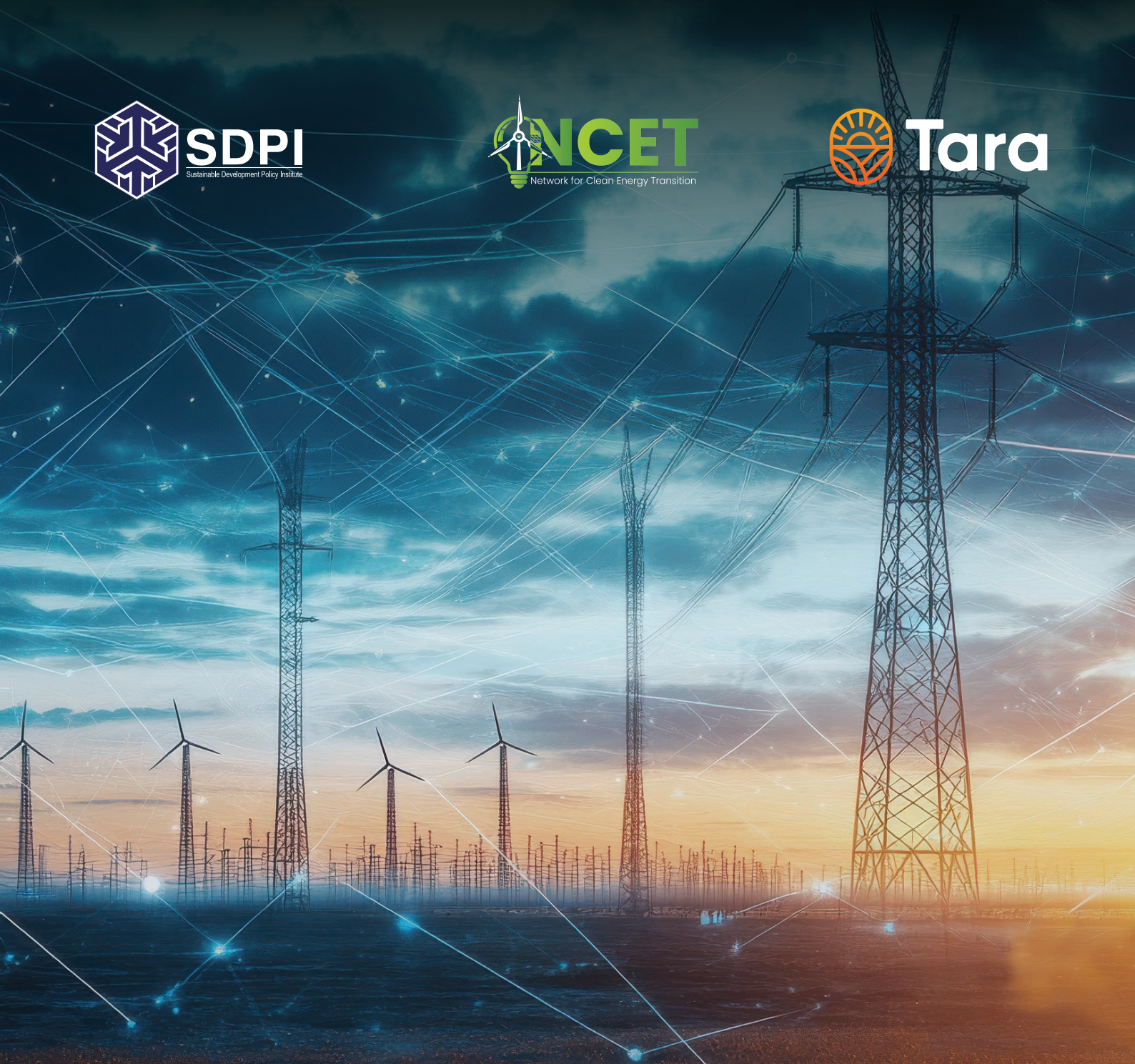

Energy Market Reforms: The Case of Wheeling Regulations for Industrial Competitiveness and Market Liberalization

White Paper | September 2025

Authors: Mr. Muhammad Umer, Mr. Ahad Nazir, Dr. Khalid Waleed and Mr. Ubaid ur Rehman Zia

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Mailing Address: PO Box 2342, Islamabad, Pakistan.

Tel: +92 (51) 2278134, 2278136, 2277146, 2270674-76

Fax: +92 (51) 2278135

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Abbreviations and Acronyms

APTMA	All-Pakistan Textile Mills Association
B2B	Business-to-Business
BPCs	Bulk Power Consumers
CBAM	Carbon Border Adjustment Mechanism
CPPA-G	Central Power Purchasing Agency
CTBCM	Competitive Trading Bilateral Contract Market
DUoSC	Distribution Use of System
DSM	Demand Side Management
DR	Demand Response
DISCOs	Distribution Companies
ETS	Emissions Trading System
EPZA	Export Processing Zone Authority
EVCI	Electric Vehicle Charging Infrastructure
EWA	Energy Wheeling Agreement
EPA	Energy Purchase Agreement
EU	European Union
FACOS	Fully Allocated Cost of Service
FCA	Fuel Cost Adjustments
FESCO	Faisalabad Electric Supply Company
FDI	Foreign Direct Investment
FTAs	Free Trade Agreements
GBCs	Green Bilateral Contracts
GDP	Gross Domestic Product
GOs	Guarantees of Origin
GEPCO	Gujranwala Electric Power Company
HESCO	Hyderabad Electric Supply Company
ICT	International Trade Centre
ISMO	Independent System Market Operator
IEP	Integrated Energy Planning
IESCO	Islamabad Electric Supply Company
KPK	Khyber Pakhtunkhwa
KE	K-Electric
LESCO	Lahore Electric Supply Company
LMS	Large-Scale Manufacturing
MoFe	Market Operating Fee
MoF	Ministry of Finance
MoIP	Ministry of Industries and Production
MW	Mega Watt
NE-Plan	National Electricity Plan
NE-Policy	National Electricity Policy
NEPRA	National Electric Power Regulatory Authority
NTDC	National Transmission and Dispatch Company
MDIs	Maximum Demand Indicators
MEPCO	Multan Electric Power Company
MoEPD	Ministry of Energy (Power Division)
PREC	Pakistan's Renewable Energy Certificate
PTAs	Preferential Trade Agreements
PEDO	Pakhtunkhwa Energy Development Organization
PESCO	Peshawar Electric Supply Company
PHP	Pehur Hydropower Project
PPA	Power Purchase Agreement
PSM	Pakistan Steel Mills
QESCO	Quetta Electric Supply Company
RCET	Regionally Competitive Energy Tariffs
SEPCO	Sukkur Electric Power Company
SEZs	Special Economic Zones
SSM	Small-Scale Manufacturing
SO	System Operator
STSA	Second-Tier Supply Authorization
SOLR	Supply of Last Report
TESCO	Tribal Electric Supply Company
TSOs	Transmission System Operators
T&D	Transmission and Distribution
ToU	Time-of-Use
TUoSC	Transmission Use of System Charge
UoSC	Use of System Charges
VPPs	Virtual Power Plants
WAPDA	Water and Power Development Authority

Abstract

Pakistan's electricity market reforms through wheeling regulations under the Competitive Trading Bilateral Contract Market (CTBCM) framework present critical challenges and opportunities for industrial competitiveness, regional equity, and decarbonization. This white paper examines the structural inefficiencies in the proposed Use of System Charges (UoSC) design, including disparities across Distribution Companies (DISCOs) that lead to critical challenges for industrial growth and investment opportunities. The study also addresses the emerging challenge of the European Union's Carbon Border Adjustment Mechanism (CBAM) and proposes a two-stage compliance strategy. The first stage, i.e. Carbon Pricing Equivalence provides a shadow carbon pricing and Pakistan's Renewable Energy Certificate (PREC) to avoid high tariffs. In the second stage, a non-equivalent adjustment includes carbon clubs and green trade deals to mitigate its liabilities. Moreover, a case study of Pakhtunkhwa Energy Development Organization (PEDO) is discussed to analyze the potential of decentralized wheeling charges, which also highlights data gaps in quantifying broader economic impacts. Finally, a set of key recommendations includes tiered Use of System Charges (UoSC) reforms, Green Bilateral Contracts (GBCs) for CBAM-ready industries, and data transparency initiatives to optimize market design, advocating policymakers to align wheeling regulations with industrial growth and climate goals.

Keywords: Energy Market, Wheeling Regulations, Competitive Trading Bilateral Contract Market (CTBCM), Carbon Border Adjustment Mechanism (CBAM), PEDO, Pakistan' Renewable Energy Certificate, and Green Bilateral Contracts.

1 Introduction

1.1 Background of Electricity Market Reforms in Pakistan

For decades, Pakistan's electricity sector has operated under a centralized, vertically integrated structure with limited scope for competition or private sector participation. The inefficiencies of this model, such as high losses, restricted consumer choice, and weak investment reforms have highlighted the need for a

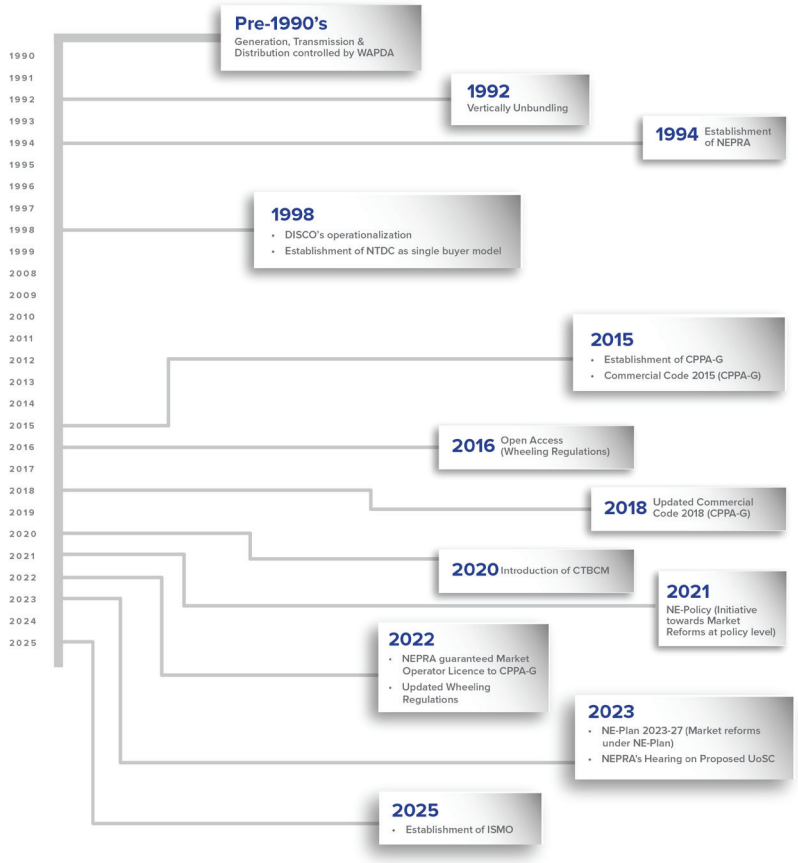


Figure 1:

Evolution of Electricity Market Reforms in Pakistan

decentralized mechanism to liberalize the market. Momentum for these reforms began with the unbundling of WAPDA and the creation of independent generation, transmission, and distribution entities. However, the true shift towards a competitive power market began to materialize with the development of Competitive Trading Bilateral Contract Market (CTBCM) model. National Electric Power Regulatory Authority (NEPRA) intended to be a competitive power market in the early 2012 under the NEPRA Act, but structural and legal limitations delayed its operationalization. Until 2018, the regulatory foundation of the CTBCM had been laid after making key amendments in the Regulation of Generation, Transmission, and Distribution of Electric Power Act (1997) and alignment with the Competition Act (2010). The formal approval of the CTBCM framework was given in 2020, followed by its inclusion in the National Electricity Policy 2021 and the National Electricity Plan 2023–27, which marked a great milestone towards opening Pakistan's wholesale electricity market. The central idea of this model is the transaction of wholesale electricity to multiple buyers and sellers, allowing Bulk Power Consumers (BPCs) to have a sanction load of 1 MW or more to procure electricity directly from competitive suppliers or DISCOs. However, due to certain challenges, the framework has not been implemented so far as of 2025.

1.2 Objectives and Scope of the Paper

This white paper seeks to explore the structure, challenges, and policy implications of wheeling regulations and Use of System Charges (UoSC) in the context of Pakistan's transition towards a competitive electricity market to enhance the industrial competitiveness. It particularly discusses the need for private sector access to competitive, affordable, and clean electricity for export-driven and high energy-intensive industries. Major objectives are as follows:

i. To propose options to implement Carbon Border Adjustment Mechanism (CBAM) under CTBCM regime;

ii. To analyze disparities in UoSC structures across DISCOs and their implications for industrial competitiveness;

iii. To identify financial and technical barriers in wheeling implementation by highlighting the case study of Pehur Hydropower Project (PHP) led by Pakhtunkhwa Energy Development Organization (PEDO); and

iv. To propose a way forward for aligning wheeling charges/UoSC with performance-based pricing, market liberalization, and equitable industrial growth.

2 Regulatory Framework of Open Access and Wheeling Charges in Pakistan

The evolution of the regulatory framework for power wheeling indicates the significant policy shift towards competitive electric power markets in Pakistan. This transformation is rooted under the objectives of CTBCM, which allows consumers to sell electricity directly via open access through grid to other consumers, thereby promotes decentralization of electricity markets and introducing efficiency, transparency and consumer right to select least cost electricity. The foundations of this reform were laid by the introduction of the NEPRA Wheeling Regulations and further reinforced through regulatory instruments, determinations, and licensing processes that followed.

2.1 Overview of NEPRA's Wheeling Regulations

The NEPRA Wheeling of Electric Power Regulations, first introduced in 2016 and provided the baseline for allowing electricity generators to sell power directly to BPCs using the existing infrastructure of DISCOs. These regulations marked Pakistan's initial step toward opening the electricity market, in line with the broader goals of CTBCM. The 2016 Regulations outlined the procedural, technical, and commercial framework under which wheeling transactions would occur, including the requirement for an Energy Wheeling Agreement (EWA) between the generator and the DISCO, and a bilateral Energy Purchase Agreement (EPA) between the generator and the BPC. The revised 2022 Wheeling of Power Regulations introduced significant improvements over the 2016 framework by expanding the scope while including both transmission and distribution systems, updating and clarifying key definitions, and broadening open access to electric power suppliers, captive generating plants, and other entities rather than just generation companies. The new regulations clearly outline responsibilities for financing, constructing, and operating interconnection facilities, allowing for third-party or special purpose company involvement if a network licensee cannot deliver, which was not as flexible in 2016. The updated regulations also provide more comprehensive use of system agreements, with detailed terms for security cover, invoicing, payments, dispute resolution, and compliance with codes. Dispute resolution is more structured, with technical and metering requirements aligned with the latest Grid and Distribution Codes, and financial security provisions are stronger, reflecting a move toward a more open, competitive, and transparent electricity market for all stakeholders. Figure 2 represents the complete flow of wheeling of electric power.

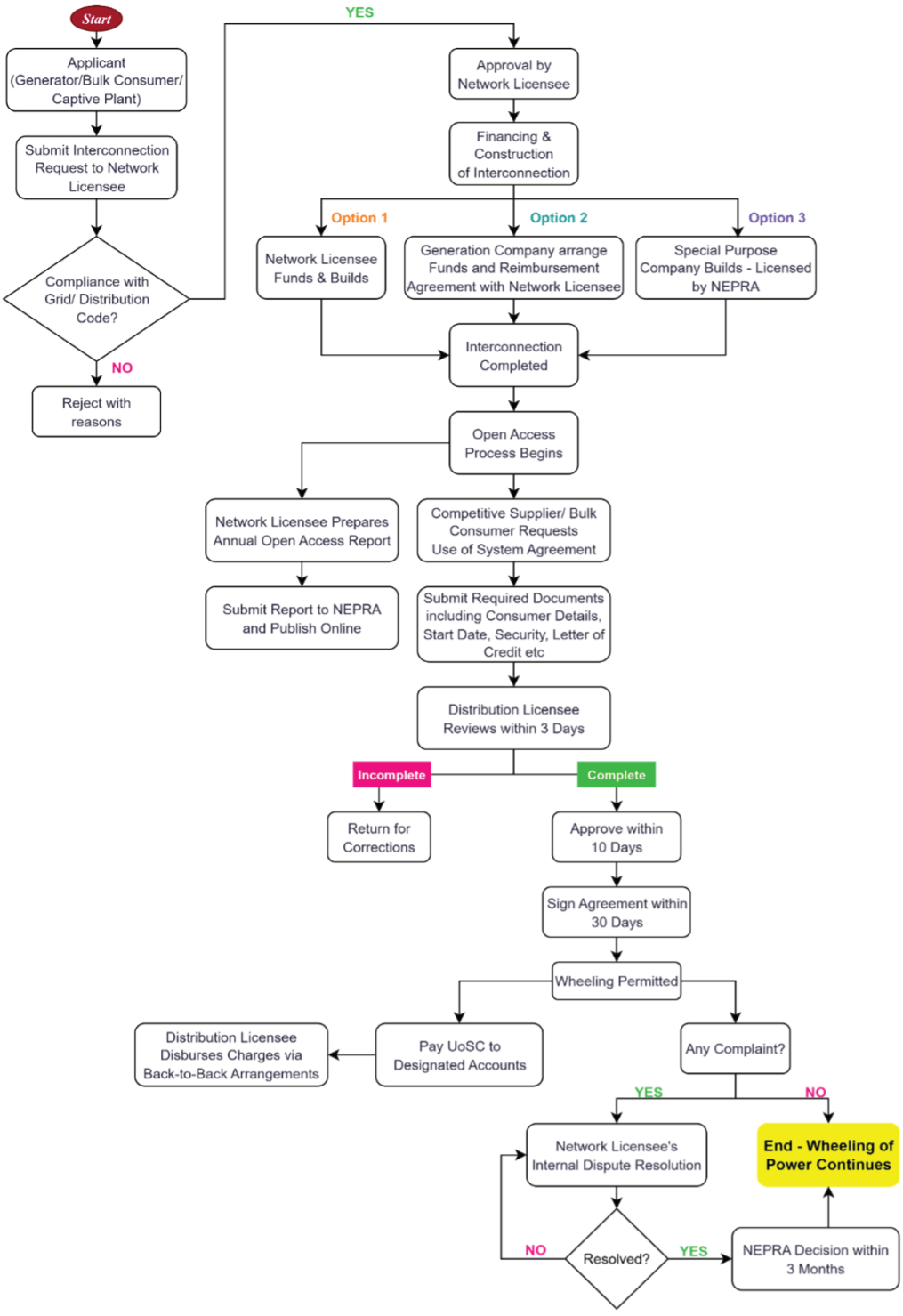
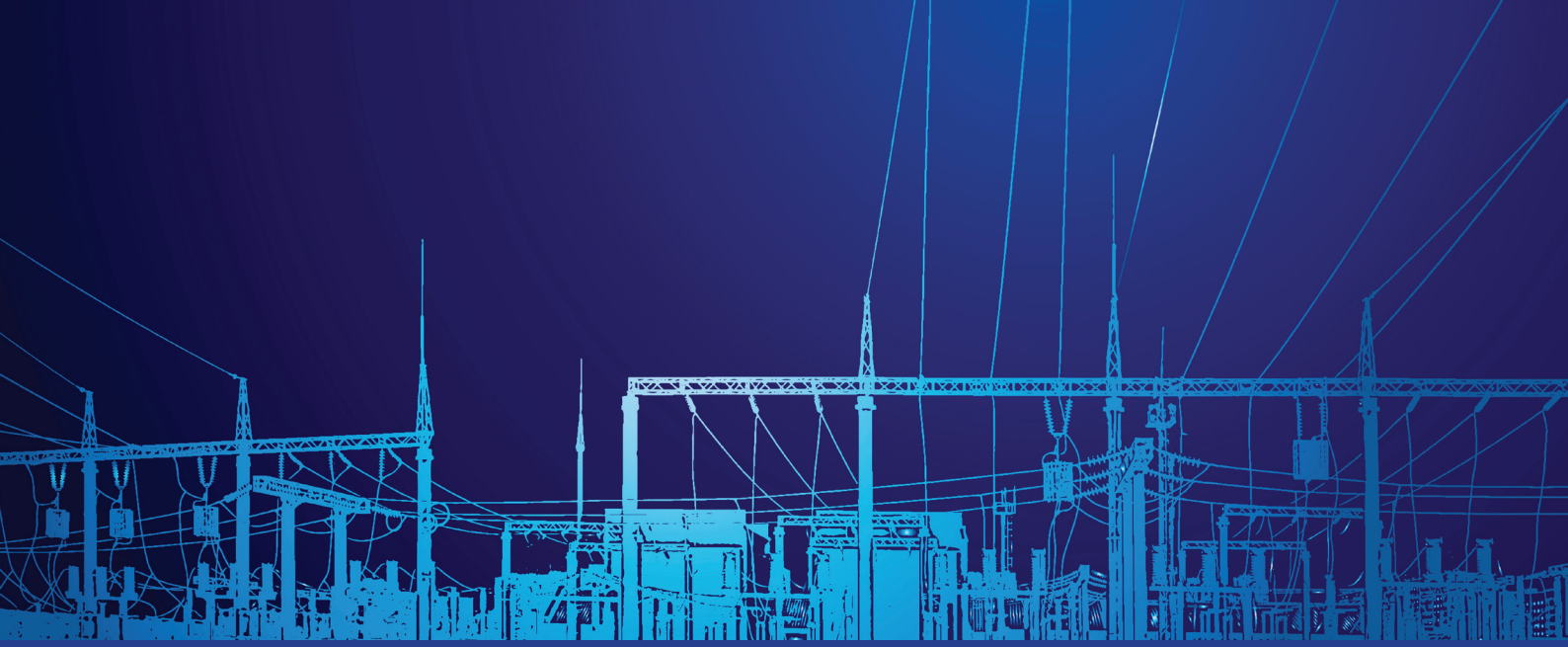


Figure 2:

Flow Diagram of Open Access (Interconnection and Wheeling of Electric Power) Regulations, 2022 Source: (NEPRA, 2022)

2.2 Key Legal Provisions and Market Eligibility

The eligibility criteria for wheeling electricity are primarily based on consumer classification and load demand, where BPCs are defined as end-users with a sanctioned load of 1 MW or more at a single premise. These consumers are permitted to procure power directly from any licensed generator through bilateral contracts, subject to maintaining a connection agreement with the local DISCO and fulfilling all technical and commercial requirements. The Energy Purchase Agreement (EPA) between the generator and the BPC must be submitted to NEPRA for record purposes, while the Energy Wheeling Agreement (EWA) with the DISCO ensures the physical delivery of power via the network. Additionally, the SO or relevant DISCO must verify that the network has sufficient technical capacity to support the power wheeling framework. The financial settlements for wheeling transactions require equitable cost sharing, including UoSC that cover operational, maintenance, and capacity costs of the distribution network. Recently, under the National Electricity Plan 2023-27, the Ministry of Energy (Power Division) proposes amendments to strengthen these provisions, including the introduction of a CTBCM with an initial allocation of 800 MW of electricity capacity for the first five years, subject to revision based on market response. These amendments also aim to establish clear frameworks for open access charges, stranded cost recovery, and tariff rationalization to improve market transparency, financial viability, and competition in the electricity sector (MoEPD, 2025).



3 Use of System Charges (UoSC) and Wheeling Charges Structure

The determination of Use of System Charges (UoSC) and wheeling charges plays a crucial role in Pakistan's wheeling framework by compensating DISCOs and transmission operators for infrastructure use during bilateral electricity transactions. In most of the international best practices, usually wheeling charges consists of transmission fee, distribution and losses charges but Pakistan employs a bundled UoSC as wheeling charges that combines transmission fees, distribution costs, technical losses, system operator fee, market operator fee, and cross-subsidies into a single composite charge. This dense bundling has raised concerns about cost recovery, competitive neutrality, and investor confidence.

3.1 Composition of Use of System Charges (UoSC)

UoSC charges are intended to cover the full costs associated with owning, operating, and maintaining the distribution network by BPCs for using the government's transmission and distribution network within a competitive electricity power market. The UoSC typically comprises the components as represented in Table 1.

Table 1: Components of UoSC

Components	Details	Designated Entity
Transmission Use of System Charge (TUoSC)	by NEPRA, under the Transmission Network Operator(s)/Licensee(s), System Operator (SO) and Metering Service Provider in all DISCOs petitions.	NTDC
Market Settlement Price Fee/ Market Operating Fee (MoF)	The charges for the development and implementation of electric power market operations.	CPPA-G[1] (Under the provision of Commercial Code 2018)
Distribution Use of System (DUoSC)	The charges imposed on consumers for utilizing the distribution network (132 kV and below) to deliver electricity.	DISCO as Distribution Licensee

1. MoF charges are applied according to the provisions of CPPA-G's commercial code. However, this will change once the Independent System Market Operator (ISMO) becomes operational.

Cross Subsidy	A mechanism where certain consumer categories (such as industrial and commercial) pay higher tariffs to subsidize lower tariffs for protected, lifeline, and residential consumers. The cross-subsidy amount is embedded in the power tariffs and is used to support vulnerable groups.	DISCO as Supply of Last Report (SOLR) for supply licensee.
Stranded Capacity Costs	Costs incurred due to underutilized or excess generation and network capacity, which are not fully recovered by market participants.	DISCO as SOLR for supply licensee.
System Operator Charge/ Fee (SoF)	Charges imposed for the system operations, balancing, and management of the transmission system, including real-time dispatch and system reliability.	SO by NTDC[2]
Transmission & Distribution (T&D) Losses	Energy losses as percentage of the units received on sales data for fiscal year.	CPPA-G

3.2 Methodology for Calculating UoSC

According to NEPRA Tariff Determinations[3], the methodology adopted by DISCOs for UoSC calculation was based on a Fully Allocated Cost of Service (FACOS) model.

FACOS
Fully Allocated Cost of Service Model

The FACOS model helps to figure out the actual cost of providing electricity to multiple consumer categories by breaking down all the costs involved in the electricity supply. It calculates the functional cost of service and assigns costs to different parts of the electricity system including generation, transmission and distribution. It helps to determine the following two major costs:

Stranded Costs:
It represents the capacity charges from underutilized generation assets due to Open Access, calculated by allocating the single system peak demand (MW) to consumer categories.

Cross-Subsidy:
It refers to the higher charges on one group to cover lower charges for another group. It is calculated as the difference between the tariff paid by a consumer category and its allocated cost of service under the FACOS model.

2. SoF charges are applied under NTDC regime. However, this will change once the Independent System Market Operator (ISMO) becomes operational.
3. End Consumer Tariff determined through "NEPRA (2014-15), Guidelines for determination of consumer end tariff (Methodology and Process)".

4 Implications of Proposed Wheeling Charges w.r.t Industrial Competitiveness and Regional Equity

Industrial sector of any country is a backbone of economic growth, employment generation, and export diversification. Industries such as textiles, cement, steel, and Large-Scale Manufacturing (LMS) sector have driven regional development, especially in case of Pakistan, Punjab, Sindh, and Khyber Pakhtunkhwa (KPK) has contributed significantly to the national Gross Domestic Product (GDP). According to the Pakistan Economic Survey 2024–25, the manufacturing sector contributes 13.2% to GDP, with LSM accounting for 8.0%, Small-Scale Manufacturing (SSM) for 2.4%, and slaughtering for 1.4% (MoF, 2025). The percentage growth rate of manufacturing and mining sector for July-March FY 2025 is represented in Figure 3.

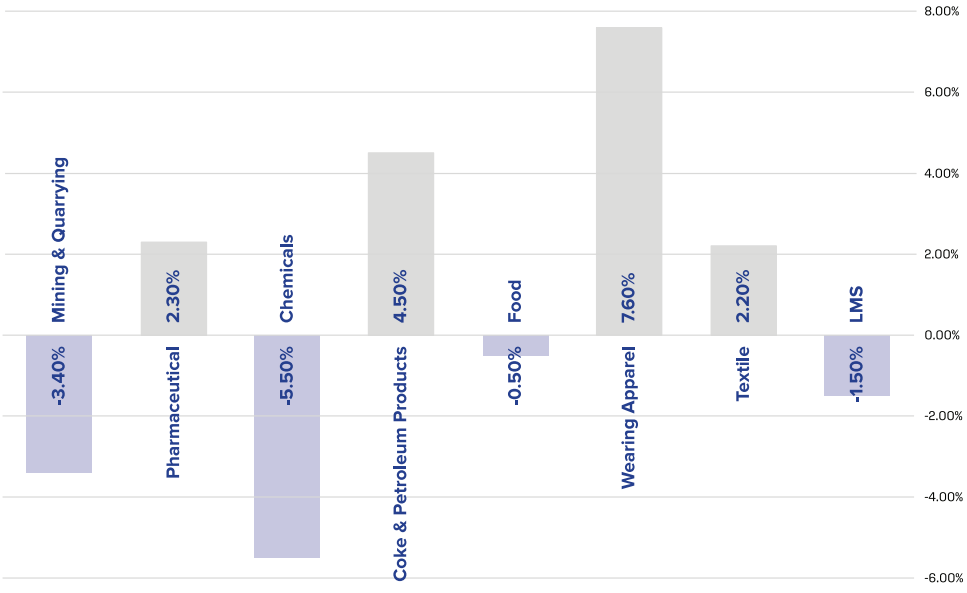
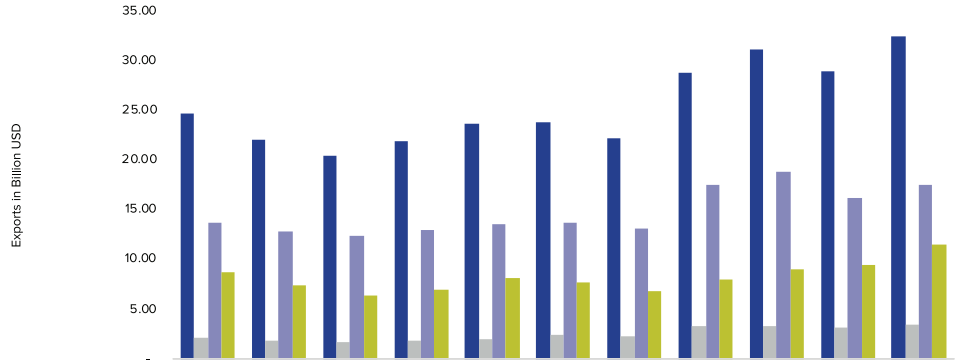


Figure 3:

%age Growth Rate of Manufacturing & Mining Sector (Jul-Mar FY2025) Source: (MoF, 2025)

Figure 3 showed that during July–March FY2025, Pakistan's LSM sector contracted by 1.5%, reflecting less industrial growth rate. While textiles, wearing apparel, and pharmaceuticals at 2.2%, 7.6% and 2.3% respectively showed modest growth. However, key sectors such as chemicals, food and mining & quarrying at -5.5%, -0.5% and -3.4% respectively have shown negative trends. This mixed performance highlights continued volatility in industrial output due to high energy tariffs and demand pressures. This industrial performance is further reflected in Pakistan's export composition, where limited value addition and structural inefficiencies hinder the diversification into higher value chain manufacturing goods. Moreover, it can be observed from Figures 4 and 5 that globally engineering goods dominate exports with a 53.65% share in 2024, Pakistan's export basket remains heavily concentrated in textiles, comprising 53.95% of total exports, with engineering goods contributing only 10.52%. Despite a modest rise in engineering exports from $2.17 billion in 2014 to $3.42 billion in 2024, the sector continues to lag in both volume and diversification. This limited industrial upgrade reflects deeper structural constraints towards energy affordability and reliability. These persistent challenges related to energy affordability, reliability, and regional disparities have constrained industrial expansion particularly in less developed sectors and provinces. As Pakistan transitions toward the liberalized CTBCM framework, the rationalization of UoSC becomes critical not only for domestic industrial competitiveness but also for addressing emerging cross-border carbon regulations. While the current UoSC design is still under dispute across regions, which leads towards serious threats to industrial competitiveness, regional equity, and investment flows. Additionally, these market reforms now also face additional complexity from the European Union (EU) Carbon Border Adjustment Mechanism (CBAM). CBAM's stringent requirements for electricity imports, particularly its restrictive definition of Power Purchase Agreements (PPAs) that conflicts with CTBCM's pooled-supply model, create new compliance challenges for Pakistan's export-oriented industries.



	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
All products	24.72	22.09	20.53	21.91	23.78	23.82	22.25	28.88	31.18	28.95	32.46
Engineering Goods	2.17	1.78	1.67	1.86	2.01	2.43	2.29	3.31	3.27	3.17	3.42
Textile & Articles of Textile	13.77	12.92	12.41	13.02	13.65	13.70	13.11	17.51	18.86	16.25	17.51
Others	8.78	7.39	6.45	7.03	8.12	7.69	6.85	8.06	9.04	9.53	11.53

Figure 4:

Pakistan's Exports in Billion USD from CY 2014-24 Source: (ICT Trade Map, 2025)

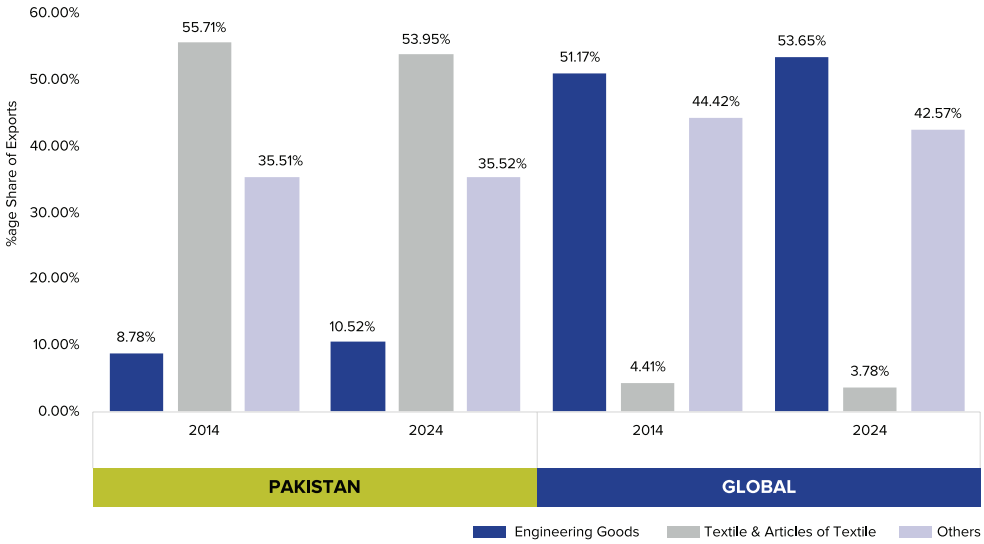


Figure 5:

Pakistan vs. Global Category-wise %age Share of Exports for CY 2014 & 2024
Source: (ICT Trade Map, 2025)

4.1 Industrial Competitiveness under Carbon Border Adjustment Mechanism (CBAM) and CTBCM Regime

The CTBCM framework presents a unique opportunity to structurally embed carbon accounting into Pakistan's power market design, while creating CBAM penalties. By mandating verified emissions data for all wheeling transactions using NTDC's grid emission factors, CTBCM can generate carbon electricity footprints and provides the foundational requirement for CBAM compliance. According to Eurelectric. (2024, June), proposed options to implement CBAM in the power sector can be applied to Pakistan's power sector under the CTBCM regime.

Table 2 outlines a proposed two-stage approach aligning CTBCM with CBAM requirements. Stage-I provides strategy that aims to secure full or partial CBAM exemptions by proactively aligning Pakistan's power market with EU climate standards. This involves integrating shadow carbon pricing into NEPRA tariffs for CFPPs, establishing a Pakistan's Renewable Energy Certificate (PREC) system recognized under EU Guarantees of Origin. Further for monitoring and reporting, a transparent, emissions-based wheeling charge model at the DISCO level helps to reduce emissions. These interventions collectively ensure the internalization of carbon cost, emissions traceability, and exports compliant with EU decarbonization to enhance green export branding and attract climate-aligned foreign investment.

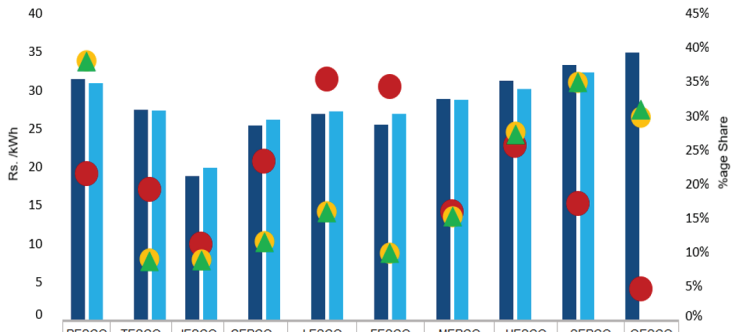
However, if full equivalence is not achieved or is delayed, Stage-II acts as a risk mitigation layer by ensuring exporters remain competitive despite CBAM-related costs. This includes creating institutional mechanisms through CPPA-G/ ISMO for exporters to purchase CBAM allowances, pursuing bilateral trade deals that include mutual recognition of RE based Green Bilateral Contracts (GBCs) for duty-free access, and establishing carbon clubs to reward industries based on efficiency and sectoral benchmarking. These targeted responses reduce CBAM liabilities while incentivizing domestic decarbonization, ultimately positioning Pakistan's efficient industries to maintain or expand market share in the EU.

Table 2: Proposed Options to Implement Carbon Border Adjustment Mechanism (CBAM) under CTBCM Regime

Stage	Objective	CTBCM Implementation Options	Key Requirements	Potential Outcomes
Stage-I: Carbon Pricing Equivalence	Introduce CBAM through recognized carbon pricing	1. Shadow Carbon Pricing for all Coal Fired Power Plants (CFPPs).	• NEPRA tariff reforms • Legal alignment with General Agreement on Tariffs and Trade (GATT). • European Union (EU) recognition of Pakistan's Renewable Energy Certificate (PREC).	• Green export branding. • Increased Foreign Direct Investment (FDI) in renewables.
		2. PREC System.	PREC registry alignment with EU Guarantees of Origins (GOs) standards.	• CBAM compliance for Renewable Energy (RE) powered exports. • Premium pricing for certified green products.
		3. Detailed Reporting of Wheeling/ UoSC Impacts.	• Non-Uniform wheeling charges across DISCOs • DISCOs-level emission factors alignment with EU's Emissions Trading System (ETS).	• Emissions mitigations. • Level playing field for industries.
Stage-II: Non-Equivalence Adjustments	Mitigate CBAM impacts when equivalence not achieved	1. Carbon Involvement.	• Bilateral negotiations • Transparent revenue allocation mechanism • Exporters buy CBAM allowances via CPPA-G/ ISMO.	• Reduced CBAM liabilities. • RE capacity addition Competitive advantage for clean industries.
		2. Green Trade Deals.	Mutual recognition of RE based Green Bilateral Contract (GBCs).	• Duty-free access for certified green exports through Free Trade Agreements (FTAs), Preferential Trade Agreements (PTAs) etc. • Technology transfer for decarbonization
		3. Carbon Clubs for Industries.	• Tiered industry classification w.r.t energy efficiency (Low/Medium/ High). • Sectoral emissions benchmarking. • Automated carbon accounting.	• Highly efficient industries will gain EU market share.

4.2 Regional Disparities in Proposed UoSC

The UoSC structure as debated in NEPRA's public hearing in November 2023 revealed multiple disparities in wheeling charges for B-3 and B-4 consumers across DISCOs. These differences are not always justified by technical factors such as voltage-level losses or system efficiency. According to (NEPRA's UoSC Public Hearing, 2023), Figure 6 provides the analysis of proposed UoSC rates, losses and industrial characteristics across DISCOs with significant regional disparities that are not explained by technical performance alone. For instance, QESCO, despite having only 5% industrial energy sales, proposed the highest B-3 UoSC at Rs. 34.99 per kWh, alongside T&D and overall distribution losses of 30% and 31% respectively. In contrast, IESCO, with relatively better operational performance with only 9% losses and a moderate 11% industrial share, offers the lowest B-3 UoSC at Rs. 18.81 per kWh. Similarly, SEPCO and HESCO, with 35% and 27% system losses, respectively, impose B-3 and B-4 UoSC rates exceeding Rs. 30 per kWh, despite having only 17% and 26% industrial consumption shares. Meanwhile, FESCO, with 34% industrial sales, 10% losses, and a more efficient cost base, charges Rs. 25.55 per kWh, indicating the benefit of operational efficiency and scale. PESCO, which records the highest total system losses of 38% with proposed B-3 UoSC of Rs. 31.5 per kWh, significantly burdening industries in KPK despite their 21% energy sales share. By comparison, GEPCO and LESCO, with industrial sales shares of 23% and 35%, maintain B-3 UoSC around Rs. 25 to 27 per kWh, benefiting from economies of scale and better loss control. The inconsistency in pricing is further amplified in B-4 consumers (66/132 kV). QESCO, SEPCO, and MEPCO all propose rates exceeding Rs. 28 per kWh, whereas IESCO, GEPCO, and FESCO remain in the Rs. 19 to 26 per kWh band. These patterns underscore a mismatch between UoSC levels, grid performance, and industrial load profiles.



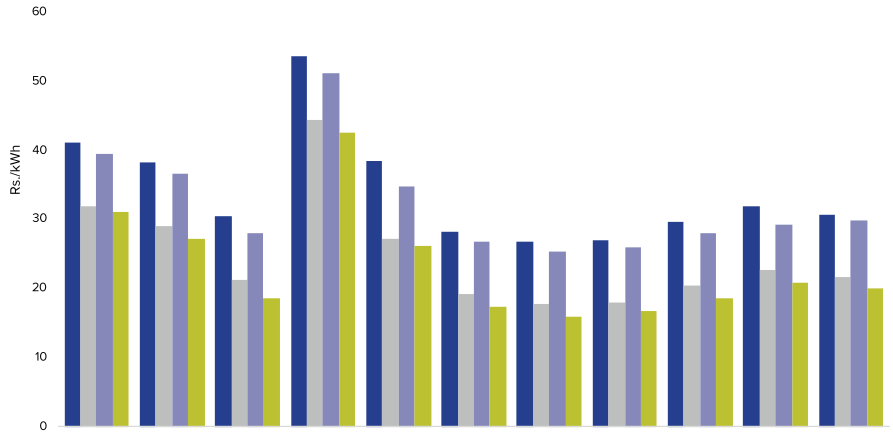
	PESCO	TESCO	IESCO	GEPCO	LESCO	FESCO	MEPCO	HESCO	SEPCO	QESCO
% age Share Industrial (GWh Sold)	21%	19%	11%	23%	35%	34%	16%	26%	17%	5%
B-3 (11, 33 kV) Proposed UoSC (Rs./kWh)	31.5	27.44	18.81	25.41	26.94	25.55	28.84	31.29	33.28	34.99
B-4 (66,132 kV) Proposed UoSC (Rs./kWh)	30.97	27.32	19.9	26.17	27.25	26.93	28.75	30.15	32.39	
T&D Losses (Total Actual %)	38%	9%	9%	12%	16%	10%	15%	28%	35%	30%
Distribution Losses (Overall System)	38%	9%	9%	11%	16%	10%	15%	27%	35%	31%

Figure 6:

Pakistan's Exports in Billion USD from CY 2014-24 Source: (ICT Trade Map, 2025)

Overall, high-loss DISCOs with limited industrial bases are passing inconsistent costs onto fewer consumers, while more efficient DISCOs offer relatively lower wheeling charges, reinforcing geographic disparities. This unequal pricing structure leads to negative impacts on investment decisions, penalizes industries in underdeveloped regions, which needs to be allied with the principles of open access and boost competitive environment under CTBCM framework. These inefficiencies are further entrenched by the existing policy mandate for uniform UoSC across all DISCOs.

The Rule 5 (2)(c) of the Supplier Rules, notified by the Government of Pakistan and Strategic Directive 88 of the National Electricity (NE) Plan 2023-27 recommends UoSC, which includes wheeling charges, cost of open access & cross subsidy, to be uniform across all DISCOs as the prevailing policy for applicable tariff is currently uniform across the country (MoEPD, 2023). This leads the monopolistic inefficiencies, directly contradicting market liberalization goals under the UoSC framework.



	PESCO	HESCO	GEPCO	QESCO	MEPCO	FESCO	LESCO	IESCO	SEPCO	TESCO	Uniform
B-3 ToU (Peak)	41.12	38.3	30.5	53.58	38.39	28.31	26.89	27.06	29.65	31.85	30.75
B-3 ToU (Non-Peak)	31.93	29.11	21.32	44.4	27.21	19.12	17.71	17.97	20.47	22.66	21.65
B-4 ToU (Peak)	39.58	36.72	28.06	51.12	34.74	26.77	25.45	26.06	28.02	29.31	29.92
B-4 ToU (Non-Peak)	31.09	27.23	18.57	42.63	26.25	17.28	15.96	16.67	18.53	20.82	19.98

Figure 7:

Tariff Determinations by NEPRA for July 2025 in Rs. per kWh Source: (NEPRA, 2025, July 1)

Figure 7 shows the NEPRA's tariff determinations for the month of July 2025, where Time-of-Use (ToU) tariffs for industrial consumers of B-3 and B-4 categories vary substantially across DISCOs. For instance, QESCO charges B-3 consumers Rs. 53.58 per kWh for peak and Rs. 44.4 per kWh for non-peak, which is almost double the rates in GEPCO with Rs. 30.5 and 21.32 per kWh, respectively. Similarly, PESCO and HESCO impose significantly higher B-3 peak tariffs compared to LESCO. A similar pattern holds for B-4 consumers, where QESCO again leads with Rs. 51.12 and 42.63 per kWh for both peak and non-peak ToUs. These varying tariffs differ significantly from NEPRA's uniform rates of Rs. 30.75 per kWh for B-3 peak and Rs. 29.92 per kWh for B-4 peak, which fails to reflect the operational realities and grid performance variations across regions. While NEPRA has acknowledged that a one-size-fits-all tariff is not equitable but is still unable to develop an Integrated Energy Planning (IEP) that accounts for regional infrastructure costs, technical losses, and investment needs. Without this, uniformity in tariffs leads to inefficiencies, results in declined industrial growth in high tariff regions, and misaligns with the core objectives of CTBCM.

4.3 Audit Insights from Ministry of Industries and Production (MoIP) 2023–24

According to MoIP (2023-24), the Ministry of Industries and Production (MoIP) audit for FY 2023–24 revealed critical gaps in consumer classification, billing integrity, and cost recovery. A few of them are discussed below.

- Pakistan Steel Mills (PSM) remained misclassified as an industrial consumer despite being non-operational since 2015. It paid high industrial tariffs to K-Electric (KE) while charging residential rates to its tenants and employees, causing a loss exceeding Rs. 1 billion in FY 2022–23.
- In Export Processing Zone Authority (EPZA) Karachi, over Rs. 3.1 billion in electricity dues remained unpaid by industrial investors. These systemic failures are two examples of mismanagement and loss of DISCO revenue in special economic zones.

4.4 Subsidy Allocation and Tariff Rationalization for Electric Vehicle Charging Stations (EVCS)

During a recent regulatory proceeding, the Federal Government filed a motion and policy guideline seeking the rationalization of electricity tariffs for Electric Vehicle Charging Stations (EVCS). In response, NEPRA issued a decision on June 14, 2024, amending the tariff classification for EVCS across all DISCOs. These emerging tariff reforms for EVCS under Pakistan's New Electric Vehicle Policy (NEVP) 2025 have raised concerns about subsidy targeting. According to (NEPRA, 2025, May 22), a revised tariff reclassification for EVCS under a dedicated A-2(d) commercial category has been proposed to NEPRA by setting a fixed rate of Rs. 23.57 per kWh, excluding monthly Fuel Cost Adjustments (FCA) to incentivize the clean mobility initiative. NEPRA rejected this proposal, responding that shifting the financial burden of supporting EVCS to the general consumer base is not a viable decision. This case highlights the growing tension between policy-driven incentives for clean technologies and the need for fair and cost-reflective electricity pricing mechanisms, which can be achieved under CTBCM.

4.5 Tariff Un-competitiveness and Exports Decline of Textile Sector

In its formal submission to NEPRA during the 2023 public hearing on UoSC reforms, the All-Pakistan Textile Mills Association (APTMA) presented a detailed analysis highlighting the uncompetitive electricity tariffs on Pakistan's export-led industries. According to (APTMA, 2023), it was highlighted by APTMA that withdrawal of Regionally Competitive Energy Tariffs (RCET) has severely disrupt Pakistan's textile exports, investment momentum, and job creation. With tariffs increasing to 14 cents per kWh, energy constitutes nearly a quarter of input costs, pushing profitability to unsustainable levels and forcing many firms to reduce operations or shifting towards off-grid solutions. APTMA linked this crisis to structural inefficiencies in the tariff regime, such as cross-subsidies, stranded costs, and duplicated charges, which increases the cost of finished goods. It is recommended that NEPRA should support CTBCM reforms, including direct B2B contracts, capping wheeling charges at 1 to 1.5 cents per kWh, and expanding net metering to 5 MW to avoid risks of export decline, industrial contraction, and non-compliance with future carbon trade regulations like CBAM.

5 Case Study: Wheeling Power Experience by Pakhtunkhwa Energy Development Organization (PEDO)

KPK has huge potential for hydropower up to 30,000 MW, but industries still face power shortages. The demand is 3,300 MW, but supply is only 1,700 MW. As a result, many industrial units rely on expensive grid electricity or diesel generation, undermining their profitability and productivity. To address this issue, the Pakhtunkhwa Energy Development Organization (PEDO) initiated a wheeling agreement through its Pehur Hydropower Plant (PHP), supplying electricity directly to BPCs using PESCO's distribution network. During Phase-I in 2019 of the wheeling agreement, eight BPCs of KPK applied have applied, out of which six have been qualified for this process. However, during Phase-II in 2020, seventy-four new BPCs applied for sales of 148 MW, reflecting strong industrial demand. Since PEDO ensured transparency through a competitive bidding process, where BPCs offered "Bid Energy Percentages" between 10% and 30%. However, the project encountered regulatory and operational pushbacks. PESCO raised concerns over revenue loss and unaccounted technical losses, while CPPA-G has mentioned the violations of central dispatch protocols. Although NEPRA approved PEDO's license modification, broader issues such as stranded cost recovery and hybrid consumer categorization were deferred for future regulatory deliberation. The case thus became a focal point for addressing broader regulatory concerns particularly around tariff recovery mechanisms, duplication of charges, and market transition protocols. Furthermore, the overall details of PHP bilateral wheeling power are discussed below:

5.1 Pehur Hydropower Project (PHP) Bilateral Wheeling Power Arrangement

The Pehur Hydropower Project (PHP) is a run-of-river hydroelectric plant developed by the Pakhtunkhwa Energy Development Organization (PEDO) in the province of Khyber Pakhtunkhwa. PHP installed capacity is 18 MW with 3 turbines of 6 MW each (1 low head, 2 Medium head). However, PHP has a dual generation trend i.e. low hydrology and high hydrology trends depending primarily on water discharge from Tarbela dam. Accordingly, the 3 units of 6 MW generally operate as per the following two settings:

- 1-unit low head 1x6 = 6 MW (from February to June - average head 40 meters).
- 2-units medium head 2x6 = 12 MW (from July to January - average head 68 meters).

PEDO transitioned towards a bilateral power wheeling arrangement, aiming to sell electricity directly to industrial consumers whether within or outside the province by utilizing PESCO and NTDC transmission networks. To enable this shift, PEDO applied to NEPRA for an amendment to its generation license, requesting Second-Tier Supply Authorization (STSA), which would allow it to function as a supplier under a bilateral Energy Purchase Agreement (EPA). Additionally, PEDO entered into a Wheeling Agreement with PESCO, authorizing the use of the 132 kV network for energy transmission. This transition was initially aligned with NEPRA's Wheeling of Electric Power Regulations, 2016. Since PHP is already connected to the PESCO grid and the prospective industrial buyers are also within the same network, the existing interconnection and metering infrastructure is expected to be adequate under the current wheeling framework. While no technical upgrades are anticipated, final confirmation from PESCO will be required after the EPA is signed with the selected buyers. Should any technical modifications be necessary, their costs identified in the bidders' Technical Proposals will either be covered by PESCO (if mandated by the Wheeling Regulations) or by the successful bidder. In this setup, the meter at the PHP facility (Entry Meter) will track the electricity fed into the PESCO network, while meters at the buyers' sites (Exit Meters) will measure the electricity received. This entry and exit meters together fulfill the metering requirements as mentioned under the Wheeling Regulations.

The Bidders in wheeling framework will compete for a portion of the available electricity based on percentages, not in fixed energy units like GWh. Only one bid is submitted by a successful bidder with 10%, 20%, or 30% of the total electricity being offered. Bids lower than 10% or higher than 30% will not be accepted. Also, the amount of electricity a bidder requests in kWh must not exceed 75% of their total electricity consumption from the PESCO grid over the past twelve months. The overall wheeling arrangement is summarized in Figure 8.

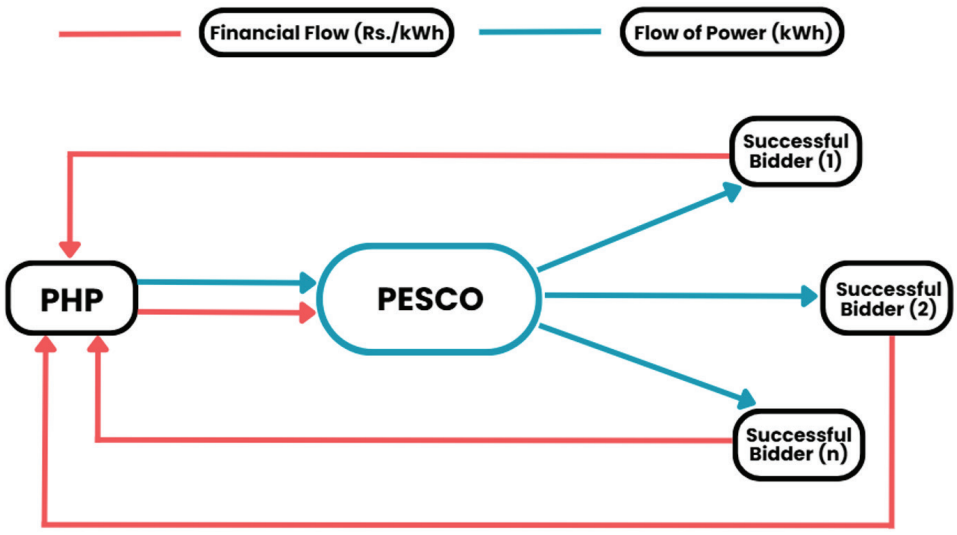


Figure 8:
Wheeling Arrangements of PEDO with PHP under PESCO's Network

5.2 Lessons Learned for Other Provinces

The experience of PEDO provides valuable lessons for shaping effective and decentralized energy strategies under the evolving CTBCM framework. PEDO's initiatives, particularly its efforts to develop indigenous renewable energy projects

and facilitate industrial wheeling arrangements in Gadoon Economic Zone, reflect the growing role of provincial entities in driving localized energy solutions. However, only a few industrial units benefitted from rates as low as Rs. 2.5 to 8 per kWh and revealed structural shortcomings in access, equity, and regulatory coordination. A few lessons that can be learned for other provinces are detailed below:

Regulatory Clarity and Adaptability: The PEDO wheeling power case revealed gaps in existing regulations, such as the lack of provisions for recovering technical losses and cross-subsidy charges from BPCs. Provincial initiatives must advocate clear, flexible regulations that balance consumer benefits with grid sustainability, as seen in NEPRA's phased modifications to the wheeling framework.

Financial Viability and Risk Allocation: PESCO's concerns about stranded costs and non-recovery of fixed charges highlighted the need for robust financial modeling. Future projects should incorporate safeguards to protect DISCO's revenue streams while incentivizing industrial consumers through competitive tariffs.

Data-Driven Planning and Scalability: KPK's demand-supply gap of 1,700 MW supply vs. 3,300 MW demand and PHP's generation data underscored the importance of data transparency for scalability. Other provinces should prioritize detailed demand assessments and pilot projects to test feasibility before large-scale projects.

6 Recommendations and Way Forward

The evolution of Pakistan's electricity market under the CTBCM presents a vital opportunity to redesign wheeling charges and UoSC in a way that balances the interests of industrial consumers and the national grid. The current cost structure shows the regional disparities, cross-subsidies, and inefficiency which undermines the major goals of market liberalization. As new types of energy transactions (grid-based wheeling, off-grid bilateral sales, and embedded generation) begin to emerge, more equitable, performance-based, and forward-looking tariff designs will become essential. The following recommendations are structured into progressive scopes, each corresponding to a different level of market maturity and grid participation.

Scope-I: Alignment of UoSC and Wheeling Charges in Grid-based Transactions Scenarios

Under the CTBCM regime, the economic interaction between industrial consumers and the national grid depends heavily on how wheeling charges are set relative to the UoSC. Based on stakeholder feedback and analysis, four different operational scenarios emerge as discussed in Table 3.

Table 3: Operational Scenarios of UoSC with Stakeholder's Benefits

Scenarios	Description	Stakeholders Benefits		
		Industrial Consumers	National Grid	Other Consumers
UoSC = Wheeling Charges (Wheeling Charges = TUoSC+ DUoSC+System Losses)	If UoSC is equal to Wheeling Charge (Ideal Case).	More benefit	Less benefit	Loss
UoSC = Wheeling Charges	If UoSC is approximately equal to Wheeling Charge.	Moderate benefit	Moderate benefit	Moderate loss
UoSC >> Wheeling Charges	If UoSC is greater than wheeling charges.	Loss	More benefit	Status Quo

- In the first and ideal scenario, UoSC is exactly equal to the wheeling charges (Wheeling Charges = Transmission Network (TUoSC equivalent) + Distribution Network (DUoSC equivalent) + System Losses (charged separately) + Postage stamp adjustment[4] as discussed in (WHEELING FRAMEWORK FOR THE ESWATINI ELECTRICITY SUPPLY INDUSTRY, 2022). This results in the highest benefit to industry, promoting competitive procurement without placing undue cost burdens of standard costs and cross subsidies. However, this arrangement yields limited financial benefit to the national grid, as DISCOs only recover baseline costs and lose volumetric revenue from large consumers and other consumers may bear outstanding cost pressures due to shifting cross-subsidies.
- In the second scenario, UoSC is approximately equal to the wheeling charges. This balance creates moderate benefit for both stakeholders and receive partial savings while the grid retains a share of value through service provision. However, the impact on other consumers is limited if the volume of bilateral trade is kept low. This scenario allows for practical compromise and may serve as the baseline for UoSC policy design in the early years of CTBCM implementation.
- In third scenario, the UoSC is greater than the wheeling charges, in which the cost of using the grid compensates for the value of open access, resulting in reduced or negative net benefit for industrial consumers. While national grid may gain higher cost recovery in the short term, this structure disincentivizes market participation and preserves the status quo for other end consumers and discourages broader market liberalization goals.

Scope-II: Encouraging Clean Industrial Transitions through Green Bilateral Contracts (GBCs)

The CTBCM framework provides a critical opportunity to support Pakistan's clean energy transition by enabling Green Bilateral Contracts (GBCs) between renewable energy producers and industrial consumers. These contracts allow export-oriented industries, particularly those in Export Processing Zones (EPZs) to procure electricity directly from solar, wind, or hybrid RE plants. To operationalize GBCs effectively, Demand Side Management (DSM) strategies should be adopted to map and unlock underutilized grid zones where Maximum Demand Indicators (MDIs) are consistently below peak demand. These MDI-based fixed charges can be optimized by integrating DSM insights, allowing more accurate cost recovery from industries while offering incentives for peak-shaving and load flexibility. This ensures that green bilateral consumers do not unfairly burden the grid while still benefiting from clean energy access. Additionally, UoSC

4. Postage stamp adjustment is a flat, non-distance-based surcharge to ensure the utility recovers total allowed network revenue after applying optimal power flow-based charges.

can be differentiated for GBC-linked industrial loads by offering preferential rates in low-demand zones or where RE integration supports grid stability and will also support CBAM initiatives. The details of DSM framework under CTBCM are further explained in Annexure-I. Additionally, a tiered UoSC framework should be introduced based on voltage level at multiple kV and DISCO-specific technical losses. This will reward efficiency and reduce the burden on low-loss, high-performance networks, avoiding a one-size-fits-all distortion. A loss-adjusted and zone-sensitive pricing formula should be adopted, gradually replacing uniform UoSC assumptions.

Scope-III: Incentivized UoSC Based on Industrial Performance and Efficiency Gains

To create long-term alignment between electricity pricing and economic development, the UoSC framework under CTBCM should incorporate performance-based incentives for industrial consumers. High energy intensive sectors such as engineering and manufacturing require stable, cost-effective, and regionally equitable power supply. Therefore, local manufacturing industries that demonstrate sustained growth in production output, export earnings, and internal efficiency improvements should be rewarded through lower UoSC rates. This approach recognizes industries not just as consumers of electricity, but as contributors to national economic value and grid stability. This incentive-based UoSC model would particularly benefit high potential sectors such as textiles, engineering goods, agro-processing, and pharmaceuticals, encouraging them to remain connected with national grid rather than shifting entirely to captive or off-grid solutions. DISCOs, in turn, would benefit from stable industrial demand, better load predictability, and improved financial performance.

Scope-IV: Addressing Negative Competition in UoSC to Preserve CTBCM Objectives

The emergence of unregulated or selectively negotiated UoSC rates has created negative competition among industrial participants, undermining the core objectives of CTBCM. A clear example of this is observed in Gadoon Economic Zone, where only a limited number of industries are accessing wheeling arrangements at preferential as low UoSC rates ranging from Rs. 2.5 to 8 per kWh, while other industrial consumers remain excluded or unserved under similar terms. Such selective arrangements lead to unfair competitive advantage for a few players while disadvantaging others operating under standard tariffs or being unable to secure similar deals. This not only discourages broader industry participation in wheeling but also reduces trust in the transparency and equity of the market reform process. To resolve this, NEPRA must establish a level playing field for all eligible industries, particularly in industrial zones and special economic regions through CTBCM.

Scope-V: Ensuring Data Transparency for Market Scalability

The effective implementation of CTBCM depends across regions and consumer categories depends on data transparency, which must be institutionalized across all market participants, particularly DISCOs, system operators, and regulators. For this purpose, designated data centers should be established for real-time data monitoring related to UoSC, grid losses, network constraints, demand profiles, and bilateral transactions should be made publicly available in standardized formats. This will not only improve investor confidence and reduce information distortions but also allow industries, provinces, and third-party suppliers to make informed procurement and siting decisions. Transparent datasets are essential to identify high-potential wheeling zones, monitor performance, and enable fair benchmarking across DISCOs.

7 Conclusion

In conclusion, this white paper highlights the potential of Pakistan's CTBCM framework in addressing industrial competitiveness, regional equity, and decarbonization through wheeling reforms. By analyzing the structural challenges in UoSC design, disparities across DISCOs, and the implications of CBAM, the paper advocates for a market-based approach that aligns wheeling charges with performance-based pricing and renewable energy integration. The PEDO case study demonstrates the viability of decentralized wheeling arrangements but also highlights critical data gaps, such as limited industrial participation towards wheeling regulations, lack of provisions for recovering technical losses, cross-subsidy charges from BPCs, and robust modeling of wheeling impacts. For future policy formulation, precise quantification of UoSC components, granular data on industry employment size, production units, and export volumes linked to wheeling of power is essential to quantify benefits accurately. Addressing these limitations while scaling CTBCM's implementation can unlock Pakistan's industrial potential, ensure CBAM compliance, and substitute a competitive, low-carbon energy market.

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9 Annexure

Annexure-I: Significance of Demand Side Management (DSM) in CTBCM

DSM is a strategy for electric utilities to control electricity demand by incentivizing consumers to modify their energy consumption patterns during peak hours or reduce their overall energy consumption. The primary objective of DSM is to optimize energy demand rather than increasing energy supply. DSM involves modifying consumer load profiles through energy efficiency, load shifting, and peak demand reduction.

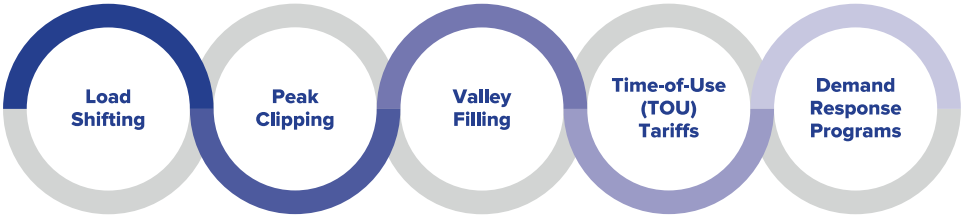

Figure 9:
DSM Techniques

Under CTBCM, where multiple market players engage in bilateral trading and competition drives efficiency, DSM provides a non-supply-side solution to balance the system. It allows both utilities and consumers to play an active role in demand shaping, particularly through mechanisms such as dynamic pricing, Time-of-Use (TOU) tariffs, peak load shifting, and Demand Response (DR) programs. Therefore, to enhance planning under the CTBCM framework under DSM, a machine learning based nodal demand profiling using K-Means clustering can enhance this process by identifying low, medium and high demand clusters.

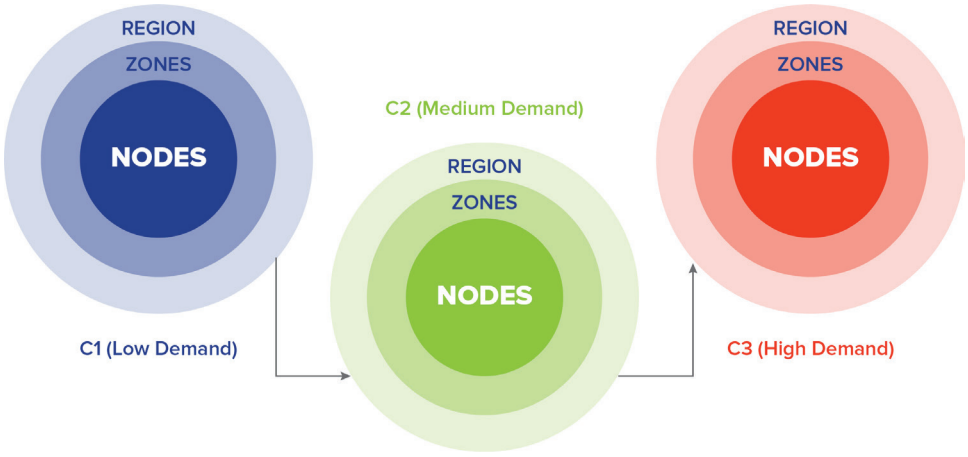

Figure 10:
DSM Conceptual Model: Clustering of Nodal Demand Patterns

According to the study by Pelekis et al., (2023), the modern electricity market is segmented into energy, capacity, and ancillary services, in which DR and nodal profiling play vital roles in enabling locational flexibility and real-time balancing in the following ways:

- Transmission System Operators (TSOs) can better anticipate nodal constraints and procure flexibility services through targeted DR contracts.
- Suppliers can create differentiated energy contracts, including DR-based tariffs specific to clustered load profiles. They also benefit from more accurate forecasting of their aggregated demand portfolios, reducing imbalances.
- End-users, especially those within Special Economic Zones (SEZs) or industrial parks, can respond to price signals or participate in automated DR programs through in-house energy management.
- Aggregators play a pivotal role by bundling small-scale flexibility from multiple nodes within a cluster, creating Virtual Power Plants (VPPs) capable of bidding into energy and ancillary markets. These clusters enable aggregators to offer reliable capacity for frequency reserves, voltage support, and ramp-up/ramp-down balancing services.
- Producers, particularly in high-demand clusters, can design hybrid generation-storage portfolios optimized for locational DR and market arbitrage.

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