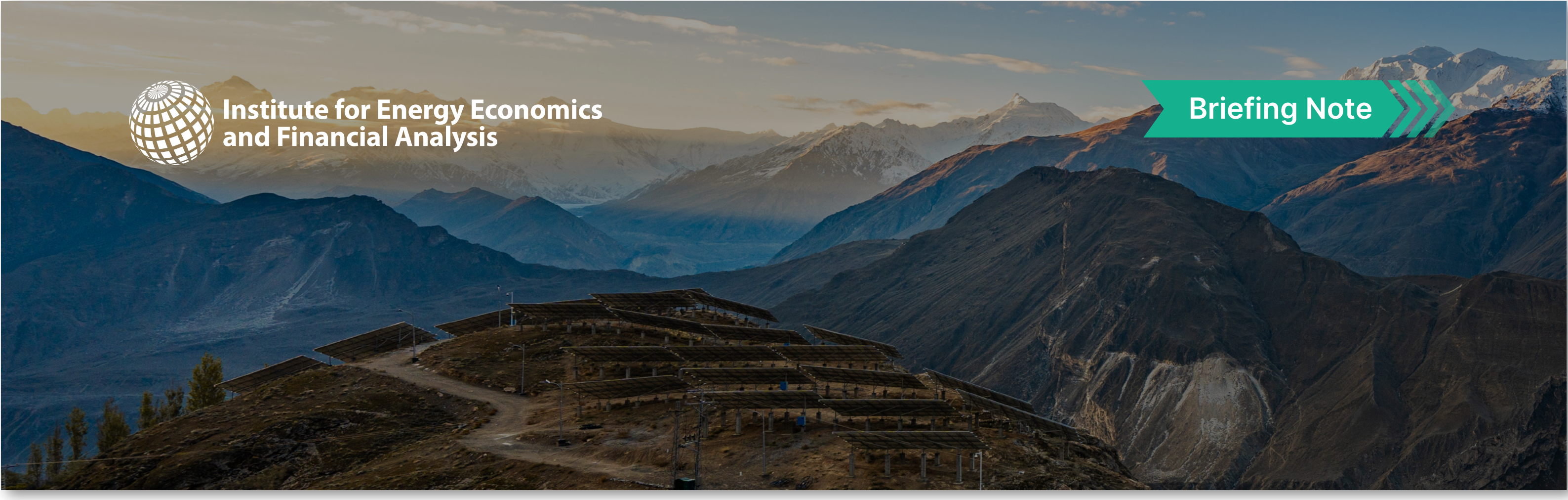

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Net Metering Reforms and Grid Challenges Amid Pakistan's Solar Rise

- *Pakistan's Economic Coordination Committee has proposed amending existing net metering regulations. It cites rising capacity payments for non-net-metered consumers due to declining energy sales and decreasing grid-based energy consumption as reasons for the change.*

- *Suggested amendments, include reducing the current buyback rate from PKR 27 per kilowatt hour (kWh) to PKR 10/kWh, eliminating the 1.5 times sanctioned load allowance, and shifting to net billing from net metering. These proposals have been met with widespread public criticism.*

- *Even with lower buyback rates, payback periods for an average 10 kilowatt (kW) solar installation would remain within the globally accepted 5-year range. The recent surge in solar photovoltaic (PV) installations in Pakistan has exacerbated grid issues such as increasing peak demand, peak shifting and transformer burnouts, resulting in financial and technical implications for the grid.*

- *The proposed amendments to the net metering regime can be a course correction, mitigating further risk to distribution infrastructure, increasing grid-based consumption, and ensuring transmission system stability in the future.*

A recent proposal by Pakistan's Economic Coordination Committee (ECC) to revise the existing net metering regulations sparked controversy within energy circles in the country. It drew widespread criticism from the public, political parties, and businesses, as well as from traders and installers of solar photovoltaic (PV) equipment. The federal government temporarily paused the approved policy changes, citing a lack of broader stakeholder consultation, and directed the country's Power Division to ensure more public buy-in.

Proposed amendments to the policy include reducing the existing buyback rate from the current National Average Power Purchase Price (NAPPP) of PKR 27 per kilowatt hour (kWh) to PKR 10/kWh, the average marginal cost of electricity production by the grid. The new policy regime would eliminate the 1.5 times sanctioned load system size allowance and convert the billing mechanism from net metering to net billing with a monthly settlement of accounts. The amendments also reduced the licensing period for new connections from 7 to 5 years.

According to the government, these revisions were needed due to a sudden surge in net-metered solar PV connections, which rose from 226,440 in October 2024 to 283,000 in December 2024. The installed capacity also doubled between June and December 2024, reaching 4,124 megawatts (MW) by the end of the year, increasing the financial burden of maintaining the grid on the remaining consumers.

The government attributes declining energy sales to the rising capacity of net-metered connections, leading to higher electricity tariffs. According to the summary of proposed amendments submitted to the ECC, electricity sales fell by approximately 3.2 billion (bn) kWh during the fiscal year (FY) 2024, leading to an additional financial burden of PKR101bn. Currently, this translates to an average increase in consumer tariffs of PKR0.9/kWh but could go up to PKR3.6/kWh by 2034 if the adoption of distributed solar continues at the same rate.

However, proponents of the existing scheme argue that the national grid's high transmission and distribution (T&D) losses and expensive generation from thermal Independent Power Producers (IPPs) are responsible for this additional burden. They contend that the proposed amendments will curb further solarization as payback periods under net billing double, pushing more consumers towards battery storage and partial defection from the grid, if not a complete exit.

Are Changes to the Existing Net Metering Regulations Justified?

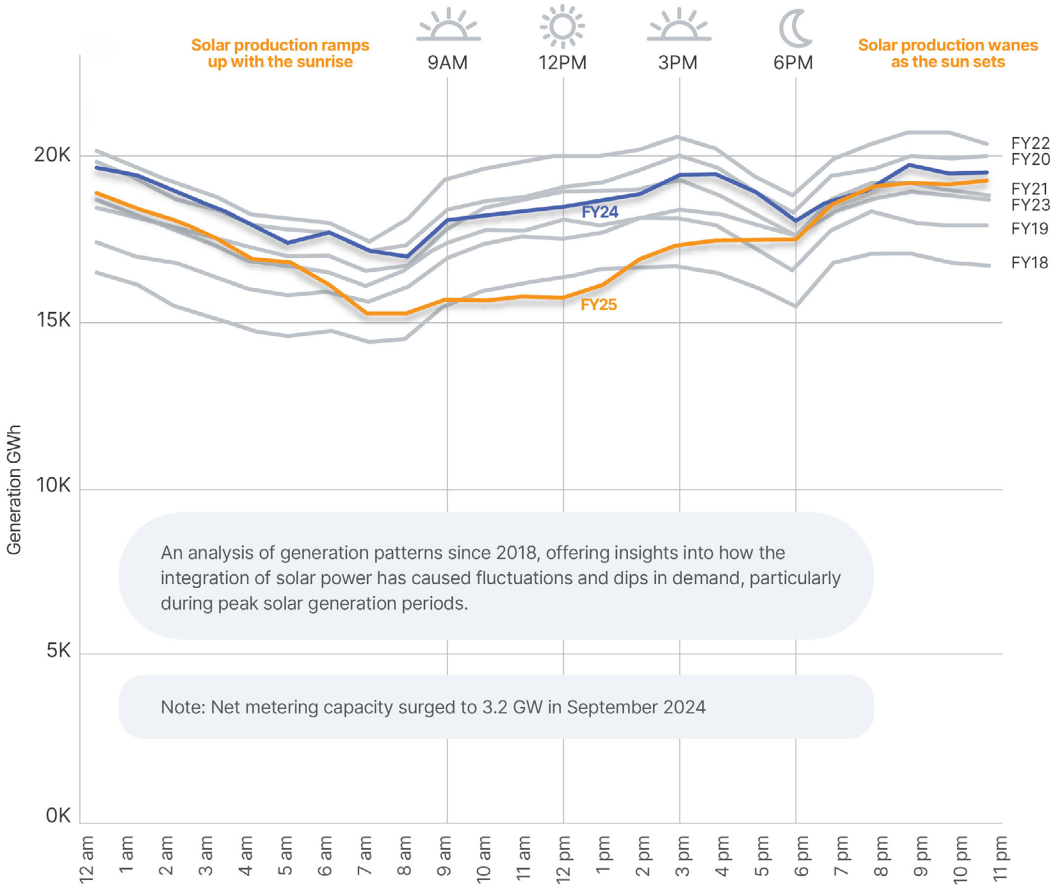
While the government's claims regarding the financial burden of net-metered consumers are still unconfirmed, the imbalance between the fixed and variable portion of electricity tariffs in Pakistan should be acknowledged. For instance, 67% of the average FY2024-2025 tariff for distribution utilities (DISCOs) includes fixed costs such as capacity charges and grid operation and maintenance costs. Conversely, consumer retail tariffs recover a majority of the determined costs through variable charges, resulting in energy sales becoming essential for cost recovery.

Peak Shifting is Creating a Cost Imbalance

Rapid solarization across Pakistan has reduced utility sales over the past two years, as net-metered consumers produce their own daytime electricity while feeding excess production back into the grid. The excess production is adjusted against units consumed at night when consumers switch back to the grid. This happens as solar production declines, contributing to higher night-time peak demand, especially during the summer.

This allowance was initially provided as an incentive to encourage rooftop solar PV installations. However, it has led to an unprecedented shift in consumption patterns. Demand has increased beyond evening peak hours (peak shifting) as consumers try to offset energy feedback by increasing consumption during off-peak hours at night.

Figure 1: Average National Hourly Generation Profiles for September (FY2018-FY2025)



Source: Renewables First. The Great Solar Rush in Pakistan. 2024.
Note: A dip in daylight generation from the grid is observed as rapid solarization occurs beyond FY2024. As solar power production declines after 6 PM, consumers switch back to the grid, contributing to higher peaks. A general trend of increasing peak demand at night can also be observed over the years.

A cost imbalance is created as these sudden demand spikes are met by operating expensive liquefied natural gas (LNG) and thermal peaking plants that generate power at PKR30-60/kWh. Consumers inject solar power into the grid during the day at a levelized cost of PKR10/kWh, which then offsets their consumption of more expensive electricity at night. There is also the advantage of selling excess power (after unit-to-unit adjustment) to the grid at PKR 27/kWh. Consequently, the grid must cover the difference.

The problem is exacerbated during the shoulder months (March-April and September-October) when transitioning between summers and winters, leading to a low heating or cooling load during the day, while nights are warmer or cooler. Meanwhile, solar irradiation is strong. Due to low energy demand during the day, all excess energy is exported to the grid, increasing the daytime fall in demand. As the weather shifts, grid demand surges at night, necessitating more peak dispatch.

As an example, the minimum daytime instantaneous operational system demand (power or energy required by consumers at any specific moment) during March 2024 is compared with March 2025. Hourly readings from 9 AM to 3 PM are used to analyze the impact of solarization on operational requirements. During March 2025, the instantaneous daytime demand declined by an alarming 1.5-2.25 gigawatts (GW) year-on-year (Table 1). At an average minimum system demand of 7.5GW for March, this demand is even lower than the winter daytime demand of December, January, or February.

Table 1: Comparison of Minimum Daytime Instantaneous Demand Between March 2024 and March 2025

Year	Time of day	Demand (MW)	Date	Year	Time of day	Demand (MW)	Date	Percentage Difference %
	9:00 AM	9691	24th March		9:00 AM	8,062	2nd March	-17%
	10:00 AM	9833	2nd March		10:00 AM	7,586	2nd March	-23%
	11:00 AM	9571	31st March		11:00 AM	7,414	2nd March	-23%
March 2024	12:00 PM	9496	31st March	**March 2025**	12:00 PM	7,073	2nd March	-26%
	1:00 PM	9444	31st March		1:00 PM	7,327	2nd March	-22%
	2:00 PM	9052	2nd March		2:00 PM	7,472	2nd March	-17%
	3:00 PM	9276	15th March		3:00 PM	7,598	7th March	-18%

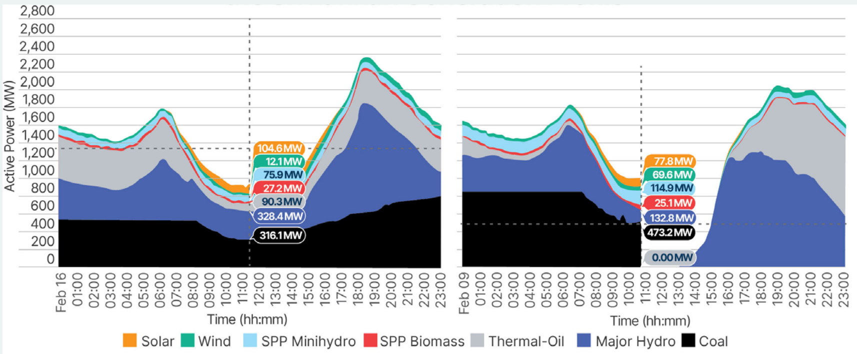
Source: Author analysis; National Power Control Center.

Daytime demand is expected to decline even further if rapid solarization continues, which may jeopardize system stability. Extreme circumstances could even lead to demand being so low that utilities trip or must be taken offline completely, leading to the potential for grid failure.

Case Study: Sri Lanka Grid Failure

Sri Lanka's recent cascading power failure in February 2025 was primarily attributed to the grid's inability to recover from shocks caused by a significant volume of rooftop solar power, according to the Ceylon Electricity Board Engineers' Union (CEBEU).

Figure 2: Impact of Increased Solar Output on Sunny Days on the Sri Lankan Generation Profile



Source: Ceylon Electricity Board (CEB), Economy Next.
Note: On sunny days, as demand drops below standard operational levels, output from dispatchable generation sources such as coal or hydropower must be sharply reduced in electricity grids with large rooftop solar volumes.

The failure was triggered by a breakdown in one of the lower voltage circuits (a 33-kilovolt substation in Panadura). This further destabilized the grid due to the high solar power share, especially on a Sunday when demand was low.

Sri Lanka's normal daytime demand rises to 2,000MW on working days when solar power starts generating at sun-up, but it falls to around 1,600MW on Sundays due to low economic activity.

Traditional grid operations usually feature spinning reserves such as gas, coal, or hydro plants. These rotating turbines provide stability and can absorb grid shocks (such as sudden large changes in demand). This is known as 'inertia' and helps with load balancing (matching supply and demand).

At the time of the grid failure, 800MW of solar PV generation, supported by a 470MW coal and a 130MW hydro plant, met over 50% of the country's electricity demand.

Due to the high penetration of solar PV generation, which cannot provide load-balancing services, the grid had low system inertia, making it vulnerable to faults. The Ceylon Electricity Board (CEB) had to de-load its coal and hydro plants because of the reduced demand. The disturbance resulted in an imbalance between the available supply and demand, leading to cascading disconnections and a complete power failure.

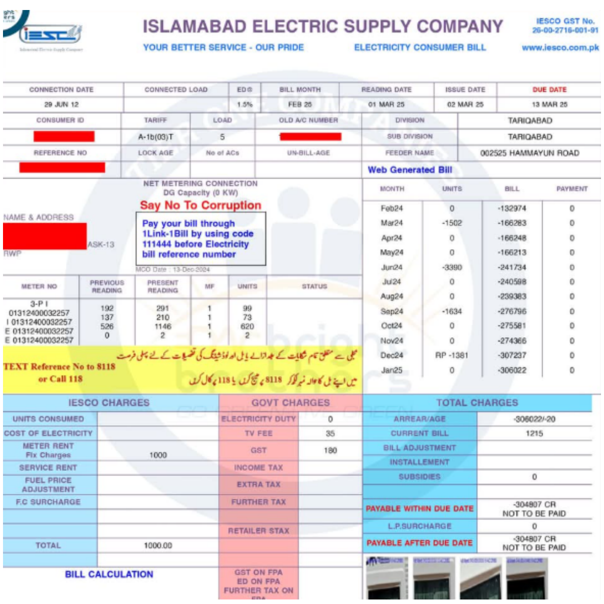
System Oversizing Leading to Financial and Technical Challenges

The current net metering regime in Pakistan allows surplus production to be carried forward for up to three months, after which all leftover units are adjusted against the monetary value of PKR27/kWh, the average Power Purchase Price (PPP). This encourages consumers with low self-consumption (during the daytime) to build up excess credit, effectively eliminating their electricity bills and thus avoiding any taxation imposed on units purchased from the grid.

As shown in Table 1, this also creates an imbalance between daytime and night-time demand, which could affect system operations in the future. Therefore, switching to a monthly billing cycle under the proposed amendments without any carryover of excess units could encourage higher self-consumption during the day.

Figure 3 shows an Islamabad Electric Supply Company (IESCO) electric bill for a consumer with a 5kW sanctioned load and an extremely high surplus credit of PKR 306,022. Looking at the historical consumption pattern, the consumer has been continuously exporting an average of 658 units per month after self-consumption and unit-to-unit adjustment. These units translate to an additional surplus capacity of 5.48kW installed over and above the consumption limits.

Figure 3: An IESCO Electric Bill Shows Excess Credit Buildup Due to an Oversized System Installation



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ELECTRICITY CONSUMER BILL
IESCO GST No. 26-00-2716-001-91
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CONNECTION DATE	CONNECTED LOAD	ED@	BILL MONTH	READING DATE	ISSUE DATE	DUE DATE
29 JUN 12		1.5%	FEB 25	01 MAR 25	02 MAR 25	13 MAR 25

CONSUMER ID	TARIFF	LOAD	OLD A/C NUMBER	DIVISION	TARIQABAD
[redacted]	A-1b(03)T	5	[redacted]	SUB DIVISION	TARIQABAD
REFERENCE NO	LOCK AGE	No of ACs	UN-BILL-AGE	FEEDER NAME	002525 HAMMAYUN ROAD
[redacted]				Web Generated Bill	

NAME & ADDRESS
[redacted] ASK-13
RWP

NET METERING CONNECTION
DG Capacity (0 KW)
Say No To Corruption
Pay your bill through 1Link-1Bill by using code 111444 before Electricity bill reference number
MCO Date : 13-Dec-2024

METER NO	PREVIOUS READING	PRESENT READING	MF	UNITS	STATUS
3-P I 01312400032257	192	291	1	99	
I 01312400032257	137	210	1	73	
E 01312400032257	526	1146	1	620	
E 01312400032257	0	2	1	2	

TEXT Reference No to 8118 or Call 118

MONTH	UNITS	BILL	PAYMENT
Feb24	0	-132974	0
Mar24	-1502	-166283	0
Apr24	0	-166248	0
May24	0	-166213	0
Jun24	-3390	-241734	0
Jul24	0	-240598	0
Aug24	0	-239383	0
Sep24	-1634	-276796	0
Oct24	0	-275581	0
Nov24	0	-274366	0
Dec24	RP -1381	-307237	0
Jan25	0	-306022	0

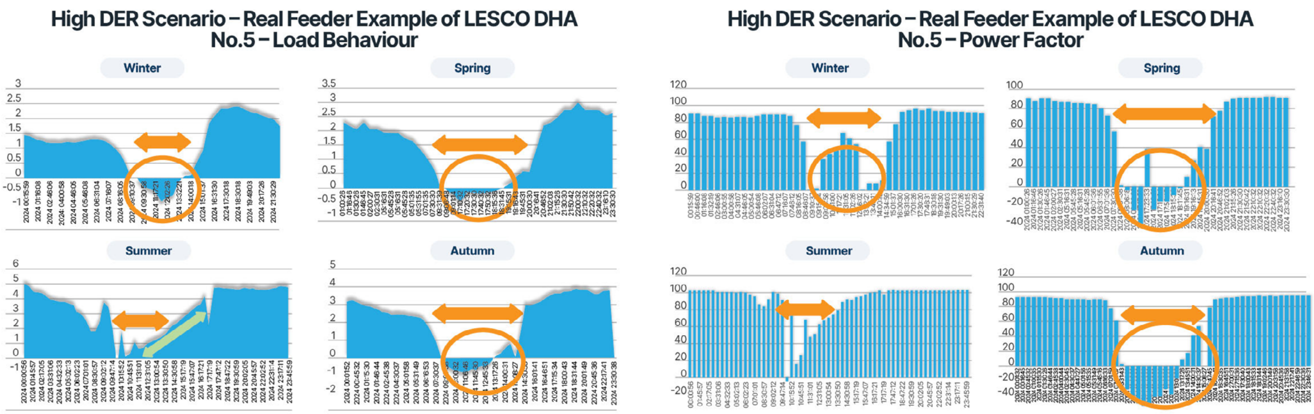
IESCO CHARGES		GOVT CHARGES		TOTAL CHARGES	
UNITS CONSUMED		ELECTRICITY DUTY	0	ARREAR/AGE	-306022/-20
COST OF ELECTRICITY		TV FEE	35	CURRENT BILL	1215
METER RENT Fix Charges	1000	GST	180	BILL ADJUSTMENT	
SERVICE RENT		INCOME TAX		INSTALLEMENT	
FUEL PRICE ADJUSTMENT		EXTRA TAX		SUBSIDIES	0
F.C SURCHARGE		FURTHER TAX		PAYABLE WITHIN DUE DATE	-304807 CR NOT TO BE PAID
		RETAILER STAX		L.P.SURCHARGE	0
TOTAL	1000.00			PAYABLE AFTER DUE DATE	-304807 CR NOT TO BE PAID
BILL CALCULATION		GST ON FPA ED ON FPA FURTHER TAX ON FPA			

Changing consumption patterns have led to financial implications for the grid. Additionally, oversized solar PV installations, which exceed the sanctioned load allowance defined by the existing net metering regulations, also contribute to the risk of technical failure for distribution infrastructure.

Allowing consumers to install solar PV systems beyond their sanctioned load (150% in Pakistan) can impact overall distribution network reliability. For instance, rapid solarization across wealthy neighborhoods in Lahore has led to voltage swells and reduced power factors. During times of high solar production, reverse power flows have increased transformer burnouts.

Power quality issues, such as decreasing power factor and voltage swelling, can damage equipment and disrupt operations. Voltage swells are short-term voltage increases, while a decreasing power factor means a system is less efficient due to higher losses.

Figure 4: An Example of the Impact of High Solar Output on System Demand and Power Factor



Note: The orange arrows show the daytime period during maximum PV generation from rooftop solar.
Source: Author analysis, Lahore Electric Supply Company (LESCO).

The left of Figure 4 shows zero power drawn from the grid during daytime by Lahore Electric Supply Company's (LESCO) feeder. During the summer, the residents of the Defence Housing Authority (DHA) area drew negligible power due to a high penetration of distributed solar. This caused the power factor to drop below tolerable limits, as shown on the right of Figure 4.

Improving project economics contrasts with global benchmarks

Significant declines in solar PV module pricing have greatly improved project economics. Moreover, a dynamically priced buyback rate pegged to the NAPPP under the current net metering regulations has meant that consumers have been recovering their initial investments within two years. The Institute for Energy Economics and Financial Analysis (IEEFA) estimates that payback periods for an average 10kW net-metered solar PV system decreased from 2.2 years in August 2024 to 1.83 years in February 2025. This contrasts with the global benchmark of 5 years and allows Pakistan's solar PV installers to gain additional returns as the current licensing period for net metering extends up to 7 years.

Therefore, the proposed amendments to the net metering regime can be a course correction, mitigating further risk to distribution infrastructure, increasing grid-based consumption, and ensuring transmission system stability in the future.

Case Study: Phased Incentives for Net Metering in Malaysia

Solar PV additions are capped to ensure that distributed resources are added together with grid upgrades and according to the country's hosting capacity. Capacity additions are often phased. The Malaysian government, for instance, introduced a quota system for its Net Energy Metering (NEM) scheme in November 2016 to promote solar energy uptake, initially with a 500MW quota. In January 2019, NEM 2.0 adopted a "one-on-one" offset model, allowing excess solar energy to be exported back to the grid. By 2020, the 500MW quota was fully subscribed. NEM 3.0 was launched in December 2020 to further encourage solar adoption, with a quota of 1,950MW from 2021 to 2025.

The latest quota is divided into three programs: NEM Rakyat (600 MW for residential users), NEM Government Ministries and Entities (GoMEn) (100MW for government entities), and Net Offset Virtual Aggregation (NOVA) (1,700MW for businesses). The NEM 3.0 program will run until 30 June 2025 or until all quotas are filled.

Figure 5: Malaysia's Net Energy Metering (NEM) Scheme 3.0

	Rakyat Domestic	GoMEn Government Buildings	NOVA Commercial, Industrial, Agriculture and Mining Buildings
Quota Allocation	600 MW	100 MW	1700 MW
Mechanism (Roll-over)	1:1 (12 Months)	1:1 (12 Months)	Average SMP (1 Month)
Offer Period	until 30 June 2025	until 30 June 2025	until 30 June 2025
Offset Rate	Prevailing Gazetted Energy Rate	Prevailing Gazetted Energy Rate	Average System Marginal Price (SMP)
Offset Period	10 Years	10 Years	10 Years
Condition after 10 years	Self-Consumption (SelCo)	Self-Consumption (SelCo)	Self-Consumption (SelCo)
Capacity limit	Single Phase: 5kWac Three Phas: 12.5kWac	1 MWac	Nett offset: 1MWac Nett offset + Virtual aggregation: 5MWac
Eligibility	TNB registered consumer under domestic tariff	Government agencies under commercial tariff	Non-domestic account holder

Source: Sustainable Energy Development Authority, Malaysia.

In addition to a quota, the allowance for system size was also reduced while transitioning from NEM 2.0 to NEM 3.0. In NEM 2.0, residential single-phase and three-phase consumers were allowed to install up to 12kW and 72kW solar PV systems, respectively. These limits were then revised to 5kW and 12.5kW in NEM 3.0. Such limits ensure reduced feedback and encourage self-consumption, thereby reducing the chances of technical issues in the grid.

Financial Implications of Proposed Changes

Net metering allows consumers to use solar power directly, export excess production during the day, and offset it at night. They only pay for grid-based consumption during peak hours and any remaining off-peak consumption not adjusted by electricity exported to the grid.

Under net billing, consumers would still use solar power directly. However, a unit-to-unit adjustment would not be allowed for electricity sent to the grid against night-time off-peak consumption. Instead, consumers would be charged separately for grid consumption, netted off against electricity exported to the grid at the designated buyback rate. Additionally, under a recent directive by the Federal Tax Ombudsman, net-metered or net-billed consumers would be charged an 18% sales tax for consumption from the grid before adjustment for energy export.

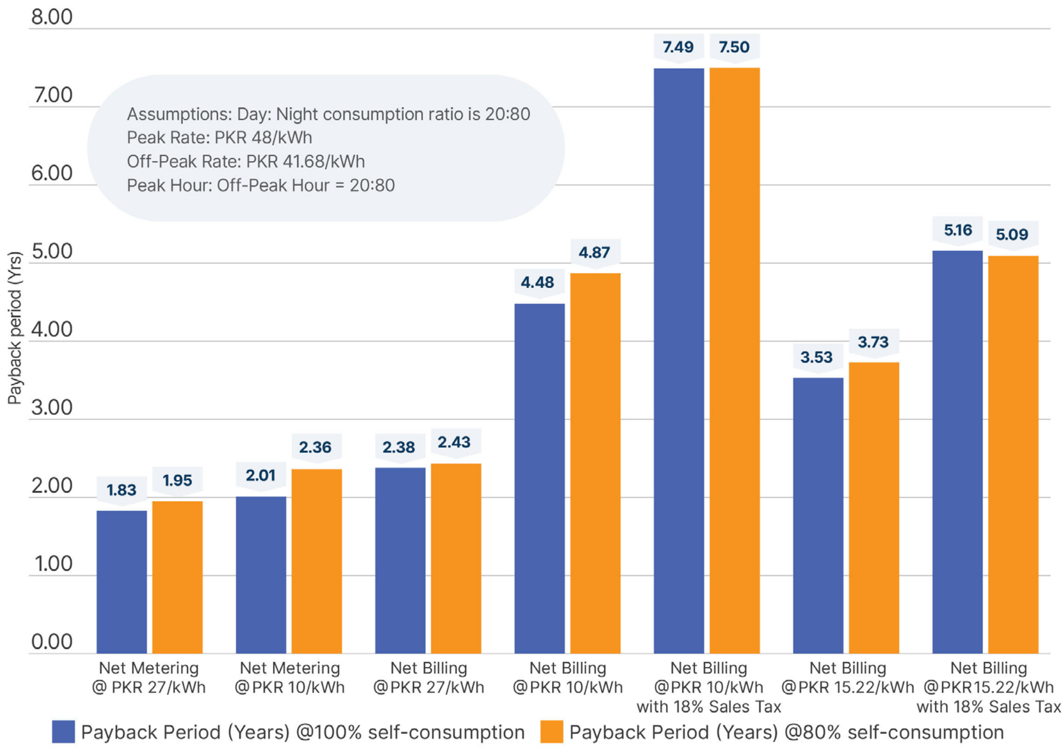
Net-metered consumers in Pakistan were breaking even in under two years because of declining capital costs for solar PV installations and an attractive buyback rate of PKR27/kWh. Net billing reduces monetary benefits for consumers, as a unit-to-unit adjustment against expensive grid-based electricity is no longer possible. Under the net billing mechanism, payback periods are expected to slightly increase to 2.38 years (from 1.83 years under the net metering scheme) for an average 10kW solar PV system with 100% self-consumption (where the sum of daytime and night-time consumption equals daily solar PV system production) at the same buyback rate.

Reducing the buyback rate to PKR10/kWh further increases the payback period to 4.5 years for a 10kW installation. However, an 18% sales tax on grid consumption changes system feasibility by increasing the payback period beyond 5 years.

Since the licensing period for solar PV installations under the amended net billing regime has decreased from 7 years to 5 years, consumers would have to renew their agreement with the government to break even.

Net billing could encourage oversized installations based on the belief that additional solar PV exports could offset a lower buyback rate. However, a proposed limitation on system size prevents this by restricting the installed capacity of rooftop solar installations to the sanctioned load. Under the proposed guidelines, if export units exceed 10% of the sanctioned load limit, all exported units would not be credited to the consumer's bill for that billing month as a penalty. Any additional units would be wasted if not consumed at the site.

Figure 6: Impact of Regime Change on Payback Periods for a 10kW Grid-Connected Solar PV Installation



Source: Author calculations based on data from DISCOs.

To restrict payback periods to the 5-year benchmark, the government could offer a slightly higher buyback rate than currently proposed. On-site distributed solar installations eliminate the need for investments in upgrading and maintaining distribution T&D assets. Therefore, it is possible that adding average T&D losses (currently PKR5.22/kWh) to the marginal cost of grid-based electricity might be fair compensation for excess power supplied by rooftop solar installations. Thus, providing a PKR15.22/kWh buyback rate could shorten payback periods to 5 years despite applying an 18% sales tax combined with net billing.

Alternatively, a lower sales tax could be applied to solar PV installers to keep the payback period within the 5-year limit. This may be a reasonable compromise, providing both the government and the public with a win-win solution.

Who Will the New Policy Impact?

Table 2: Types of Distributed Solar PV Installations in Pakistan

Type of Installation	Net Metered	Grid Connected	Energy Feedback to the Grid	*As of January 2025* Installed Capacity (GW)	Impacted by Proposed Amendments to the Net Metering Policy?
All kinds of domestic net-metered solar	Yes	Yes	Yes	2.05	Yes
Non-net-metered residential or other types of solar (provincial programs)	No	Yes	No	1.5	No
Commercial and Industrial (C&I) Solar	Yes	Yes	Yes	2.0	Yes
	No	Yes	No	3	No
Off-Grid Solar	No	No	No	0.5	No
Agriculture Tubewell Solarization	No	No	No	5	No
	No	Yes	No	1.45	No
	Yes	Yes	Yes	0.05	Yes
Total				**15.55**	

Source: Author analysis based on information from DISCOs.

These changes would apply to new consumers entering into electricity export agreements with the government. Existing consumers would continue to benefit from the current net metering scheme until their licenses expire. Since most solar PV additions by net-metered systems occurred after 2023, it is safe to assume that approximately 75% of consumer licenses may have at least 6 years left on their net metering licensing term.

Currently, 283,000 net-metered connections exist across the three-phase domestic, commercial, and industrial sectors, totaling 4.1GW in capacity. However, these connections account for less than 10% of the total consumer base, while the number of non-net-metered (grid-connected and off-grid) solar installations is much larger. It is estimated to be around 10GW to 12GW across agricultural, industrial, and other solar applications (Table 2).

Net metering has never been permitted for single-phase consumers in the domestic sector. If they switched to three-phase connections, their billing mechanism would change from consumption-based incremental tariff slabs to a time-of-use tariff, which imposes flat rates for peak and off-peak consumption. As a result, very few consumers transition from single-phase to three-phase to opt for net metering.

Therefore, single-phase consumers would remain unaffected by the revised policy guidelines and can continue installing single-phase hybrid solar systems according to their needs. Notably, 90% of domestic consumers are single-phase users who remain unaffected, meaning solar adoption will continue without disruption.

There are approximately 1.5 million tube wells in the agricultural sector, 80% of which are off-grid and do not participate in net metering. Only a small fraction of the remaining 20% of grid-connected tube wells have opted for net metering. The overall percentage of agricultural consumers utilizing net metering is less than 1%. Therefore, the revised net metering policy will have minimal impact on this sector, and solar adoption will continue as usual.

Most businesses in the industrial sector prefer non-net-metered solar installations. Notably, between 3GW and 4GW of industrial solar capacity has been installed without net metering. Furthermore, the sector has shown growing interest in Battery Energy Storage Systems (BESS), regardless of net metering policies. Consequently, most industrial consumers pay little attention to net metering regulations, and solar adoption in this sector will continue as usual.

Only industries with a load below 1MW are eligible for net metering, most of which already avail the option. Policy changes will affect industries planning to install new net-metered systems below 1MW in the future.

Could There be a Shift Towards Battery Storage?

Discouraged by low buyback rates and the inability to adjust production against off-peak consumption, an increased adoption of BESS is expected by the public, which could accelerate the downward spiral for utilities.

Net-metered consumers account for only 10% of Pakistan's total consumer base. Most of the country's solarization potential lies outside this group, with single-phase consumers, industries, and commercial entities already adopting battery storage systems to gain independence from the grid. These consumers are usually based in affluent areas and are financially capable of adopting battery storage systems, regardless of net metering.

Complete grid defection seems unlikely due to a variety of reasons. First, going completely off-grid will require additional solar PV output to charge batteries for evening and night-time consumption. This will require more rooftop space to house extra solar panels.

Moreover, batteries require significant upfront capital investment, which could lead to much higher payback periods. IEEFA's calculations show that the payback period for a 10kW solar and a 5kWh BESS under the current net metering regime would be 3.6 years. Shifting to net billing with a PKR10/kWh buyback rate increases the timeframe to 6.5 years, which becomes 7.5 years after adding an 18% sales tax on grid-based imports.

In the industrial sector, batteries are not used for complete backup power. Instead, they are used for frequency regulations or renewable energy integration as industries seek to diversify their generation mix. Nonetheless, partial defection from the grid is possible and will be observed.

Falling lithium-ion battery prices in the future could accelerate BESS adoption, strengthening the case for grid modernization and digitization. An important tradeoff is allowing consumers to go off-grid and encouraging new net metering connections.

Under the current policy regime, net metering consumers defect from the grid during the day, while exporting excess power and reappear on the grid during the evening. Pakistan's grid code stipulates a Loss of Load Probability (LOLP) of 1%, which provides an 87-hour buffer annually when the load can be shed due to resource unavailability. This causes the government to procure additional power plants to meet the rising peak demand, which run only for a few hours during the summer months while remaining idle for most of the year. This adds to the grid's capacity costs, increasing consumer tariffs.

In the case of batteries, the possibility of energy arbitrage (difference between buyback and retail peak rates) offers an advantage. Consumers are incentivized to discharge their stored power for self-consumption during peak hours to reduce reliance on the grid and generate savings. This inadvertently results in demand-side management on the consumer end while shaving off-peak demand on the grid.

While peak shaving can be an added benefit for the grid, an overall reduction in grid-based demand can be a concern, largely because there is a surplus of generation capacity in Pakistan. The available generation capacity during the summer months is approximately 29,500 to 30,000MW, while peak demand for FY2024 was 25,500MW (with 3.5-4GW commercial load shedding). If the influx of distributed solar continues under a 'business as usual' (BAU) scenario, peak demand is predicted to rise annually. Conversely, due to the daytime defection of solarized grid users, the grid's electricity demand declines, with FY2024 already recording a 10.4% drop in generation.

Finding a balance between encouraging battery usage for peak demand management and preventing declining grid sales will be a challenge. However, it can be managed with corrective distributed energy generation policies and incentives for battery storage installations. Concurrently, centralized procurement of additional capacity should be carefully planned, with existing IPP contracts being renegotiated to account for the reduced energy output.

Some thermal power plants in Pakistan have been necessary as they offer ancillary services such as reactive power compensation, frequency regulation, and voltage support. Providing these services becomes crucial as more distributed solar comes online.

Most modern solar inverters and battery storage systems can also provide the same ancillary services at the level needed for grid modernization and a two-way flow of information.

While the primary function of solar inverters is to convert Direct Current (DC) electricity from solar modules to Alternating Current (AC) for consumer use, most modern inverters are equipped with reactive power compensation capabilities.

Distributed BESS, when aggregated into virtual power plants, can also provide many ancillary services provided by large-scale utilities, such as inertia, voltage control, and frequency regulation, and alleviate grid congestion when needed.

Using advanced renewable energy systems for grid management requires innovative monitoring and control systems and a government-regulated framework that allows small-scale solar PV installations to participate in electricity markets. Grid-forming inverters would be required to sell excess power to the grid.

Tariff structures must also be established to compensate consumers for reactive power control and grid stability services.

Table 3: Policy Changes to Address Challenges from Rapid Solarization

Recommended Policy Change	Target Grid/Financial Challenge
Conversion to net billing	Removes the financial imbalance between daytime energy exports to the grid and the adjustment against expensive night-time grid energy production. Discourages system oversizing and ensures revenue generation for distribution utilities.
Reduction in buyback rate	Discourages excess electricity export to the grid and encourages self-consumption.
Restrict excess power sales by placing limits on rooftop solar installations sizes	Reduces risks to transmission and distribution infrastructure by preventing reverse power flow, voltage swelling, and transformer overload during times of high solar photovoltaic (PV) generation.
Creation of incentives for battery storage and establishment of regulatory frameworks for participation of distributed energy resources in electricity markets	Allows an opportunity for meeting peak demand through demand-side management, reducing the need for further investment in peaking power plants.

Case Study: Incentivizing Battery Storage in Australia

Australia is a leading example of encouraging the use of batteries in its residential sector. Various federal and provincial state incentive programs have been announced that provide rebates on the use of batteries.

Table 4: BESS Incentive Programs for the Residential Sector in Australia

State/Territory	Incentive Program	Details
Federal Incentives	Small-scale Renewable Energy Scheme (SRES)	Install solar panels and earn Small-scale Technology Certificates (STCs) to reduce installation costs.
New South Wales (NSW)	Battery Incentive	From 01 November 2024: Up to AUD2,400 off installation cost of household battery; up to AUD400 for Virtual Power Plant (VPP) connection.
Victoria (VIC)	Solar Battery Loan	From 01 November 2024: Interest-free loans up to AUD8,800 for solar battery installations, to be repaid over four years.
Queensland (QLD)	Queensland Battery Booster Program	The Queensland Battery Booster program closed on 08 May 2024. The program offered up to AUD3,000 for eligible households toward the purchase and installation of a battery storage system.
South Australia (SA)	Home Battery Scheme	The Home Battery Scheme (now closed) offered rebates on household battery systems. Households could receive up to AUD6,000 for the installation of a home battery storage system. The amount of the rebate varied based on the size of the battery installed.
Australian Capital Territory (ACT)	Sustainable Household Scheme	No rebates for batteries but offers zero-interest loans up to AUD15,000 for energy-efficient upgrades, including solar and battery systems.
Northern Territory (NT)	Home and Business Battery Scheme	Grants of AUD400 per kWh, up to a maximum of AUD12,000, for eligible battery systems.
Western Australia & Tasmania	No specific state-based battery rebates	No state-based battery rebates; residents can benefit from federal incentives. Local councils to be consulted for available programs.

Source: Author analysis; Solar quotes; NSW Climate and Energy Action; RedX.

How Consumers Could Manage Policy Changes by Shifting Consumption Patterns

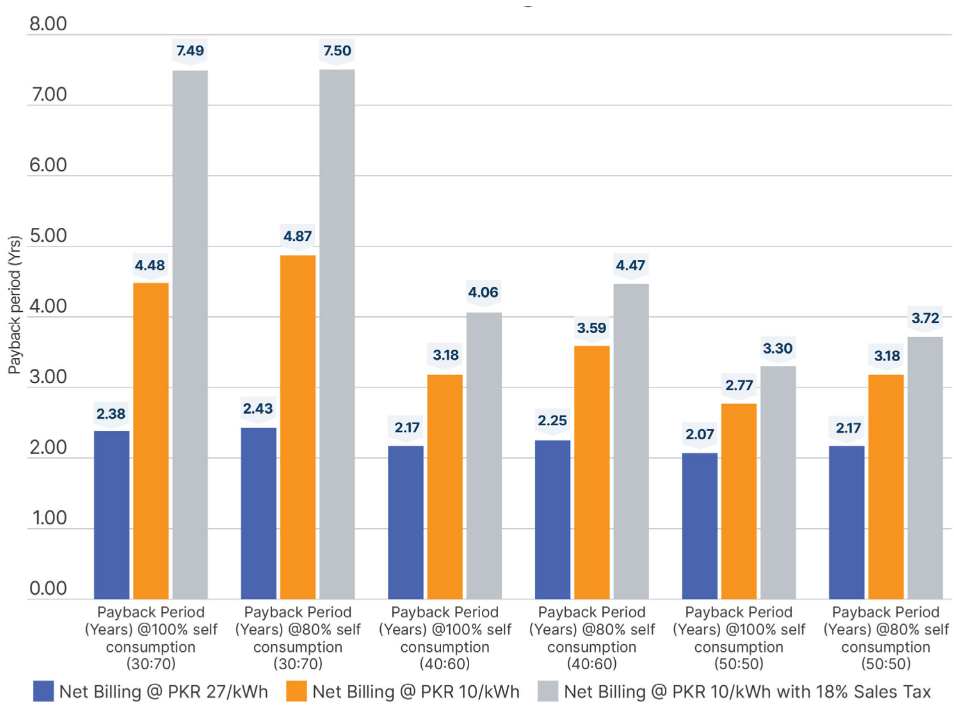
Under the proposed shift to net billing, consumers in Pakistan would not be able to adjust their excess daytime production against off-peak consumption at night. While the previous regulations encouraged electricity export to the grid, the new policy regime would result in lower consumer savings. The off-peak tariff applicable at night would be higher than the buyback rate offered during the day, leading to a longer payback period.

Nonetheless, consumers would still have the option of generating higher savings and reducing payback periods by adopting changes in consumption patterns and increasing their daytime energy usage, specifically during peak solar generation hours.

Currently, daytime self-consumption for most consumers ranges between 20 and 30% of the total solar PV generation output. Self-consumption ratios depend on daytime activity, which varies from season to season. It is generally observed that residential daytime self-consumption increases during the summer, specifically during school holidays (June to August), as cooling requirements are higher. Increasing self-consumption during the rest of the year could allow consumers to improve payback periods, as they would offset their self-generated solar PV output against higher-priced off-peak units.

Figure 7 illustrates how varying day and night-time consumption ratios could result in shorter payback periods for consumers. As consumers shift a higher portion of their consumption loads to the daytime, a significant decrease in payback periods is observed, bringing it within the 5-year benchmark despite the 18% sales tax application.

Figure 7: Payback Periods under Varying Day and Night-time Consumption Ratios



Source: Author calculations based on data from DISCOs.

Changes to the existing net metering regulations have been expected and may be warranted, as demonstrated by the grid-based technical challenges resulting from widespread solarization in Pakistan. However, the public protest against the proposed amendments shows the importance of community buy-in for successful policy implementation. A temporary pause on enacting the proposed changes by the government is an opportunity for rationalizing the existing net metering policy from both a consumer and government perspective. While providing financial relief to consumers is important, the grid-related challenges posed by increasing distributed renewable energy resources must be addressed by carefully reconsidering existing incentives.

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