Industrial Decarbonization Monitor

IDM Quarterly Monitor

Pakistan's Textile Sector

Alternate Development Services
RE-UPTAKE • CLEAN ENERGY • INDUSTRIAL DECARBONIZATION

First Quarter · January – March 2026

Industrial Decarbonization Monitor (IDM)

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Abbreviations

BESS	Battery Energy Storage System
CBAM	Carbon Border Adjustment Mechanism
CO_2	Carbon Dioxide
CTBCM	Competitive Trading Bilateral Contract Market
EU	European Union
EV	Electric Vehicles
FOB	Free On Board
GDP	Gross Domestic Product
HFO	Heavy Fuel Oil
IRR	Internal Rate of Return
kWh	Kilowatt-hour
LCOE	Levelized Cost of Electricity
LNG	Liquefied Natural Gas
MDI	Maximum Demand Indicator
MW	Megawatt
NB	Net Billing
NM	Net Metering
NTDC	National Transmission & Dispatch Company
PV	Photovoltaic
PKR	Pakistani Rupee
RLNG	Regasified Liquefied Natural Gas
SCADA	Supervisory Control and Data Acquisition
SBTi	Science Based Targets initiative
ToU	Time-of-Use
tCO_2	Tonnes of Carbon Dioxide
T&D	Transmission & Distribution
TPH	Tons per Hour
UAE	United Arab Emirates
UK	United Kingdom
USA	United States of America
VoS	Value of Solar
WWTP	Wastewater Treatment Plant

Industrial Decarbonization Monitor (IDM)

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Highlights of the Quarter

Economic Scale:

- Share of national GDP: **~8–9%.**
- Share of industrial value added: **~25–27%.**
- Share of total exports: **~54.5%** (USD **16–19 billion annually**).
- Direct and indirect employment: **~15–16 million workers.**

Net Metering to Net Billing:

- NM – **1:1 Offset**, NB: exports at **~8 – 10 PKR/kWh**, imports at retail.
- Slow on-site PV deployment as payback increases **1.5-2X.**
- SMEs are most vulnerable: **LCOE jump >100%**.
- Large textiles: **IRR falls ~44%** and **payback ~2X** with sanctioned caps.
- NB with VoS/ToU pricing and BESS can preserve decarbonization.

Optional ToU tariff for industrial prosumers:

- Fixed charges jump from **PKR 250/kW to 6,800–7,400/kW** for B1–B4 users.
- Solar-hour rates fall below **PKR 6/kWh**, and unit cost drops from **PKR 26–29 to 20–24** if load rises.
- Industry says 24-hour, closed, and shift-based plants gain udropsnevenly; 50% load-based fixed charges hinder.

War's impact on energy security, government regulations, and decentralization:

- **~90%** imports at risk; **LNG +143%, oil >$100/bbl.**
- **EV tariffs -45%**; policies shifting to clean energy.
- **Rooftop solar 6.3 GW**; cutting grid demand and industry use.

Emissions Profile:

- Share of Pakistan's industrial CO_2 emissions: **~9% national emissions.**
- Percentage of Industrial Natural Gas use in textiles: **~28.6%.**
- Percentage of Industrial Electricity use in textiles: **~28%.**

Engagement with the Kohinoor Textile Mills Limited:

- **18.2 MW** onsite solar **(31.38 MW total)** supplied **~90% of daytime load.**
- **45% CO_2** cut achieved since 2021; solar alone **reduced ~29,834 tCO_2 annually.**
- **20 TPH biomass boiler** plus waste heat recovery reduces fossil fuel use.
- **80–85% water recycling and 24 t/day** textile recycling enhance circularity.
- Solar cost competitive **(26–27 PKR/kWh)** but curtailed by grid limitations and policy uncertainty, limiting full financial returns.

1. Analysis of Major Industrial Advancements:

Government has cut industrial electricity rates by about Rs 4.04–4.40 per unit and reduced wheeling charges to under Rs 9 per unit, the fees industry pays to use the grid, while also lowering export refinance costs to 4.5 % from 7.5 % under the broader export support package.

For textile mills, which are very energy-intensive, this directly lowers production cost per unit of fabric/garment. Here's how to practically use this relief, not just in theory:

i). Cut cash costs immediately, every Rs 4 saved per kWh trims your variable cost line, so if a mill uses 100,000 kWh/month, that's Rs 400,000/month saved, immediately improving margins without new investment.

ii). Lower costs let you quote competitive Free on Board (FOB) prices while protecting or increasing profit, crucial for markets like EU, US, or UK buyers, especially under thin margins.

iii). With wheeling charges under Rs 9, units can buy power competitively on CTBCM instead of being stuck with expensive and fossil fuel-based supply. This cuts production cost, helps mills quote better FOB prices, meet EU CBAM pressure on carbon, and stay competitive in export markets.

iv). Lower energy cost makes running extra shifts or newer lines cheaper, helping reduce idle capacity and spread fixed costs over more output, key to meeting large textile orders.

2. Macroeconomic Importance of the Textile Sector

2.1 Contribution to GDP, Exports, and Industrial Employment

The textile and apparel sector is Pakistan's largest manufacturing industry and the backbone of its export economy, contributing approximately 8–9% of national GDP, 25–27% of industrial value added, and maintained an annual average of around 54.5% of total merchandise exports, with annual export earnings in the range of USD 16–19 billion (Figure 1). The sector is also the country's largest industrial employer, directly and indirectly supporting an estimated 15–16 million jobs across the full value chain, from spinning and weaving to wet processing and garment manufacturing, with particularly high labor intensity in downstream segments. Structurally, the sector ranks among the top industrial consumers of natural gas (approximately 28.6%) and electricity (around 28%), alongside cement and fertilizer, but with far greater geographic dispersion and SME participation. These characteristics make textiles one of the largest contributors to industrial GHG emissions; the textile industry accounts for roughly 9% of Pakistan's total energy-related emissions. Internationally, the sector's emissions profile is increasingly consequential due to its deep integration into global value chains and exposure to emerging carbon-related trade and disclosure requirements in key export markets, including the European Union, United States, and United Kingdom, directly linking mill-level emissions performance to long-term export competitiveness.

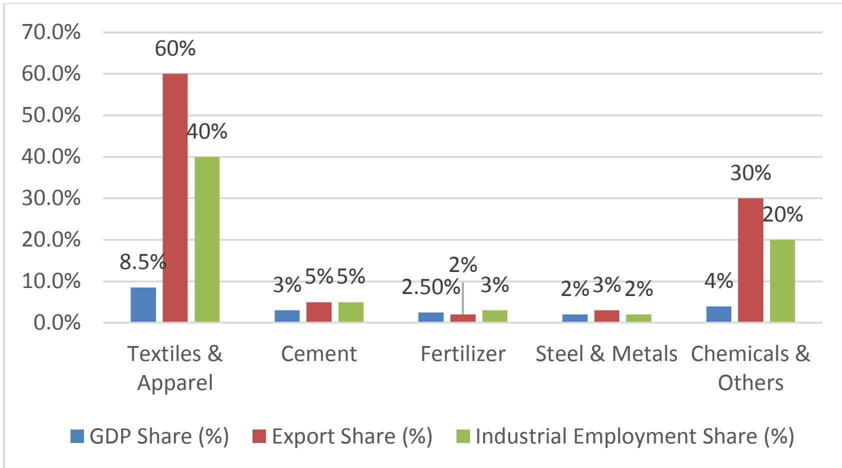


Figure 1 Shares of Different Sectors in GDP, Export, and Industrial Employment[i]

2.2 Export Structure and Performance

Pakistan's export performance shows a moderate upward trend overall, with total exports (BOP basis) increasing from $30.98 billion in 2023–24 to $32.34 billion in 2024–25, before reaching $20.74 billion in July–Feb 2025–26 (partial year). The textile sector remains the backbone of exports, contributing the largest share and demonstrating consistent growth, particularly in high-value segments like knitwear, garments, and bedwear. In contrast, the food group experienced a decline, primarily due to reduced rice exports, although some diversification is visible in fish, meat, and processed food items. Petroleum exports showed volatility, with a noticeable rise in 2024–25, reflecting shifting global energy dynamics.

These trends underscore the textile sector's continued dominance in Pakistan's export basket, both in absolute value and relative performance compared to other industrial sectors (Table 1). Textiles remain the single largest contributor among top export commodities. Sector-wise comparisons indicate that export growth in textiles outpaces overall industrial exports, reinforcing its role as the primary foreign exchange anchor despite broader macroeconomic volatility. For industrialists, energy inefficiency is both a cost and a competitiveness issue. Improving energy management, fuel switching, and efficiency upgrades can lower production costs, reduce exposure to carbon-related regulations, and help maintain market share in increasingly competitive global markets.

Other manufacturing exports, including chemicals, surgical goods, and engineering products, remain stable but underdeveloped relative to textiles, highlighting Pakistan's limited diversification. Encouragingly, sectors like cement and pharmaceuticals show gradual growth, indicating potential for expansion. However, structural challenges persist, including dependence on a few sectors, fluctuations in commodity exports (e.g., sugar, rice), and limited value addition. Overall, while exports are growing, Pakistan's export base requires diversification, technological upgrading, and a stronger focus on high-value and sustainable products to ensure long-term resilience.

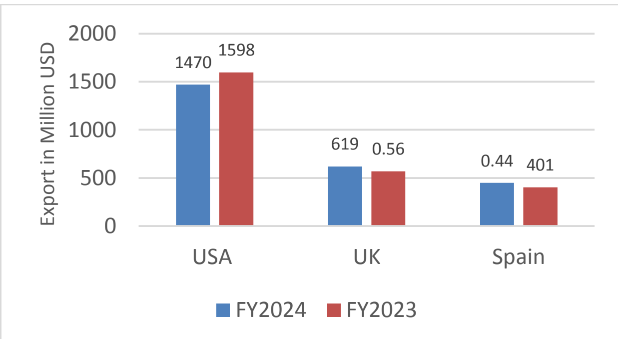
Table 1 Pakistan's Export Performance by Commodity in thousand US dollars[ii]

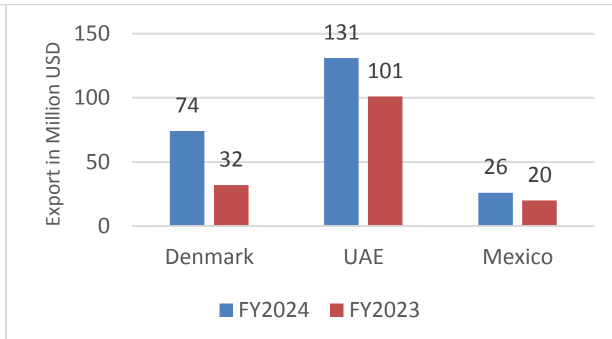
Commodity	July-23 to June-24	July-24 to June25	July-25 to Feb-26
A. Food Group	7,095,165	6,326,672	3,088,824
01 Rice	3,692,366	2,952,712	1,262,128
A) Basmati	856,093	782,869	404,367
B) Others	2,836,272	2,169,843	857,760
02 Fish & Fish Preparations	423,960	457,916	302,687
03 Fruits	309,406	241,349	201,098
04 Vegetables/Leguminous Vegetable	400,414	249,648	103,346
05 Tobacco	82,676	186,558	123,915
06 Wheat	0	0	0
07 Spices	76,973	81,534	55,564
08 Oil Seeds, Nuts and Kernals	387,053	366,590	132,206
09 Sugar	20,060	398,542	0
10 Meat and Meat Preparations	521,736	485,296	337,646
11 All Other Food Items	1,180,521	906,527	570,235
B. Textile Group	16,312,623	17,270,535	11,914,234
12 Raw Cotton	53,371	448	4,266
13 Cotton Yarn	1,050,775	686,311	452,653
14 Cotton Cloth	1,894,209	1,833,134	1,138,353
15 Cotton Carded or Combed	1,527	254	0
16 Yarn Other than Cotton Yarn	34,322	32,480	18,704
17 Knitwear	4,018,036	4,499,807	3,289,202
18 Bed Wear	2,795,346	3,085,213	2,139,162
19 Towels	957,177	1,056,496	644,933
20 Tents, Canvas & Tarpulin	122,000	125,265	89,068
21 Readymade Garments	3,471,683	3,963,440	2,810,612
22 Art, Silk & Synthetic Textile	375,602	369,900	231,213
23 Madeup Articles(incl. Other Tex.)	686,841	700,233	454,976
24 Other Textile Materials	851,734	917,552	641,091
C. Petroleum Group	552,542	903,378	546,583
25 Petroleum Crude	28,005	136,488	56,481
26 Petroleum Products	448,542	676,420	432,042
27 Solid Fuel including Naptha	75,995	90,469	58,060
D. Other Manufacture	4,045,045	4,166,860	2,703,854
28 Carpets,Rugs & Mats	65,284	130,250	35,563
29 Sports Goods	439,370	408,606	287,652
A) Footballs	248,604	231,574	172,548
B) Gloves	72,223	74,003	46,888
C) Others	118,542	103,029	68,216
30 Leather Tanned	140,830	138,393	86,548

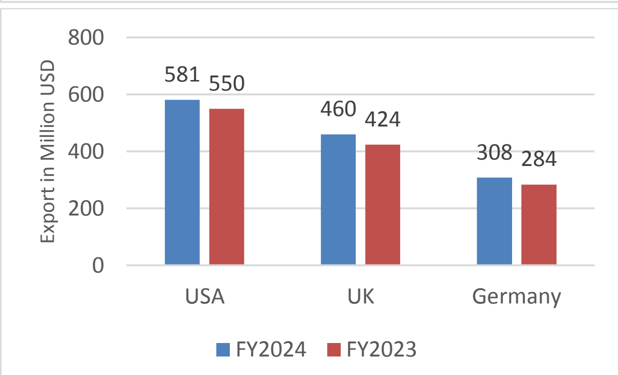
31 Leather Manufactures	606,253	622,775	428,737
A) Leather Garments	269,761	254,208	188,071
B) Leather Gloves	294,383	318,225	204,705
C) Other Leather Manufact	42,110	50,342	35,961
32 Footwear	166,873	168,367	119,423
A) Leather Footwear	130,372	136,921	99,038
B) Canvas Footwear	1,075	623	669
C) Other Footwear	35,426	30,823	19,715
33 Surgical Goods & Medical Instr	459,233	475,792	310,312
34 Cutlery	65,813	60,221	40,421
35 Onyx Manufactured	4,550	4,651	3,178
36 Chemical & Pharmaceutical Prod	1,422,923	1,451,688	855,441
A) Fertilizer Manufacture	13	1,310	24
B) Plastic Materials	436,174	495,866	239,441
C) Pharmacautical Product	213,029	262,950	180,493
D) Other Chemicals	773,706	691,561	435,484
37 Engineering Goods	279,173	279,140	249,577
A) Electric Fans	28,223	28,311	16,756
B) Transport Equipment	28,010	35,450	59,571
C) Other Electrical Machi	52,262	67,433	68,363
D) Machinery Specialized	45,962	38,495	27,333
E) Auto Parts	22,205	22,463	14,254
F) Other Machinery	102,510	86,987	63,300
38 Gems	8,010	8,329	13,094
39 Jewellary	13,349	14,370	2,972
40 Furniture	8,383	7,934	5,703
41 Molasses	52,262	16,918	2,096
42 Handicrafts	211	199	170
43 Cement	262,384	344,887	245,358
44 Guar and Guar Products	50,145	34,339	17,608
E. All Others	2,699,953	2,801,267	2,059,368
I. Total Export Receipts through Banks	30,705,328	31,468,713	20,312,862
II. Freight on Export	657,845	856,583	564,158
III. Export Receipts Banks (fob) (I-II)	30,047,484	30,612,130	19,748,704
IV. Other Exports	932,480	1,727,873	992,367
Total Export as per BOP (III+IV)	30,979,964	32,340,003	20,741,071

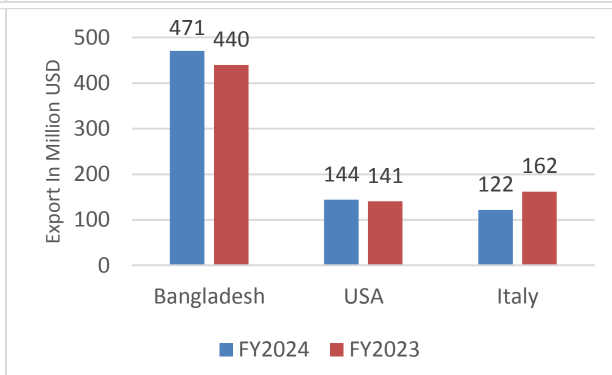
2.3 Export Destinations and Market Concentration

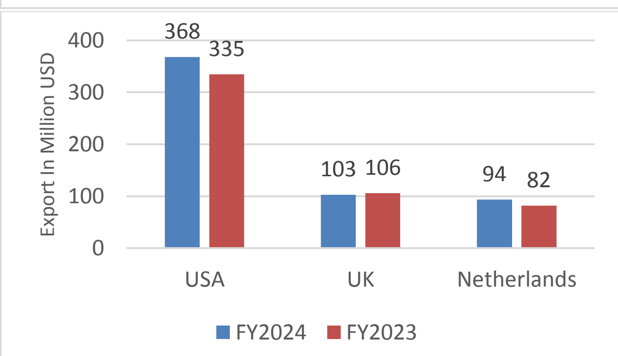
The figures on export destinations show that Pakistan's textile exports remain heavily concentrated in a few key markets, mainly the EU, the US, and the UK, across almost all major product categories (Figure 2(a)-2(g)). This concentration means pricing power sits largely with buyers, not suppliers, and cost increases from energy, fuel, or inefficiencies are difficult to pass on. Since these markets are also the first to demand emissions data, energy audits, and lower carbon products, mills with higher gas, coal, or inefficient captive power use face higher compliance pressure and weaker negotiating positions. In practical terms, improving energy efficiency and cutting emissions helps mills protect margins, respond faster to buyer requirements, and avoid losing orders to lower-carbon competitors, especially in repeat and long-term contracts.

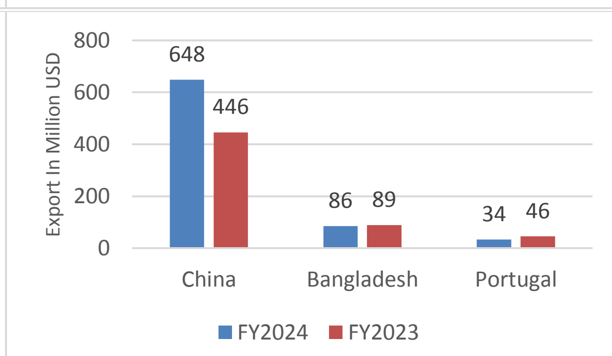












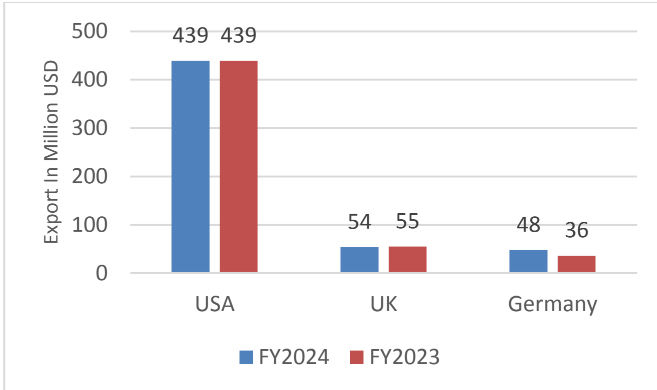


Figure 2(a)*: Top 3 Destinations of Knitwear Export in USD Million FY2024 Vs FY 2023*, 2(b)*: Top 3 Destinations of Ready-Made Garments Export in USD Million FY2024 Vs FY 2023*, 2(c)*: Top 3 Destinations of Bed Wear Garments Export in USD Million FY2024 Vs FY 2023*, 2(d)*: Top 3 Destinations of Cotton Cloth Export in USD Million FY2024 Vs FY 2023*, 2(e)*: Top 3 Destinations of Towel Export in USD Million FY2024 Vs FY 2023*, 2(f)*: Top 3 Destinations of Cotton Yarn Export in USD Million FY2024 Vs FY 2023*, and 2(g)*: Top 3 Destinations of Textile Made-ups Export in USD Million FY2024 Vs FY 2023*

Pakistan's yarn and cotton cloth exports are highly concentrated in a few key markets[iii]. In FY25, China remained the dominant destination for yarn, taking ~61.9% of exports despite a ~7.7% YoY decline, supported by the China-Pakistan FTA. Bangladesh and Portugal together account for ~13.5% of yarn exports. Similarly, cotton cloth exports are led by Bangladesh (~27.4%), with the USA and Italy contributing ~14.3%, while Turkey and Portugal represent smaller yet steady markets, highlighting potential for niche expansion (Figure 3). Pakistan's value-added textile exports are more diversified than yarn and cotton cloth, with the USA leading (~24.6% bedwear, ~35.3% knitwear) and Europe contributing ~36–38%, while "Others" account for a significant ~28–37%, showing broader market reach (Figure 4). Furthermore, garment exports are largely concentrated in the USA (~29.4%), with Europe accounting for smaller shares, while FY26 volumes rose ~10% YoY (Figure 5). Growth in value-added textiles boosts competitiveness, though Pakistan faces higher costs and a smaller scale compared to low-cost competitor Bangladesh.

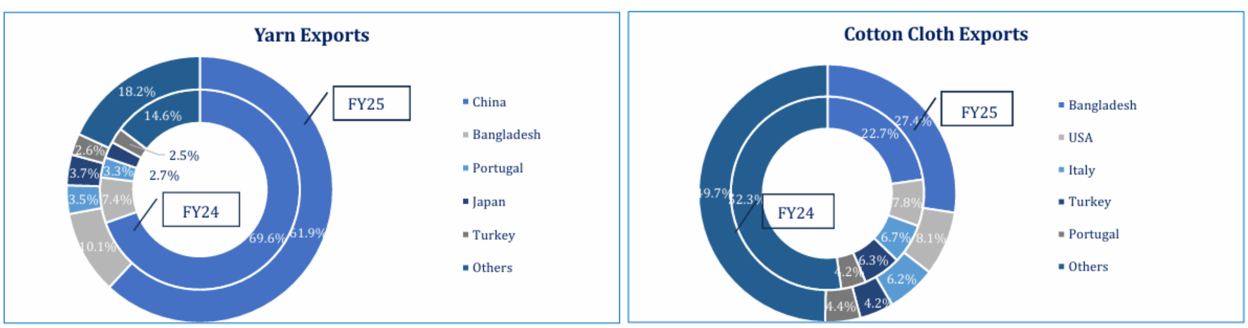


Figure 3 Country-wise Share of Pakistan's Yarn and Cotton Cloth Exports: FY24 vs FY25

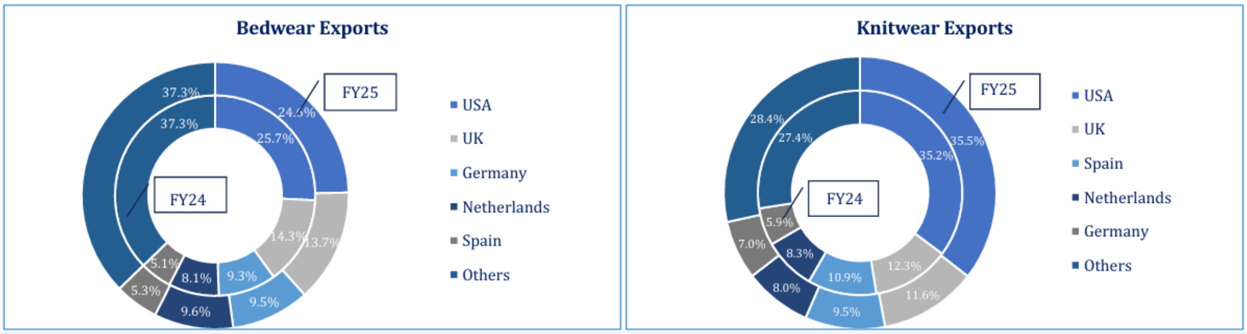


Figure 4 Country-wise Share of Pakistan's Bedwear and Knitwear Exports: FY24 vs FY25

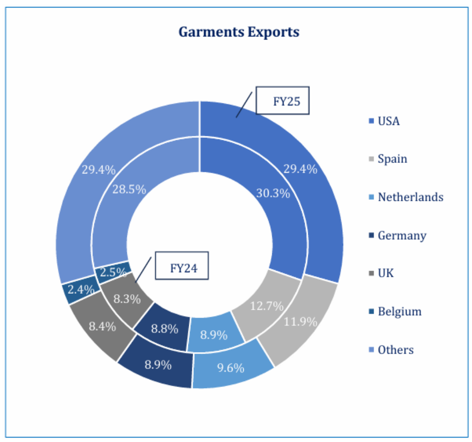


Figure 5 Country-wise Share of Pakistan's Garments Exports: FY24 vs FY25

3. Sports and Apparel

Pakistan's sports and apparel sector, anchored in Sialkot, contributes 55–60% of national exports yet remains highly carbon-intensive. The city alone produces 70% of the world's hand-stitched footballs, employing over 200,000 workers across thousands of SMEs. Industrial facilities average 25.9 tonnes of CO_2 emissions per month, largely due to dependence on coal and gas-based energy. Despite this, renewable energy uptake in Pakistan's electricity mix is still below 6% (2024), with solar and wind adoption in industrial clusters trailing regional benchmarks. Recognizing the risk of losing competitiveness under the EU's Carbon Border Adjustment Mechanism (CBAM), decarbonization manuals and training programs launched in 2024 for Sialkot's sports ball producers target 20–30% emission reductions by 2030. With coordinated financing, rooftop solar, biomass substitution, and energy efficiency retrofits, the sector could cut emissions by up to 40%, safeguarding its global market share while aligning with sustainability standards.

4. Impact of Prosumer Regulations 2026 on Industrial (Textile) Prosumers

Net-billing replaces the old symmetric 1:1 retail offset with separate buy/sell prices, which materially reduce the value of daytime exports (typical buy/sell spreads cut export value by roughly 40–60% in illustrative tariff designs) unless complemented by time-differentiated credits, storage compensation, or aggregation (Figure 6). This single design choice changes near-term cash flows: annual bill savings from on-site PV can fall by 50–70%; and monthly liquidity, and it erodes long-term economic viability (project IRR drops by 25–40%, payback periods lengthen by 50–70 %) far more than modest changes in equipment cost. Practically, the policy choice is not “net-metering vs net-billing” alone; it is whether the new settlement is paired with measures that let distributed assets deliver and be paid for system value (peak shaving, capacity deferral, ancillary services.

On-site solar is the fastest, verifiable route for textile mills to cut scope-2 emissions and meet buyer demands: depending on roof area and self-consumption, rooftop PV typically reduces scope-2 by ~20–40% for a mill, and in some high-self-use cases, even higher. A reliable export credit under net-metering made rooftop PV economically attractive; switching to net-billing can reduce that near-term decarbonization impact by an estimated 30–50% unless counter-measures are introduced. Unless net-billing is paired with VoS/TOU payments, explicit storage compensation, or aggregation pathways, many firms will delay or downscale on-site renewables, slowing industrial decarbonization and delaying measurable emission cuts. Conversely, pairing net-billing with time-of-system/value (VoS/TOU) payments and BESS compensation, or allowing aggregation, can restore a large share of the lost value (recouping ~60–90% of project economics in illustrative cases), aligning private incentives with system needs; enabling peak reduction, capacity deferral, and verifiable emissions cuts. Regulators should therefore design settlement changes to pay for time and flexibility, not just implement NB without any counter-measures.

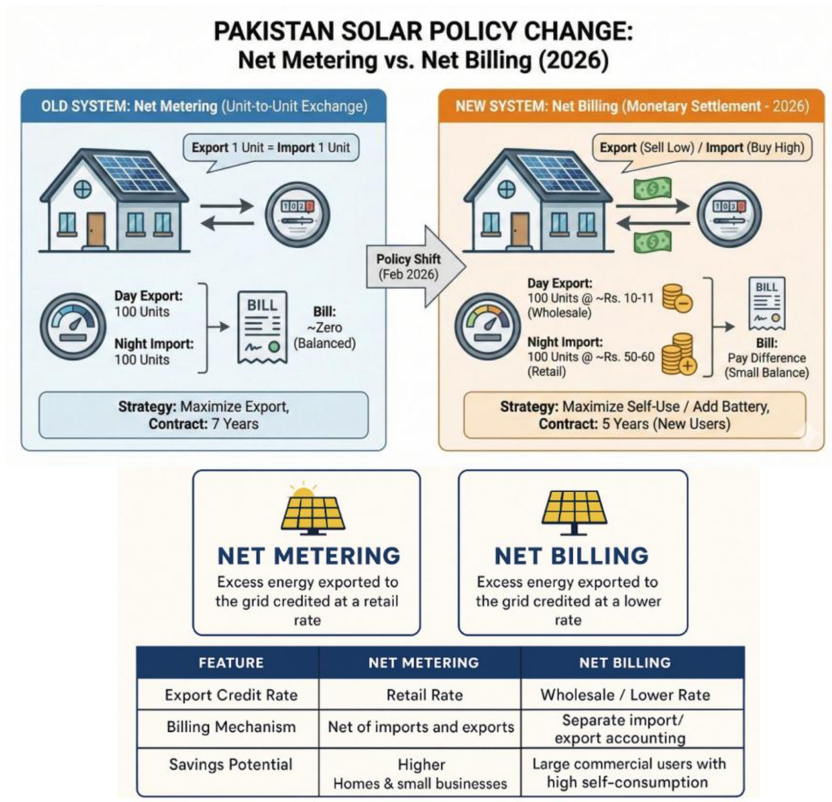


Figure 6 From Net Metering to Net Billing in Pakistan's Solar Policy Transition (2026)

4.1 Impact on Industrial Prosumers by Scale

Net-metering produces the strongest bankability across scales (IRRs ≈ 55–57%, paybacks ≈ 2.7–2.9y) (Table 2). Plain net-billing roughly halves IRR and lengthens paybacks ~1.4–1.5 years for large/medium mills; small mills suffer proportionally more. Sanctioned caps and low self-consumption (i.e., large, exported volumes) are the worst NB outcomes; high self-consumption and adding BESS materially improve NB economics (BESS shortens payback by ~0.3–1.1 years and raises IRR by ~3–14 %points compared to nominal NB). The detailed impact is presented in the table below:

Table 2 Financial Performance of Solar Systems Under Net Metering vs. Net Billing Scenarios

Scenario	Large: IRR (%)	Large: Payback (yrs)	Large: LCOE (PKR/kWh)	Medium: IRR (%)	Medium: Payback (yrs)	Medium: LCOE (PKR/kWh)	Small: IRR (%)	Small: Payback (yrs)	Small: LCOE (PKR/kWh)
Net-Metering (NM)	54.5	2.84	6.69	56.7	2.76	6.92	55.9	2.79	8.61
Net-Billing (NB): nominal	30.5	4.26	16.55	30.2	4.3	16.99	28.1	4.53	19.06
NB + sanctioned export cap (250 kW L/M; 20 kW S)	26.5	4.74	23.97	28.1	4.54	23.83	19.7	5.97	26.43
NB: low self-consumption / high TOU (more exports)	19.5	5.99	21.06	19.9	5.9	20.61	20.9	5.68	22.15
NB: high self-consumption / low TOU (more on-site use)	32.2	4.09	15.74	32.9	4.03	16.83	37.5	3.66	19.21
NB + Battery (BESS)	33.9	3.94	13.66	33	4.02	17.56	32	4.11	20.16

4.2 Optional Time-of-Use Tariff for Industrial Prosumers

The proposed optional Time-of-Use (ToU) tariff is intended to shift industrial demand toward lower-cost hours by combining lower variable energy charges with higher fixed recovery charges. Under the new design, fixed charges are linked to 50% of sanctioned load or MDI, whichever is higher, while variable rates fall during solar and off-peak periods; PPMC's presentation suggests this could reduce average industrial unit cost from about Rs. 26–29/kWh to Rs. 20–24/kWh, depending on load factor and voltage class. Official tariff guidance already shows that the industry is proposed to carry heavy fixed time-based tariff components, so the reform is clearly trying to make consumption more cost-reflective and system-friendly. The policy logic is evident: encourage higher utilization, improve productivity and increase grid demand, and reduce pressure on the grid, while recovering more of the power system's fixed costs through fixed charges rather than energy sales.

Industrial response, however, has been mixed. Stakeholders have broadly welcomed lower variable rates, but they argue that the package is uneven across industrial operating patterns: continuous 24-hour plants gain little from shifting, closed or low-utilization plants still pay high fixed charges, and shift-based mills that already run heavily during solar hours may see limited additional benefit. Industry representatives have therefore asked for fixed charges to be based on 25% of sanctioned load or MDI, and for the extra quarterly recovery charges to be removed. They also noted that the reform only works if firms can actually raise load; otherwise, a much higher fixed charge simply raises the cost base without delivering proportional savings. This concern is especially relevant because the current industrial tariff structure already differentiates by voltage level, with B3/B4 consumers paying lower per-unit rates than lower-voltage classes, so the final design needs to reflect real production patterns rather than assume all mills can respond in the same way. In short, the ToU proposal is useful for grid stability and industrial productivity, but its impact will depend on how carefully it is calibrated to different industrial classes and operating schedules, while also reviewing whether it hinders solarization in any aspect, considering broader ARE 2019 goals.

5. War's impact on energy security, government regulations, and decentralization

5.1 Impact on energy security

The Iran-Israel conflict has reminded energy-dependent economies that imported fuel exposure is a strategic vulnerability, not just a cost issue. Reuters has reported that the Strait of Hormuz carries about a fifth of global oil and LNG flows, and disruptions have pushed crude above $100/bbl and driven sharp LNG price spikes as prices in Asia have risen 143% since the war began, with Pakistan among the countries facing demand destruction and supply stress.

For Pakistan, the situation is relevant and critical because the country is already balancing an RLNG crisis, high power-sector costs, and a rapid solar transition. As 74% of electricity in Pakistan is obtained from domestic sources and Pakistan's rooftop solar output is expected to exceed grid demand in some hubs, showing how solar is already becoming an accidental strategic hedge, while the government's recent EV charging tariff cut (by 45%) also signals a broader shift toward electrification. In this context, industrial decarbonization is not only about emissions; it is also about resilience. Rooftop solar, storage, and flexible demand can reduce exposure to imported-fuel shocks, but only if prosumer rules, tariff design, and grid upgrades are aligned so that clean energy remains financially viable and system-supportive rather than simply shifting costs elsewhere.

5.2 Impact on solar, government regulations, and decentralization

Pakistan's energy transition is best understood through the numbers. By 2025, installed power capacity exceeded 46,000 MW, yet effective supply remains constrained due to inefficiencies, fuel shortages, and system losses. Transmission and distribution (T&D) losses persist at 25–30%, while circular debt has crossed PKR 1.6–2.6 trillion, reflecting deep financial stress in the sector. These inefficiencies translate into macroeconomic losses, with power outages historically costing 2–3% of GDP annually. At the same time, around 90% of oil and gas imports pass through vulnerable global supply routes, exposing the country to external shocks (Table 3).

In contrast, solar adoption has surged rapidly. Net-metered rooftop solar capacity has exceeded 6.3 GW by 2025, while total distributed solar (including off-grid systems) is estimated at ~40 GW, indicating that decentralized systems now rival centralized generation in scale. In 2024 alone, Pakistan imported 16–17 GW of solar panels, nearly doubling the previous year's imports, a clear indicator of accelerating adoption. This growth is largely consumer-driven, with households, industries, and commercial users investing heavily in behind-the-meter solutions.

Economic signals strongly support this shift. Electricity tariffs increased by approximately 155 % between 2021 and 2024, significantly improving solar's cost competitiveness. Simultaneously, Pakistan benefits from strong solar irradiance averaging ~5.5–6.0 kWh/m²/day, ensuring high system productivity. As a result, solar is not only environmentally viable but economically compelling.

The impact on the grid is already measurable. National electricity demand declined by ~3% in 2024 despite GDP growth, indicating structural demand displacement. Industrial consumers in major hubs have reduced grid reliance by 10–15% during daytime, while localized excess solar generation is causing reverse power flows in distribution networks. On the macroeconomic front, distributed solar has contributed to estimated fuel import savings of ~$10–12 billion, easing pressure on foreign exchange reserves. Overall, the data highlights a structural transition: while centralized grid performance remains constrained by inefficiencies and financial stress, decentralized solar is scaling rapidly as a parallel energy system, improving resilience, reducing import dependence, and reshaping demand patterns across Pakistan.

Table 3 Effects on Solar Adoption, Government Policies, and Grid Decentralization

Category	Metric	Value / Trend	Insight / Implication
Grid Capacity and Performance	Installed capacity	46–47 GW	High capacity but underutilized
	Effective generation gap	15–25 % below capacity	Due to fuel and operational constraints
	T&D losses	25–30 %	Among the highest globally
	Circular debt	PKR 1.6–2.6 trillion	Severe financial bottleneck
	GDP loss (outages)	2–3 % annually	Major economic drag

Energy Security Risk	Oil and gas import dependency	~90 % via Strait routes	High geopolitical exposure
	Fuel import bill	$15–20 billion/year	Vulnerable to price shocks
Solar Deployment	Net-metered solar	6.3 GW+	Rapid urban adoption
	Total distributed solar	~40 GW	Massive informal expansion
	Annual solar imports (2024)	16–17 GW	Nearly 2× YoY growth
	Solar share (unofficial)	~25–30 % of demand (daytime pockets)	Growing parallel system
Economic Drivers	Electricity tariff increase	+155 % (2021–2024)	Key adoption trigger
	Solar LCOE (est.)	20–30 PKR/kWh	Competitive vs grid
	Payback period	3–5 years	Strong investment case
Grid Impact	Demand change	−3 % in 2024	Despite economic growth
	Industrial displacement	10–15 % daytime	Reduced grid dependence
	Reverse power flow	Increasing in urban feeders	Grid stability challenge
Macroeconomic Impact	Fuel import savings	$10–12 billion	FX relief
	Solar investment trend	Billions USD (private sector)	Consumer-led transition

6. Energy Use and Emissions Profile of the Textile Sector

The energy-use figures show that most emissions in the textile sector come from process heat and power, mainly through gas-fired boilers, thermic fluid heaters, and captive power generation (Figure 7). Wet processing and spinning remain the most energy-intensive stages, where inefficiencies directly translate into higher fuel consumption and emissions. Heavy reliance on natural gas and grid electricity with a high emissions factor increases both operating costs and exposure to supply and price volatility. For industrialists, this means emissions are largely a controllable cost. Improvements in boiler efficiency, heat recovery, load management, and power sourcing can deliver immediate fuel savings while lowering emissions, without waiting for large-scale technology shifts.

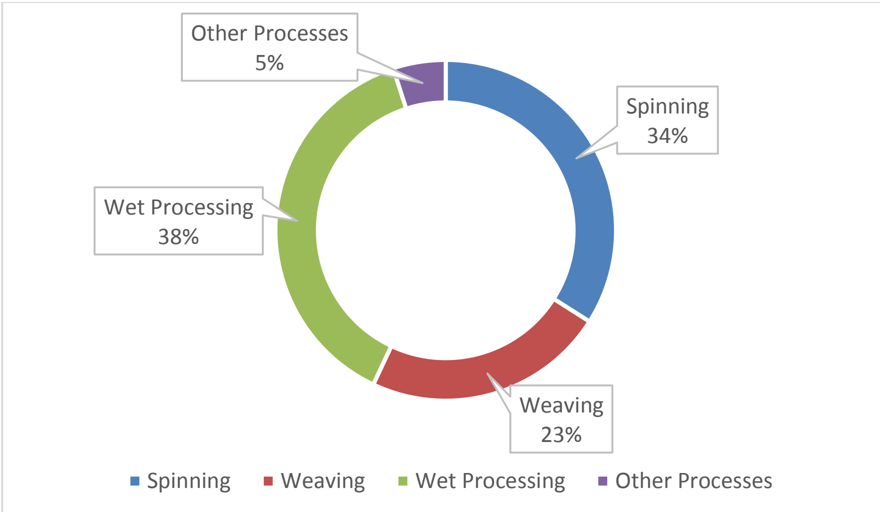


Figure 7 Percentage Distribution of Energy Use Across Textile Processes

6.1 Direct Emissions

Direct emissions arise primarily from on-site fuel combustion for process heat and captive power generation (Figure 8). Boilers, thermic fluid heaters, and gas engines are widely used across spinning and processing units.

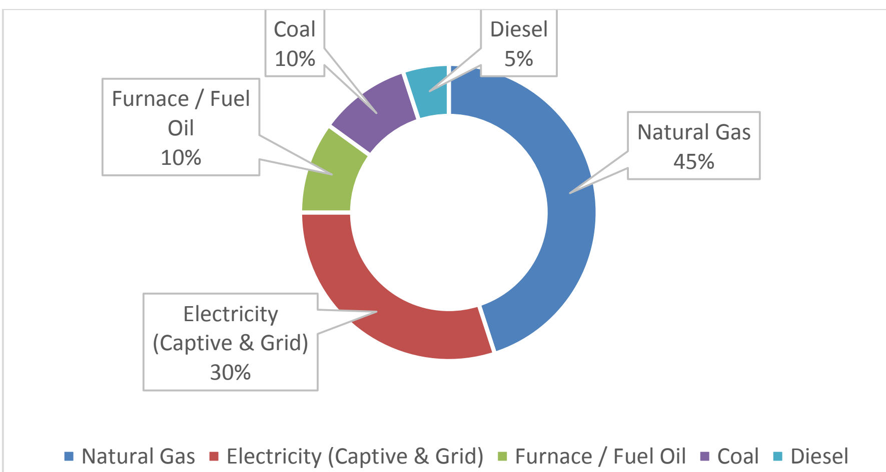


Figure 8 Estimated Share of Direct CO2 Emissions (%) By Fuel Type

Note: In Fig 14 fuel consumption shares for Pakistan's textile sector are based on primary energy use statistics from the World Bank (2025) and supporting industry studies, which indicate dominant reliance on natural gas and electricity. Direct CO_2 emissions by fuel type are estimated using standard IPCC emission factors.

This figure is indicative and based on assumptions. In particular, fuels such as coal and heavy fuel oil (HFO), while accounting for a relatively small share of total energy use, contribute disproportionately to emissions and therefore represent near-term mitigation opportunities. Evidence suggests that coal use can be phased out in many textile applications, HFO can be eliminated through fuel switching, and low-carbon alternatives such as biomass and electrification can be deployed in selected thermal processes with comparatively limited disruption.

6.2 Indirect Emissions

Indirect emissions stem from electricity consumption drawn from the national grid (Figure 9 and 10). Pakistan's grid emission factor remains relatively high due to continued reliance on fossil fuels, particularly natural gas and imported coal, despite recent growth in hydropower and renewables.

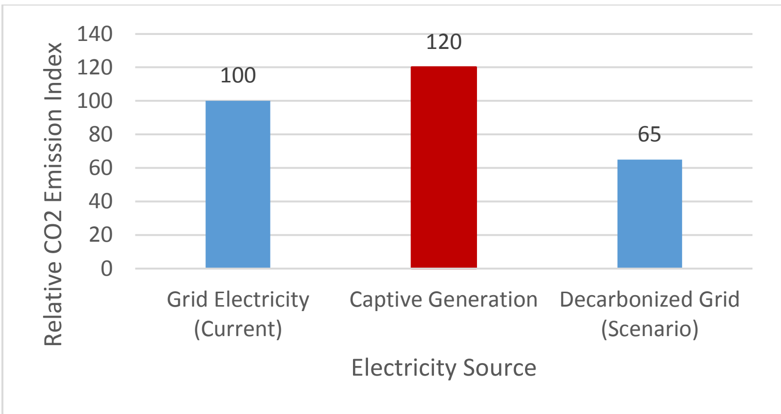


Figure 9 Relative CO_2 Emissions Index for Different Electricity Sources

Note: Grid electricity is normalized to an index of 100 using NEPRA average grid emission factors. Captive generation is indexed at 120 based on higher emissions intensity observed in gas- and diesel-based CPPs in textile mills (World Bank Study). The decarbonized grid scenario (index 65) reflects NTDC IGCEP-aligned reductions in fossil fuel share.

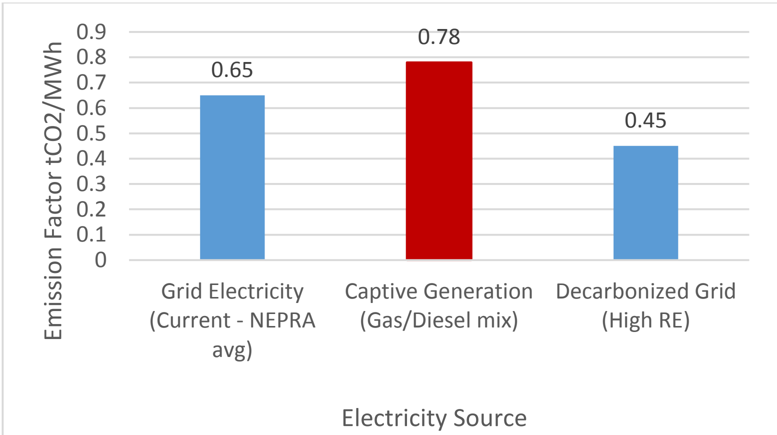


Figure 10 Electricity Emissions Factors by Electricity Source (tCO_2/MWh)

Note: NEPRA State of Industry Reports (grid emission factor ~0.65 tCO_2/MWh)[iv]; World Bank and ADB industrial diagnostics for captive gas/diesel generation (~0.78 tCO_2/MWh); NTDC IGCEP and national power sector decarbonization scenarios (~0.45 tCO_2/MWh). Values are indicative and used to illustrate relative emissions performance.

This analysis compares grid electricity and captive power generation (CPPs) in Pakistan's textile sector using both a relative emissions index and absolute emission factors to highlight structural differences in carbon intensity. Grid electricity is normalized as the baseline, while captive generation is shown to be significantly more emissions-intensive due to its reliance on small-scale gas engines, frequent diesel backup, lower operating efficiencies, and limited heat recovery. A forward-looking decarbonized grid scenario illustrates the scale of emissions reductions achievable through cleaner power generation. Although scenario-based, the comparison underscores a critical insight for the textile industry: despite offering reliability and energy security, CPPs are structurally more carbon-intensive than grid electricity. This contrast is particularly important for textiles, given their high electricity demand and growing exposure to carbon-related trade and reporting requirements, reinforcing the importance of grid decarbonization, electrification, and improved access to low-carbon power as central levers for emissions reduction and long-term competitiveness.

7. Kohinoor Textile Mills Limited - Primary Analysis by ADS

7.1 Executive Snapshot

KTML demonstrates significant progress in industrial decarbonization, anchored by 18.2 MW onsite solar and 20 TPH biomass steam generation. During the visit, solar supplied ~90% of the load (11–11.2 MW), with minimal grid reliance. The facility has achieved 45% emissions reduction (since 2021) and targets 50% by 2030 and Net Zero by 2050.

7.1.1 Solar Energy System

Solar is the primary energy source, with 18.2 MW at the Rawalpindi site and 31.38 MW across all facilities (Table 4). Real-time observations showed strong generation but also curtailment (~250 kW) due to limited grid export options. This indicates that technical capacity exists, but policy constraints limit full utilization.

Table 4 Solar Energy Capacity, Generation Performance, and Economic Indicators

Component	Capacity / Value	Remarks
Solar PV (Rawalpindi site)	18.2 MW	Confirmed onsite capacity
Solar PV (Total – 3 facilities)	31.38 MW	Group cumulative
Solar Generation (observed)	11–11.2 MW	At ~11:00–11:30 AM
Solar Cost (favorable case)	26–27 PKR/kWh	Reported
Solar Payback	3.5–4 years	Ideal case

7.1.2 Biomass and Thermal Energy

A 20-ton/hour biomass boiler using rice and wheat husk provides saturated steam, significantly reducing fossil fuel dependence (Table 5). The system is supported by waste heat recovery (WHR) and backup dual-fuel boilers (gas/HFO). Coal is largely phased out, indicating a clear shift toward low-carbon thermal energy.

Table 5 Thermal Energy Systems, Boiler Operations, and Fuel Utilization Profile

Parameter	Value	Remarks
Biomass Boiler Capacity	20 ton/hr	Saturated steam
Steam Output	~20,000 kg/hr	Biomass boiler
Boiler Pressure (gas/HFO)	1.87 bar	Recorded value
Fuel Type (Primary)	Biomass (rice/wheat husk)	Main decarbonization fuel
Backup Fuels	Gas / HFO	Dual-fuel boilers
Coal Usage	Very limited	Mostly phased out
Waste Heat Recovery	Installed	Heat reuse system

7.1.3 Energy Mix and System Integration

KTML operates a hybrid system combining solar, biomass, grid supply, and limited backup generation (9 MW gas, 14 MW furnace oil). This multi-source setup requires real-time balancing and curtailment management. Solar dominates daytime operations, while grid and backup ensure reliability (Table 6 and 7).

Table 6 Overview of Energy System Capacity, Generation Profile, and Grid Interaction

Component	Capacity / Value	Remarks
Solar PV (Rawalpindi site)	18.2 MW	Confirmed onsite capacity
Solar PV (Total – 3 facilities)	31.38 MW	Group cumulative
Solar Generation (observed)	11–11.2 MW	At ~11:00–11:30 AM
Grid Backup (observed)	250–500 kW	During visit
Curtailment (observed)	~250 kW	Instantaneous
Gas Engine Capacity	9 MW	Rarely used
Furnace Oil Backup	14 MW	Standby
Grid Capacity	20 MW	Managed internally

Table 7 Electricity Consumption, Tariff Structure, and Cost Dynamics

Parameter	Value	Remarks
Monthly Electricity Consumption	150,000–300,000 units	Variable range
Solar Cost (favorable case)	26–27 PKR/kWh	Reported
Grid Cost (off-peak)	32.75 PKR/kWh	Reported
Grid Cost (on-peak)	42–43 PKR/kWh	Reported
Captive Cost (worst case)	48–54 PKR/kWh	Reported
Solar Payback	3.5–4 years	Ideal case

7.1.4 Production and Energy Monitoring

The facility is fully vertically integrated, from spinning to finished products. Energy consumption monitoring shows 118–262.75 kWh per unit (midday operations), supported by SCADA systems. This enables better tracking of energy intensity across processes.

7.2 Energy Economics and Constraints

Electricity costs vary widely: 26–27 PKR/kWh (solar mix) vs 32–43 PKR/kWh (grid), and up to 48–54 PKR/kWh in worst-case captive scenarios. Solar payback is estimated at 3.5–4 years, but the absence of net-metering and high-capacity charges weakens financial returns. Policy uncertainty remains a major barrier.

7.3 Water Management and Circularity

7.3.1 Water and Wastewater Management

The facility operates an advanced WWTP with up to 4,440 m^3/day capacity and achieves 80–85% water recycling (Table 8). Treated water is reused in dyeing and washing processes, significantly reducing freshwater demand. A 62,000 m^3 rainwater reservoir further strengthens water sustainability.

Table 8 Water Management, Wastewater Treatment, and Recycling Performance

Parameter	Value	Remarks
WWTP Input Capacity	185 m^3/hour (4,440 m^3/day)	Reported
WWTP Output Capacity	15 m^3/hour	Reported
Operational Throughput	1,611 m^3/day	Observed
Water Recycling Rate	80–85%	Operational figure
Rainwater Reservoir	62,000 m^3	Main reservoir
Secondary Pond	70,000 gallons	Colony wastewater

7.3.2 Circularity and Recycling

KTML has integrated circular practices through three recycling plants with 24 tons/day capacity. Textile waste is mechanically recycled, while sludge and ash are repurposed into construction materials (Table 9). These systems demonstrate practical, large-scale circular economy implementation.

Table 9 Material Circularity and Waste Utilization Systems

Parameter	Value	Remarks
Mechanical Recycling Capacity	24 tons/day	Total
Recycling Plants	3 units	Onsite
Sludge Use	Bricks	Via third parties
Ash Use	Bricks / packaging	Reused externally
Water Reuse	RO/UF reuse	In production processes

7.4 Emissions Performance

With a 2021 baseline, the company reports a 45% reduction in emissions, largely attributable to the adoption of solar and biomass. Solar installations alone avoid ~29,834 tCO_2 annually (Table 10). The strategy prioritizes direct emission reductions, with limited reliance on carbon offsets.

Table 10 Emissions Performance and Decarbonization Targets

Parameter	Value	Remarks
Emission Baseline Year	2021	Established
Emission Reduction Achieved	45%	As of March 2026
Solar CO_2 Avoidance	29,834.3 tCO_2/year	3 plants
2030 Target	50% reduction	SBTi-aligned
2050 Target	Net Zero	Long-term

7.5 Market Linkages

KTML is export-oriented, with 64–70% of exports to the USA and 15–25% to Europe (Table 11). While international buyers demand sustainability compliance, cost-sharing for decarbonization remains limited. This creates financial pressure despite strong environmental performance.

Table 11 Export Market Distribution

Region	Share	Remarks
USA	64% (profile) / 65–70% (visit)	Primary market
Europe	15% (profile) / ~25% (visit)	Secondary
UK	10%	Profile
UAE	5%	Profile

7.6 Strategic Outlook

KTML is in an advanced decarbonization stage, with strong systems already in place across energy, water, and materials. However, future progress depends on policy stability, verified data systems, and improved market incentives. Addressing these gaps can unlock further emissions reductions.

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[ii] State Bank of Pakistan. (n.d.). Economic Data. Retrieved April 2, 2026, from https://www.sbp.org.pk/ecodata/index2.asp
[iii] Pakistan Credit Rating Agency (PACRA). (2026, January). Composite & Garments – PACRA Research. Retrieved April 2, 2026, from https://www.pacra.com/view/storage/app/Composite%20&%20Garments%20-%20PACRA%20Research%20-%20Jan%2725_1736248077.pdf
[iv] State of The Industry Report, NEPRA, 2024