

BEYOND THE GRID: DECENTRALIZED GOVERNANCE FOR A JUST AND EQUITABLE ENERGY TRANSITION IN SINDH

***A LEGAL, INSTITUTIONAL, AND TECHNICAL ASSESSMENT
FOR DECENTRALIZED ENERGY GOVERNANCE***

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Table of Contents

Table of Contents	2
Acknowledgements	4
Executive Summary	5
Key Findings	5
Recommendations	6
1. Introduction and Context	7
1.1 Purpose and Scope	7
1.2 Why Decentralization, and Why Now	7
1.3 Approach and Methodology	9
2. Sindh's Climate and Energy Challenges	9
2.1 Climate Vulnerabilities	9
2.2 Key Sector Indicators	9
2.3 Sindh's Energy Production, Use, and Demand	10
Sindh Government Solar Home Systems Program	13
2.4 Renewable Energy Potential	13
2.5 Climate Finance Needs	14
3. Existing Energy Governance in Pakistan	14
3.1 Institutional Structure: Generation, Transmission, and Distribution	14
3.2 Constitutional Provisions	15
3.2.1 Article 157: Electricity	15
3.2.2 Fourth Schedule and the Council of Common Interests	16
3.2.3 What Sindh Can and Cannot Do	16
3.3 Issues with Centralized Governance	17
3.3.1 Overlapping Jurisdictions and Ambiguities	17
3.3.2 National Transmission and Grid Constraints	17
3.3.3 Circular Debt and High Tariffs	17
3.3.4 Net Metering and the Prosumer Regime	17
3.3.5 Constitutional Duality: The Wider Debate	18
3.4 Opportunities for Decentralized Energy Governance	19
3.5 Sindh Energy Reforms: SEPRA and STDC	19
3.6 Recommendations: Institutional Effectiveness for Decentralized Energy	20
4. Framing Decentralization in Sindh	21
4.1 Legal and Institutional Dimension	21
4.2 Political and Intergovernmental Dimension	21
4.3 Political and Fiscal Sensitivities	22
4.4 Technical and Operational Dimension	22
5. SEPRA's Institutional Position	24
6. Institutional and Governance Realities	24
7. Key Themes from Analysis	25
7.1 Limitations	25

7.2 Opportunities	25
7.3 Evidence from Comparative Literature	26
8. Entry Points for SEPR	27
8.1 Clarify the Micro-Grid and Off-Grid Regulatory Framework	27
8.2 Standardize Public-Sector Solarization and Wheeling Guidelines	27
8.3 Establish an Inter-Agency Energy Taskforce	27
8.4 Deploy Localized Battery Storage Pilot Projects.....	27
8.5 Phased Roadmap.....	27
8.6 Complementary Measures Raised in Consultations.....	27
9. Way Forward	28
10. Positioning of the Working Paper	28
11. References	30
11.1 Legislation and Regulatory Instruments	30
11.2 Government and Regulatory Data Sources.....	30
11.3 Legal and Policy Commentary	31
11.4 International Organizations.....	31
11.5 Research and Sector Reports	31
11.6 News and Institutional Sources.....	32

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We also look forward to the participation of the National Electric Power Regulatory Authority (NEPRI) and other stakeholders at the forthcoming provincial conference, where this paper will be presented and discussed through a panel session.

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Executive Summary

This working paper presents an integrated legal and constitutional, political, institutional, and technical analysis of Sindh's evolving energy governance landscape. It has been prepared to inform the regulatory mandate of the Sindh Electric Power Regulatory Authority (SEPRa). It draws on structured institutional and sector-expert consultations completed with the Energy Department (Government of Sindh), the Sindh Transmission and Dispatch Company (STDC), the Environment, Climate Change and Coastal Development Department, the Planning & Development Department (P&D), and civil society organizations. This is a working paper and can be further strengthened by obtaining views from the Provincial Standing Committee on Energy, the National Electric Power Regulatory Authority (NEPRA), independent sector experts, and other stakeholders.

The paper sets out Sindh's climate and energy baseline, maps the existing structure of energy governance in Pakistan, frames the legal, political, and technical dimensions of decentralization, and assesses SEPRa's institutional position. It identifies critical regulatory ambiguities arising from jurisdictional overlaps between NEPRA and SEPRa under the 18th Constitutional Amendment; examines the implications of Pakistan's 2026 shift from net-metering to net-billing on private solar investment; evaluates escalating distribution transformer overloads across K-Electric, HESCO, and SEPCO networks; and analyzes the institutional fragmentation impeding cohesive provincial energy planning. Against this backdrop, the paper sets out concrete entry points and a phased roadmap for SEPRa, and also makes the case for decentralized governance to address critical energy-sector challenges impeding economic development.

The findings underscore that meaningful energy decentralization in Sindh requires technical grid upgrades alongside institutional strengthening and autonomy, inter-agency governance reform, and strategically deployed climate finance.

Key Findings

- Sindh's legal foundation for energy decentralization already exists. The Sindh Regulation of Electric Power Services Act, 2023 gives SEPRa broad authority over licensing, tariff determination, mini-grids, and competitive market development, drawing its constitutional authority from Article 157(2) ¹. The binding constraint is operationalization, not legislative authority.
- Grid defection is accelerating faster than institutional readiness. Estimated cumulative private rooftop solar installations in Pakistan grew from roughly 16,000 in 2020 to roughly 378,000 in 2025, while K-Electric's overloaded distribution transformers grew from 900 to 2,882 over the same period, rising from 35% to 46% of its active fleet ².
- Regulatory overlap between NEPRA and SEPRa in electricity generation licensing, tariff setting, transmission, off-grid systems, mini-grids, and projects that touch federally regulated distribution networks (HESCO, SEPCO, and K-Electric) remains unresolved. A clearer division of responsibility is emerging in practice but has not yet been formalized.
- SEPRa is under-resourced relative to its mandate. Its initial allocation of PKR 197.9 million for FY2024–25 is an order of magnitude smaller than the administrative cost base of a single federal power-sector entity, and is structured as a fixed provincial grant rather than the self-financing, fee-based model NEPRA uses ³.
- Transmission, not resource availability, is the binding physical constraint. Over 550 MW of dependable wind capacity in Thatta routinely faces curtailment because the national grid cannot reliably evacuate

¹ Government of Sindh, The Sindh Regulation of Electric Power Services Act, 2023, passed by the Provincial Assembly of Sindh on 7 June 2023 and published in the Sindh Government Gazette (Extraordinary), 6 July 2023, <https://faolex.fao.org/docs/pdf/pak225224.pdf>.

² NEPRA, State of Industry Report 2025, <https://nepra.org.pk/publications/State%20of%20Industry%20Reports/State%20of%20Industry%20Report%202025.pdf>.

³ "Sindh govt establishes SEPRa, allocates Rs22.72 Bn for key projects," Pakistan Observer, 15 August 2024, <https://pakobserver.net/sindh-govt-establishes-sepra-allocates-rs22-72-bn-for-key-projects/>.

⁴ Afia Malik, "National Electric Power Regulatory Authority (NEPRA)," Pakistan Institute of Development Economics, Chapter 4, <https://file.pide.org.pk/pdfpideresearch/book-50-06-national-electric-power-regulatory-authority-nepa.pdf>.

power from the resource-rich south to northern demand centers ⁵. This capacity could be utilized locally by developing decentralized transmission and distribution networks.

- Political and fiscal sensitivities are specific and material: NEPRA's institutional and revenue incentives, K-Electric's distinct status as the only fully privatized utility, and the National Finance Commission revenue-sharing architecture all shape how far and how fast decentralization can proceed ⁶.
- Federal policy volatility directly affects provincial incentives. The February 2026 shift from net-metering to net-billing cut export compensation for private solar generators from full retail parity (approximately PKR 27–55/unit) to roughly PKR 10–11/unit, materially reducing the return on new private clean electricity generation ⁷.

Recommendations

- Develop a phased ten-year strategic plan for SEPRA, in consultation with NEPRA and other stakeholders, to independently issue power-generation licenses in the province, work with STDC to expedite new transmission lines and upgrade existing ones, set tariffs, and provide universal access to affordable renewable energy.
- Clarify the micro-grid and off-grid regulatory framework, with simplified licensing, provincial consumer-protection terms, and localized tariff benchmarks for isolated systems under 1 MW.
- Encourage and facilitate distributed solar and wind generation across the province, particularly for unserved and underserved communities.
- Standardize public-sector solarization and wheeling guidelines in partnership with STDC, enabling solarized public assets to wheel surplus generation across local networks.
- Establish a standing inter-agency energy taskforce spanning the Energy Department, SEPRA, STDC, the Planning & Development Department, and major utilities, to align capital investment with regulatory direction.
- Deploy localized battery-storage pilot projects in high-vulnerability coastal areas to demonstrate that decentralized networks can manage intermittency and relieve local transformer strain.
- Pursue a provincial revenue base for SEPRA by operationalizing the SEPRA Fund's fee-collection powers, so that regulatory capacity grows with caseload rather than remaining tied to periodic budget allocations.

The remainder of this paper sets out the evidence behind these findings: Sindh's climate and energy baseline (Section 2), the existing structure of energy governance in Pakistan and Sindh's constitutional position within it (Section 3), the legal, political, and technical dimensions of decentralization (Section 4), SEPRA's institutional position (Section 5), institutional and governance realities (Section 6), the paper's consolidated themes (Section 7), and the proposed entry points and phased roadmap for SEPRA (Section 8).

⁵ Global Energy Monitor, "Power Sector Transition in Sindh," https://www.gem.wiki/Power_Sector_Transition_in_Sindh.

⁶ M. Siddique Ali Pirzada, "Constitutional devolution without design: Pakistan's power sector," Pakistan Observer, June 2026, <https://pakobserver.net/constitutional-devolution-without-design-pakistans-power-sector/>.

⁷ NEPRA, National Electric Power Regulatory Authority (Prosumer) Regulations, 2026, SRO 251(I)/2026, notified 9 February 2026, [https://www.nepra.org.pk/Legislation/3-Reg/3.35%20NEPRA%20%20Prosumer%20Regulations%202026/NEPRA%20Prosumer%20Regulations%20\(SRO%20251\(I\)2026\)%2009-02-26.PDF](https://www.nepra.org.pk/Legislation/3-Reg/3.35%20NEPRA%20%20Prosumer%20Regulations%202026/NEPRA%20Prosumer%20Regulations%20(SRO%20251(I)2026)%2009-02-26.PDF).

1. Introduction and Context

Climate change continues to reshape development priorities globally, with increasing emphasis on both mitigation and adaptation. Countries across regions are navigating transitions in energy systems to reduce emissions while maintaining economic stability and ensuring access to affordable energy. Within this context, the idea of a just energy transition has gained prominence, focusing on shifting to cleaner energy sources while ensuring that communities, particularly vulnerable populations, are not left behind.

Pakistan remains among the countries most affected by climate change despite contributing minimally to global emissions⁸. Its policy direction reflects a growing recognition of the need to balance development, energy security, and climate resilience. Under its Nationally Determined Contributions (NDCs), Pakistan has committed to increasing the share of renewable energy and reducing projected emissions, while also strengthening adaptation measures. The country's National Adaptation Plan further highlights the importance of building resilience across sectors, including energy, infrastructure, and water systems.

Within this broader landscape, provinces are increasingly engaging with the energy transition agenda, with Sindh emerging as a key region due to its vast resource base and high exposure to climate risks. The establishment of SEpra as a provincial regulatory authority represents a critical institutional milestone — one whose mandate, operational scope, and intergovernmental positioning must be strategically defined to unlock the province's decentralized energy potential⁹.

1.1 Purpose and Scope

The purpose of this working paper is to serve as an analytical foundation and a facilitative tool for structured institutional dialogue. It seeks to:

- Explore the legal, political, institutional, and technical dimensions of energy decentralization in Sindh
- Map institutional and regulatory constraints affecting provincial energy governance
- Identify intergovernmental understandings and regulatory overlaps between federal and provincial authorities
- Examine opportunities and limitations for SEpra in managing decentralized energy systems
- Support informed, systematic engagement among provincial departments, federal entities, and civil society

1.2 Why Decentralization, and Why Now

Sindh's energy transition is not primarily a policy choice awaiting SEpra's activation — it is already underway, driven by the failure of centralized governance to keep pace with the province's needs, and by households and businesses quietly opting out of the national grid faster than the grid itself is being modernized. This section states that case directly, drawing on evidence set out in full in Sections 2, 3, 4, and 7.

Centralized governance has not delivered a reliable, affordable, or efficient electricity system for Sindh. More than 40 million people nationally remain without access to reliable grid electricity, and national transmission and distribution losses average 17–18% (Section 2.2)¹⁰. Sindh's own distribution transformer fleet illustrates the strain directly: K-Electric's overloaded transformers — operating above 100% of rated capacity — grew from 900 in 2021 to 2,882 in 2025, rising from 35% to 46% of its active fleet even as the fleet itself grew roughly two-and-a-half-fold (Section 4.4, Table 8). Meanwhile, over 550 MW of dependable wind capacity in Thatta alone routinely faces curtailment because the national transmission grid, designed around northern demand centers, cannot reliably evacuate power from the resource-rich south (Sections 2.4 and 3.3)¹². And when the federal regulator changed the distributed-generation framework in February 2026, it cut export compensation for private solar generators by more than half — from full retail parity (approximately PKR 27–55/unit) to a national average purchase price of roughly PKR 10–11/unit — with no advance provincial input into a decision that directly affects

⁸ World Bank, Pakistan Country Overview, <https://www.worldbank.org/en/country/pakistan/overview>.

⁹ Sindh Regulation of Electric Power Services Act, 2023.

¹⁰ NEpra, State of Industry Report 2025.

¹¹ World Bank, Pakistan Country Overview.

¹² Global Energy Monitor, "Power Sector Transition in Sindh."

Sindh's own energy transition (Section 3.3, Table 6; NEPRA, SRO 251(I)/2026). None of this is an imaginary governance risk: it is the documented, current performance of the centralized system, which is the basic premise of this paper's argument for decentralized governance.

Faced with that unreliability, Sindh's households and businesses are already moving to rooftop solar systems. Estimated cumulative private rooftop solar installations in Pakistan grew more than twentyfold in five years, from roughly 16,000 in 2020 to roughly 378,000 in 2025 (Section 3.4, Table 7)^{13,14,15}, not because of a coordinated provincial or federal program, but because grid electricity has become expensive, unreliable, or both. This is grid defection happening in real time, and it is accelerating even as this working paper is being finalized.

This pattern matters for a reason beyond individual household economics: left unmanaged, it risks becoming self-reinforcing in a way that threatens the viability of the grid itself. The mechanism is well documented in the international energy-economics literature as the "utility death spiral"¹⁶: as the wealthier, higher-consumption customers who can afford solar-plus-storage systems leave the grid or reduce their draw on it, the fixed costs of maintaining transmission and distribution infrastructure do not fall proportionally — they are instead recovered from a shrinking base of remaining, disproportionately lower-income, grid-dependent consumers through higher tariffs. Higher tariffs then make self-generation more attractive to the next tier of consumers, accelerating further defection. Some academic literature finds this dynamic overstated in mature, financially stable utility markets¹⁷. Pakistan's power sector is not that market. It already carries a chronic circular debt burden funded in part through cross-subsidized consumer tariffs (Section 3.3), and DISCOs such as HESCO and SEPCO are already reporting overloaded infrastructure even before large-scale battery storage arrives. Battery storage — which this paper's own analysis expects to follow solar's cost-decline trajectory (Section 3.4) — would extend defection from daytime hours into round-the-clock self-sufficiency, compounding the strain further. In a system already this financially and technically strained, the death-spiral mechanism is not a distant risk. It is a plausible extension of trends already visible in this paper's own data.

This is why the timing question matters as much as the legal question. Grid infrastructure decisions — transformer upgrades, new transmission capacity such as STDC's K-IV project (Section 3.5), regulatory framework design — take years to plan and finance. Grid defection, by contrast, is compounding annually and is already reshaping Sindh's technical load profile (Section 4.4). Sindh's legal foundation for decentralized energy governance is already in place through the Sindh Regulation of Electric Power Services Act, 2023 (Sections 3.5 and 9)¹⁸. The risk this paper identifies is that operationalizing that authority on a multi-year institutional timeline, while defection compounds on an annual one, could mean SEPCO inherits a grid whose paying customer base and cost-recovery structure have already been eroded by the time its regulatory tools are fully in place. Acting now, while the legal authority is available and the technical and financial trends are still early-stage rather than entrenched, is materially different from acting after the fact.

Decentralization is Sindh's most direct available response to this trajectory, for four concrete reasons that recur throughout this paper:

- Faster renewable integration and less curtailment, by siting generation and giving a provincial regulator authority over local transmission and wheeling closer to load (Sections 2.4 and 3.3).
- Insulation of provincially-anchored generation — particularly mini-grids and off-grid systems — from unilateral federal policy shifts of the kind seen in the 2026 net-metering to net-billing transition (Section 3.3, Table 6).
- Local accountability and faster fault response, through district- and tehsil-level distribution structures and community billing models raised repeatedly in consultations (Section 6)¹⁹.

¹³ NEPRA, State of Industry Reports 2020 to 2025 (annual series), <https://nepra.org.pk/publications/State%20of%20Industry%20Reports/>.

¹⁴ Pakistan Institute of Development Economics, "Power to the Provinces: Devolution of Power in Pakistan's Energy Sector," <https://pide.org.pk/research/power-to-the-provinces-devolution-of-power-in-pakistans-energy-sector/>.

¹⁵ Ministry of Finance, Government of Pakistan, Pakistan Economic Survey, Chapter 14: Energy, https://finance.gov.pk/survey/chapter_24/14_energy.pdf.

¹⁶ Kenneth W. Costello and Ross C. Hemphill, "Electric Utilities' 'Death Spiral': Hyperbole or Reality?", *The Electricity Journal* 27, no. 10 (2014): 7–26.

¹⁷ M. Muaafa et al., "Can adoption of rooftop solar panels trigger a utility death spiral? A tale of two U.S. cities," *Energy Research & Social Science* 34 (2017): 154–162.

¹⁸ Sindh Regulation of Electric Power Services Act, 2023.

¹⁹ Sector-expert and parliamentary consultations conducted for this working paper, 2026.

- Managed, rather than unmanaged, grid transformation: bringing already-occurring distributed generation into a regulated framework — with proper safety, interconnection, and tariff standards — rather than allowing it to continue eroding the grid's finances and technical stability outside any provincial oversight ²⁰.

The remainder of this paper sets out the legal basis (Section 3), the institutional and political landscape (Sections 4–7), and the concrete entry points (Section 8) through which SEPRa can act on this rationale.

1.3 Approach and Methodology

This working paper was developed through an ongoing, multi-stage engagement process rather than a single research exercise, combining legal and regulatory analysis, political economy analysis, institutional assessment, and technical systems analysis. The central research question guiding the work is: what legal, political, institutional, and technical factors shape the opportunities and limitations for SEPRa to play a more active role in decentralized energy governance in Sindh?

An initial multi-stakeholder workshop formed the foundation of the analysis, surfacing the core governance and decentralization challenges and opening a discussion of SEPRa's emerging role in distributed energy. This was followed by roughly seventeen structured one-to-one consultations. Engagements with partner organizations — The Knowledge Forum, CSSP, Indus Consortium, and the Climate Action Center — focused on community energy access, policy advocacy, and implementation realities on the ground. Institutional consultations were completed with the Energy Department (Government of Sindh), SEPRa members, the Planning & Development Department, the Provincial Standing Committee on Energy, and the Sindh Transmission and Dispatch Company (STDC), focused on institutional mandates and coordination, regulatory overlaps, and the practical constraints on decentralization. Informal consultations with Sindh MPAs added a perspective on legislative feasibility, political ownership, and realistic reform pathways that is not always visible in purely technical or legal analysis.

Legal, political, and technical insights from these engagements were then consolidated to identify recurring patterns and emerging themes, which form the basis of Sections 4 through 7 of this paper. These consultations culminate in a provincial conference bringing together SEPRa, the Energy Department, the Planning & Development Department, NEPRa, and other stakeholders, intended as an initial round of dialogue on SEPRa's evolving role. This paper is presented at that conference for feedback and discussion; it is not a final assessment, and is expected to be refined through this and subsequent rounds of engagement.

Because this paper draws on institutional and sector-expert consultations rather than on published primary research alone, qualitative findings are attributed in the text by respondent type (for example, "consultations with sector experts indicated...") rather than reproduced as standalone interview transcripts.

2. Sindh's Climate and Energy Challenges

2.1 Climate Vulnerabilities

Sindh faces acute climate-related disruptions that threaten both physical infrastructure and macroeconomic security. Recent decades have highlighted these vulnerabilities, notably through the catastrophic flood events of 2010 and 2022, which caused widespread power infrastructure damage ²¹. Coastal areas face ongoing sea intrusion, while agricultural zones suffer from severe waterlogging and salinity, and forest cover along the coast continues to decline — all of which fundamentally shift localized energy demand and disrupt infrastructure load resilience.

Addressing these vulnerabilities requires climate finance directed at both mitigation (renewable generation, grid modernization) and adaptation (flood-resilient infrastructure, coastal protection). Sindh's own commitments toward energy transition targets need to be read against this dual mitigation-adaptation finance need, rather than treated as a mitigation issue alone.

2.2 Key Sector Indicators

At the national level, energy distribution remains deeply uneven and is governed largely by centralized, federal arrangements:

²⁰ International Renewable Energy Agency, publications portal, mini-grid reports, <https://www.irena.org/Publications>.

²¹ World Bank, Pakistan Country Overview.

- More than 40 million people in Pakistan remain without access to reliable grid electricity ²².
- Total nominal installed generation capacity has ranged between roughly 39,800 MW and 45,900 MW over 2021–2025, peaking at approximately 45,888 MW in 2024 before easing to about 41,121 MW in 2025 as thermal capacity was retired (Table 1)²³.
- Transmission and distribution (T&D) losses average 17–18% ²⁴.
- Renewable energy (non-hydel renewable) accounts for only 6–7% of the centralized grid mix ²⁵²⁶.

2.3 Sindh's Energy Production, Use, and Demand

Note on units

Two different units recur throughout this section and are worth distinguishing clearly. Megawatts (MW) measure installed generation capacity, the instantaneous rate at which a plant or the system can produce electricity at any given moment. Gigawatt-hours (GWh) measure energy generated or consumed over a period, in this case over a full year. A plant's capacity in MW therefore does not translate directly into its annual output in GWh, since actual output depends on how much of the time that capacity is being used (its "capacity factor"). Table 1 below reports installed capacity (MW); Table 2 reports actual annual generation (GWh).

Sindh's existing energy production spans nuclear generation at Karachi, Thar coal, and a growing base of wind and solar, including decentralized household- and business-level investment. The national generation mix has shifted modestly toward renewables and nuclear capacity over the past five years, while thermal generation has declined in relative share (Table 1):

Year	Hydel (MW)	Thermal (MW)	Nuclear (MW)	Renewable (MW)	Total (MW)
2021	9,915	25,098	2,612	2,147	39,772
2022	10,635	26,683	3,620	2,837	43,775
2023	10,635	28,766	3,620	2,717	45,738
2024	10,635	28,766	3,620	2,867	45,888
2025	11,500	23,134	3,620	2,867	41,121

Table 1. National installed generation capacity by source, 2021–2025. Source: WAPDA / CPPA-G / IPPs / K-Electric, as compiled in NEPRA, State of Industry Report 2025.

Year	Hydel (GWh)	Thermal (GWh)	Nuclear (GWh)	Renewable (GWh)	Total (GWh)
2020–21	38,800	88,677	11,090	4,522	143,588
2021–22	35,546	93,270	18,294	6,432	154,056
2022–23	36,262	71,422	24,055	6,321	138,539
2023–24	39,902	67,244	23,155	6,400	137,078
2024–25	39,973	66,171	22,452	6,029	135,079

Table 2. National electricity generation by source, 2020–21 to 2024–25. Source: WAPDA / CPPA-G / IPPs / K-Electric, as compiled in NEPRA, State of Industry Report 2025. Column totals exceed the sum of the four categories shown by roughly 380–515 GWh each year; the residual reflects imported electricity and other minor sources reported separately in the source tables.

Power consumption inside Sindh is historically dominated by domestic consumers, followed closely by a growing industrial sector (Figure 1):

²² World Bank, Pakistan Country Overview.

²³ NEPRA, State of Industry Report 2025.

²⁴ NEPRA, State of Industry Report 2025.

²⁵ NEPRA, State of Industry Report 2025.

²⁶ Renewables First, Pakistan Electricity Review 2025, https://uploads.renewablesfirst.org/Pakistan_Electricity_Review_2025_89f0b613d6.pdf.

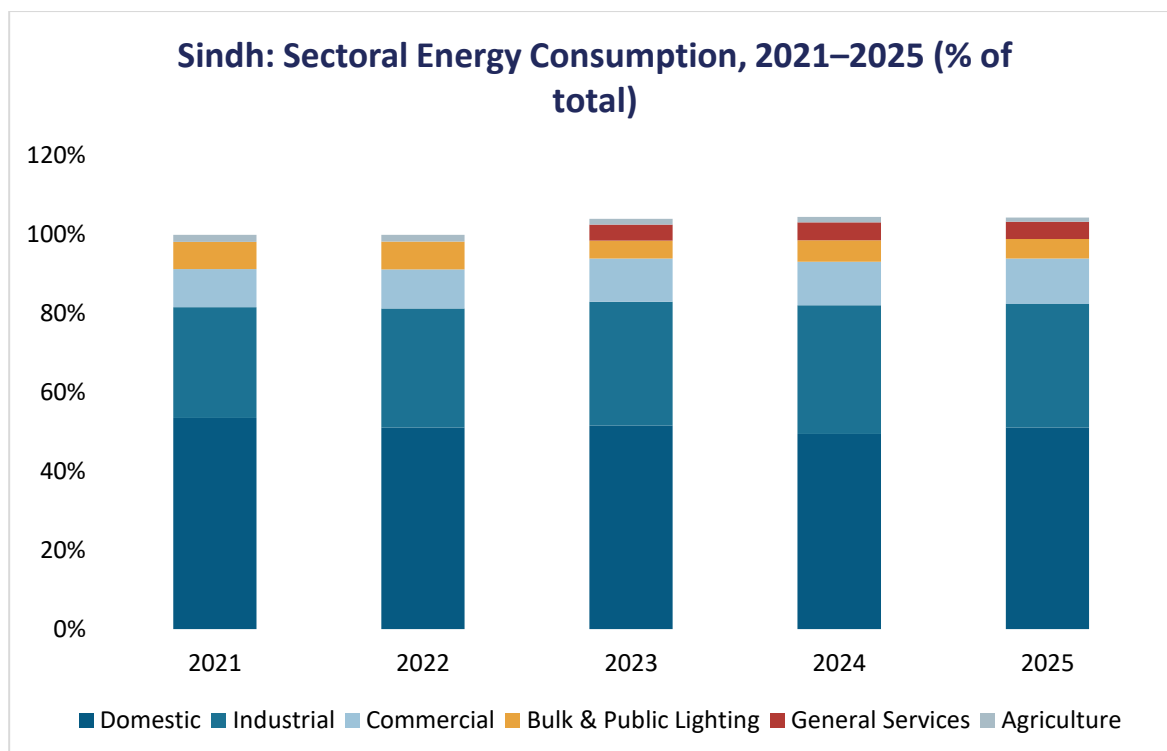


Figure 1. Sindh's sectoral energy consumption trend, 2021–2025 (% of total consumption). Source: author's calculation from NEPRA, State of Industry Reports 2021–2025. Category shares are reported as published; totals exceed 100% in some years due to rounding in the underlying NEPRA category breakdowns.

Industrial consumption grew from 28.1% of total demand in 2021 to over 31–32% in 2024–2025, while domestic consumption — though still the largest single category — eased slightly as commercial and industrial load grew.

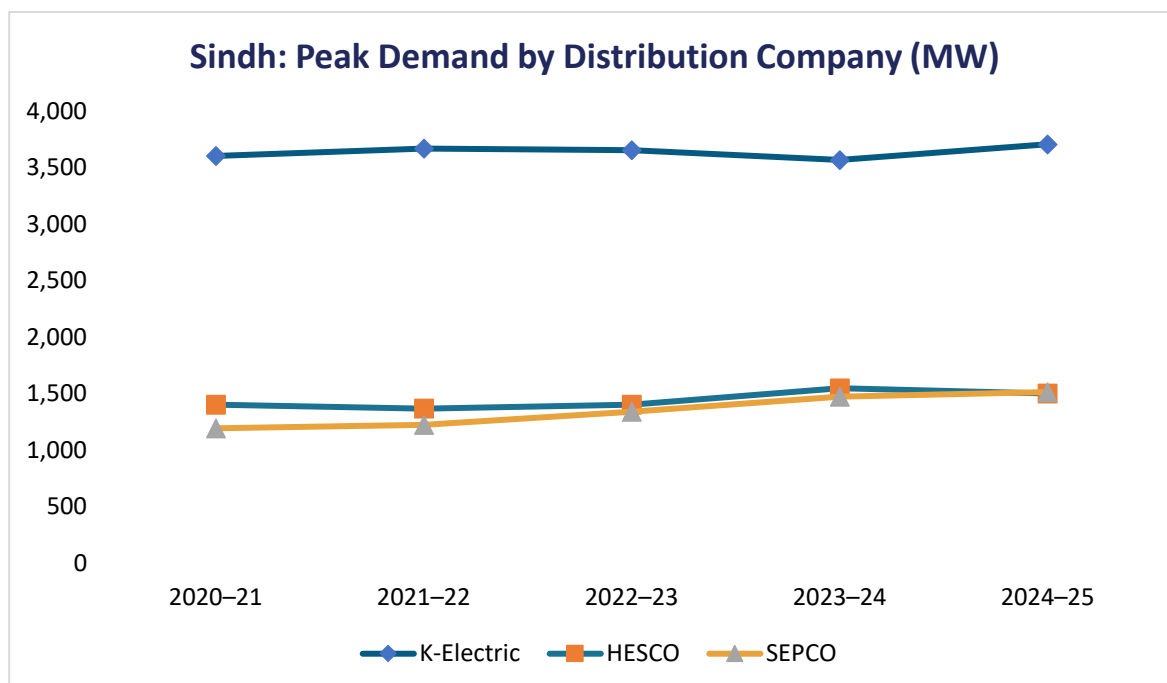


Figure 2. Peak demand by distribution company, 2020–21 to 2024–25 (MW). Source: NEPRA, State of Industry Report 2025.

K-Electric's peak demand grew only modestly and unevenly (3,604 MW to 3,707 MW over five years), while SEPCO's demand grew more consistently (1,191 MW to 1,512 MW, +27%) and HESCO's was more volatile, including a year-on-year contraction in 2024–25. This divergence reflects differing urbanization, industrial growth, and recovery rates across HESCO's and SEPCO's service territories.

This rising peak demand at HESCO and SEPCO does not contradict the solar rush documented in Section 3.4 — the two measure different things. Peak demand is recorded during the evening hours when household and business solar systems are not generating, so grid defection during daylight hours does not show up in this figure at all; it shows up instead as reduced daytime energy purchased from the grid, and in the transformer-loading strain documented in Section 4.4. Rising evening peak demand alongside daytime grid defection is therefore the expected pattern, not an inconsistency: overall connections and appliance ownership (air conditioning, industrial load) continue to grow provincewide, while a growing subset of consumers increasingly self-supplies only during sunlight hours.

Year	Electricity Sold in Sindh (GWh)	Sindh Population	Per Capita (kWh/person)
2020	21,500	51,610,000	417
2021	22,300	52,940,000	421
2022	23,100	54,300,000	425
2023	24,000	55,696,147	431
2024	24,800	57,130,000	434
2025*	25,600 (proj.)	58,600,000	437

*Table 3. Macro energy indicators for Sindh. Electricity sold in Sindh is the author's calculation aggregating annual sales reported for HESCO, SEPCO, and an attributed share of K-Electric's Sindh-based load, derived from NEPRA State of Industry Reports; it is not a published NEPRA provincial aggregate. Two boundary effects apply and run in opposite directions: K-Electric's licence area extends into Balochistan, covering Hub, Uthal, Vinder and Bela, while parts of northern Sindh fall outside the HESCO and SEPCO territories. Neither effect is separately quantified here. Population figures derive from the 7th Population and Housing Census 2023, which recorded Sindh at 55,696,147 with an intercensal growth rate of 2.57 per cent; earlier and later years are backcast and projected at that rate. Per capita figures are electricity sold divided by population. *2025 energy and population figures are projections based on trend extrapolation and are not published values.*

Sindh's projected 2025 per-capita consumption of approximately 437 kWh is low by almost any external benchmark, which points to suppressed or unmet demand rather than a demand ceiling. Comparison requires care, because jurisdictions publish on different measurement bases and the choice of basis materially changes the ratio. India's headline figure of about 1,460 kWh for FY2024–25 is computed by the Central Electricity Authority as gross generation plus net imports divided by mid-year population, a generation basis, while the Sindh figure above is electricity sold to consumers, after transmission and distribution losses of roughly 17 to 18 per cent. Grossed up to a comparable generation-equivalent basis, Sindh's figure is approximately 530 kWh, a little over a third of India's, roughly one seventh of the global average of about 3,700 kWh per capita, and under a tenth of the European Union average of about 6,088 kWh. Even allowing for Pakistan's lower income level and smaller industrial base, and noting that India's GDP per capita is roughly double Pakistan's so the two are not exact developmental peers, the gap remains large enough to suggest that a meaningful share of Sindh's population is consuming well below what reliable access and normal appliance ownership would imply, consistent with the more than 40 million Pakistanis nationally who remain without reliable grid access (Section 2.2).

Because the Sindh series is constructed rather than published, it is worth testing against national totals. NEPRA reports national consumption across all distribution companies including K-Electric at 124,628 GWh in FY2021–22, 112,902 GWh in FY2022–23, 109,707 GWh in FY2023–24 and 111,467 GWh in FY2024–25. Measured against these, the series in Table 3 implies a provincial share rising from 18.5 per cent to 23.0 per cent over four years, against a census population share of 23.1 per cent, during a period when national demand contracted by roughly 12 per cent. Either Sindh's share genuinely converged on its population share, which would itself be a significant finding requiring its own explanation, or the series overstates growth in the later years. Until the distribution-company figures are confirmed year by year against the source tables, the second reading cannot be excluded. The series is therefore presented as indicative rather than settled, and the analysis that follows rests on the level of per-capita consumption rather than on its rate of change.

One further qualification strengthens rather than weakens this reading. None of the figures above capture off-grid and behind-the-meter solar generation. Pakistan imported roughly 45 GW of solar panels over the past four to five years, including approximately 17 GW in 2024 alone, and net-metering connections across all distribution companies passed 378,000 by June 2025. A growing share of actual electricity use in Sindh therefore never passes through a distribution-company meter, so grid-based per-capita figures increasingly understate real consumption while overstating grid dependence. That is itself evidence for the decentralisation dynamic documented in Section 3.4.

Sindh Government Solar Home Systems Program

In its FY2026–27 budget, the Sindh government announced a PKR 18.206 billion Solar Home System program to provide free solar kits — a 180-watt panel, lithium battery, fan, and LED lights — to 275,000 households, comprising 132,000 off-grid families and 143,000 protected on-grid consumers, alongside a separate subsidized solar financing scheme for middle-income households ²⁷. Implementation, led by the Energy Department through the Annual Development Program, had reached over 15,000 installed systems as of mid-2026, with completion targeted for June 2027 ²⁸.

This programme illustrates the scale of household-level solar deployment already underway in Sindh, distinct from the market-driven private rooftop solar expansion documented in Section 3.4. Together, public programme deployment and private market-driven installation are reshaping Sindh's demand profile in ways that existing regulatory frameworks were not designed to accommodate.

2.4 Renewable Energy Potential

Sindh is well positioned to become Pakistan's leading renewable energy province, given its resource base:

- **Utility-scale solar across the province as a whole:** Sindh's plain, largely cloud-free terrain and high solar irradiance are not confined to the districts most commonly cited (Tharparkar, Jamshoro, Khairpur). Resource assessments and existing project siting — including Sukkur and Jacobabad, among others — indicate that most of Sindh's districts have utility-scale solar potential, with actual project siting more a function of grid connection points, land availability, and transmission access than of any meaningful difference in solar resource between districts ²⁹³⁰.
- **Wind:** strong resources along the Jhimpir–Gharo corridor, hosting over 550 MW of dependable wind assets in Thatta alone, including the Master Green, Act 2 Din, Artistic 2, Indus, Lakeside, and Liberty clusters ³¹.
- **Thar coal:** substantial reserves, though these should be read with the caveat that coal is not a clean energy source, and its role in the province's energy mix sits in tension with just-transition objectives.
- **Municipal waste-to-energy:** potential in Karachi and Hyderabad.
- **Bagasse-based cogeneration:** Sindh hosts approximately 30 of Pakistan's roughly 90 operational sugar mills, with a provincial crushing capacity of around 2.5 million tons of sugarcane per year ³². Nationally, NEPRA's 2013 upfront-tariff determination for bagasse cogeneration estimated that the roughly 86 sugar mills then operating could produce around 14.4 million tons of bagasse annually (at a 30% bagasse-to-cane yield), sufficient to support an estimated 1,500 MW of cogeneration capacity nationwide, of which only a fraction has been built out to date ³³³⁴. Applying Sindh's roughly one-third share of national mill count to that national estimate suggests a provincial potential in the range of 450–500 MW, though this is a proportional extrapolation rather than a Sindh-specific engineering assessment. Confirmed operating examples in Sindh include JDW Sugar Mills' 26.35 MW bagasse plant in Ghotki (commissioned 2014) and a 12 MW bagasse-

²⁷ "Pakistan's Sindh to distribute 275,000 solar systems among households in FY27," Arab News, 25 June 2026, <https://www.arabnews.com/node/2648507/pakistan>.

²⁸ "Murad Orders Faster Rollout of Rs18.2bn Solar Home System Project Across Sindh," Energy Update, 18 July 2026, <https://www.energyupdate.com.pk/2026/07/18/murad-orders-faster-rollout-of-rs18-2bn-solar-home-system-project-across-sindh/>.

²⁹ Global Energy Monitor, "Power Sector Transition in Sindh."

³⁰ Sustainable Development Policy Institute, Annual State of Renewable Energy Report, Pakistan 2023–2024, https://sdpi.org/annual-state-of-renewable-energy-report-pakistan-2023-2024/publication_detail.

³¹ Global Energy Monitor, "Power Sector Transition in Sindh."

³² "Sugar Mills in Pakistan: An Overview," Graana.com, 2024, citing Pakistan Sugar Mills Association data, <https://www.graana.com/blog/sugar-mills-in-pakistan-an-overview/>.

³³ NEPRA, Upfront Tariff for Bagasse/Biomass Cogeneration Power Projects, determination dated 29 May 2013, <https://nepra.org.pk/tariff/Tariff/Upfront/TRF-UTB%20Upfront%20Baggase%2029-05-2013%205152-54.PDF>.

³⁴ World Bank ESMAP, Biomass Resource Mapping in Pakistan: Final Report on Biomass Atlas, June 2016, <https://documents1.worldbank.org/curated/en/104071469432331115/pdf/107200-REPLACEMENTPUBLIC-Pakistan-Biomass-Mapping-Final-Report-WB-ESMAP-June2016.pdf>.

and-rice-husk plant in Mirpurkhas ³⁵ — together illustrating that only a small share of the province's bagasse cogeneration potential is currently connected to the grid.

Realizing this potential is constrained less by resource availability than by transmission: large renewable pools in the resource-rich south routinely face curtailment when linking to demand centers in the north (see Section 3.3).

Land tenure is a related constraint: many communities in resource-rich areas lack formal land ownership, which complicates project siting for utility-scale solar and wind installations and can limit the economic benefits communities receive from resource development near them.

Consultations with sector experts also linked this resource base directly to unrealized economic potential ³⁶. Districts such as Badin and Sujawal have significant agro-industrial potential — including tomato processing — that remains constrained by unreliable electricity, while Larkana's guava sector and Khairpur's internationally recognized dates could support local food-processing and value-added manufacturing (such as date biscuits currently imported) if power supply were reliable. Reliable electricity was repeatedly identified as a precondition for this kind of rural industrialization and employment generation, rather than a separate issue from the energy transition itself.

Canal-top solar installations — raised in consultations as a model already used in India — were also identified as a potential fit for Sindh's irrigation network, reducing water evaporation while generating electricity on land that is otherwise already allocated ³⁷.

2.5 Climate Finance Needs

Sindh's energy transition needs span both mitigation finance (grid-scale renewables, transmission upgrades, storage) and adaptation finance (climate-resilient infrastructure, flood protection for power assets, and community-level resilience programs). Multilateral development banks and climate funds have shown active interest in localized, climate-resilient interventions of this kind (see Section 7.3; ADB, 2019; World Bank, Powering Homes and Businesses), but SEPR's own initial budget allocation (Section 5) is far too limited to fund such investments directly — reinforcing the case for blended public-private and concessional climate finance rather than reliance on provincial public revenue alone.

3. Existing Energy Governance in Pakistan

3.1 Institutional Structure: Generation, Transmission, and Distribution

The Power Division, at the federal level, sets national energy policy, while the energy supply chain itself operates in three main steps ³⁸:

- Generation (GENCOs and IPPs): electricity is produced from hydro, thermal, solar, or nuclear plants.
- Transmission (NTDC): the National Transmission & Dispatch Company carries high-voltage electricity across the country over the national grid.
- Distribution (DISCOs): DISCOs take that high-voltage power from the national grid, step it down to safe home voltages using local transformers, and deliver it to the consumer meter.

Between generation and distribution sits the Central Power Purchasing Agency (Guarantee) Limited (CPPA-G), which functions as the sector's single buyer: it purchases electricity in bulk from GENCOs and Independent Power Producers (IPPs) at their NEPRA-determined generation tariffs, pools that power on the national grid, and then sells it in bulk to the DISCOs at a uniform ex-WAPDA rate, with the difference between what it pays generators and what it charges DISCOs adjusted monthly through the Fuel Charges Adjustment (FCA) mechanism that

³⁵ "Upgrading bagasse-based power plants," Dawn, 8 October 2014, <https://www.dawn.com/news/1136227>.

³⁶ Consultations with sector experts conducted for this working paper, 2026. Qualitative findings are attributed by respondent type rather than to named individuals.

³⁷ Sector-expert consultations conducted for this working paper.

³⁸ Chambers and Partners, "Power Generation, Transmission & Distribution 2025 — Pakistan," Global Practice Guides, <https://practiceguides.chambers.com/practice-guides/power-generation-transmission-distribution-2025/pakistan>.

NEPRA reviews ³⁹⁴⁰. On the generation side, GENCOs are the state-owned thermal and hydel generation companies inherited from WAPDA, while IPPs are privately owned generation companies operating under Power Purchase Agreements. As of the most recent NEPRA State of Industry Report, thermal IPPs supply the largest share of dispatched generation, followed by hydel (largely WAPDA/GENCO-owned) and a fast-growing but still comparatively small share from nuclear and renewable IPPs (Tables 1 and 2).

Pakistan's distribution companies include, among others: LESCO (Lahore), IESCO (Islamabad and surrounds), FESCO (Faisalabad), GEPCO (Gujranwala), MEPCO (South Punjab), PESCO (most of Khyber Pakhtunkhwa), TESCO (erstwhile FATA), HESCO (lower Sindh), SEPCO (upper Sindh), QESCO (Balochistan), and K-Electric (Karachi) — the only fully privatized, vertically integrated utility. DISCOs do not generate electricity and all public DISCOs are regulated by NEPRA, which controls electricity pricing and distribution licenses ⁴¹. As part of ongoing economic reforms, the Privatization Commission is pursuing the sale or private management outsourcing of several DISCOs, starting with FESCO, GEPCO, and IESCO, alongside federal preparatory work on transferring distribution companies to the provinces ⁴².

3.2 Constitutional Provisions

Pakistan's Constitution generally allocates legislative and executive authority between the Federation and the Provinces through the Federal Legislative List (Fourth Schedule) and the residual powers left to provinces after the 18th Amendment. Most subjects on that list, including defense, foreign affairs, and currency, sit exclusively with the Federal Government. Electricity is a partial exception: it appears in Part II of the Federal Legislative List, which places it under the joint oversight of the Council of Common Interests (CCI) rather than under exclusive federal control — a middle category, alongside subjects such as major ports and inter-provincial matters, that neither the Federation nor a province may govern entirely unilaterally. Sindh's specific position within this general electricity framework is set out below.

Under the current Constitution of Pakistan (as amended through the 26th Constitutional Amendment), Sindh has more authority over electricity than is often assumed, but does not have complete constitutional control over the sector. Electricity is a shared subject, with defined roles for both the Federation and the Provinces.

3.2.1 Article 157: Electricity

Article 157 gives specific constitutional powers to provincial governments. A provincial government may require bulk supply of electricity from the national grid, levy taxes on electricity consumption within the province, construct power houses and grid stations, lay transmission lines for use within the province, determine tariffs for electricity distribution within the province, and refer disputes with the Federal Government to the Council of Common Interests (CCI).

This constitutional basis supported the creation of SEPR, and means Sindh can constitutionally develop its own generation projects, build provincial transmission infrastructure, establish provincial distribution systems, regulate distribution tariffs within the constitutional framework, and collect provincial electricity duties and taxes. The National Electricity Policy 2021 expressly confirms these provincial transmission and grid-station powers ⁴³.

Article 157 is structured in sub-clauses rather than as the single undifferentiated power described above. Clause (1) reserves to the Federal Government the power to construct hydro-electric or thermal installations and inter-provincial transmission lines in any province, subject to a proviso — inserted by the 18th Amendment — requiring the Federal Government to consult the provincial government first. Clause (2) is the specific source of Sindh's own powers: it allows a province, to the extent it is supplied electricity in bulk from the national grid, to require that bulk supply, levy tax on electricity consumption within the province, construct its own power houses, grid

³⁹ Chambers and Partners, "Power Generation, Transmission & Distribution 2025 — Pakistan."

⁴⁰ "NEPRA Cuts CPPA-G Market Fee to Rs10.5248/kW for FY25-26," Profit by Pakistan Today, 30 June 2026, <https://profit.pakistantoday.com.pk/2026/06/30/nepra-cuts-cppa-g-market-fee-to-rs105248-per-kw-per-month>.

⁴¹ Government of Pakistan, Regulation of Generation, Transmission and Distribution of Electric Power Act, 1997 (NEPRA Act, Act XL of 1997), as amended, <https://sindhinvestment.gos.pk/system/files/Nepa%20Act,%201997%20as%20amended%20from%20time%20to%20time.pdf>.

⁴² "Centre starts preparatory work for transferring Discos to provinces," Dunya News, 27 June 2023, <https://dunya.com.pk/Business/735278-Centre-starts-preparatory-work-for-transferring-Discos-to-provinces>.

⁴³ Government of Pakistan, Power Division, National Electricity Policy 2021, para 5.2.2, <https://www.ppib.gov.pk/policies/National%20Electricity%20Policy%202021.pdf>.

stations and transmission lines for use within the province, and determine the tariff for distribution of electricity within the province. Clause (3) is a savings clause protecting existing compulsory-acquisition and anti-corruption property laws from being displaced by the Article. The Sindh Regulation of Electric Power Services Act, 2023 draws its constitutional authority specifically from clause 157(2) — its preamble invokes the sovereign rights vested in the province under that sub-clause⁴⁴ (see Section 3.5).

One limitation of this constitutional provision is that, when it was framed in 1973, the drafters did not anticipate the scale of renewable energy potential now available. Renewable energy offers a localized solution to a localized problem, which argues for revisiting these provisions to address renewable generation at the local and provincial level, along with distribution and related governance matters^{45,46}.

3.2.2 Fourth Schedule and the Council of Common Interests

Electricity appears in Part II of the Federal Legislative List, meaning it falls under the jurisdiction of the CCI (Articles 153–154) rather than being an exclusively federal matter. Provincial Chief Ministers sit on the CCI, giving Sindh a direct constitutional role in national electricity governance. Major electricity matters are jointly governed, and the Federation cannot act entirely unilaterally on shared electricity issues.

3.2.3 What Sindh Can and Cannot Do

Area	Constitutional Position
Solar and wind energy	Yes
Provincial power generation	Yes
Provincial transmission lines (within the province)	Yes
Provincial grid stations	Yes
Distribution companies / mini-grids / rooftop solar	Yes
Electricity taxation / distribution tariffs	Yes, subject to the legal framework
Community energy systems / renewable planning	Yes
Selling power to other provinces	Possible through national mechanisms, not independently
Exporting electricity to other countries	No — federal authority

Table 4. Sindh's constitutional position across key electricity functions. Source: author's analysis of Constitution of Pakistan, Article 157 and the Fourth Schedule, Part II.

The table above states Sindh's constitutional authority in yes/no terms, but constitutional authority is only the starting point — what matters operationally is who actually holds each specific regulatory function today. Table 5 maps that same terrain against five distinct regulatory functions, showing that Sindh's authority is strong on paper across most functions but only partially exercised in practice, particularly for tariff-setting and dispute resolution involving federally regulated distribution networks.

Regulatory Function	Federal (NEPRA) Role	Provincial (SEPRA) Role
1. Generation licensing	Licenses generation projects connected to the national grid or exceeding NEPRA thresholds	Can license off-grid and provincially-sited generation under the 2023 Act; in practice, most utility-scale generation still licensed by NEPRA
2. Transmission licensing / wheeling	Licenses inter-provincial transmission and sets national wheeling charges	Can license intra-provincial transmission (STDC); provincial wheeling framework still under development
3. Distribution licensing	Licenses HESCO, SEPCO, K-Electric as federally regulated DISCOs	Can license new provincial distribution entities and mini-grids; existing DISCOs remain under NEPRA
4. Tariff-setting	Sets DISCO consumer tariffs and national net-billing / prosumer rates	Can set tariffs for provincially-licensed generation and distribution under Article 157(2); has not yet exercised this for the existing DISCO networks
5. Dispute resolution / enforcement	Adjudicates disputes involving NEPRA licensees nationally	Can adjudicate disputes involving SEPRA licensees; jurisdiction over mixed federal-provincial projects remains contested

⁴⁴ Sindh Regulation of Electric Power Services Act, 2023.

⁴⁵ Pirzada, "Constitutional devolution without design," Pakistan Observer, 2026.

⁴⁶ PIDE, "Power to the Provinces."

Table 5. Sindh's constitutional and statutory position mapped against five regulatory functions. Source: author's analysis of the Sindh Regulation of Electric Power Services Act, 2023 and the NEPRA Act, 1997.

3.3 Issues with Centralized Governance

3.3.1 Overlapping Jurisdictions and Ambiguities

- **Centralized regulatory hold:** NEPRA maintains statutory authority over the national grid, inter-provincial transmission lines, major generation licensing, and uniform tariff formatting ⁴⁷.
- **An emerging division of labor rather than a turf conflict:** NEPRA continues to lead on matters with a national or inter-provincial footprint — the national grid, inter-provincial transmission, and uniform tariff-setting — while SEPR is positioned to lead on matters that are substantively provincial, including off-grid generation, mini-grids, and intra-provincial distribution, working in close coordination with NEPRA where a project touches a federally regulated network (HESCO, SEPCO, or K-Electric). The practical task ahead is formalizing that division through clearer jurisdictional rules for projects that sit at the boundary between the two.
- **Distributed and off-grid gaps:** mini-grids and dedicated municipal generation schemes occupy a legal grey zone, with ambiguity over whether SEPR or NEPRA holds final licensing and dispute-resolution authority ⁴⁸.

3.3.2 National Transmission and Grid Constraints

The Sindh Transmission and Dispatch Company (STDC) has built initial provincial transmission infrastructure, but the province remains structurally bound by the national grid's limitations. Large renewable pools — such as the 550+ MW of dependable wind assets in Thatta — routinely face curtailment due to transmission bottlenecks between the resource-rich southern region and northern industrial load centers ^{49,50}.

3.3.3 Circular Debt and High Tariffs

Sindh's energy transition is highly sensitive to the national circular debt crisis, wheeling tariff structures, and the federal cross-subsidy mechanism ^{51,52}. These fiscal realities constrain how much can be achieved through provincial regulatory design alone (see Section 5).

3.3.4 Net Metering and the Prosumer Regime

The legal friction between federal policy and provincial market dynamics is visible in the shifting regulatory framework for distributed solar generation. The 2026 transition from net-metering to net-billing represents a fundamental recalibration of the financial incentive landscape for private solar investors (Table 6).

Regulatory Metric	2015 Framework (SRO 892(I)/2015)	2026 Framework (Prosumer Regulations)
Billing mechanism	Net-metering: exported units offset imported units at identical retail tariff	Net-billing: exported power purchased at a separate, decoupled rate
Export compensation	Full retail parity, approx. PKR 27–55/unit	National average energy purchase price, approx. PKR 10–11/unit
Contract duration	7 years	5 years (renewable by mutual consent)
Licensing / fees	Handled by DISCOs for systems under 25 kW; no processing fee	One-time concurrence fee of PKR 1,000/kW, all system sizes
Transitional treatment	—	Agreements executed before 9 Feb, 2026 continue under old rates until contract expiry

⁴⁷ NEPRA Act, 1997.

⁴⁸ IRENA, mini-grid publications.

⁴⁹ Global Energy Monitor, "Power Sector Transition in Sindh."

⁵⁰ Renewables First, Pakistan Electricity Review 2025.

⁵¹ Asian Development Bank, Pakistan: Energy Sector Restructuring Program (Performance Evaluation Report), <https://www.adb.org/documents/pakistan-energy-sector-restructuring-program-0>.

⁵² Pakistan Economic Survey, Chapter 14: Energy.

Table 6. Legal progression of Pakistan's distributed generation framework. Sources: NEPRA, SRO 892(I)/2015; NEPRA (Prosumer) Regulations 2026, SRO 251(I)/2026, notified 9 February 2026.

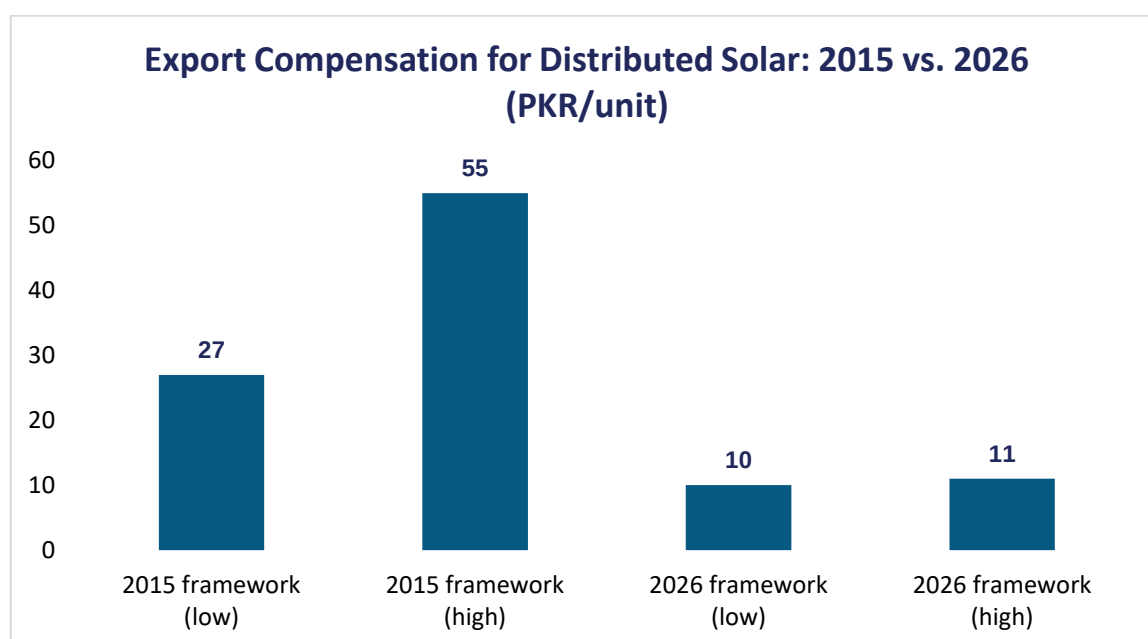


Figure 3. Export compensation for distributed solar generation under the 2015 and 2026 frameworks (PKR/unit). Source: author's chart from NEPRA, SRO 892(I)/2015 and NEPRA (Prosumer) Regulations 2026, SRO 251(I)/2026.

Consumers holding valid net-metering licenses executed before 9 February, 2026 may retain legacy billing rates until their existing contracts expire. NEPRA initially signaled an immediate, blanket transition, then issued a clarifying amendment confirming that pre-9 February agreements remain protected for their original term — a sequence worth noting given how directly it affects investor confidence in provincial solar incentives⁵³. This transition has materially reduced the financial incentive for new private urban clean generation, making it important for SEPRA to consider whether complementary, provincially-anchored pricing incentives are appropriate within its own jurisdiction.

3.3.5 Constitutional Duality: The Wider Debate

For SEPRA specifically, this debate is best read as a description of the transition SEPRA is operating within, rather than as a verdict on SEPRA's own institutional standing.

Recent legal commentary frames Sindh's experience as one symptom of a broader, unresolved structural tension in Pakistan's electricity sector⁵⁴. The NEPRA Act, 1997 established NEPRA as a unified federal regulator, reflecting a centralized, single-buyer market model designed for investment certainty⁵⁵. The 18th Amendment then layered expanded provincial constitutional and fiscal space on top of that federal architecture — under Article 157 — without a corresponding redesign of regulatory institutions. Commentators describe this as a condition of institutional duality: a centralized regime built around federal tariff-setting exists alongside an emerging decentralized layer of provincial assertions of competence, most visibly in Sindh and, to a lesser extent, Punjab^{56,57}.

⁵³ "NEPRA rolls out new regulations abolishing net metering," The Express Tribune, 9 February 2026, <https://tribune.com.pk/story/2591628/neptra-rolls-out-new-regulations-abolishing-net-metering>.

⁵⁴ Pirzada, "Constitutional devolution without design," Pakistan Observer, 2026.

⁵⁵ NEPRA Act, 1997.

⁵⁶ Pirzada, "Constitutional devolution without design," Pakistan Observer, 2026.

⁵⁷ PIDE, "Power to the Provinces."

3.4 Opportunities for Decentralized Energy Governance

Falling global solar panel prices have driven an exponential surge in private distributed solar installations across commercial and residential sectors — the "solar rush." While this reduces daytime load demand on thermal generation, it also creates technical challenges for existing distribution networks, discussed in Section 4.4 ⁵⁸⁵⁹.

Year	Estimated Cumulative Installations	Estimated Generation (GWh)
2020	~16,000	~120
2021	~25,000	~200
2022	~56,000	~400
2023	~141,000	~900
2024	~283,000	~1,400
2025	~378,000	~2,000

Table 7. Estimated private rooftop solar expansion in Pakistan. Sources: NEPRA net-metering license data; Pakistan Institute of Development Economics (PIDE); Ministry of Finance, Pakistan Economic Survey. Figures are estimates and are reported as approximate.

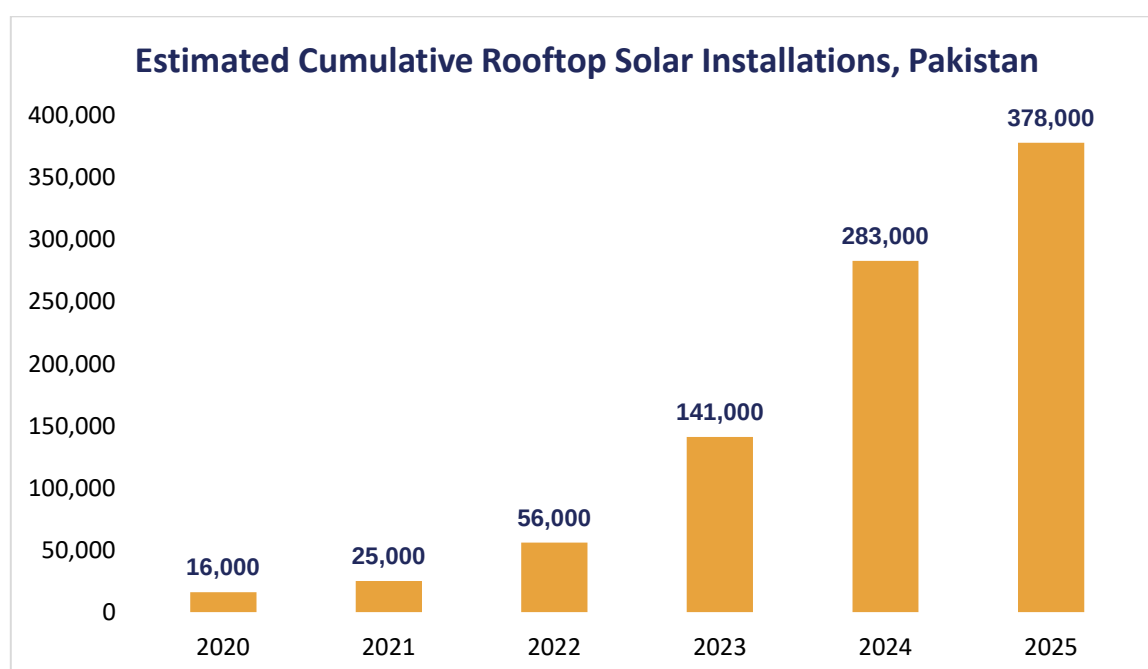


Figure 4. Cumulative rooftop solar installations in Pakistan, 2020–2025. Source: author's chart from NEPRA net-metering license data, PIDE, and Ministry of Finance, Pakistan Economic Survey.

An incoming wave of battery storage adoption, following the same cost-decline trajectory as solar panels, is widely expected to extend this trend from daytime solar generation into round-the-clock distributed supply — reinforcing the underlying case for decentralized, community- and household-level energy governance ⁶⁰⁶¹.

3.5 Sindh Energy Reforms: SEPR and STDC

The Sindh Regulation of Electric Power Services Act, 2023 was passed unanimously by the Provincial Assembly of Sindh on 7 June 2023 and published in the Sindh Government Gazette (Extraordinary) on 6 July 2023 ⁶²⁶³. It gives practical effect to the provincial authority over electricity recognized under Article 157(2) of the Constitution, establishing SEPR as an autonomous regulator responsible for licensing, tariff determination,

⁵⁸ SDPI, Annual State of Renewable Energy Report, Pakistan 2023–2024.

⁵⁹ Renewables First, Pakistan Electricity Review 2025.

⁶⁰ IRENA, mini-grid publications.

⁶¹ SDPI, Annual State of Renewable Energy Report, Pakistan 2023–2024.

⁶² Sindh Regulation of Electric Power Services Act, 2023.

⁶³ "Provincial power regulator bill passed," The Express Tribune, 8 June 2023, <https://tribune.com.pk/story/2420708/provincial-power-regulator-bill-passed>.

consumer protection, technical standards, dispute resolution, and electricity market development within Sindh. The Act explicitly recognizes and facilitates mini-grids and distributed generation for remote and underserved communities, provides for a dedicated provincial grid and energy-planning mechanisms, and establishes a dedicated SEpra Fund. It also opens the door to open access, wheeling, competitive electricity markets, and bilateral power transactions, alongside provisions covering solar, wind, biomass, biogas, hydropower, hydrogen, waste-to-energy, and storage technologies.

Beyond this general grant of authority, the Act sets out SEpra's operative functions in more specific terms. The Authority is empowered to grant, issue, notify, renew and cancel licenses for electric power services within Sindh; to determine tariffs, rates and charges and to regulate inter-province transmission; to approve electric power service undertakings without financial limit; to adjudicate disputes between licensees; and to impose and collect fees, fines and penalties⁶⁴⁶⁵. The Act also gives SEpra a consultative check on the federal regulator within the province: NEpra is required to consult SEpra before issuing any license relating to electricity generation, transmission or distribution located in Sindh, and a NEpra licensee operating in the province is treated as a SEpra licensee as well. This license-issuance authority — not tariff-setting alone — is arguably the more consequential decentralization lever, since it determines who may build and operate generation, transmission, and distribution assets in the first place, ahead of any downstream tariff question.

SEpra became operational with the Sindh Cabinet's approval of its Chairman and Members: Rafique Ahmed Sheikh as Chairman, with Nand Lal P. Sharma (Member Technical and Development), Irtafa-ur-Rehman (Member Legal and Corporate), and Muhammad Hanif Idris (Member Finance) — a development welcomed by provincial trade bodies including the Korangi Association of Trade and Industry (KATI) and the Bin Qasim Association of Trade and Industry (BQATI)⁶⁶⁶⁷.

The Sindh Transmission and Dispatch Company (STDC), a wholly owned subsidiary of the Sindh Energy Holding Company established following the 18th Amendment, provides parallel evidence of provincial institutional capacity. STDC provides transmission services for wind, solar, and biomass power producers, and generated PKR 676 million in revenue in 2025 with approximately PKR 354 million in profit before tax. It is also implementing the PKR 11.5 billion K-IV Grid Station and Transmission Line Project — demonstrating that a provincial transmission utility can operate profitably while remaining integrated within NEpra's national regulatory framework⁶⁸.

In practical terms, the Act demonstrates that Sindh's legal foundation for energy decentralization already exists. The remaining challenge is not legislative authority but the effective operationalization of SEpra: institutional coordination, regulatory capacity-building, and sustained political commitment to implementation — the challenges taken up in Sections 4 through 7.

Civil society representatives consulted for this paper noted that SEpra itself clarified, during engagements, that it does not intend to duplicate NEpra's regulatory functions. Rather, it intends to focus primarily on off-grid and provincial electricity regulation while remaining complementary to the national regulator⁶⁹. This self-description is a useful reference point for the jurisdictional questions raised in Sections 3.3 and 5.

3.6 Recommendations: Institutional Effectiveness for Decentralized Energy

The full rationale for decentralized energy governance — including the urgency case and the risk of unmanaged grid defection — is set out in Section 1.2. Within Sindh's existing legal foundation, achieving institutional effectiveness requires clarifying the dispatch and transmission network's decentralized role, resolving the

⁶⁴ Sindh Regulation of Electric Power Services Act, 2023.

⁶⁵ "Provincial power regulator bill passed," The Express Tribune, 8 June 2023.

⁶⁶ "KATI hails SEpra's approval by Sindh cabinet," Business Recorder, 26 February 2026, <https://www.brecorder.com/news/amp/40409024>.

⁶⁷ "BQATI Welcomes Sindh Electric Power Regulatory Authority Leadership Approval by Sindh Cabinet," Biz Today, 25 February 2026, <https://www.biztoday.news/2026/02/25/bqati-welcomes-sindh-electric-power-regulatory-authority-leadership-approval-by-sindh-cabinet/>.

⁶⁸ Consultations with the Sindh Transmission and Dispatch Company (STDC), conducted for this working paper, 2026.

⁶⁹ Consultations with civil society representatives (CSSP, The Knowledge Forum, Indus Consortium, Climate Action Center) conducted for this working paper, 2026.

jurisdictional ambiguities set out above, and building SEPRAs own regulatory and technical capacity — the specific entry points for which are set out in Section 8.

4. Framing Decentralization in Sindh

4.1 Legal and Institutional Dimension

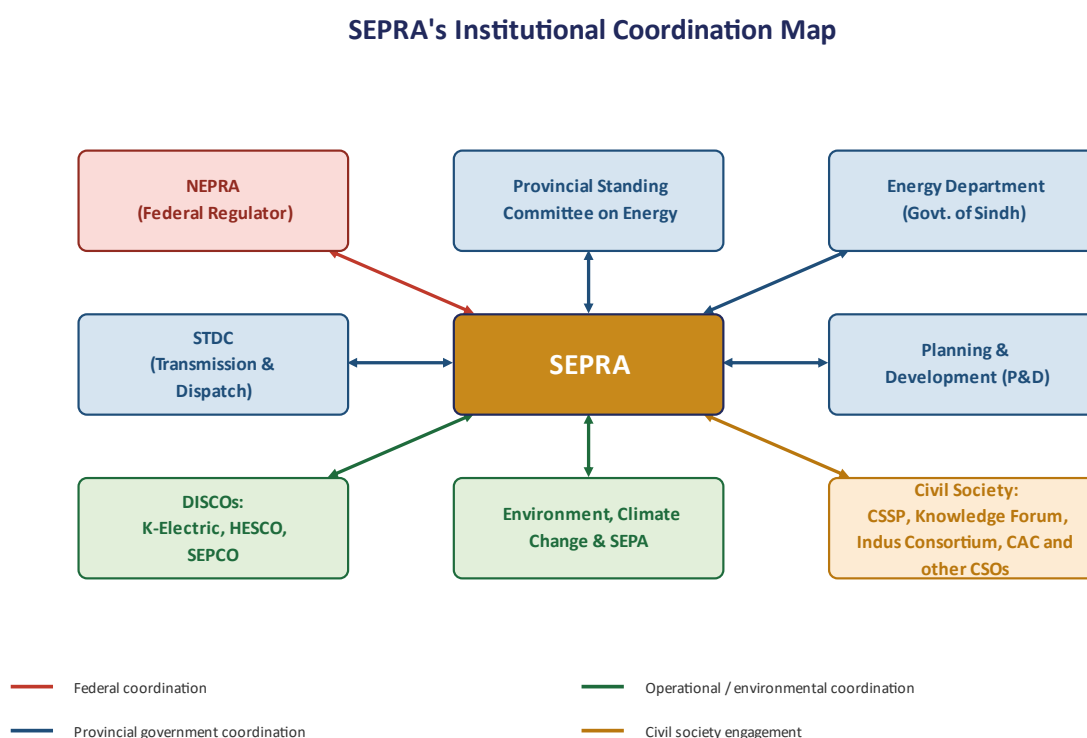
The 18th Constitutional Amendment significantly expanded provincial legislative and executive space over power-sector development (see Section 3.2). However, translating that constitutional space into operational reality remains constrained by the regulatory ambiguity and jurisdictional overlap set out in Section 3.3. The framework for decentralized energy in Sindh continues to evolve as SEPRAs own regulatory practice develops alongside NEPRAs (see Section 5).

As contextual background to this framing, it is worth noting that decentralized electricity provision has historical precedent in Sindh. More than a century ago, Shikarpur was served by a privately established power plant that supplied uninterrupted electricity across the city before the development of Pakistan's national grid, supporting the city's emergence as a major commercial and financial center and enabling infrastructure such as covered markets and underground drainage. This history is included here as general contextual evidence rather than as a specific stakeholder claim ⁷⁰, and suggests that localized electricity governance has long been technically and economically feasible in Sindh.

4.2 Political and Intergovernmental Dimension

Energy governance remains a highly sensitive arena for intergovernmental negotiation in Pakistan. While Sindh contributes substantially to national generation capacity — housing the wind corridors of Jhimpir and Gharo, nuclear generation in Karachi, and the lignite coal reserves of Thar — provincial actors express ongoing concern that electricity allocation and distribution priorities continue to be set by centralized planning bodies ⁷¹.

Consultations revealed fragmentation across departments along several institutional fault lines, mapped in Figure 5:



Source: Author's construction based on institutional consultations conducted for this working paper.

⁷⁰ Consultation with a serving Senator, conducted for this working paper, 2026.

⁷¹ Global Energy Monitor, "Power Sector Transition in Sindh."

Figure 5. Institutional coordination map for energy governance in Sindh. Source: author's construction based on institutional consultations conducted for this working paper.

- **The Energy Department and SEPRa relationship:** the division between the Energy Department's policy-making functions and SEPRa's independent oversight mandate requires structural definition to prevent political cross-over.
- **Planning and Development (P&D) gaps:** capital allocations for major energy transitions are often decoupled from regulatory roadmaps; P&D projects for public-sector solarization or localized distribution frequently bypass structural evaluation by SEPRa or STDC.
- **The utility bottleneck (K-Electric, HESCO, SEPCO):** the presence of two federally regulated DISCOs alongside a privatized utility creates divergent corporate incentives that complicate cohesive provincial regulatory enforcement.

4.3 Political and Fiscal Sensitivities

Beyond the legal, institutional, and political limitations set out above, three political-economy sensitivities are worth naming explicitly rather than leaving implicit in the "institutional duality" framing (Section 3.3).

First, NEPRA has structural incentives to resist further devolution of licensing and tariff authority. Its mandate under the NEPRA Act, 1997 is built around a centralized, single-buyer market model designed for investor certainty, and its own operations are funded from license fees and tariff-petition charges collected nationally — a revenue base that narrows if provinces assume more licensing authority directly^{72,73}. Any further transfer of authority to SEPRa is, from NEPRA's institutional vantage point, a transfer of both regulatory scope and revenue, not merely an administrative handover.

Second, K-Electric's status as Pakistan's only fully privatized, vertically integrated utility (Section 3.1) makes it a structurally different case from the publicly owned HESCO and SEPCO. A provincial framework designed around public-sector DISCOs may not transfer cleanly to a private, shareholder-owned utility operating under its own multi-year regulatory agreements with NEPRA — a case-specific complication a uniform provincial approach could underestimate⁷⁴.

Third, provincial tariff-setting and taxation authority under Article 157(2) interacts with the wider National Finance Commission (NFC) award framework governing federal-provincial revenue sharing. Legal commentary has already noted that the 18th Amendment and successive NFC awards expanded provincial fiscal space without a corresponding redesign of electricity-sector institutions (Section 7.3)⁷⁵ — and any material shift of tariff revenue from federal to provincial hands would need to be worked through this wider fiscal-federalism architecture, not treated as a standalone electricity-sector decision.

4.4 Technical and Operational Dimension

The growth of private distributed solar (Section 3.4) is already reshaping the technical demands on Sindh's grid. During peak solar generation hours, reverse power flows can create voltage fluctuations and thermal stress on local substations, and a significant share of provincial distribution transformers are operating at or beyond their maximum rated thermal capacity⁷⁶.

Consultations with civil society representatives underlined that no single distributed-generation model fits both urban and rural Sindh⁷⁷. Mini-grids are well suited to rural communities, but Karachi's dense urban environment presents land constraints that limit conventional mini-grid deployment. Virtual Power Plants (VPPs) — aggregating rooftop solar, batteries, and other distributed resources into a single coordinated resource — were identified as a more promising urban model, with surplus generation from these systems potentially redirected to

⁷² NEPRA Act, 1997, Section 7(3) and the provisions establishing the Authority's Funds (licence fees, tariff-petition fees and other sector charges).

⁷³ Malik, "National Electric Power Regulatory Authority (NEPRA)," PIDE.

⁷⁴ Chambers and Partners, "Power Generation, Transmission & Distribution 2025 — Pakistan."

⁷⁵ Pirzada, "Constitutional devolution without design," Pakistan Observer, 2026.

⁷⁶ NEPRA, State of Industry Report 2025.

⁷⁷ Civil society consultations conducted for this working paper.

low-income communities facing load shedding. Consultations also noted that Punjab currently has greater rooftop solar potential than Sindh, owing to larger available industrial and residential roof space.

Utility	Year	Total Active Transformers	80–90% Load	91–100% Load	Overloaded (>100%)
K-Electric	2021	2,567	1,018	649	900
K-Electric	2023	5,608	1,989	1,302	2,317
K-Electric	2025	6,300	1,993	1,425	2,882
HESCO	2021	1,114	635	405	74
HESCO	2023	1,679	831	598	250
SEPCO	2021	2,677	1,378	718	581
SEPCO	2023	6,637	4,089	1,743	805

Table 8. Distribution transformer loading in Sindh. Source: NEPRA, State of Industry Report 2025.

Note on data quality

The 2025 HESCO and SEPCO transformer-loading figures reported in the source NEPRA tables show an implausible year-on-year contraction in total active transformers (to 329 and 3,242 respectively, against 1,679 and 6,637 in 2023), and SEPCO's reported overloaded-transformer count falls to zero despite 778 transformers reported at 91–100% load in the same year. This pattern is inconsistent with a stable or growing network and most likely reflects a transcription or reporting-basis change in the source data rather than an actual contraction. Pending verification against NEPRA's primary dataset, these unverified 2025 HESCO and SEPCO figures have been excluded from this paper. The verified 2021 and 2023 figures are retained above.

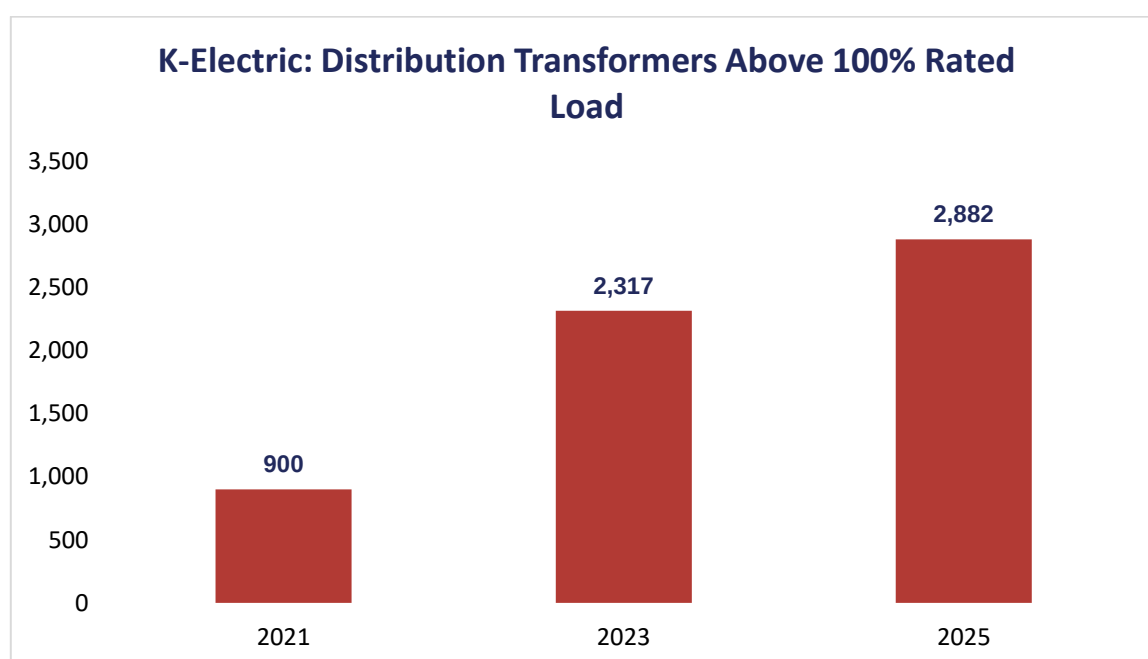


Figure 6. K-Electric: distribution transformers operating above 100% of rated load, 2021–2025. Source: NEPRA, State of Industry Report 2025. HESCO and SEPCO 2025 figures are excluded pending source verification, as set out in the note above.

K-Electric's data shows a consistent trend: overloaded transformers (operating above 100% of rated capacity) grew from 900 in 2021 to 2,882 in 2025, rising from 35% to 46% of its active fleet over the same period — even as the fleet itself grew roughly two-and-a-half-fold, from 2,567 to 6,300 units. This underscores the case for localized, distributed mini-grids capable of isolating load clusters and siting generation closer to the end consumer, alongside grid-storage investment to manage the intermittency of a rapidly growing solar and, eventually, battery fleet.

5. SEPRAs Institutional Position

SEPRAs emerging regulatory role sits at the intersection of the legal space described in Section 3.2 and the coordination challenges described in Section 4.2. Its spatial jurisdiction remains ill-defined for projects that inject power into distribution networks owned by federally regulated entities (HESCO, SEPCO) or K-Electric's multi-jurisdictional network, and it faces open questions of licensing and tariff authority for mini-grids and off-grid generation that operate wholly detached from the national transmission network.

SEPRAs fiscal position is a central constraint on how quickly it can build out this role. The Sindh Chief Minister approved an initial budget of PKR 197.916 million for SEPRAs for fiscal year 2024–25⁷⁸. This limited allocation demands a strategic approach focused on regulatory design and targeted pilots rather than attempting to fund large, capital-intensive transmission additions from public revenue — the approach reflected in the entry points proposed in Section 8.

This allocation is small not only in absolute terms but relative to the scale of the federal power-sector institutions SEPRAs must coordinate with. A precise, published total administrative budget for NEPRAs itself was not available for direct citation, but the scale difference is visible in adjacent, disclosed figures: research on NEPRAs administrative cost structure finds that salaries and benefits alone have consistently accounted for 76–80% of NEPRAs total administrative expenses over recent years⁷⁹, and NEPRAs 2026 determination for CPPA-G — a single federal power-sector body, not NEPRAs itself — approved roughly PKR 1.83 billion in salaries and employee benefits alone for one fiscal year⁸⁰. Set against that scale, SEPRAs entire PKR 197.9 million annual allocations, covering every regulatory function it is meant to perform, is an order of magnitude smaller than the administrative cost base of a single federal power-sector entity, let alone NEPRAs as a whole.

This is also structurally different in kind from NEPRAs funding model: under the NEPRAs Act, 1997, NEPRAs operations are funded from license fees, tariff-petition fees, and other charges collected directly from the sector it regulates — a self-financing model that scales with regulatory activity⁸¹. SEPRAs initial allocation, by contrast, is a fixed grant from the Sindh government's Annual Development Program, which does not automatically grow as SEPRAs licensing and tariff caseload increases. The 2023 Act does establish a dedicated SEPRAs Fund with the power to collect its own fees, fines and penalties⁸² — but until that fee-based revenue stream operates at scale, SEPRAs capacity will remain tied to periodic provincial budget allocations rather than growing with its regulatory workload the way NEPRAs does.

Sector experts consulted for this paper consistently framed SEPRAs appropriate posture as gradual and proactive rather than waiting for federal delegation: renewable projects sited within Sindh, particularly wind power, should increasingly fall under SEPRAs jurisdiction, with NEPRAs and SEPRAs jointly regulating certain activities during the transition period. Sector experts also suggested SEPRAs position itself as the provincial repository for electricity sector data — a role distinct from, but complementary to, its regulatory functions⁸³.

6. Institutional and Governance Realities

SEPRAs technical and regulatory capacity is still evolving, and consultations with civil society and institutional stakeholders alike point to a consistent theme: SEPRAs legal mandate is necessary but not sufficient without parallel investment in administrative and technical capacity^{84,85}.

District-level engagement in energy planning remains limited. Energy planning is still largely centralized at the provincial level, with minimal district or community participation in decision-making. Coordination gaps persist across the Energy Department, SEPRAs, STDC, and the Planning & Development Department, as set out in the

⁷⁸ "Sindh govt establishes SEPRAs," Pakistan Observer, 2024.

⁷⁹ Malik, "National Electric Power Regulatory Authority (NEPRAs)," PIDE.

⁸⁰ "NEPRAs Cuts CPPA-G Market Fee," Profit by Pakistan Today, 2026.

⁸¹ NEPRAs Act, 1997.

⁸² Sindh Regulation of Electric Power Services Act, 2023.

⁸³ Sector-expert consultations conducted for this working paper.

⁸⁴ Civil society consultations conducted for this working paper.

⁸⁵ Consultation with a former Advisor to the Chief Minister of Sindh on Finance, conducted for this working paper, 2026.

institutional coordination map in Section 4.2 (Figure 5), and these gaps — rather than any lack of natural resources — are repeatedly identified by stakeholders as the binding constraint on progress ⁸⁶.

Consultations pointed to concrete institutional reforms that would close this district-level gap: introducing district-level, and where feasible tehsil-level, electricity distribution companies; developing prepaid electricity systems; and, in one recurring model, having Union Council Chairpersons oversee local electricity collection through collective village meters, which stakeholders suggested could improve bill recovery and accountability ⁸⁷. A Provincial Electricity Distribution Act, clearly defining distribution responsibilities, tariff-collection mechanisms, and institutional roles, was proposed as the legislative vehicle for this shift. Federal preparatory work on transferring distribution companies to the provinces gives this proposal additional practical relevance ⁸⁸.

A separate but related theme raised by a former Advisor to the Chief Minister of Sindh on Finance was that Sindh's governance challenges are rooted more in institutional leadership than in institutional design ⁸⁹. Weak transparency, inconsistent merit-based appointments, and limited public trust were identified as constraints on investor confidence in provincial institutions independent of the sector's legal or technical position — a caution against treating institutional capacity purely as a staffing or budget question.

7. Key Themes from Analysis

7.1 Limitations

- **Regulatory ambiguity:** unresolved NEPRA–SEPPA jurisdiction over tariffs, wheeling, and prosumer rules (Section 3.3).
- **Institutional fragmentation:** inconsistent coordination across the Energy Department, SEPPA, STDC, P&D, and climate agencies (Figure 5).
- **Technical grid constraints:** high transformer overloads and transmission bottlenecks for southern wind farms, with limited battery storage (Table 8)⁹⁰.
- **Weak local ownership:** energy planning remains centralized, with minimal district or community participation.
- **Weak governance signals:** limited transparency and inconsistent merit-based appointments have constrained investor confidence in provincial institutions, independent of the underlying legal or resource position ⁹¹.
- **Land acquisition constraints:** many local communities in resource-rich areas lack formal land ownership, complicating project siting and limiting the economic benefits communities receive from resource extraction near them (see also Section 2.4) ⁹².
- **Political and fiscal sensitivities:** federal revenue implications of provincial tariff-setting under the NFC framework, K-Electric's distinct private-utility status, and the risk that district and tehsil-level distribution companies (Section 6) could fragment accountability further rather than improve it if not paired with strong SEPPA oversight capacity — addressed in full in Section 4.3.

7.2 Opportunities

- **Rapid decentralized solar growth:** massive rooftop deployment creates an immediate opening to formalize local solar clusters and virtual power plants (Table 7, Figure 4).
- **Abundant resource endowments:** premier high-irradiation solar zones and mature wind corridors support low-cost generation (Section 2.4)⁹³.

⁸⁶ Consultation with a former Advisor to the Chief Minister of Sindh on Finance.

⁸⁷ Sector-expert and parliamentary consultations.

⁸⁸ "Centre starts preparatory work for transferring Discos to provinces," *Dunya News*, 2023.

⁸⁹ Consultation with a former Advisor to the Chief Minister of Sindh on Finance.

⁹⁰ NEPRA, State of Industry Report 2025.

⁹¹ Consultation with a former Advisor to the Chief Minister of Sindh on Finance.

⁹² Civil society consultations conducted for this working paper.

⁹³ Global Energy Monitor, "Power Sector Transition in Sindh."

- **Development partner alignment:** multilateral banks and climate funds are actively seeking localized, climate-resilient interventions ⁹⁴⁹⁵.
- **Dedicated policy space:** growing provincial political will to implement green energy and just-transition agendas.
- **Domestic manufacturing potential:** civil society representatives pointed to Sindh's potential to establish a domestic solar-manufacturing industry rather than remaining dependent on imported panels, alongside the technical-skills and green-jobs growth this could generate ⁹⁶.
- **Public-private partnership precedent:** existing PPP arrangements in the coal sector demonstrate that government-private collaboration is achievable in Sindh's energy sector, offering a template that could extend to renewables ⁹⁷.

7.3 Evidence from Comparative Literature

A wider body of policy research and institutional evaluation supports the case for a more active, better-defined provincial regulatory role:

- PIDE research argues that devolving energy authority to sub-national institutions can improve responsiveness, but only where local entities have real financial and administrative capacity — echoing Germany's Energiewende experience of empowered local governments driving community-owned renewable generation ⁹⁸.
- Legal commentary observes that the 18th Amendment and successive NFC awards expanded provincial constitutional and fiscal space without a corresponding redesign of the electricity sector's institutional architecture, producing a lasting "institutional duality" ⁹⁹.
- An ADB independent evaluation of over a decade of energy-sector support found governance and interagency coordination to be persistent weak points, recommending explicit attention to coordination mechanisms and support for competitive electricity markets and renewables ¹⁰⁰¹⁰¹.
- World Bank Group-supported reforms and IFC-led private investment have, since 2014, helped reduce the cost of new generation in Pakistan to below 10 cents per kilowatt-hour in several projects, demonstrating that blended public-private financing — rather than direct public capital expenditure — is a proven route to expanding capacity ¹⁰².
- The Pakistan Economic Survey documents continued federal investment in modernizing the prosumer interface, including the Online Net Metering Application Portal (ONMAP), suggesting an opening for SEPR to position itself as a provincial complement to federal digitization rather than a competing channel ¹⁰³.
- Independent tracking confirms that Sindh holds substantial coal, solar, and wind resources, and that the national transmission network linking the resource-rich south to northern demand centers remains structurally fragile — reinforcing that transmission, not generation potential, is the binding constraint ¹⁰⁴¹⁰⁵.
- Peer-reviewed energy-policy research on distributed generation and regulatory design provides comparative grounding for the institutional questions examined here.

⁹⁴ Asian Development Bank, "ADB Support Key to Strengthen Pakistan's Energy Sector: Independent Evaluation," 12 February 2019, <https://www.adb.org/news/adb-support-key-strengthen-pakistan-s-energy-sector-independent-evaluation>.

⁹⁵ World Bank, "Pakistan: Powering Homes and Businesses," <https://www.worldbank.org/en/about/partners/brief/pakistan-powering-homes-and-businesses>.

⁹⁶ Civil society consultations conducted for this working paper.

⁹⁷ Consultation with a former Advisor to the Chief Minister of Sindh on Finance.

⁹⁸ PIDE, "Power to the Provinces."

⁹⁹ Pirzada, "Constitutional devolution without design," Pakistan Observer, 2026.

¹⁰⁰ ADB, "ADB Support Key to Strengthen Pakistan's Energy Sector," 2019.

¹⁰¹ ADB, Pakistan: Energy Sector Restructuring Program.

¹⁰² World Bank, "Pakistan: Powering Homes and Businesses."

¹⁰³ Pakistan Economic Survey, Chapter 14: Energy.

¹⁰⁴ Global Energy Monitor, "Power Sector Transition in Sindh."

¹⁰⁵ Renewables First, Pakistan Electricity Review 2025.

8. Entry Points for SEPRA

Based on the preceding analysis, four concrete, sequenced entry points are proposed for SEPRA to pursue within its current legal mandate and fiscal constraints.

8.1 Clarify the Micro-Grid and Off-Grid Regulatory Framework

Draft specialized regulations for isolated micro-grids under 1 MW, defining provincial consumer protection terms, simplified licensing, and localized tariff benchmarks to encourage private mini-grid deployment in off-grid rural communities ¹⁰⁶.

8.2 Standardize Public-Sector Solarization and Wheeling Guidelines

Partner with STDC to design a comprehensive provincial energy wheeling framework, enabling public assets — such as water-pumping stations and hospitals — solarized with provincial funds to wheel excess generation across local networks.

8.3 Establish an Inter-Agency Energy Taskforce

Convene a dedicated, structured coordination platform including the Energy Department, SEPRA, STDC, P&D, and major utility representatives to align infrastructure investments with provincial regulatory goals, responding directly to the coordination weaknesses identified in ADB's evaluation of Pakistan's energy sector ¹⁰⁷.

8.4 Deploy Localized Battery Storage Pilot Projects

Use a portion of strategic funds to seed hybrid solar-plus-storage mini-grids in high-vulnerability coastal areas, proving the technical viability of decentralized networks to manage intermittency and reduce local transformer strain.

8.5 Phased Roadmap

These entry points are sequenced across three-time horizons, reflecting the pace at which legal clarity, institutional capacity, and fiscal resources can realistically be expected to develop (Table 9).

Short term	Medium term	Long term
Facilitate dialogue on decentralized governance	Develop frameworks for distributed generation	Function as a full provincial energy regulator
Clarify regulatory issues for distributed systems	Establish licensing and consumer protection rules	Support localized energy markets
Support mini-grid and community pilots	Build technical and institutional capacity	Contribute to provincial energy security and climate resilience
Strengthen inter-institutional coordination	Integrate decentralized energy into provincial planning	Coordinate Sindh's broader energy transition

Table 9. Phased roadmap for SEPRA's evolving role across three-time horizons. Source: author's construction based on the analysis in Sections 3 to 7 and institutional consultations.

8.6 Complementary Measures Raised in Consultations

Beyond the four core entry points above, stakeholder consultations surfaced several complementary, lower-cost measures that SEPRA and its partner institutions could pursue alongside the phased roadmap:

- **Workforce development:** STEVTA introducing specialized technical training programs for renewable energy installation, maintenance, and repair, with more flexible admission requirements in rural areas to widen access to green jobs ¹⁰⁸.

¹⁰⁶ IRENA, mini-grid publications.

¹⁰⁷ ADB, "ADB Support Key to Strengthen Pakistan's Energy Sector," 2019.

¹⁰⁸ Civil society consultations conducted for this working paper.

- **Prepaid and community billing models:** prepaid electricity systems and Union Council-managed collective village meters to improve bill recovery and local accountability ¹⁰⁹.
- **Canal-top solar pilots:** siting solar generation over irrigation canals to generate electricity while reducing water evaporation, as piloted elsewhere in the region ¹¹⁰.
- **Legislative clarity:** a Provincial Electricity Distribution Act to formally define distribution responsibilities, tariff-collection mechanisms, and institutional roles as district-level distribution is introduced ¹¹¹.

9. Way Forward

Three conclusions stand out from this analysis.

First, the legal foundation for provincial energy decentralization in Sindh is already in place. The Sindh Regulation of Electric Power Services Act, 2023 grants SEPRa broad authority over licensing, tariffs, mini-grids, and competitive markets ¹¹². The principal constraint is not legislative authority but its effective operationalization — a function of institutional capacity, inter-agency coordination, and sustained political commitment, compounded by an unresolved structural duality with the federal regulatory regime that predates SEPRa's establishment ¹¹³.

Second, the technical case for decentralization is mounting independently of policy choices. The rapid, organic growth of private rooftop solar — more than twenty-fold in five years — combined with escalating distribution transformer overloads, particularly within K-Electric's network, means that distributed energy systems are already reshaping Sindh's grid whether or not provincial regulation keeps pace (Tables 7 and 8). SEPRa's choice is not whether this transition happens, but whether it happens in a regulated, safe, and equitable manner or in an unmanaged one.

Third, the 2026 shift from net-metering to net-billing demonstrates how exposed provincial solar investment incentives remain to federal policy changes, reinforcing the case for SEPRa to consider complementary, provincially-anchored frameworks — particularly for mini-grids and off-grid systems that fall more clearly within provincial jurisdiction ¹¹⁴.

Underlying all three conclusions is a single, time-sensitive argument: the grid-defection trend documented in this paper (Sections 1.2, 3.4, and 4.4) does not pause while institutional and legal questions are resolved. Left unmanaged, rising self-generation among Sindh's higher-consumption customers risks eroding the paying base that funds the fixed costs of the grid itself — a dynamic that, in a power sector already carrying chronic circular debt and elevated tariffs, could compound into materially higher costs and reduced reliability for the grid-dependent consumers who cannot afford to leave it ¹¹⁵. SEPRa's window to bring this transition into a regulated, managed framework — rather than allowing it to continue unmanaged — is open now, while its statutory authority is in place and the trend is still early-stage. That is the central urgency behind the entry points proposed in Section 8. The provincial conference described in Section 1.3 is intended as an initial round of dialogue on SEPRa's evolving role, bringing this paper before SEPRa, the Provincial Standing Committee on Energy, NEPRa, and independent technical experts for feedback and discussion. Beyond that conference, three areas warrant deeper, dedicated follow-on study: a formal legal analysis of the NEPRa–SEPRa jurisdictional boundary, a political economy assessment of reform sequencing, and technical feasibility studies for the mini-grid and battery storage pilots proposed in Section 8.

10. Positioning of the Working Paper

This paper is positioned as a facilitative and discussion-oriented document, not a final legal opinion or a comprehensive technical study. It reflects institutional perspectives and field insights gathered through the consultation process described in Section 1.3, and is intended to serve as a baseline for continued engagement

¹⁰⁹ Sector-expert and parliamentary consultations.

¹¹⁰ Sector-expert consultations conducted for this working paper.

¹¹¹ Consultation with a serving Senator.

¹¹² Sindh Regulation of Electric Power Services Act, 2023.

¹¹³ Pirzada, "Constitutional devolution without design," *Pakistan Observer*, 2026.

¹¹⁴ NEPRa (Prosumer) Regulations, 2026, SRO 251(I)/2026.

¹¹⁵ Costello and Hemphill, "Electric Utilities' 'Death Spiral'," 2014.

among SEPRAs, provincial departments, federal regulators, and civil society, rather than as a concluded assessment of Sindh's energy transition.

11. References

Every source listed below is cited at the relevant point in the text as a numbered footnote on the page where the claim appears. The first footnote for a source gives the full citation; later footnotes for the same source use a short form. This consolidated list is provided for convenience and as a bibliography. Qualitative findings drawn from consultations are footnoted by respondent type rather than attributed to named individuals, in line with the approach set out in Section 1.3.

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Note on data and estimates: Sindh-specific consumption and peak-demand figures are drawn from NEPPRA State of Industry Reports and are presented as published, with rounding artefacts in the underlying source noted where relevant. Per-capita figures for 2025 in Table 3 are projections based on trend extrapolation and are marked with an asterisk. Unverified 2025 HESCO and SEPCO transformer-loading figures have been excluded from Table 8 and Figure 6 pending verification against NEPPRA's primary dataset. The Sindh-specific bagasse cogeneration estimate in Section 2.4 is a proportional extrapolation from national figures rather than a Sindh-specific engineering study, and should be treated accordingly. Where this paper draws on institutional or sector-expert consultations, findings are attributed by respondent type rather than to named individuals.

ABOUT PIDC

Partners in Development and Consultancy (PIDC) is a Pakistan-based research and development consultancy working to advance evidence-driven, inclusive, and climate-resilient policy across the country, with a core presence in Karachi.

PIDC conducts multi-disciplinary research and policy analysis; designs and manages development programs from concept note through evaluation; builds institutional and human capacity for public, private, and civil-society partners; and implements innovative, donor-funded initiatives focused on poverty reduction, gender equality, youth leadership, and climate resilience.

This working paper was prepared as part of PIDC's ongoing engagement on energy governance and climate finance in Sindh, undertaken in consultation with provincial institutions, regulators, and civil society.

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