidized solar in these segments, a process already underway through various government and donor programs.

6.2 Market Segments: Ready to Scale Versus Primed for Inclusion

The assessment of market readiness highlights two distinct lanes for accessing financial markets. Some customer groups exhibit clear commercial viability and can expand rapidly through conventional credit channels and are thus *ready to scale*. Others demonstrate strong demand and repayment potential but remain underserved due to documentation gaps, collateral requirements, or institutional risk perceptions. These are *primed for inclusion* as segments that can be financed sustainably once new credit origination models, risk-sharing tools, or alternative investor capital are mobilized.

6.2.1 Urban Residential

Urban middle-income households represent the gateway segment for distributed solar. They're large enough in number, financially capable, and already seeking cost stability and energy reliability. Most households require collateral-free, small-ticket consumer loans with simple documentation and digital credit origination, enabling both rapid scale among already-banked users and inclusion of comparable unbanked households.

Table 20: Urban Residential Assessment for Scale & Inclusion

Threshold	*Ready to Scale*	*Primed for Inclusion*
Income & Debt Service Capacity		
After-tax household income of at least PKR 228,000/month (USD 800) [90] *This can support a PKR 33,000/month repayment over 2.5 years at 18% interest on a PKR 0.8 million illustrative loan.*	Salaried or business owners with income and assets declared to FBR[91] OR Individuals with banked cashflows OR Individuals with assets such as properties, vehicles, investments, gold that can be collateralized	*Informal earners with comparable inflows verified through lifestyle markers (e.g. car ownership, private school fees, travel, consistent broadband and post-paid mobile phone subscriptions, verified e-commerce spending)*
Electricity Consumption		
> 500 units per month *Starting at 500-700 units, bills are PKR 26,000-37,000 and economic case becomes stronger.*	Mostly ToU and net-metered customers	Behind-the-meter (Solar+Battery) deployments, for slab-based households
System Sizes		
3kW+ *Economics improve with larger system sizes. 5kW system is priced 1.5x higher (on a per kW basis) than a 1 MW system, but a 1kW system is 2.5x more expensive.*	Typical loan amounts align with system sizes of 7kW-20kW	3kW-10kW
Home Ownership		
Legal feasibility / roof rights	Owned homes or where applicant is a close family member of the homeowner, the homeowner becomes a passive co-applicant	Rented homes where home owner becomes co-applicant with the tenant

Source: Author Analysis

6.2.2 SME / Light Industrial

The B2 industrial category forms the backbone of Pakistan's mid-sized manufacturing base and is selected for intervention because they have the operational maturity and credit discipline to service collateral-light loans. Within this segment, larger and banked enterprises are ready to scale, while smaller firms with traceable cashflows but limited collateral are primed for inclusion once supported by partial-risk guarantees or supplier-linked financing.

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[90] Prudential Regulations for MFBs
Note: Considers earners below PKR 1.5 million in annual income 'poor' and a regulatory lending ceiling of PKR 500,000 applies to them.

[91] Friday Times News Feb 2025
Note: FBR data indicates 1.3 million individuals earning between PKR 1 million and 5 million annually.

These enterprises include textiles/apparel, sports goods, surgical instruments, cutlery/utensils, electrical fans and home appliances, auto-parts vendors, leather/tanning, food and packaging, concentrated across Faisalabad, Sialkot-Gujranwala-Gujrat, Lahore, Karachi, Sheikhupura, Hattar/Haripur and other estates.

Units facing load-shedding or power-quality issues can deploy hybrid configurations with limited battery storage (30-60 kWh) to cover critical process loads.

Table 21: SME/Light Industrial Assessment for Scale & Inclusion

Threshold	*Ready to Scale*	*Primed for Inclusion*
Income & Debt Service Capacity		
Minimum monthly turnover of PKR 10 million or PKR 120+ million annually *At an operating margin of 8% and DSCR ≥ 1.5x, Net cashflows of PKR 0.8 million/month can support instalments of PKR 0.25 million, equivalent to a PKR 8 million solar investment over 5 years at a 16% markup.*	Businesses with banked monthly cashflows of PKR 15 million or more, and an operating history of 3+ years typically qualify for unsecured loans (SAAF/ISAAF) OR Smaller enterprises where business/owners can offer collateral	Businesses with traceable monthly cashflows of PKR 10 million or more, and an operating history of 3+ years, without additional collateral
Business Formalization		
Forms of ownership	SECP registered companies with audited accounts	Proprietorships and Partnerships whose management accounts are verifiable through utility bills, supplier ledgers, bank deposits, and employee payroll volumes, as a proxy to audited accounts.
Electricity Consumption		
> 10,000 units per month and 50kW+ system size *Meaningful savings at this level 50kW system can serve around 60% of the daytime load with a physical footprint under 2500sq feet.*	> 10,000 units per month which matches with about 100kW+ systems	Enterprises with similar or slightly lower consumption (8,000-12,000 units/month) where a 50-75 kW system would yield strong savings, but upfront affordability constrains adoption.
Premises Type		
Possession and Usage Rights	Owned or Long-leased	Long-standing tenancy (+5 years) where landlord provides written consent for solar installation.

Source: Author Analysis

6.2.3 Service Sector SMEs / Commercial

The commercial segment is fragmented with varying energy intensity, warranting targeted inclusion.

It covers a wide range of users such as small shops, offices, clinics, gyms, restaurants, schools, and hospitals. Electricity use is driven mainly by lighting, HVAC, and IT equipment. Most have low to moderate loads, with smaller users showing household-like demand patterns and larger ones resembling light industrial SMEs. Because many operate from rented or shared premises, overall solarization potential remains limited. Since these are asset-light businesses, therefore the credit evaluation standards for this segment are stricter.

Within this group, educational institutions, hospitals, and Tier-1 retailers present the strongest solarization potential due to stable revenue streams, predictable demand and sufficiently large premises.

Table 22: Service Sector SMEs / Commercial Assessment for Scale & Inclusion

Threshold	*Ready to Scale*	*Primed for Inclusion*
Income & Debt Service Capacity		
Minimum monthly turnover of PKR 10 million or PKR 120+ million annually *At an operating margin of 8% and DSCR ≥ 1.5x, Net cashflows of PKR 0.8 million/month can support instalments of PKR 0.25 million, equivalent to a PKR 8 million solar investment over 5 years at a 16% markup.*	Businesses with banked monthly cashflows of PKR 20 million or more, and an operating history of 5+ years typically qualify for unsecured loans OR Smaller enterprises where business/owners can offer collateral	Businesses with banked monthly cashflows of PKR 10 million or more, and an operating history of 3+ years, without additional collateral.
Business Formalization		
Forms of ownership	Private schools, registered hospitals, or Tier-1 retailers with FBR registration, structured management, and audited or management accounts.	Proprietorships and Partnerships or Trusts whose management accounts are verifiable through fee receipts, patient billing records, or POS transaction data as proxies for audited accounts.
System Size & Rooftop Requirements		
400-1,000 sq yd clear rooftop area. Suitable for 55-150 kW PV systems (90-250 × 600 W modules) generating 7-25 MWh/month	100 kW+ systems (under PPA or leasing models)	30-75 kW systems
Premises Type		
Possession and Usage Rights	Owned or Long-leased	Long-standing tenancy (+5 years) where landlord provides written consent for solar installation.

Source: Author Analysis

6.2.4 Microenterprises Within Concessional Finance Channels

Micro and small enterprises sit in a blind spot between household borrowers and formal SMEs. They are too large and active to be treated purely as residential users, yet lack the formal documentation and collateral required for standard SME credit. Many operate from homes or small rented shops as food preparation units, tailoring and stitching businesses, salons, tuition centres, micro-retail, repair workshops, that rely on fans, freezers, mixers, ovens, sewing machines, chillers or IT equipment. These activities translate into higher household-level electricity loads, but their credit needs are not served through conventional solar finance because lenders struggle to evaluate mixed personal-business cashflows and to underwrite small-ticket systems at volume. Treating these borrowers as a distinct segment helps differentiate those who can scale through commercial channels from those who need structured origination, vendor-linked appraisal, and partial risk cover.

Tier 1 and Tier 2 borrowers within youth and micro-enterprise programmes display the typical traits of semi-formal microbusinesses: steady turnover, partial documentation, and thin collateral. Their repayment behaviour indicates creditworthiness. These users fall naturally into the “primed for inclusion” lane for 2-10 kW systems. Tier 3 borrowers sit at the other end of the spectrum. They resemble fully bankable SMEs with structured accounts, collateral, and the scale to deploy 30-100 kW

systems through commercial credit. Their participation in subsidised schemes reflects pricing arbitrage rather than limited access. For solar, they align with the "ready to scale" lane, with subsidised credit offering cost advantages rather than enabling access.

Table 23: Microenterprises Assessment for Scale & Inclusion

Threshold	*Ready to Scale*	*Primed for Inclusion*
Income & Debt Service Capacity		
Monthly turnover of PKR 80,000+ *Ability to support concessional instalments for systems from 2kW+*	Monthly business income of PKR 300,000-1,000,000+ supporting instalments for 30-100 kW systems. Able to provide collateral and otherwise eligible for commercial SME loans.	Home-based and micro-enterprises with PKR 80,000-250,000 income supporting PKR 5,000-15,000 instalments for 2-10 kW systems.
Business Formalization		
Forms of ownership	Proprietorships or companies with structured or audited accounts and NTN/GST registration.	Semi-formal businesses verified through utility bills, supplier receipts, or mobile-wallet flows.
System Size & Rooftop Requirements		
100+ sq yd clear rooftop area	High-consumption activities such as commercial kitchens, small workshops, bakeries or refrigeration-heavy shops suitable for 30-100 kW systems.	Home-based food businesses, salon and grooming services, stitching/tailoring, micro-retail, and tuition centres requiring 2-10 kW systems
Premises Type		
Possession and Usage Rights	Owned or Long-leased	Long-standing tenancy (+5 years) where landlord provides written consent for solar installation.

Source: Author Analysis

6.3 Market Size Estimation for Distributed Solar

The market sizing exercise was conducted to estimate the potential for distributed solar and hybrid energy solutions across key customer segments, commercial, urban households and SMEs, in Pakistan's major cities (Karachi, Lahore, and Islamabad). Market demand was modelled for base, low and high penetration scenarios. Core assumptions are as follows:

- **System sizes:** Derived from typical load patterns and set at 5-10 kW for residential; 200-600 kW for SMEs/Light Industrial; 60-100 kW for schools; 120-200 kW for hospitals.
- **Capital cost:** Depending on system size, PKR 90,000-125,000 per kW for panels, inverters and installation, and PKR 150,000-200,000 per kW inclusive of batteries.
- **Eligibility/adoption filters:**
    - Adoption percentages of 5%-10% for households
    - Eligibility range of 20-30%, depending on ownership and feasible rooftops suitability across private sector educational institutions and hospitals
    - Eligibility range of 25%-45% for SME/Industrial category

The model applies to a standard bottom-up calculation in Excel using the following relationships:

TAM (MW) = No of consumers x Eligibility or Adoption % x Average System Size in MW

Value in PKR = TAM (kW) x Price per kW

For each city and segment, 'Low', 'Base', and 'High' scenarios were constructed by adjusting eligibility/adoption shares and average system size. The outputs are presented both in megawatt potential and in PKR investment value.

Table 24: Market Size Estimation

(PKR Bn)	Karachi	Lahore	Islamabad	Total
Base Case				
Residential	248	253	30	531
Commercial	26	16	4	46
SME	72	387	78	536
Total	**346**	**655**	**111**	**1,113**
Low Penetration				
Residential	120	122	14	257
Commercial	16	10	3	28
SME	24	128	26	178
Total	**160**	**260**	**43**	**462**
High Penetration				
Residential	532	542	64	1,138
Commercial	44	27	7	78
SME	147	782	157	1,086
Total	**722**	**1,352**	**228**	**2,302**

Source: Author Analysis

6.4 Financing Needs

While these estimates represent total investment potential, only a portion of it translates into financing potential. Actual lending opportunity depends on system size, credit access, and household or business liquidity. To bridge the investment and financeable opportunity, the analysis assumes different leverage ratios across customer segments under the base case scenario.

Table 25: Financing Potential for Segments

Segment	Total Investment (PKR Bn)	Debt Share (%)	Financing Potential (PKR Bn)
Residential	531	75	398
Commercial	46	60	28
SMEs	536	70	375
Total	**1,113**	-	801

Source: Author Analysis

This suggests that the distributed solar market in the three major cities represents roughly PKR 800 billion (about USD 2.8 billion) in near-term lending potential under the base scenario.

6.5 Delivery Models - Pathways for Market Access

Access to distributed solar varies by customer profile, asset ownership, and financing capacity, rather than by technology alone. Each financing or delivery pathway effectively serves a different user segment, defined by who controls the premises, how they can pay, and their ability to assume system ownership.

At present, the market is led by self-financed and individually owned systems, adopted mainly by high-income households and large enterprises with clear title and liquidity. Lease-to-own and installment-based models are emerging as entry points for salaried or SME customers who have repayment capacity but lack upfront capital. Service-based or third-party ownership models, such as energy-as-a-service, PPAs, or shared systems, remain limited to large corporates and institutions, but represent the primary route to reach rented, informal, or multi-tenant users who cannot install or finance systems directly. These pathways mirror the commercial readiness of each segment identified earlier, but their reach can widen substantially through aggregation mechanisms, credit guarantees, vendor-led financing, or bundled service contracts that lower entry barriers for viable yet commercially underserved users.

Table 26: Delivery Models

Turn-key EPC, Direct Ownership	
User purchases and owns the system outright, and installers manage design, installation and optionally O&M. This remains the most common model across residential and commercial customers with adequate roof ownership and upfront liquidity, or access to finance. Typical size: 5-15 kW for households, 50-100 kW for commercial/SME clients, upto 1MW for larger institutions or corporates.	
Current Use Case	*Adjacent Segments*
High-income, high consumption urban residential households, mostly net-metered	
High consumption households with partially documented income, and behind-the-meter PV only or hybrid setups	Non-net metered, medium consumption, middle income residential segment
Single tenant commercial buildings & offices	Medium sized commercial and industrial segments, organized as partnerships or sole proprietorships, and unable to offer collateral
Corporates and institutions with access to formal banking	
Plug-and-Play Portable Systems	
User purchases and owns the system outright. Compact, portable self-contained off-grid units (1-2 kW)	
Current Use Case	*Adjacent Segments*
Low-income, low consumption urban, peri-urban, rural residential households	Middle income apartment dwellers (non-net-metered)
Lease-to-Own (NBFI/Modaraba Model)	
EPC installs the system that the leasing company owns, while the customer pays periodic lease rentals until ownership transfers. O&M is the responsibility of the customer.	
Current Use Case	***Adjacent Segments***
Mid-tier industrial, commercial and institutional clients (50-500kW) with reliable cash flows but limited collateral or formal credit history.	Small industrial, commercial and institutional clients (20-50kW), with limited collateral or formal credit history.
High-income, high consumption urban residential households, with partial documentation	Medium consumption, middle income residential segment, with partial documentation
Energy Service Company (ESCO)	
The provider installs, owns, and operates the system, selling energy or capacity at a client's site, under a long-term PPA or lease contract.	
Current Use Case	*Adjacent Segments*
Mainly 50-500 kW institutional, commercial and industrial customers	Mid consumption apartments, commercial plazas, office blocks, shopping centres, where there is a coordinated entity representing the cluster and individual ownership of generation assets is not feasible..

Energy-as-a-Service	
An extension of the ESCO approach, where the provider serves a large user with multiple dispersed sites. Provider retains ownership of assets and sells energy per unit consumed under a performance-based service contract including O&M, monitoring, and uptime guarantees.	
Current Use Case	**Adjacent Segments**
Prevalent model for the telecom industry where towers are being solarized.	Business chains with multiple outlets (e.g. retail franchises, fuel stations, banks, warehouses)
Pay-as-you-go / Subscription Model	
The provider owns the asset, and users make small, recurring payments via mobile money or prepaid meters.	
Current Use Case	**Adjacent Segments**
Community solar in off-grid rural areas or low-consumption clusters	Low-income households in peri-urban areas, using digital payment integration

Source: Author Analysis

The diversity of these models reflects adaptation to market constraints and varying demand levels across consumer types rather than deliberate product design. Most remain concentrated in higher-income or institutional segments where ownership and liquidity are straightforward. Service-based and shared models are emerging but have yet to reach scale. In Section 8, we will examine how these delivery structures align with credit visibility and market potential, setting the stage for identifying scalable and inclusive financing pathways.

7. Stakeholder Perspectives

7.1 Multi-Stakeholder Consultation

7.1.1 Consultation Overview

To understand the market's perspective, we convened a stakeholder consultation on retail and SME solar financing in Pakistan. The discussion identified several critical barriers limiting financial institutions' participation in solar financing, including weak collateral frameworks, limited branch-level capacity for solar product evaluation, short-term liquidity constraints particularly affecting microfinance banks, and the absence of standardized risk mitigation tools.

The consultation brought together a cross-section of stakeholders from Pakistan's financial, renewable energy, and technology sectors.

Participating organizations included commercial banks such as Meezan Bank Limited, JS Bank Limited and National Bank of Pakistan; development finance institutions and funds including Pak Brunei Investment Company Limited and Climate Core Asia; credit enhancement platforms represented by National Credit Guarantee Company Limited (NCGCL); digital and microfinance banks including Easypaisa Digital Bank, Raqami Islamic Digital Bank, and Abhi Microfinance Bank; solar developers and engineering firms such as Delta Energy Limited and ACT Engineering; as well as independent microfinance and banking experts.

7.1.2 Discussion Themes

Credit Risk, Collateral, and Recoverability

Commercial banks emphasized that their lending decisions are guided more by collateral quality and recoverability than by transaction pricing. Solar assets are not viewed as reliable security because insurers apply annual value reductions and settle claims at depreciated values, leaving the loan under-protected. Legal delays in collateral enforcement further discourage reliance on asset-backed lending, particularly for small-ticket exposures.

Yet, solar exposure in their portfolios remains limited and largely confined to ISAAF-backed schemes, where SBP covers part of the credit risk. Microfinance banks, in contrast, handle borrower risk differently. They use behavioral scoring and alternative income proxies to assess repayment capacity and wide recovery systems with delinquencies under 2%. This positions them well for higher-volume, smaller-ticket lending in rural and peri-urban markets.

Emerging Opportunity: Streamlined repayment and recovery mechanisms can address collateral and enforcement gaps. Participants suggested linking repayments to electricity bills or digital wallets through partnerships among banks, fintechs, and utilities. Embedding repayment in existing payment channels can strengthen discipline and reduce administrative costs for lenders.

Lending Models and Delivery Channels

Banks favored anchor-based and portfolio-level financing because it simplifies due diligence and fits existing ‘Supply-chain Financing Product’ systems. They were less open to securitizing their own portfolios, given low advances-to-deposit ratios and limited scale.

Microfinance and digital lenders proposed onward lending and embedded finance structures for outreach expansion. Easypaisa, for instance, has built a PKR 6 billion small-ticket portfolio through weekly and monthly cycles, which could be adapted for solar using automated collections and digital credit scoring. Raqami Digital also plans to add solar loans upon launch.

Banks and DFIs supported channeling capital through microfinance partners or certified EPC vendors, allowing pre-approved technical and credit standards to be applied at origination. This model combines last-mile reach with portfolio oversight.

Emerging Opportunity: Onward lending and EPC-linked financing can enhance scalability and quality assurance. By lending to certified vendors or MFBs under standardized frameworks, banks can delegate origination while retaining credit control, improving both outreach and asset performance.

Product Design and Risk Mitigation

Developers and EPC vendors emphasized that high system quality and long-term service contracts are essential to lender confidence. They recommended lease-based or warranty-backed models that tie repayment to performance, similar to auto financing structures.

Guarantee institutions such as NCGCL and Pak Brunei advocated simpler claim processes and better alignment of guarantee tenor with loan maturity. They viewed guarantees as transitional tools rather than permanent substitutes for sound underwriting. Banks supported performance-linked guarantees that begin with higher first-loss coverage and taper as portfolio performance improves.

Emerging Opportunity: Graduated guarantee frameworks can bridge early-stage risk and incentivize portfolio growth. Linking guarantee coverage to repayment performance encourages disciplined origination and gradually reduces dependence on concessional or donor-backed support.

Capital Market and Structural Innovations

Participants identified opportunities to securitize microfinance and EPC solar portfolios into commercial papers or sukuks. Such instruments could deliver investor returns near 16% against underlying portfolio yields of 36%. This would diversify funding sources, enhance liquidity, and establish solar finance as a credible asset class.

They also noted lessons from India's right-of-access and rental frameworks, which allow asset recovery without litigation in multi-tenant and urban rooftop settings. Similar legal and contractual approaches could unlock segments currently constrained by ownership complexity.

Emerging Opportunity: Developing capital market instruments and adopting adaptable legal frameworks can attract private investment into distributed solar. These innovations could convert solar finance from a niche development product into a mainstream, investable category.

7.1.3 Key Takeaways

- Solar assets are viewed as weak collateral due to depreciation-based insurance in a loss and damage scenario and lengthy repossession and collateral enforcement in a default scenario. Lease-based structures avoiding enforcement related delays. Warranty-backed lending strengthens repayment security by linking credit to equipment performance.
- Embedding repayments in utility or digital systems can improve credit administration.
- Anchor-based and onward lending models mediated by intermediaries simplify due diligence for commercial banks and enhance scalability.
- Microfinance banks and fintechs have the most suitable infrastructure for small-ticket, informal market segments.
- Graduated guarantee mechanisms can de-risk early portfolios while building market confidence.
- Capital market instruments and standardized delivery models can expand liquidity and institutional participation in solar finance.

7.2 Stakeholder Interviews

To further enhance our understanding conducted a series of 10 targeted stakeholder interviews, to complement the multi-stakeholder consultation.

7.2.1 Microfinance Institutions & NBFCs

Ali Ladhubhai, Fintech & Microfinance Expert

Ali believes the future scale of solar financing depends on microfinance banks rather than commercial banks. Microfinance banks are better positioned to expand solar lending because of their grassroots networks, familiarity with low-income segments, innovative collateral schemes and higher risk tolerance compensated by yields they charge. In contrast, commercial banks remain hesitant to cater to such segments due to collateral challenges and lack of familiarity / limited experience with small-ticket clients. A key factor is their ability to cater to larger clients with far greater ease, which significantly reduces their cost of doing business.

He also noted that the progression of customers/borrowers from microfinance to commercial banking (the concept of graduation) is not happening at the desired pace. Ideally, microfinance should serve smaller business clients and then help them progress to a level where they can access lending from commercial banks. Hence, the immediate opportunity lies in enabling microfinance banks to expand lending to these mid-tier segments, supported by partial de-risking mechanisms such as first-loss guarantees of 10-20%. He emphasized that pricing, rather than demand itself, is the key constraint when it comes to expansion: current lending rates in the microfinance sector average around 36% for fully secured loans, discouraging uptake. With partial guarantees, these rates could also see a fall to around 20-22% making solar financing accessible to a much broader customer base.

Ali recommended that the solar financing sector use creative collateral structures such as those seen in tractor financing programs. These provided a successful local precedent for financing movable and depreciating assets outside mainstream cities. In those programs, banks managed their risk through asset-based lien marking, land collateralization, and partial risk cover mechanisms that allowed large-scale lending despite weak resale markets.

Ali also commented on the importance of reliable collection mechanisms such as payroll deductions or on-bill recovery, which can help build confidence across multiple financial institutions with different risk appetites and scale overall solar financing. At a broader level, he observed that microfinance banks/institutions in Pakistan generally maintain strong credit discipline, but loan tenors for working-capital products are often short. As solar systems require longer repayment periods, institutions are increasingly exploring operational models and risk-sharing tools that would allow for multi-year solar loans aligned with system payback profiles.

To support long-term growth, he noted that microfinance institutions are increasingly exploring capital-market avenues to diversify their funding sources. Potential structures such as securitization particularly when paired with credit guarantees on receivables portfolios would enable banks to provide liquidity against secured cash flows. However, limited market depth remains a key constraint for deploying such instruments at scale in Pakistan. He emphasized that while first-loss guarantees are not essential, portfolio-level guarantees in moderate ranges could significantly accelerate solar product distribution through microfinance networks. With the right enablers, including options such as NBFC licensing for higher-value clients, microfinance institutions are well positioned to serve a broad spectrum of segments from households and micro-enterprises to mid-market players such as EPC contractors.

Riaz Bangash, President & CEO, NRSP Microfinance

Riaz shared that NRSP Bank began financing solar systems about few years ago, just before the pandemic disrupted microfinance operations nationwide. During the pandemic, portfolio repayments were disrupted and delinquencies rose as rural and micro-business clients struggled with liquidity. That experience led NRSP Bank to shift its credit-policy framework away from unsecured solar lending to adopting a double-collateral model in which the solar asset is backed by a lien on land or gold, indicating a deeper structural issue: the absence of viable recourse mechanisms for non-collateralized lending.

He explained that while solar systems are used as physical collateral, their resale value is weak, so the double collateralization significantly improves recovery confidence. The Punjab Land Records Authority (PLRA) has facilitated this process by digitizing land registries, which has made land lien

marking faster and legally more enforceable. Post-pandemic, NRSP's risk management framework has stabilized with a more mature and cautious approach to green lending.

In discussing NRSP Bank's current solar operations, Riaz shared solar portfolio now stands at approximately PKR 3 billion, with around 90% of borrowers being rural agricultural clients. Urban exposure remains limited due to tenancy issues and lower branch presence. NRSP Bank's portfolio quality has strengthened, with non-performing loans (NPLs) below 1%, compared to 8-10% during early unsecured pilots (on a smaller PKR 100 million portfolio). He shared pricing is around 30-32% (notably below the rates charged by competitors), typical ticket sizes reach up to PKR 3 million (in line with SBP's allowable ceilings), and average loan tenor is three years.

Riaz emphasized that liquidity is not a constraint, capital adequacy is. With strong deposit mobilization, equity injections, and consistent profitability, the main regulatory bottleneck is the Capital Adequacy Ratio (CAR), which limits balance sheet expansion. For the bank to re-enter unsecured solar lending at scale, CAR buffers would need to improve (which he expects by end of year), and board governance would need to support higher-risk segments. NRSP Bank's climate focus is embedded in its board strategy; the bank has built a huge green-energy portfolio and aims to expand it further under stronger CAR and risk-sharing support mechanisms.

On risk-sharing mechanisms, he noted that guarantees could meaningfully unlock scale. He believes structures such as 40-50% first-loss or partial guarantees would allow NRSP Bank to extend lending without heavy collateral, increase loan tenors, and materially accelerate disbursements. He emphasized that guarantee pricing is critical here. Around 2% fee for a 50% guarantee is financially viable, but any higher fees would make products unattractive. Such schemes, he argued, could replace the double-collateral approach with more efficient, inclusion-oriented lending.

However, certain systemic barriers still remain in unsecured lending; weak legal enforcement and low credit discipline discourage banks from unsecured lending to all sectors. He suggested that stronger government enforcement mechanisms could improve credit discipline and lower perceived risk across the microfinance industry.

On the funding side, NRSP Bank maintains a diverse and independent liquidity base. Beyond deposits and bank lines, the bank has raised funds from the capital market through Term Finance Certificates (TFCs). TFCs were used particularly during the COVID-19 period to refinance institutional borrowings. These TFCs, alongside deposit mobilization, ensure stable, long-term liquidity and reduce dependence on commercial banks. New TFC issuances could be considered in future to further lengthen funding maturity profiles and diversify funding base.

Talha Ameer Khan, CFA, MD Investments, Burj Clean Energy Modaraba (BCEM)

Talha shared that Burj Clean Energy Modaraba (BCEM)'s go-to-market strategy is enabling Pakistan's green transition by offering innovative solar financing and product solutions across a wide customer base from larger commercial and industrial clients to smaller-ticket residential and SME segments. BCEM partners exclusively with reputable solar vendors who serve as key market touchpoints for customer acquisition. These vendors are responsible for system installation and post-installation after-sales service, which is essential for ensuring quality, reliability, and long-term performance of the system. In such transactions, BCEM's role remains strictly that of a financier.

Building on this, he talked about how BCEM's credit approval decisions have no vendor involvement. BCEM's proprietary credit-scoring system automatically screens and identifies customers who meet the required credit criteria for solar financing. This structure ensures high-quality installations through vetted vendors while allowing BCEM to independently build and maintain direct financing relationships with its customers.

BCEM chose lease financing for their residential portfolio via completely digital processes, which has streamlined customer onboarding, credit assessment, repayment, and other logistical challenges of managing multiple individual projects across a broad customer base. Talha also highlighted the distinct risk dynamics across client profiles, noting that small-ticket residential solar projects

inherently carry higher risks than C&I customers, which often results in differentiated pricing structures across the two market segments.

Addressing collateralization challenges, Talha acknowledged the absence of a robust secondary market for solar PV panels that could provide meaningful recovery value upon repossession. However, he proposed innovative solutions including smart inverters enabling remote disconnection in default scenarios and increased client equity contributions in lease arrangements to reduce incentives for willful default. Together, these mechanisms create multiple layers of protection while maintaining the accessibility that makes residential solar financing attractive to homeowners.

Looking ahead, Talha emphasized that market dynamics strongly favor expansion and that the demand (both for solar and financing for solar) significantly exceeds supply capacity. He noted that the market could easily absorb manifold increases in financing availability. However, he also identified a critical structural challenge in capital market financing for this asset class: the mismatch between capital markets' demand for immediate returns and distributed solar projects' infrastructure-like characteristics including longer return periods for segments such as the C&I.

7.2.2 Solar Developers & Experts

Waqas Moosa, CEO, Hadron Solar & Chairman, Pakistan Solar Association

Waqas highlighted that Pakistan's solar market has entered a period of adjustment following an exceptional growth phase in 2023-24. Industry balance sheets have contracted due to a sharp decline in panel prices (down nearly 40-50% year-on-year) combined with lower overall sales volumes. Intense competition among EPCs has further compressed margins, forcing firms to improve operational efficiency and diversify service offerings.

He noted that while module prices are unlikely to fall further given Chinese manufacturers' overcapacity, thinning margins, and reduced export rebates, battery prices are still declining. This creates new opportunities for battery energy storage systems (BESS) as substitutes for diesel backup. For customers, typical payback periods range from 1.5-2 years for solar-only systems and 3-4 years for hybrid setups with batteries, depending on tariff exposure and consumption patterns.

On financing, Waqas emphasized that solar should be treated as a bankable asset class if financial institutions adopt appropriate valuation and risk frameworks. He proposed that banks could accept solar systems as collateralized assets, provided they apply accelerated depreciation rates to reflect technological aging. Interestingly, he pointed out that imported solar asset values hold relatively well amid rupee depreciation, partially offsetting global price drops. To enhance risk management, he recommended structured partnerships between banks and reputable EPCs, where EPCs provide partial performance or buy-back guarantees, potentially supported through standby letters of credit (SBLCs) to secure repayment or replacement in default scenarios.

Demand for financed solar systems remains robust, particularly for 2-3 year installment plans, which many suppliers already offer at markups exceeding 20%. However, he highlighted that access to formal finance could bring greater price transparency and consumer protection compared to informal vendor-led credit. He further noted that the upcoming wave of battery integration, driven by declining lithium-ion costs and worsening grid reliability, presents a unique opportunity for banks and microfinance institutions to design hybrid financing products that combine solar generation with energy storage, thereby improving customer economics and repayment capacity.

Overall, Waqas's perspective is that Pakistan's solar sector is at an inflection point: transitioning from rapid expansion to consolidation and professionalization. The next growth phase, he suggests, will depend less on hardware price cycles and more on the availability of tailored financing mechanisms, enforceable guarantees, and risk-sharing frameworks that can mobilize institutional capital into distributed solar at scale.

Farman Lodhi, Consultant/Advisor, Industrial Projects & Renewable Energy

Farman strongly highlighted a significant untapped market opportunity in lower to lower-middle income urban areas for rooftop solarization. He observed that these communities often fall outside the reach of traditional bank financing due to limited income documentation, tenancy issues, or absence of formal property titles. While individual financing for such customers may be uneconomical for banks, aggregated EPC or installer-led financing models could bridge this gap. In his view, EPCs are best positioned to extend credit based on reputation and reference-based due diligence, supported by recurring payments or 'on-bill' recovery mechanisms.

He referenced the success of Pay-As-You-Go (PAYG) solar models in Africa, particularly in Kenya and Nigeria, suggesting that similar approaches could be localized for Pakistan's urban low income segment. These models, where the EPC or service provider retains ownership and aggregates customer portfolios, can achieve commercial viability through scale and predictable cashflows rather than collateral. However, he emphasized that limited access to capital remains the foremost barrier, both in securing long-term project financing (given the lack of tangible security) and in maintaining sufficient working capital to support ongoing installations.

Farman believes that the current economic fundamentals strongly support solar expansion, as the payback for customers remains attractive and financing costs remain within viable thresholds for both banks and EPCs. He noted that EPC financing structures already existed under the SBP Renewable Energy Refinance (REEF) Scheme, indicating that regulators and lenders recognize EPCs as credible credit intermediaries. Building on this precedent, he suggested that formalizing EPC-led credit lines, backed by partial guarantees or blended finance, could unlock large-scale adoption in previously underserved markets.

There is a need for innovative aggregator-based financing to extend solar access beyond formal banking channels. He envisions a model where EPCs act as financial and technical intermediaries, supported by concessional funds or guarantee mechanisms; turning a currently fragmented small-ticket market into a scalable, commercially sustainable segment of Pakistan's distributed solar economy.

7.2.3 Enablers, Regulators & Policy Bodies

Mohammad Asif, Deputy General Manager Policy & Program Design, Small and Medium Enterprises Development Authority (SMEDA)

Asif emphasized that Pakistan's financial ecosystem continues to face a structural disincentive for commercial banks to lend to the private sector, particularly to small and medium enterprises (SMEs). In identifying priority segments for policy and financial intervention, Asif suggested that 'medium enterprises with upward mobility potential' should be the central focus of credit facilitation. These are firms that already maintain basic financial systems, tax registration, and compliance processes, making them better aligned with lender requirements.

Within the services sector, he highlighted the hospitality and tourism industry, along with organized education enterprises such as private colleges and school networks, as promising candidates due to their steady cashflows, formal structures, and potential for expansion. In the industrial sector, he recommended targeting auto parts, surgical instruments, textile apparel, leather and footwear, pharmaceuticals, sportswear, and sports goods manufacturing that are export-oriented, relatively formalized, and capable of scaling with appropriate financial support.

Conversely, he was less optimistic about agri-businesses as immediate financing targets, noting that while they present large market potential, the sector suffers from fragmented supply chains, inconsistent management capacity, and weak value addition, which collectively reduce bankability of the sector.

To promote targeted financing, Asif referenced six industrial clusters where SMEDA has already conducted feasibility studies and enterprise surveys, representing tested and bankable entry points for lenders:

- Aluminum Utensils, Gujranwala
- Agriculture Implements, Takht Bai, Khyber Pakhtunkhwa

- Printing & Publishing, Lahore & Karachi
- Salt Products
- Agriculture Implements Punjab (Faisalabad, Mian Channu, Multan)
- Pharmaceutical Clusters, Karachi & Lahore

Asif also outlined several ongoing institutional initiatives to address systemic barriers to SME finance. These include the development of a unified SME credit scoring model that banks can adopt to standardize risk assessment, simplified loan application formats being designed jointly with the Pakistan Banks' Association (PBA) to ease documentation burdens, and credit enhancement product design in collaboration with the National Credit Guarantee Company Limited (NCGCL). Together, these measures aim to de-risk SME lending, improve credit visibility, and reduce administrative frictions that currently deter banks from engaging with smaller enterprises.

Nadir Khan Niazi, Deputy Director, Pakistan Council of Renewable Energy Technologies (PCRET)

Nadir explained that PCRET's last major Public Sector Development Programme (PSDP) projects were implemented around 2015, marking the end of an active phase of government-led renewable demonstrations. Since then, only minor initiatives such as the KOICA PV testing Laboratory grant and a Micro Hydro program have been pursued, with limited operational follow-up. He noted that while PCRET completed work for several solar sites, a number of these did not progress beyond initial implementation phases due to approval processes, resulting in incomplete rollout. In community-based solar sites handed over to local users, long-term equipment maintenance and oversight proved challenging, reflecting the need for strengthened post-installation monitoring frameworks.

Among long-standing collaborations, he highlighted China-supported small hydro initiatives, including the Hangzhou Research Center which focused on off-grid micro-hydropower development. Beyond these, the Alternative Energy Development Board (AEDB), now PPIB, became the primary implementing body for most renewable energy initiatives, taking over much of PCRET's earlier mandate.

On current developments, Nadir mentioned ongoing projects in Gilgit-Baltistan (GB), including a 100 MW off-grid solar project under provincial purview. He also referenced the Sindh Solar Energy Project (SSEP) project with the World Bank, GIZ's REEE-II project on net-metering expansion and regulatory reform and the ADB funded transmission-strengthening programs to accommodate variable renewable generation.

Discussing Pakistan's long-term decarbonization prospects, Nadir observed that while the policy has envisioned 30% renewables in the energy mix, implementation has lagged, with flagship projects like the 400 MW Quaid-e-Azam Solar Park experiencing operational challenges including dust accumulation, water availability constraints for panel cleaning, and maintenance coordination gaps that have affected output levels. He remarked that no substantial new utility-scale solar projects are in the pipeline beyond SSEP, with most new initiatives localized at the provincial level.

Nadir noted emerging concerns around solarization moratoriums, particularly in Punjab, where utilities like LESCO flagged grid stability challenges arising from rapid net-metering adoption during 2020-21. As a member of the PPIB Technical Evaluation Committee, he noted that between 50 to 100 net-metering installer registrations are processed monthly, illustrating both demand strength and the regulatory strain it places on grid management.

On technological gaps, he identified battery storage as a 'major policy blind spot,' noting that despite the global shift toward energy storage integration, Pakistan has no formal policy or investment plan for battery energy storage systems (BESS). While pilot projects exist such as those by LUMS Energy Institute (LEI), they remain small-scale and donor-driven, with varying implementation timelines across development partners. Chinese-supported initiatives have demonstrated greater flexibility regarding project schedules compared to partners like KOICA or JICA. He described storage as among the most viable long-term solutions for grid flexibility, noting that projects often remain at pilot scale due to planning and implementation timelines that limit scale-up.

Regarding public-private partnerships (PPP), Nadir observed that while PPP frameworks exist, execution timelines at the federal level have been extended and variable. Ministerial transitions have

occasionally interrupted project continuity, requiring re-initiation of planning processes. He cited examples such as the 1MW solar project in Hunza between the GB government and NPAK Energy and railway station solarization projects, the latter remained delayed at the technical evaluation stage. Provincial PPPs, he added, have demonstrated relatively shorter implementation cycles than federal initiatives, though pace remains a sector-wide challenge. Nadir noted that the Special Investment Facilitation Council (SIFC) now serves as the primary government platform for capital access and private investment coordination, offering some optimism for future collaboration.

Overall, Nadir characterized Pakistan's renewable energy ecosystem as technically capable but requiring greater institutional coordination. The challenge lies in maintaining governance continuity, strengthening implementation systems, and developing integrated policy frameworks needed to sustain progress from pilot to scale.

Ammar Habib, CEO, National Credit Guarantee Company Ltd. (NCGCL)

Ammar outlined that the company's core mandate is to address market failures where capital remains unavailable to otherwise productive, underserved, or unserved segments capable of generating economic activity. While sector agnostic in principle, NCGCL maintains a strong climate orientation, prioritizing adaptation focused finance over mitigation due to its longer gestation periods and higher risk profile, which often deter conventional investors. Within this climate stream, NCGCL's scope extends beyond solar to include biomass, captive wind, and adaptation technologies such as pond-based aquaculture systems, with specialized teams managing each vertical, including a dedicated lead for solar guarantees.

He shared that the company's engagement model is broad and inclusive, working with financial institutions, development finance institutions, anchor corporates, and capital market intermediaries to unlock new credit channels. Ammar particularly highlighted the company's ambition to securitizations, creating a tradable asset class for renewable energy and enabling blended transactions that combine structured finance and risk participation.

Ammar noted that guarantees can be designed across multiple layers including first loss, second loss, pari passu, and mezzanine equity tranches with built in first loss protection for equity holders. He explained that Pakistan's issue is not a shortage of liquidity but rather an access and credit allocation problem, where risk aversion and regulatory inertia limit demand for new asset classes. To overcome this, he stressed that regulatory support is key to enabling long tenor instruments such as securitized SME or solar portfolios. If the regulator supports something that has never been done before, the market will follow, he said, highlighting that success depends on how products are pitched and structured to align with policy priorities.

On underwriting, Ammar explained that NCGCL follows a transaction-specific approach, focusing on three factors: cashflow generation, certainty of repayment, and counterparty credibility. The institution prefers securing charges on receivables or escrow controlled cashflows over traditional asset-backed collateral, given the limited recovery value of solar hardware. He noted that funding tenors between 7 to 10 years are viable when bankable structures exist, with guarantee pricing ranging between 50 and 200 basis points depending on risk, structure, and tenor. NCGCL is open to guaranteeing both EPC financing and PPA linked credit, selecting the lower risk, scalable option for broader deployment.

Ammar noted that the current solar market shows limited market failure at the individual level, as motivated customers are already self-financing installations. Instead, he recommended focusing on aggregation-based models such as microgrids or captive EPC consortiums that can collectively serve multiple SME consumers. These models, he argued, address both economies of scale and the financing gap faced by SMEs lacking collateral or equity. He identified underserved SME and middle to upper-middle residential segments as attractive targets for pilot programs given their stable cash flows but limited access to formal finance.

He concluded that Pakistan's challenge is not liquidity but risk allocation, and that institutions like NCGCL can play a catalytic role of absorbing early-stage losses to crowd in private investors.

7.2.4 Development Partners

Noorulain Masood, Founder & CEO, Center for Social Innovation in Developing Countries (CSIDC)

Noorulain and her colleague Zoya Dhakam explained that CSIDC's Gender-Just Energy Transition project examines how large-scale solar and wind investments in Sindh's Indus Delta are influencing local communities, with a particular focus on opportunities and impacts for women. They observed that two parallels seem to be running simultaneously: on one hand, substantial IFI and provincial investments in renewables; and on the other, nearby villages that remain unelectrified and reliant on low-capacity solar units that do not yet meet household or productive needs. In these circumstances, women bear the bulk of energy-related labor (e.g. cooking, cooling, and safety), yet energy planning rarely accounts for these differentiated roles.

Noorulain noted that national and provincial frameworks could have been more inclusive if they incorporated gender-disaggregated data, affordability mechanisms, and meaningful community consultation; measures that would make women's energy needs and decision-making roles more visible in policy. She also highlighted that utility-scale projects should integrate opportunities for local job creation and skill development, particularly for women who could participate in manufacturing, installation, and maintenance.

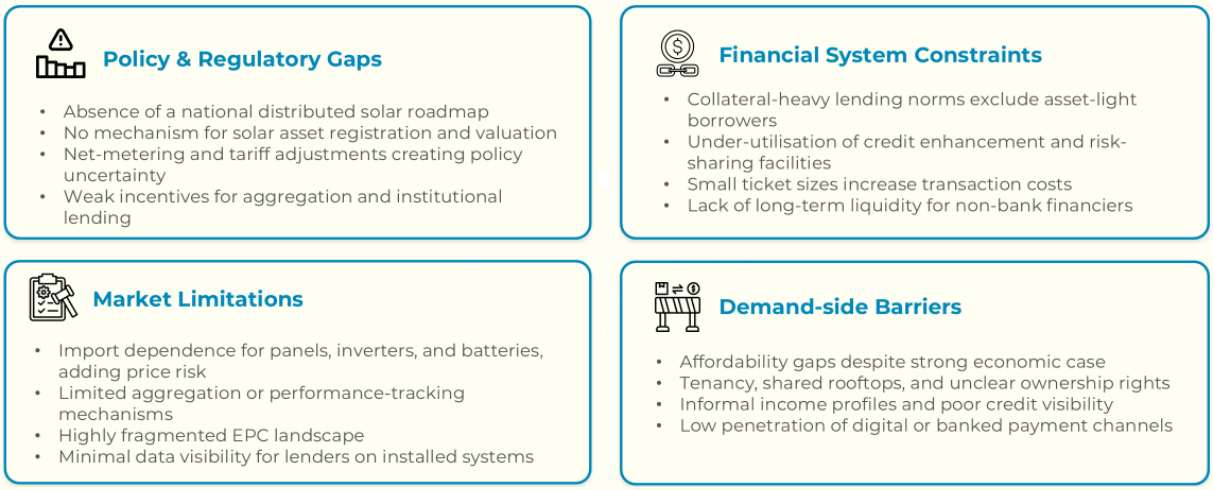
Zoya cited models such as India's "Solar Mamas" program, where women are trained to assemble and service solar systems, as examples that could be replicated through vocational institutes in Pakistan. She also discussed potential for community-owned, women-led enterprises using solar power for income generation, such as laundromats, cold storage units, and sewing hubs, linked to cooperative or mesh-grid systems. She recommended targeted subsidies or concessional financing for female-headed households and women-run enterprises and embedding gender-responsive criteria in renewable project design, procurement, and monitoring. A national framework for gender-inclusive energy governance, supported by gender-disaggregated data, would enable accountability and equitable outcomes. Noorulain concluded that achieving a gender-just transition requires shifting from top-down energy delivery to community-driven models that position women as active participants and co-owners in Pakistan's clean energy economy.

8. Strategic Diagnostic & Product Development

8.1 Root-Cause Analysis

Pakistan's distributed solar market lacks scalable origination channels, standard credit risk proxies, and mechanisms for accessing large pools of capital, because it has grown rapidly but in a fragmented, demand-driven manner without corresponding institutional, financial, or regulatory alignment. As a result, lending interest is limited to a few institutions, and financing for the middle tier remains sporadic.

Structural Constraints Preventing Scale and Financial Inclusion in Distributed Solar



Structural Frictions in Solar Credit Flows

Demand-Side Perceptions

- Information asymmetry: limited repayment data and asset unfamiliarity make solar borrowers appear high-risk.
- Collateral dependence: asset-light SMEs and informal earners excluded despite repayment capacity.

Supply-Side Design Gaps

- Product-segment mismatch: loan structures replicate generic credit lines, not energy-linked repayment models.
- Fragmented delivery chain: lenders, EPCs, and service providers operate in silos, diffusing responsibility.

Systemic Constraints

- Liquidity limitations: NBFIs lack access to long-term, low-cost capital for 5-7 year assets.
- Regulatory uncertainty: shifting net-metering tariffs and import policies undermine portfolio planning.

8.2 Key Exposures in Distributed Solar Finance

The distributed solar market presents distinct technical, credit, and operational risks that influence lender confidence and portfolio design. The table below outlines the most relevant risks and possible mitigation measures.

Table 27: Risk Type & Mitigation Measures

	Description	Mitigation Measures
Technical risk	Low yield or equipment failure due to low-quality components or poor installation	Standardized equipment packages Vendor prequalification and EPC performance guarantees Equipment warranties
Market risk	Volatility in equipment prices	Fast turnaround between EPC quotation and loan processing
Credit risk	Borrower default or delayed payments	Instalment deduction at source through salaries or utility bills Pre-paid meters Structured repayments aligned with energy savings Loan duration aligned with payback period Credit guarantees
Physical Damage	Severe weather, physical impact, improper handling	Insurance O&M guarantees
Collateral risk	Limited secondary market potential for used PV assets Weak enforceability Theft	Buyback agreements with EPC Partial credit guarantees Asset tagging and moveable asset registries
Operational risk	Poor maintenance of installed systems leading to performance degradation	Remote monitoring Bundled O&M Asset tagging, and insurance coverage
Regulatory risk	Changes in net-metering rates, import policies, or taxes	System size aligned with load profile to minimize tariff arbitrage and associated risks Policy advocacy

Source: Author Analysis

8.3 Framework for Product and Market Alignment

The following framework outlines the key levers through which financial institutions can expand distributed solar lending in Pakistan. It links capital supply, borrower demand, and institutional risk appetite into a coherent product development pathway. Each lever draws directly from the diagnostic findings in previous sections and forms the structural basis for the product concepts detailed in Section 8.4.

1. Tapping into Large Pools of Capital

Redirect liquidity from banks, NBFCs, DFIs, MFBs, Mutual Funds into solar portfolios through structured products, guarantees, and securitized receivables. The liquidity concentration and lending potential identified in Section 4.6 highlight where capital can realistically be mobilized for distributed solar.

2. Adjacent Segments

Target borrower groups that are either ready to scale or primed for inclusion. The segmentation and readiness analysis in Section 6.2 provides the foundation for defining these target cohorts.

3. Commercial Rationale

Prioritize segments with clear economic payback under current tariff structures, where solar savings exceed financing costs even at commercial rates. The tariff and payback diagnostics in Section 6.1.2 quantify where this breakeven point lies for different user categories.

4. Feasibility of Alternative Collateral

Develop mechanisms that substitute or supplement traditional security, to enable credit access for viable but undercollateralized borrowers. Evidence from lender interviews and financing patterns in Section 7 demonstrates why collateral remains the primary exclusion filter.

5. Expanding Access and Affordability

Improve utilization of existing SBP refinance and risk-sharing facilities to extend clean, collateral-free loans for solar deployment. Mapping in Section 5.5 on credit visibility of various consumer segments underscore the need for this intervention.

6. Separation of Loan Origination, Administration, and Underwriting

Design delivery models where credit risk is underwritten by formal lenders, but origination and servicing are managed by EPCs, anchors, or fintechs. The operational disconnect between lenders and delivery chains mapped in Section 5.1 supports this shift toward specialized intermediation.

7. Alternative Assessment for Income and Debt Servicing Capacity

Use transaction, utility, and digital payment data to assess creditworthiness of thin-file or informal borrowers.

8.4 Product Design by Market Segment

The following financial structures directly address these barriers and align with the readiness spectrum established earlier. Products under the ready-to-scale track leverage existing formal banking and vendor networks to expand credit volumes rapidly within bankable customer segments.

The primed-for-inclusion track targets viable but credit-invisible users through blended structures, EPC intermediation, or fintech channels supported by concessional or first-loss capital.

Anchor-based Finance - Retail

Market Track: Ready to Scale *Friction Point:* Small ticket unit economics, weak enforceability of asset security, lenders want clean recoveries with low ops cost. *What Unlocks Capital:* Payroll deduction as payment control, employer roster as continuity signal, portfolio first loss to reduce LGD and capital charge.	
Segments Covered	Salaried Persons
Financier/Lender	Commercial Banks / MFIs / MFBs
Average Loan Amount	PKR 700,000, for a 7kW net-metered deployment with 20% downpayment
Origination	Financing offered through anchors; employees opt-in via HR or payroll portal
Administration	At-source deduction from salary and direct remittance to lender; loan servicing handled through anchor
Credit Screening	Employer-verified salary slips and service record Utility-bill review for load sizing
Equity	20%
Collateral	Hypothecation of solar asset Remote monitoring of assets Optional anchor undertaking or comfort letter confirming contract continuity
Structural Protections	Standardized 5-15kW equipment packages, PV + invertor or PV + invertor + battery, with OEM models pre-cleared by lenders Disbursement directly to EPC upon verified installation Bundled O&M (cleaning, servicing)

Anchor-based Finance - SME/Commercial

Market Track: Ready to Scale	
Friction Point: Limited hard collateral, uneven vendor cash flows, slow legal recoveries.	
What Unlocks Capital: Anchor invoice setoff to lock cash, anchor performance data as credit signal, SAAF or ISAAF for pricing and capital relief.	
Segments Covered	SME vendors/service providers of large corporates/institutions
Financier/Lender	Commercial Banks / MFIs / MFBs
Typical Ticket Size	PKR 7,500,000 for a 100kW net-metered deployment with 25% downpayment
Origination	Financing offered through anchors Vendors opt in through the vendor management system
Administration	At-source deduction from invoices and direct remittance to lender; loan servicing handled through anchor
Credit Screening	Invoice history of vendor; Utility-bill review for load sizing
Equity	25%
Collateral	Hypothecation of solar asset Remote monitoring of assets Optional anchor undertaking or comfort letter confirming contract continuity
Structural Protections	Standardized 50-500 kW equipment packages, PV + invertor or PV + invertor + battery, with OEM models pre-cleared by lenders Disbursement directly to EPC upon verified installation Bundled O&M (cleaning, servicing) Bundled Insurance Option to maintain accounts with lender
Credit Enhancement	Coverage under SBP SAAF/ISAAF Scheme
	Bundled Insurance
	Option to maintain accounts with lender
Credit Enhancement	First loss guarantee cover of 20% on portfolio basis;

Vendor-Linked Consumer Finance

Market Track: Primed for Inclusion	
Friction Point: Insufficient income proofs at point of sale and high per-loan processing cost.	
What Unlocks Capital: Utility-bill and payment history as repayment proxy, e-wallet autopay for control, portfolio guarantee to absorb tail risk.	
Segments Covered	Individual household borrower
Financier/Lender	Commercial Banks / MFIs / MFBs
Typical Ticket Size	PKR 455,000 for a 5kW net-metered deployment with 30% downpayment
Origination	Vendor-linked financing embedded at EPC point of sale; EPCs pre-vetted by lenders
Administration	Integrated repayment through e-wallets or accounts
Credit Screening	Simplified loan approval process using utility-bill history for credit scoring
Equity	30%
Collateral	Hypothecation of solar asset Remote monitoring of assets

Vendor-Linked Micro-Enterprise Finance

Market Track: Primed for Inclusion	
Friction Point: Informal documentation, mixed personal and business cash, little attachable collateral.	
What Unlocks Capital: Program lending via vetted EPCs with PMYB&ALS to lower effective pricing, bank statement and receipts data as capacity signal, simple cash sweep.	
Segments Covered	Micro-enterprises
Financier/Lender	Commercial Banks for Tier 2 and Tier 3; Commercial Banks as on-lenders and MFIs / MFBs as outreach partners for Tier 1;
Typical Ticket Size	PKR 520,000 for a 5kW net-metered deployment with 30% downpayment
Origination	Vendor-linked financing embedded at EPC point of sale; EPCs pre-vetted by lenders
Administration	Integrated repayment through e-wallets or accounts
Credit Screening	Simplified loan approval process using utility-bill history for credit scoring
Equity	20%
Collateral	Hypothecation of solar asset Remote monitoring of assets
Structural Protections	Standardized 3-10kW equipment packages, PV + invertor or PV + invertor + battery, with OEM models pre-cleared by lenders Disbursement directly to EPC upon verified installation Bundled O&M (cleaning, servicing) Bundled Insurance
Credit Enhancement	50% of principal (10% for MFIs/MFBs on first-loss basis, and 40% for On-lenders on pari-passu basis), on Tier 1 loans; 25% of principal for Tier 2 loans 10% of principal for Tier 3 loans
ructural Protections	Standardized 3-10kW equipment packages, PV + invertor or PV + invertor + battery, with OEM models pre-cleared by lenders Disbursement directly to EPC upon verified installation Bundled O&M (cleaning, servicing) Bundled Insurance
Credit Enhancement	First loss guarantee cover of 50% on portfolio basis; Optionally, EPC guarantees for equipment buy-back

Vendor-Linked SME/Commercial Finance

Market Track: Primed for Inclusion	
Friction Point: High origination effort per small loan, thin collateral, seasonal volatility.	
What Unlocks Capital: Embedded approval with simplified scorecards using sales tax, bank, and utility signals, controlled collections through dedicated accounts, portfolio guarantee to stabilize losses.	
Segments Covered	Small enterprises with turnover of PKR 100 million+
Financier/Lender	Commercial Banks / MFIs / MFBs
Typical Ticket Size	PKR 1,925,000 for a 25kW net-metered deployment with 30% downpayment
Origination	Vendor-linked financing embedded at EPC point of sale; EPCs pre-vetted by lenders
Administration	Ringfencing of SME cashflows
Credit Screening	Simplified loan approval process using credit scoring models
Equity	30%

Collateral	Hypothecation of solar asset Remote monitoring of assets
Structural Protections	Standardized 15-50 kW equipment packages, PV + invertor or PV + invertor + battery, with OEM models pre-cleared by lenders Disbursement directly to EPC upon verified installation Bundled O&M (cleaning, servicing) Bundled Insurance
Credit Enhancement	First loss guarantee cover of 50% on portfolio basis; Optionally, EPC guarantees for equipment buy-back

Installer Finance / On-lending Model

+	
Friction Point: Banks cannot profitably underwrite and service granular retail or micro SME risk at scale. *What Unlocks Capital:* Wholesale line to EPC or aggregator that underwrites and services, receivables assignment and performance covenants shifting risk, first-loss layer for the senior lender.	
Segments	Residential clients without proper income documentation; Small enterprises (commercial/industrial) without collateral;
Financier/Lender	Commercial Banks or DFIs providing wholesale credit lines to vetted EPCs or solar aggregators
Typical Ticket Size	PKR 560 million for a 10MW portfolio
Counter-party	Aggregator-Installer Partnership or a large EPC acts as the on-lending intermediary and credit underwriter for solar customers
Origination	EPC screens and on-lends to eligible customers based on pre-agreed criteria
Administration	Bank disburses bulk facility to Aggregator/EPC, who in turn manage individual sub-loans, collections, and servicing; portfolio-level performance reported to lender periodically
Credit Screening	Bank does independent due-diligence on EPC;
Equity	30%
Collateral	Bank takes assignment of receivables and creates charge on Aggregator / EPC's assets Aggregator/EPC secures end-user receivables through smart meter
Structural Protections	Aggregator EPC maintains escrow account for repayments or provides a DSRA SBLC portfolio-level insurance of distributed generation assets
Credit Enhancement	First loss guarantee cover of 25%

Securitization of EPC PPA Receivables / Lease Rentals

Market Track: Primed for Inclusion *Friction Point:* Balance sheet and tenor limits. *What Unlocks Capital:* True sale to an SPV with reserves and overcollateralization to hit target ratings, tapping long-term investors and recycling originator capacity.	
Financier/Investor	Capital market investors (banks, funds, institutions, retail); Possible co-investment from climate funds
Counter-party	SPV established by an EPC, ESCO, NBFI to aggregate small solar PPAs or solar leases
Deal Size	PKR 2,000 million for a 26MW portfolio
Origination	EPC/NBFI/Modarba
Administration	EPC/NBFI continues as servicer, responsible for billing, O&M, and collections under each PPA
Credit Screening	Bank does independent due-diligence on EPC/NBFI;
Collateral	PPA cashflows or lease rentals backed by operating solar assets with smart-meter data, verified installation certificates, and assignment of payment rights to SPV
Structural Protections	True-sale of solar assets to SPV Assignment of PPA receivables/lease rentals to SPV Escrow or collection account for all payments Over-collateralization or reserve fund (5-10 %) Performance and maintenance covenants with EPC
Credit Enhancement	First loss guarantee cover of 40%

BNPL With On-lending Model

Market Track: Primed for Inclusion *Friction Point:* Upfront affordability for low-income users, little or no credit history, variable repayment behavior, capital constrained Intermediary *What Unlocks Capital:* Ticket size linked to observed wallet inflows with short tenors, remote shutoff as behavioral collateral, donor first loss protecting the senior line.	
Segments	Low-income urban/peri-urban
Financier/Lender	Commercial Bank/DFI
Intermediary	Fintech, MFI/MFBs
Deal Size	PKR 1 billion
Origination	Fintech, MFI/MFBs through app-based channels
Administration	Repayments via e-wallet
Credit Screening	Simplified credit scoring model based on e-wallet history Loan size at 3-5 times the average monthly credits in the e-wallet
Equity	25%
Collateral	Hypothecation of solar assets
Structural Protections	Standardized 1-4kW equipment packages, PV + invertor or PV + invertor + battery, with OEM models pre-cleared by lenders 25% equity investment Short tenor of 12-18 months Smart meters with remote turnoff capability Disbursement directly to EPC/Installer
Credit Enhancement	First loss tranche from donors or philanthropic funds of 25%

8.5 Risk Coverage for Proposed Products

The table below maps the financing volume and risk coverage needed across key solar product types. It reflects portfolio structures currently in use or early development stages, where partial guarantees can unlock lender participation or enable aggregation for capital-market take-outs.

Table 28: Financing Volume and Risk Coverage for Solar Products

Product Type	Avg. Loan *(PKR)*	Support	Coverage	Borrowers	Limit Reqd. (PKR Mn)
Anchor-based Retail	700,000	Portfolio Guarantee	20%	80,000	11,200
Anchor-based SME	7,500,000	SAAF/ISAAF	30%	10,000	22,500
Vendor-Linked Consumer Finance	455,000	Portfolio Guarantee	50%	10,000	17,063
Vendor-Linked Finance - Entrepreneurs	455,000	PMYB&ALS	50%, 25%, 10%	25,000	6,500
Vendor-Linked SME Finance	1,925,000	Portfolio Guarantee	40%	5,000	3,850
Installer Finance / On-lending Model	560,000,000	Portfolio Guarantee	25%	50	7,000
Securitization of PPAs	2,000,000,000	Portfolio Guarantee	40%	1	800
BNPL / On-lending Model	1,000,000,000	Portfolio Guarantee	25%	1	250
Total					**54,375**

The combined exposure of less than PKR 60 billion, highlights that a targeted, performance-based guarantee framework, in combination with pre-existing subsidy programs, could substantially expand solar lending.

1. Collateral Perfection & Recovery Pathways

- Register a security interest on panels and inverters in the SECP Secured Transactions Registry, linked to CNIC and meter numbers.
- Use title retention or conditional sale so legal ownership of solar assets transfers only after final payment.
- Landlord consent and roof rights agreement with explicit lender step in and removal rights.
- Standard repossession and redeployment protocol with time bound notices and certified deinstallation vendors.

2. Cashflow Control and Assignability

- On bill repayment of loan instalments through DISCOs or KE with a right of set-off of net metering credits against instalments.
- Payroll or POS sweep mandates where relevant.
- Assignment of receivables from anchor buyers or fee ledgers for schools and hospitals.
- Dedicated collection account and DSRA at site level for SMEs and at portfolio level for EPC on lending.

3. Data and Performance Visibility

- Minimum data pack at origination set at three to six months of interval meter data, connected load, runtime logs for major loads.
- Ongoing data feed via secure API from smart meters and inverters with production to load matching.

- Covenant triggers based on generation ratio, load factor, and arrears days with automated alerts.
- Vendor performance file with warranty status, preventive maintenance records, and ticket resolution times.

4. Physical Control and Tamper Deterrence

- Asset fingerprinting plus QR tags on site, photo and video verification at commissioning, GPS enabled inverters where available.
- Geofence and tilt tamper alerts routed to lender and EPC.
- Modular racking and standardized connectors to ease lawful removal and redeployment.
- Approved equipment list and minimum specs to preserve resale value.

5. Risk Transfer and Valuation

- All risk and theft insurance with lender as loss payee and parametric add on for extreme weather.
- Vendor warranty escrow or surety bond sized to expected claim rate.
- Standard valuation schedule and haircuts by age, make, capacity, and performance so secondary sale pricing is predictable.

6. Market Infrastructure and Backups

- Central asset registry that maps serial numbers to CNIC, NTN, meter ID, GPS, and loan ID.
- Utility and EPC data sharing MOUs and a common API spec.
- Backup servicer arrangement for EPC portfolios with data escrow so collections and O&M continue if the originator fails.
- Portfolio stratification rules by geography, meter type, and vendor to cap concentration risk.

7. Implementation Checklist

- Register moveable charge in SECP STR and file landlord NOC.
- Capture NADRA CNIC, FBR NTN, DISCO meter IDs, and geo tagged site photos in one KYC pack.
- Use utility bill histories and POS or bank statements for thin files.
- Covenants include DSCR floor, arrears triggers, production trigger, and insurance continuity.

8.6 Leveraging Concessional Finance & Guarantees

Step 1: Prioritizing Utilization of Existing Facilities

Pakistan's solar credit ecosystem already has substantial liquidity through the State Bank of Pakistan and Government of Pakistan refinance and guarantee schemes. Before new subsidy or risk-sharing mechanisms are introduced, the priority should be to increase utilization of these existing facilities. Their low uptake reflects procedural and perception barriers, not lack of capital.

Commercially viable customers, urban households, schools, hospitals, and light industrial SMEs, can already be financed through the SAAF and Refinance Facility for Modernization of SMEs, while semi-formal or smaller users fit within the PMYB&ALS and Risk Coverage Scheme for SMEs windows.

To improve access, lenders need operational flexibility in collateralization and faster processes for claim realization and refinance drawdowns. This requires SBP to issue detailed implementation SOPs for registering moveable assets in the SECP's Secured Transactions Registry, accepting landlord consents for rooftop installations, and enabling utility or payroll-based repayment channels. Such steps would unlock concessional funding already available in the system without introducing new subsidy layers.

Step 2: Extend Reach with Targeted Credit Enhancements

Where structural risk remains high despite concessional pricing, especially for borrowers without fixed collateral or thin financial records, portfolio-level credit enhancements become necessary. These should be used only to extend the reach of existing schemes, not replace them. A first-loss guarantee of 10-30%, sized by portfolio risk, can enable lending to informal households and semi-formal SMEs that demonstrate repayment capacity but lack mortgageable assets. Coverage should taper automatically as portfolio performance improves. Similarly, performance or warranty insurance linked to EPC portfolios can protect lenders from correlated technical or quality risks while creating accountability among installers.

Step 3: Strengthen Liquidity and Tenor Matching for Intermediaries

Non-bank financial institutions, leasing companies, and Modarabas face a mismatch between their short-term funding base and the 5-7-year tenor typical of solar assets. Concessional refinance or medium-term liquidity lines from SBP, DFIs, or climate funds can bridge this gap at capped spreads, contingent on proper data reporting and asset registration. Over time, seasoned portfolios from these institutions should transition to capital-market take-outs through securitization or pass-through certificates, recycling concessional capital toward new originations.

Step 4: Aligning Concessional Tools with Market Tracks

The role of concessional finance differs across the two market tracks identified earlier. In the ready-to-scale track, which includes bankable households, formal SMEs, and institutional clients, concessional credit lines can reduce cost of funds and extend tenors but should not distort pricing. Guarantees or first-loss coverage are largely unnecessary except for thinner-credit SME pockets.

In the primed-for-inclusion track, concessional or blended finance is essential. These include installer on-lending pools, BNPL programs via fintechs or microfinance banks, and small semi-formal SMEs. Here, first-loss guarantees, reserve funds, and partial subsidies on borrower interest can offset risk premiums and demonstrate viability until lenders build repayment data.

Step 5: Establish Clear Governance, Phasing, and Exit Pathways

All concessional or guarantee facilities should adhere to three operating principles: additionality, transparency, and tapering. Additionality ensures public or donor capital only supports borrowers who meet performance thresholds but are excluded for collateral reasons. Transparency requires standardized reporting on disbursement, arrears, and production data at the product level. Tapering involves reducing guarantee coverage or subsidy intensity after 12-18 months of successful performance to promote market discipline. Together, these measures create a pathway from concessional entry to commercial graduation, aligning SBP and donor programs with the twin objectives of expanding solar credit access and building a self-sustaining market.

8.7 Digital Lending and Fintech Integration

Digital channels can expand solar credit access to thin-file and informal borrowers by substituting alternative data for traditional documentation. Lenders should integrate utility bill, e-wallet, and telco payment histories into credit scoring through API-based partnerships. Smart meter data can automate instalment deductions proportional to energy use, while on-bill and mobile-wallet repayment links reduce collection risk. Fintechs can originate and service micro solar loans (1-7 kW) under standardized APIs with MFBs or banks providing the balance sheet. Data-sharing protocols, digital KYC, and e-signatures must be standardized to qualify such portfolios for refinance and credit guarantee coverage.

8.8 ESG and Impact Integration Framework

Solar finance products should embed measurable ESG outcomes to align climate and inclusion mandates. Each loan portfolio must track GHG emissions avoided (tCO_2/year), share of women or low-income borrowers, and share of installations in underserved areas. EPCs and lenders should adopt minimum equipment recycling and disposal protocols and require proof of safe battery handling. Gender and social inclusion KPIs should be integrated into guarantee and refinance eligibility. Reporting must follow IFC Performance Standards and SBP's Green Banking Guidelines, enabling

aggregated disclosure to investors and DFIs for verification and mobilization of green or sustainability-linked capital.

8.9 Prioritization Matrix (Feasibility vs Impact)

Table 29: Prioritization Matrix

Product	Capital Availability	Complexity	Cost to Consumer	Development Impact	Mitigation Potential
Anchor-based Finance	High	Low	Low	Medium	Medium
Consumer Finance	Medium	Low	Medium	Medium	Medium
Commercial/SME Finance	Medium	Low	Medium	Medium	High
Installer Finance	Low	Medium	Medium to High	Medium to High	Low
Securitization	Low	High	Medium	Medium	Medium
BNPL	Low	Medium	High	High	Low

Capital Availability refers to willingness of financiers to participate based on the perceived risk of the financial product

Complexity depends on the number of stakeholders and approvals required to execute

Cost to consumer refers to credit spreads built in a financial product (< 3% low, 3%-7% medium, 7%-15% high)

Development Impact refers to improvements in energy affordability and energy access for the target segment

Mitigation Potential refers to the quantum of grid energy displacement

8.10 Composite Scorecard

The scoring below uses a simple ordinal framework across the five dimensions above. Capital availability, development impact, and mitigation potential are scored positively, where high scores higher. Complexity and cost to consumer are inverted, so lower complexity and lower cost receive higher scores.

Each attribute is assigned a numeric value of 3 for high, 2 for medium, and 1 for low, with half steps used where the assessment sits between categories. Scores are summed without weighting to produce a total out of 15.

The intent of this scorecard is comparative ranking, so the framework highlights relative attractiveness and implementability rather than optimizing for any single outcome.

Table 30: Composite Scorecard

Rank	Product	Composite Score	Implementation Focus
1	Anchor-Based Finance	**13**	Immediate scale-up through employers and anchors
2	Consumer (Vendor-Linked) Finance	**12**	Rapid expansion leveraging certified EPC networks
3	Commercial / SME Finance	**13**	Structured pilots under SBP and blended lines
4	Installer Finance (On-lending)	**8**	Expansion through guarantees and DFIs
5	BNPL / Fintech Model	**8**	Inclusion pilots with digital lenders
6	Securitization / EPC Receivables	**8**	Pilot with mature ESCO portfolios

9. Policy Support Needed to Equitably Scale Distributed Solar

The recommendations below group the required interventions into three themes: price and grid rules, financial architecture, and the role of development and climate finance.

9.1 Align Price Signals, Net-metering and Grid Operations

Tariff structures and grid rules need to balance three objectives: protect low-income users, give clear economic signals for solar, and maintain utility balance sheets.

Recommended actions:

- Simplify residential tariff categories and cap cross subsidization at users up to 300 units per month. Above this band, move gradually to cost reflective tariffs so that higher consuming households face clear incentives to invest in efficiency and solar.
- Maintain clear, stable policy on import duties, sales taxes and buy back rates for solar equipment and net metering. Commit to a medium-term policy horizon to give lenders and investors confidence on payback assumptions.
- Revise net metering rules to include systems below 5 kilowatt and introduce workable frameworks for shared or multi-tenant systems in apartments, plazas and housing schemes.
- Introduce targeted incentives for hybrid systems that combine solar and storage in feeders with high rooftop penetration to reduce the duck curve and support evening peak supply. These can be time limited, performance-based rebates or concessional lines tied to storage.
- Prioritize smart metering, feeder level monitoring and data driven planning in high solar distribution companies. Focus first on feeders with rapid rooftop growth and use this data to manage voltage, back-feed risk and loss reduction.
- Pilot grid connected storage projects in one or two high solar distribution companies using donor co financing or private concession models, with clear learning objectives for replication.

9.2 Build Financial and Data Infrastructure for Scale

Lenders face high transaction costs, weak collateral frameworks and thin data on performance of small scale solar. Policy support should lower these frictions so that commercial capital can flow at scale.

Recommended actions:

- Expand partial credit guarantee coverage for priority segments such as SMEs, installers and on lending intermediaries under State Bank schemes to 50-70%, coupled with simplified, standard due diligence templates agreed between SBP and financial institutions.
- Offer preferential tax treatment on income from eligible solar lending portfolios for a defined period, subject to reporting and portfolio quality thresholds, to reward early movers and offset higher origination costs.
- Simplify and clarify legal processes for creating, registering and enforcing security interests over solar systems, including standard templates for tripartite agreements between lender, installer and customer. Fast track the repossession and redeployment procedures for financed systems to improve recoveries.
- Establish a centralized solar asset registry that records installations by customer segment, size, technology and location and verifies key equipment serial numbers. Link this registry to financial institutions and insurers to support collateralization, performance tracking and secondary market development.
- Mandate basic asset tagging at installation level for financed systems so that lenders and regulators can monitor portfolios on the ground and reduce fraud or double pledging.
- Require banks and distribution companies to report their solar portfolios regularly to NEPRA and SBP using a common template. Publish aggregated statistics to create a transparent data layer on distributed generation, financing flows and portfolio performance.
- Encourage the Securities and Exchange Commission to develop guidance and fast track approval processes for securitization of solar receivables and pay-as-you-go portfolios. Support early

transactions with technical assistance so that capital market investors can participate with confidence.
- Promote net metered aggregators and energy service company models that bundle small users into diversified portfolios. Provide regulatory clarity on how such entities can contract with distribution companies and access guarantees or concessional lines.

9.3 Use Development and Climate Finance to Reach Underserved Segments

Development finance and climate funds should not compete with commercial lenders but unlock new customer segments, business models and geographies that are currently off the map.

Recommended actions:

- Provide first loss capital and performance-based grants for pilots that test lending to new segments, such as mid-tier residential users without formal income documentation, women led SMEs, or off grid peri urban and rural clusters. Structure these pilots through local financial institutions, microfinance providers and non-bank finance companies rather than parallel project structures.
- Prioritize onward lending models with clear environmental, social and governance standards and explicit gender outcomes. Tie concessional terms to metrics such as the share of women-led enterprises financed, number of certified female technicians employed, or proportion of loans in underserved districts.
- Use blended finance facilities to offer simple, phased products. In the first phase, focus purely on de-risking credit for private risk takers including commercial banks, MFBs, MFIs, NBFCs and capital market investors. In later phases, add layers such as results based payments for deeper penetration in low income or off grid areas.
- Support the design of a national platform to aggregate verified carbon credits from distributed solar portfolios, with standardized methodologies and low transaction costs. Direct a share of carbon revenues to expand access for low-income households and community institutions such as schools and clinics.
- Align fiscal tools with these objectives rather than scattershot exemptions. For example, time bound tax rebates or import duty relief for components that support storage, smart metering or inclusive business models, linked to clear eligibility and sunset clauses.

10. Conclusion

Pakistan's distributed solar market has advanced rapidly, but financial intermediation has not kept pace. As Sections 5 and 8 highlight, demand, liquidity, and technology readiness are in place; however, lending remains constrained by institutional design rather than financial capacity. The core limitation is the misalignment between cashflow-based solar assets and a credit system optimized for collateralized lending.

10.1 Structural Insight: Liquidity Without Intermediation

Despite sufficient liquidity, financing does not flow to the segments with the strongest economic rationale; mid-tier industries, SMEs, and organized households. Banks and DFIs continue to operate mainly as liquidity protectors, prioritizing secured lending and regulatory comfort over their actual role of financial intermediation and fueling the productive sectors of the economy. Solar offers predictable savings and stable repayment profiles but has limited collateral value, creating a structural mismatch that leads to persistent under-lending despite manageable risk.

10.2 Market Insight: Information Friction, Not Credit Risk

The market's most investable clients; the mid-tier industries, service SMEs, and organized residential users are caught in a structural blind spot. Their credit behavior is observable through energy payments, consumption patterns or transaction data, and digital footprint, yet these are not recognized as proxies in formal credit scoring. Vendors and anchors, who have real repayment visibility, sit outside the regulated credit perimeter. As a result, origination occurs in one layer, underwriting in another, and risk absorption in yet another, producing high friction and low throughput. The report's findings make clear that Pakistan's constraint is informational, not financial. Solar finance will scale when repayment visibility replaces collateral as the organizing principle of credit design.

10.3 Strategic Implication: From Pilots to Infrastructure

Global experience shows that portfolio guarantees, receivable securitization, and digital credit anchors only work when aligned with local institutional behavior. Pakistan's pathway is not to import new models, but to formalize the efficiencies already functioning in the market—vendor-led origination, anchor-based customer filtering, and digital repayment mechanisms. Long-term scale depends on building the enabling infrastructure: standardized contracts, transparent EPC verification, shared credit and technical data, cashflow-based underwriting systems, and blended capital structures that mobilize private liquidity rather than displace it..

10.4 Call to Action

The next stage requires execution.

- Financial institutions need ready-to-use instruments—standard documentation, risk-sharing templates, DSCR models, credit-scoring tools, and monitoring dashboards—to translate design into transaction flow.
- Development partners should focus concessional support on portfolio guarantees, refinancing windows, and digital registries that unlock bank liquidity at scale.
- Regulators can accelerate adoption by embedding cashflow-based lending, asset tagging, and simplified security structures within existing prudential norms, making distributed solar genuinely bankable.

By aligning incentives, reducing friction, and strengthening market infrastructure, Pakistan can move from fragmented initiatives to a coherent, scalable solar-finance ecosystem capable of channeling mainstream capital into households, SMEs, and industry, supporting both energy security and economic resilience.

11. Appendix

11.1 Catalog of Solar Financing Products by Banks

Bank	Product Name	Eligibility Criteria	Min/Max Financing	Financing Tenure	Markup/Interest Rate	Collateral Requirements	Finance to Equity Ratio
JS Bank Ltd.	JS Smart Roshni Solar Solution Financing	Pakistani nationals, businesspersons with cash flows	PKR 0.5 to 10 million	3-7 years	Fixed Markup of 12.49% (Up to 3 years)	Any collateral + hypothecation of solar solution + personal guarantee + post-dated cheques	Min 20% equity contribution
	JS GharApna Solar Solution Financing	Pakistani nationals for residential use	PKR 0.3 to 7 million	3-7 years	Fixed Markup of 12.49% (Up to 3 years)	Any collateral + hypothecation + personal guarantee + post-dated cheques	Min 20% (up to 6M), Min 30% (up to 7M) (depends on credit history)
Meezan Bank Ltd.	Solar Panel Financing (Islamic)	Pakistani adult nationals, permanent residents with CNIC	PKR 0.1 to 2.5 million (PKR 3 million for premium customers)	1-5 years	15%-16%	HPA on solar panel and 3 cheques	On-Grid System Down Payment:15% - 50% Off-Grid System Down Payment: 30% - 50%.

Allied Bank Ltd.	Allied Solar System Finance (conventional)	Pakistani nationals	PKR 0.2 to 3 million	Up to 7 years	Salaried Individuals: KIBOR + 3% Self-Employed Individuals: KIBOR + 3.5% Spread	Land, gold, or tangible collateral + personal guarantee	Min 30% equity required
	Allied Aitebar Solar System Finance (Islamic)	Salaried individuals (permanent/direct contract, no third-party)	PKR 0.2 to 3 million	1-7 years	Salaried Individuals: KIBOR + 3% Self-Employed: KIBOR + 3.5%	Islamic collateral structure	Min 30% - Max 80%
Bank Alfalah Ltd.	Alfalah Green Energy	Individuals, SMEs, commercial, and agri businesses (net metered only)	Up to PKR 400 million, For residential capped at PKR 2.5M (rental premises) / PKR 4M (owned premises)	Up to 5 years	KIBOR + spread	Hypothecation of equipment, personal guarantees, cheques, insurance, and mortgage (as per case). SMEs & Commercial: Financing above PKR 10M requires adequate collateral Agri: Collateral equivalent to loan amount required	20% down payment (self-owned), 25% (rental/leased)
	Islamic Financing Facility for Renewable Energy (IFRE)	Sponsors (Domestic, Commercial, Industrial, and Agriculture) or vendors for renewable energy projects. Category 1: 1-50 MW Category 2: upto 1 MW Category 3: Vendors/suppliers	Category 1: upto PKR 6 billion/project Category 2: upto PKR 0.4 billion/customer Category 3: upto PKR 1 billion/vendor	Category 1: upto 12 years Category 2: upto 10 years Category 3: upto 10 years	6% fixed	As per Islamic financing principles	Not specified

AlBaraka Bank (Pakistan) Ltd.	Al Baraka Green Energy Solar Financing (Islamic)	Salaried Individuals, Self Employed Businessmen, Self Employed Professional, Applicant of Pension / Rental / Remittance Income / Saving Certificates/Term Deposit Segments	PKR 0.3 to 5 million	1-7 years	KIBOR + spread (15-18%)	Islamic collateral	Min 20% equity
First Women Bank Ltd.	FWBL Solar Loan	Business professionals	PKR 0.5 to 125 million	Upto 10 Years	5% for women/Transgender, 6% for men	Up to PKR 2 Million: Hypothecation of Solar System (panels etc.), Personal guarantee of Government employee in Grade 17 or above. Over PKR 2 Million: Lien / Pledge over Cash/Prize Bonds/ Saving Certificates	Not specified
National Bank of Pakistan	NBP Roshan Ghar Solar Finance	Pakistani nationals, Federal/ Provincial Government Employees	PKR 0.4 to 5 million (upto 3 million for Government Employees)	Up to 7 Years	KIBOR+2%	Property mortgage	Min 20% equity
Sindh Bank Ltd.	Solar Finance Facility	All types of Individuals, SMEs & Agri Borrowers	Salaried: PKR 0.1 to 5 million SEP/SEB/Agri Borrowers: PKR 0.1 to 20 million SME borrowers: upto PKR 100 million	Up to 7 Years	Affordable (As per SBP scheme)	Not specified	Min 15% equity
Bank Islami Pakistan Ltd.	Islamic Solar Financing	both residential and commercial	Not specified	3-5 years	Sharia-compliant (no interest)	Islamic collateral	Min 20% equity

Dubai Islamic Bank Pakistan Ltd.	Consumer Durable Finance (includes solar)	Salaried Individual	PKR 0.03 to 2 Million	6 months-3 years	Islamic profit rates	Islamic collateral	Zero Down Payment
Faysal Bank Ltd.	Faysal Islami Solar Solutions	Individuals and businesses Vendors: Financing only SBP-approved vendors Residential Systems: 4kW -25 kW Agricultural Systems: 10 kW - 200 kW Commercial & Industrial Systems: upto 1MW	PKR 0.1 to 3 million	1-7 years	6% fixed	Collateral or guarantees may be required, depending on the loan size	Not specified
MCB Islamic Bank Ltd.	Solar Energy Financing	Salaried and self-employed individuals	Upto PKR 20 million	Up to 10 years	Competitive Islamic profit rates	Islamic collateral structure	Min 20% equity contribution
The Bank of Punjab	BOP Shamsi Tawanai	Individuals, SME, Commercial Enterprises, Agribusinesses	PKR 0.5 to 100 million	up to 8 years	KIBOR + 5%	Hypothecation of equipment + mortgage OR cash/near-cash OR vehicle lien OR 50% forced sales value for online-monitored systems. Zarai Pass Book charge (40% margin, agri only). No tangible security for <PKR 3M loan if owned property & salary/turnover > loan amount	Min 20-25% equity
The Bank of Khyber	BOK Raast Roshan Ghar (Islamic)	Cat A: Government / Semi Govt. employees Cat B: Businessmen & self-employed	Cat A: PKR 0.05 to 0.2 million Cat B: PKR 0.2 to 0.5 million	6-60 months	9-15% p.a.	Cat A: 1 PG Grade 17+ Cat B: 2 PGs Grade 17+ Cat C:	Min 25% equity

		Cat C: Pvt Sector Employees	Cat C: PKR 0.5 to 2 million			Mortgage/tangible security	
Askari Bank Ltd.	Askari Ujala Finance	Small enterprise (10-200KW), Medium enterprise (30-500KW), Vendors (30-500KW)	Small enterprise: up to PKR 15 million Medium enterprise: up to PKR 25 million Vendors: PKR 5 to 25 million	Up to 5 years	Competitive rates	Not specified	Not specified
Habib Bank Ltd.	HBL Farm Irrigation Solutions	Farmers cultivating own/leased land	Up to PKR 15 million	3-5 years	Competitive rates	Not specified	Not specified
MCB Bank Ltd.	MCB Green Ghar Finance	Salaried/self-employed individuals	PKR 0.2 to 5 million	Up to 7 years	6M KIBOR + 3.5%	Above PKR 1.5M: Residential property/mortgage	Min 20% equity
Soneri Bank Ltd.	Soneri Renewable Energy Finance	Salaried (approved companies), self-employed maintaining Soneri accounts	Up to PKR 5 million	3-10 years	Fixed 6% (SBP Refinance) / KIBOR + 2% (Variable)	Up to PKR 3M (hypothecation) or 5M (tangible collateral)	Min 20% equity
Bank AL Habib Ltd.	AL Habib Kissan Farm Mechanization Scheme & AL Habib Tube well/ Abyari Finance Scheme	agricultural	Not specified	Not specified	Not specified	Not specified	Not specified
HBL Microfinance Bank Ltd.	Mehvar Home Loan (can be used for solar)	Salaried, pensioners and self-employed individuals	Up to PKR 5 million	Up to 15 years	Not specified (special rates for women entrepreneurs mentioned)	Equitable or registered mortgage of property	Not specified
U Microfinance Bank Ltd.	Solar Financing	Farmers, micro-entrepreneurs, households	PKR 0.05 to 3 million	Up to 10 years	44-46%	Mortgage on agriculture, commercial property, gold, or lien on savings, TDR, etc. (54% backed by gold)	Min equity required

Mobilink Microfinance Bank Ltd.	Solar Loan	households, farmers, and small business	Up to PKR 5 million	3-10 years (multiple tenor estimates)	35-65% (multiple loan rate estimates)	Gold, Property (Residential/Commercial), Agri Passbook, Vehicle (Used), Term Deposit Receipts (TDRs), National Saving Certificates (NSCs), Future Salary/Pension, Letter of Hypothecation (for Solar), Personal Guarantee	Not specified
NRSP Microfinance Bank Ltd.	Kissan Zarri Taraqiati Loan (KZTL)	agricultural	PKR 0.03 to 0.5 million	3 to 36 months	30-32%	Lien on Agriculture Pass Book, Hypothecation on Vehicle, Gold/Gold ornaments, Urban/Rural registered property, Guarantee letter, Post-dated cheques, Demand promissory note	Not specified
	Rozgar Murabaha Solar Product	Commercial, Agriculture & Household, PLS Account holders	PKR 0.5 to 1.5 million	3 - 60 months	30-32%	Property mortgage	Not specified
Khushhali Microfinance Bank Ltd.	Solar Solutions Partnerships	Rural customers	Not specified	Not specified	Microfinance rates	Microfinance collateral	Not specified

11.2 Stakeholder Consultations & Details

S.No.	Stakeholder Details	Mode of Consultation
1	Ali Ladhubhai, Fintech & Microfinance Expert	One-on-One Interview
2	Riaz Bangash, President & CEO, NRSP Microfinance	One-on-One Interview
3	Talha Ameer Khan, CFA, MD Investments, Burj Clean Energy Modaraba (BCEM)	One-on-One Interview
4	Waqas Moosa, CEO, Hadron Solar & Chairman, Pakistan Solar Association	One-on-One Interview
5	Farman Lodhi, Consultant/Advisor, Industrial Projects & Renewable Energy	One-on-One Interview
6	Mohammad Asif, Deputy General Manager Policy & Program Design, Small and Medium Enterprises Development Authority (SMEDA)	One-on-One Interview
7	Nadir Khan Niazi, Deputy Director, Pakistan Council of Renewable Energy Technologies (PCRET)	One-on-One Interview
8	Ammar Habib, CEO, National Credit Guarantee Company Ltd. (NCGCL)	One-on-One Interview
9	Noorulain Masood, Founder & CEO, Center for Social Innovation in Developing Countries (CSIDC)	One-on-One Interview
10	Aijaz Haq, Head of Growth and External Linkages, KSBL	Multi-Stakeholder Event
11	Mutaher Khan, Head of InsightLab, KSBL	Multi-Stakeholder Event
12	Dr. Ahmad Junaid, Rector, KSBL	Multi-Stakeholder Event
13	Faisal Iqbal, Head of SME Banking, Meezan Bank	Multi-Stakeholder Event
14	Irfan Umar, Head of Products, JS Bank	Multi-Stakeholder Event
15	Muhammad Faisal, National Business Head Commercial, SME and Agri Business, National Bank Pakistan	Multi-Stakeholder Event
16	Faizan Shamsi, Head of Sustainable Finance/Green Banking, JS Bank	Multi-Stakeholder Event
17	Adnan Naqvi, Head Corporate & Investment Banking, Pak Brunei	Multi-Stakeholder Event
18	Gulfishan Shaikh, Head of Strategic Initiatives Digital Banking Group, UBL (Ex-Easy paisa)	Multi-Stakeholder Event
19	Mehr Shah, Head of Segments and Research, Raqami Islamic Digital Bank	Multi-Stakeholder Event
20	Asghar Hussain, Head of Digital Supply Chain Finance, Raqami Islamic Digital Bank	Multi-Stakeholder Event
21	Moazzam Ahmed, Co-Founder, Cashnow	Multi-Stakeholder Event
22	Shahid Mustafa, Microfinance Expert, Ex-CEO Telenor MFB/PMIC	Multi-Stakeholder Event
23	Shahmir Khan, Analyst, NCGCL	Multi-Stakeholder Event
24	Adil Mansoor, Head of Research & Communications, NCGCL	Multi-Stakeholder Event
25	Hasan Ahmad, CEO, Delta Energy	Multi-Stakeholder Event

26	Ghazil Jabbar, Managing Partner, Climate Core Asia	Multi-Stakeholder Event
27	Muhammad Salman Siddiqi, Head of Secured Lending, JS Bank	Multi-Stakeholder Event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