



RENEWABLES FIRST

PAKISTAN
E  **ELECTRICITY**
REVIEW 2024

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Disclaimer:

All the information and analysis provided in this document are accurate and to the best of our knowledge and understanding, in case you identify any error, feel free to reach out to us at: info@renewablesfirst.org

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Pakistan Electricity Review 2024

The Pakistan Electricity Review 2024 report aims to improve technical accessibility and awareness of critical aspects of power generation, transmission, and consumption. Focusing on the Fiscal Year 2022-23 (FY23), this thorough analysis also explores key aspects such as K-Electric (KE), Circular Debt, and China-Pakistan Economic Corridor (CPEC) projects. The report utilizes publicly available data for the power sector, with NEPRA's State of Industry Report (SIR) and Energy Yearbook serving as primary data sources.

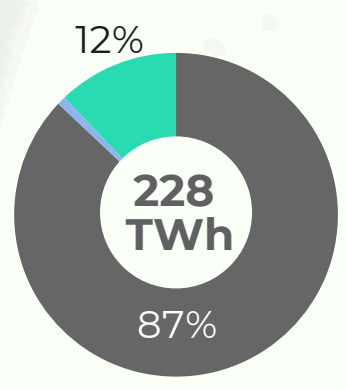
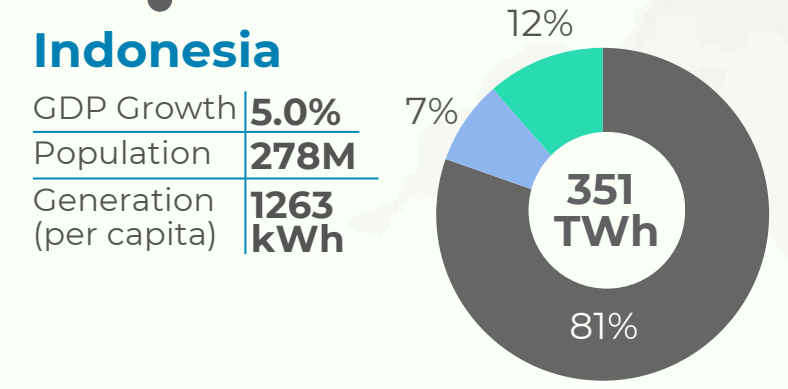
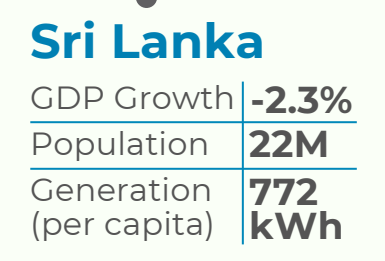
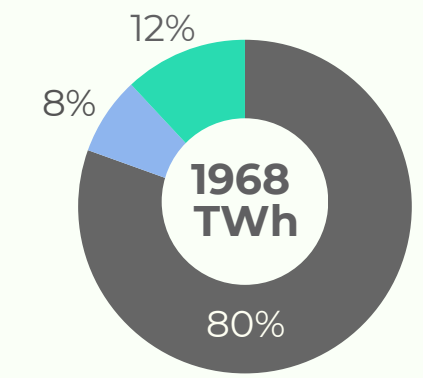
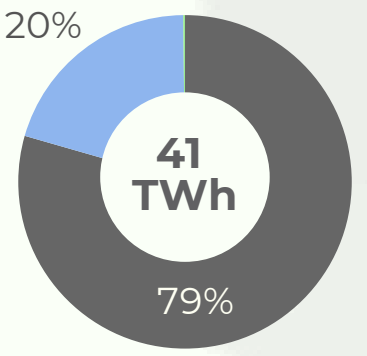
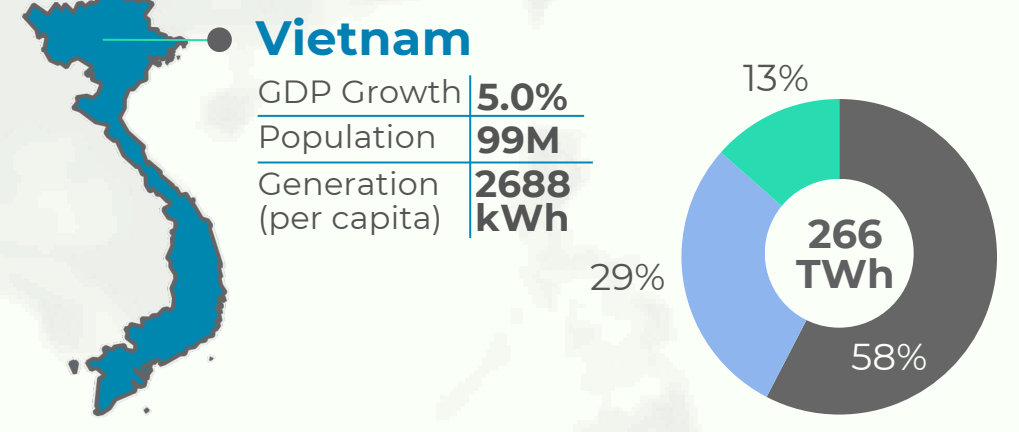
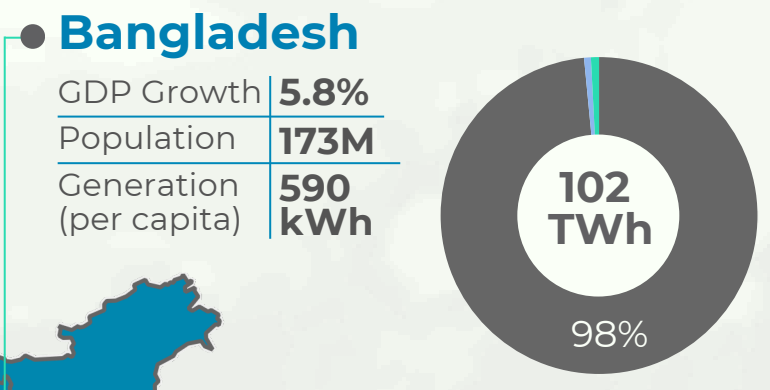
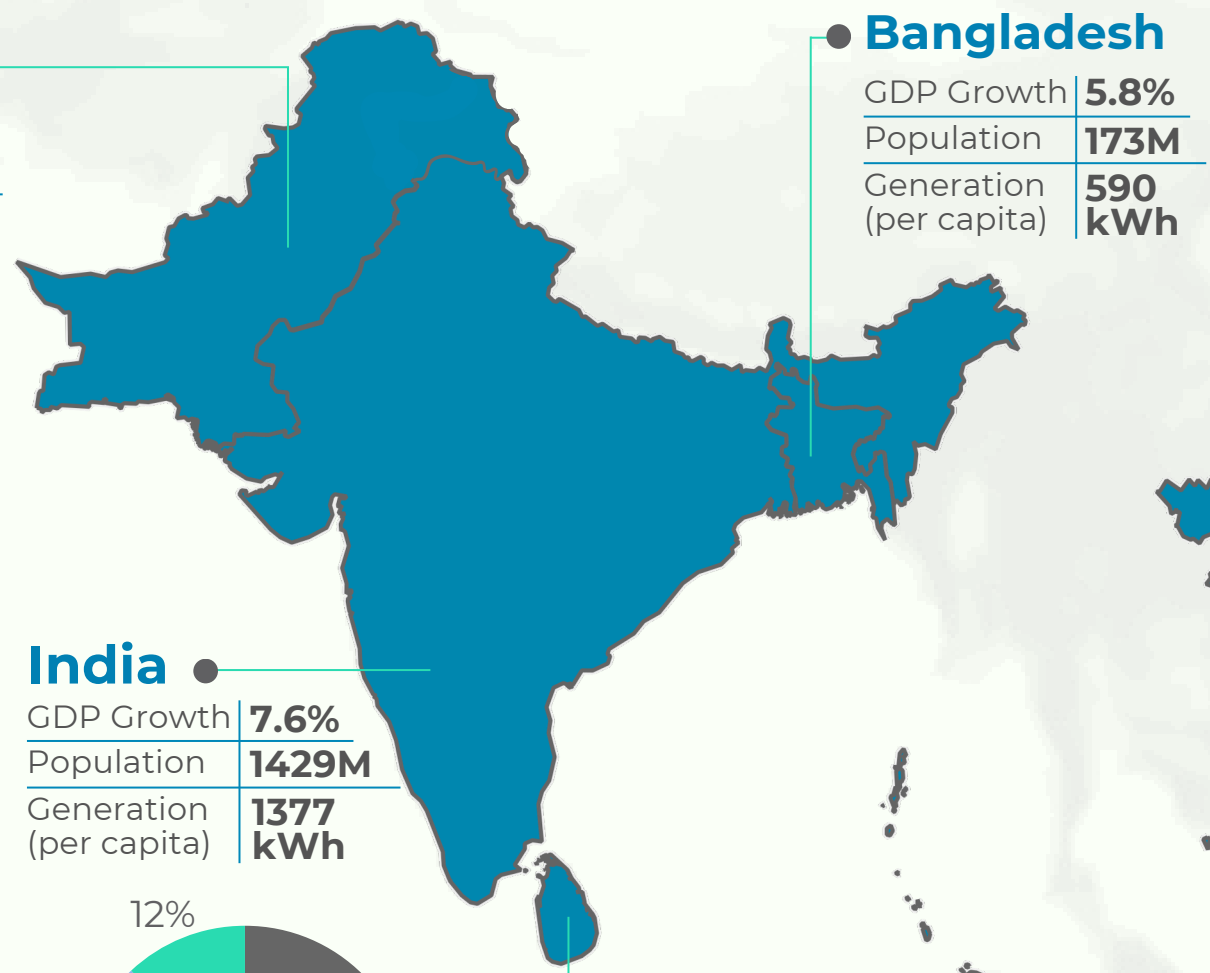
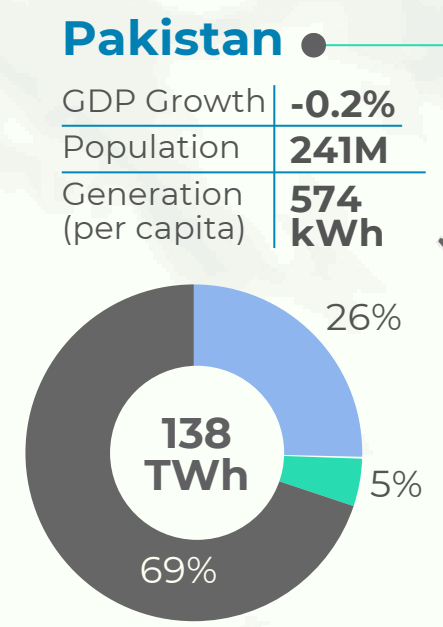
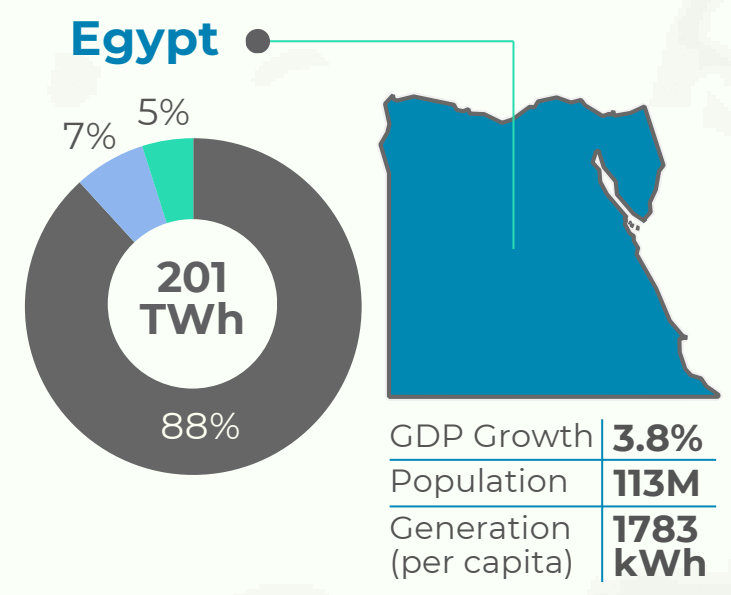
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Global Electricity Trends: Fossil Fuels, Renewables, & Growth

(Data Source: Ember-Climate 2023, World Bank, SIR 2023, RF Calculations)

Renewables Hydro Fossil Fuels

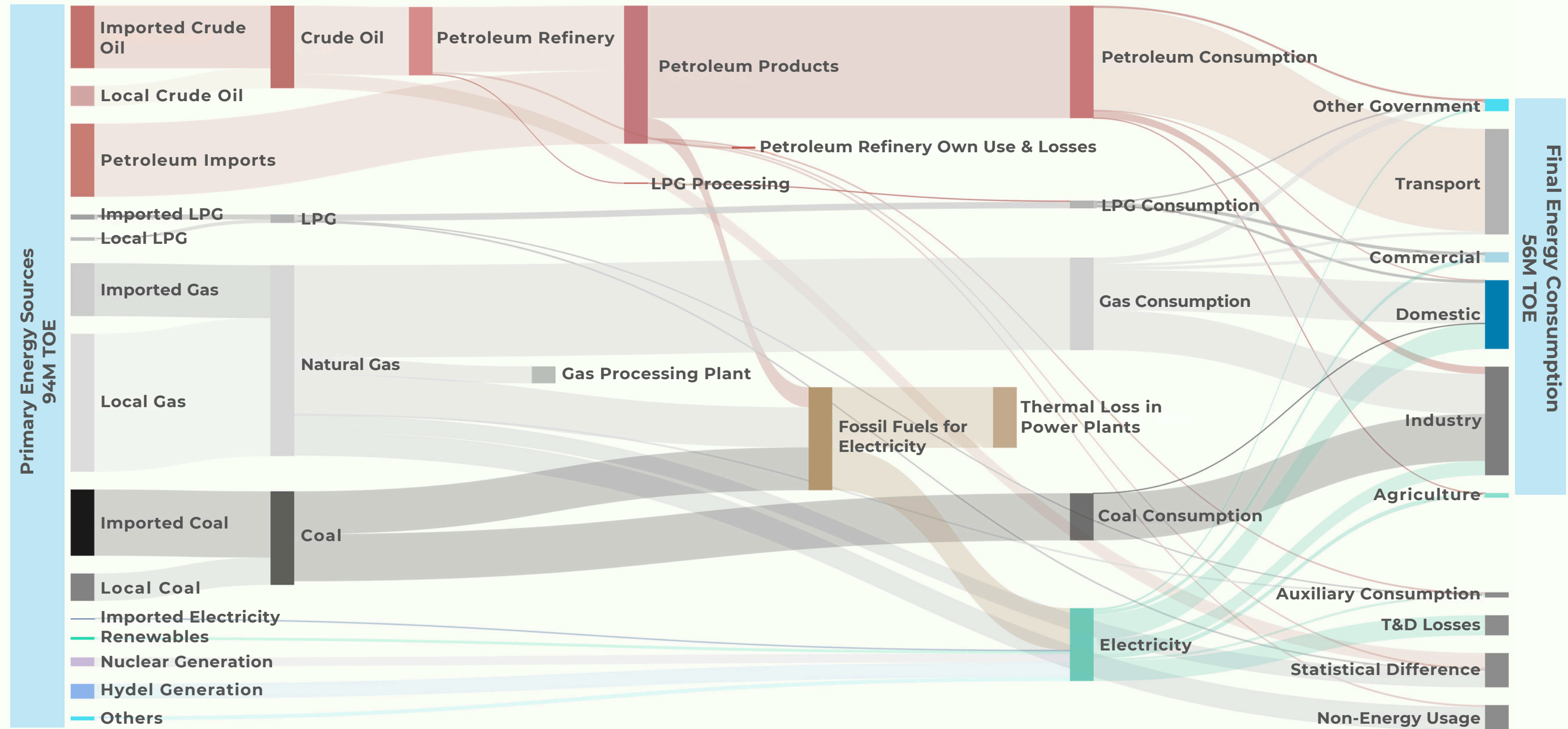


Primary Energy Supplies

Final energy consumption saw a **▼7.4%** decline from the previous year, largely attributed to reduced industrial consumption. The industrial sector accounted for **35%** of the total energy consumption.

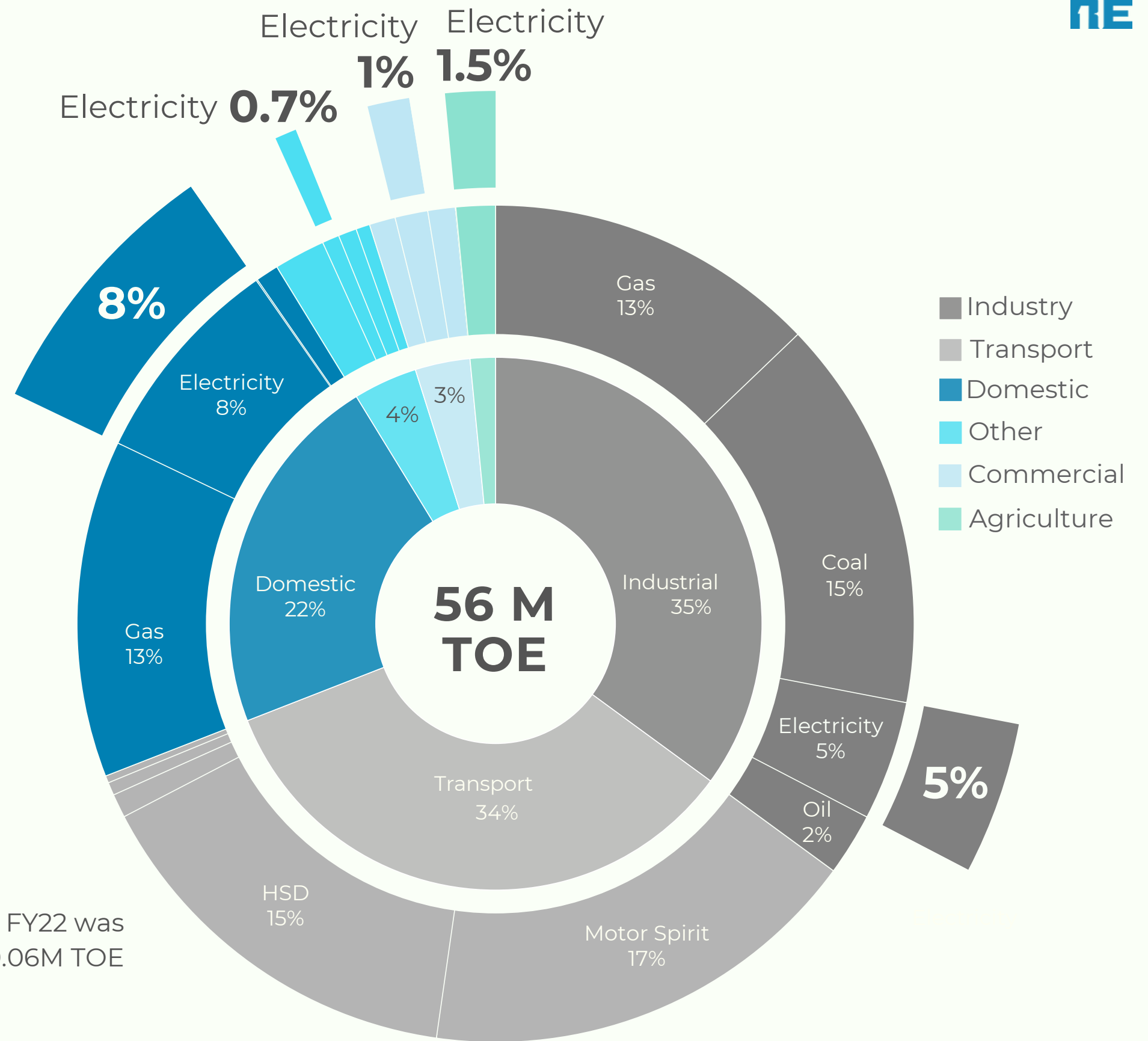
To view the interactive version, please visit the following link: <https://renewablesfirst.org/resources/pakistanelectricityreview>

Energy Flow Diagram: FY22



In FY22, final energy use decreased despite increased energy supplies.

Total energy supplies in the country were 94 million (M) tons of oil equivalent (TOE) with a growth rate of **▲7.9%** compared to the previous year. However, on the energy consumption end, the final energy consumption in FY22 was 56M TOE, with a decline in consumption of around **▼7.4%**.



Electricity consumption in FY22 was **16%** totaling 9.06M TOE

Energy consumption across different sectors in FY22

Key Highlights

Key highlights of Pakistan's power sector FY23

The increase in installed capacity was undermined by declining electricity generation and usage, rendering excess capacity ineffective.

In FY23, there was a significant decline of **▼10.4%** in electricity generation. Higher fuel costs and other macroeconomic headwinds led to increased electricity costs, resulting in a decline in electricity generation.

The **▼10.4%** drop in sales in FY23 highlighted the situation's complexity. Due to high electricity costs, consumers attempted to reduce their electricity usage and increasingly turned to alternative options.

In FY23, capacity payments saw a **▲29%** Year-on-Year (YoY) increase, emerging as a significant factor in driving up power tariffs across the country. By FY25, the power purchase price was forecasted to reach PKR 3.3 trillion (T) i.e. **▲17.5%** YoY increase. This significant increase was expected to further escalate electricity costs in the upcoming years.

As of January 2024, the power sector's circular debt had reached PKR 2.6T. While efforts had contained it in recent years, it continued to pose a significant threat to the financial stability of the power sector.

From generation to consumption, how we powered the year?

Installed Capacity

45.8 GW
▲4.7% YoY

Electricity Generated

138 TWh
▼10.4% YoY

Electricity Transmitted

132 TWh
▼5.7% YoY

Electricity Sold

112 TWh
▼10.4% YoY

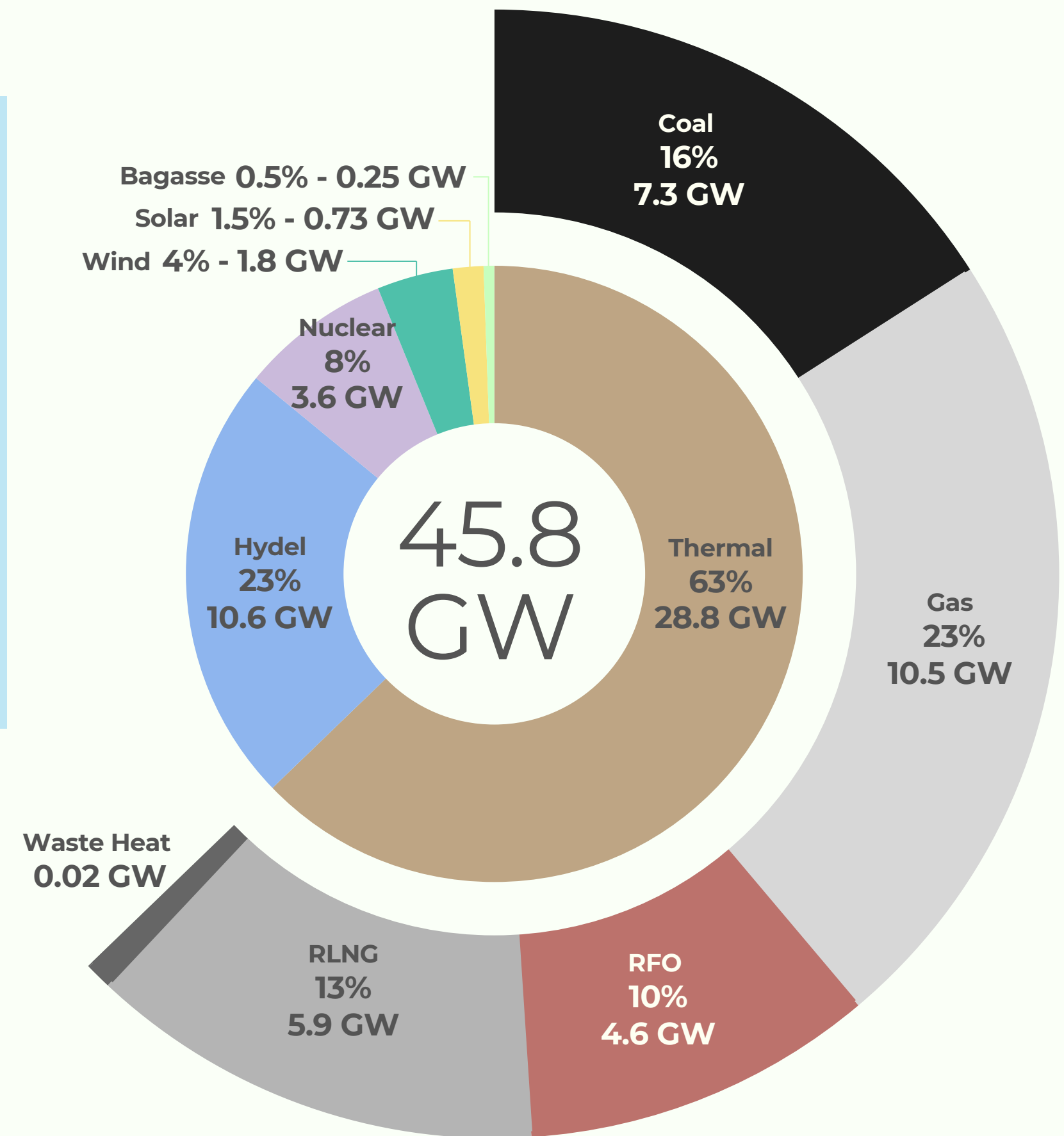
Generation FY23

In FY23, Pakistan's installed capacity saw a growth of ▲4.7% on YoY basis.

With the addition of three coal-based projects, the country's thermal installed capacity increased by ▲7.9% YoY, reaching 28.8 GW, taking the share of thermal to 63% of the total installed capacity.

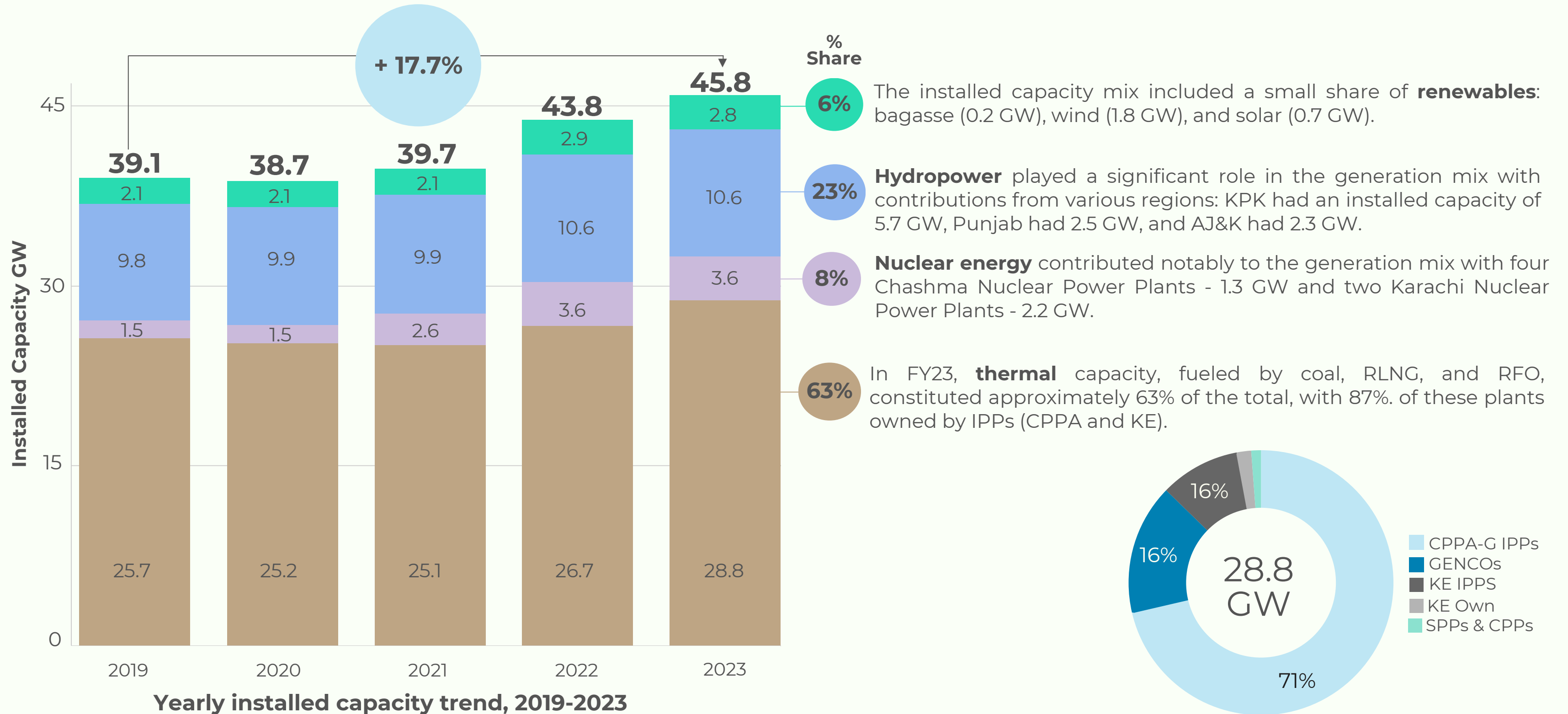
Wind energy experienced no growth, remaining flat at 1.8 GW for the past two years. In contrast, solar energy saw a minor increase of 0.04 GW during the same period.

The private sector held approximately 50.2% share (23 GW) of the country's installed capacity, primarily in thermal power and under "take-or-pay" terms.



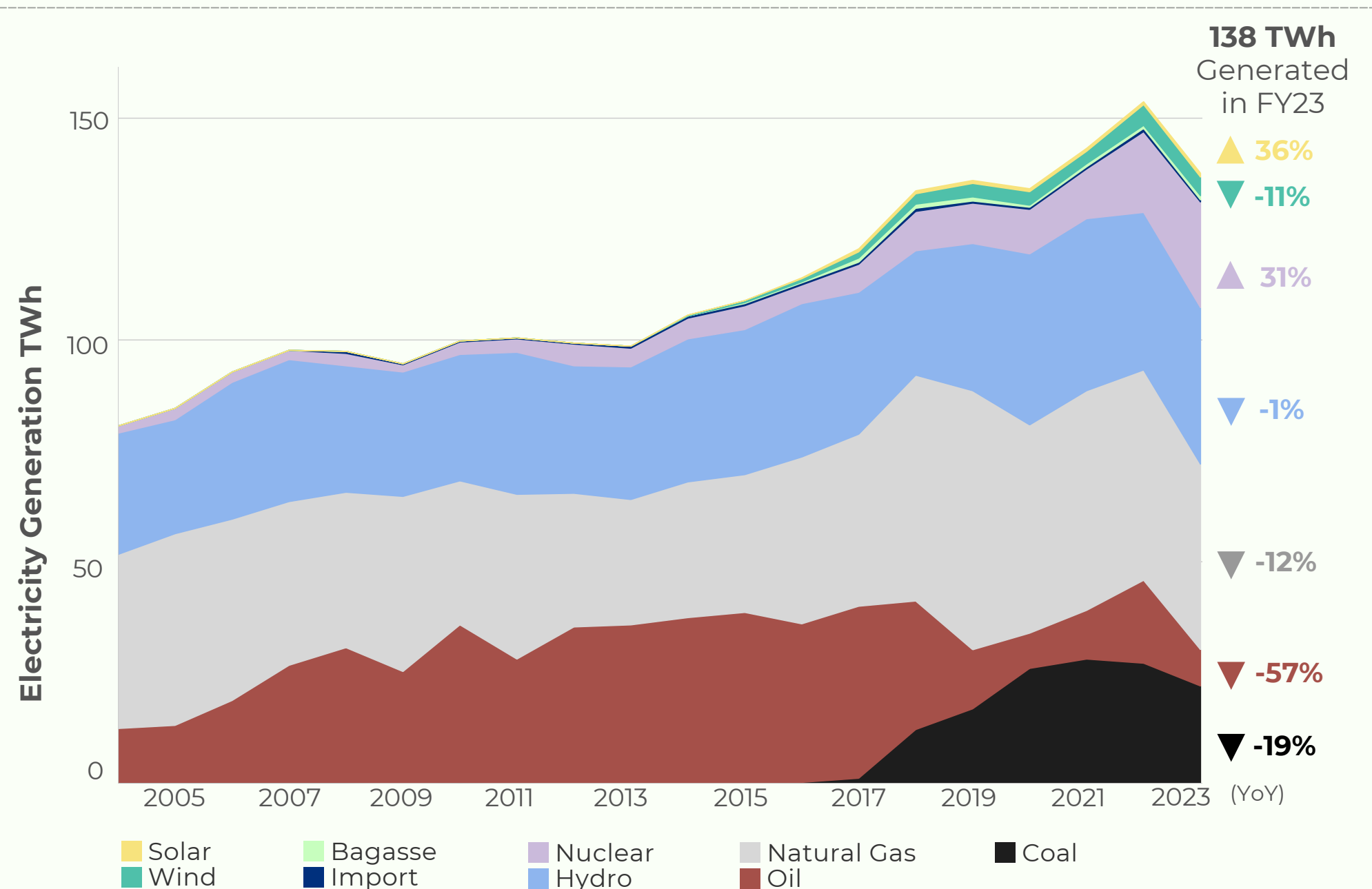
Pakistan's installed power generation capacity in FY23

Renewable Energy (RE) deployment remained elusive despite the government's target to achieve 30% Variable Renewable Energy (VRE) capacity by 2030.

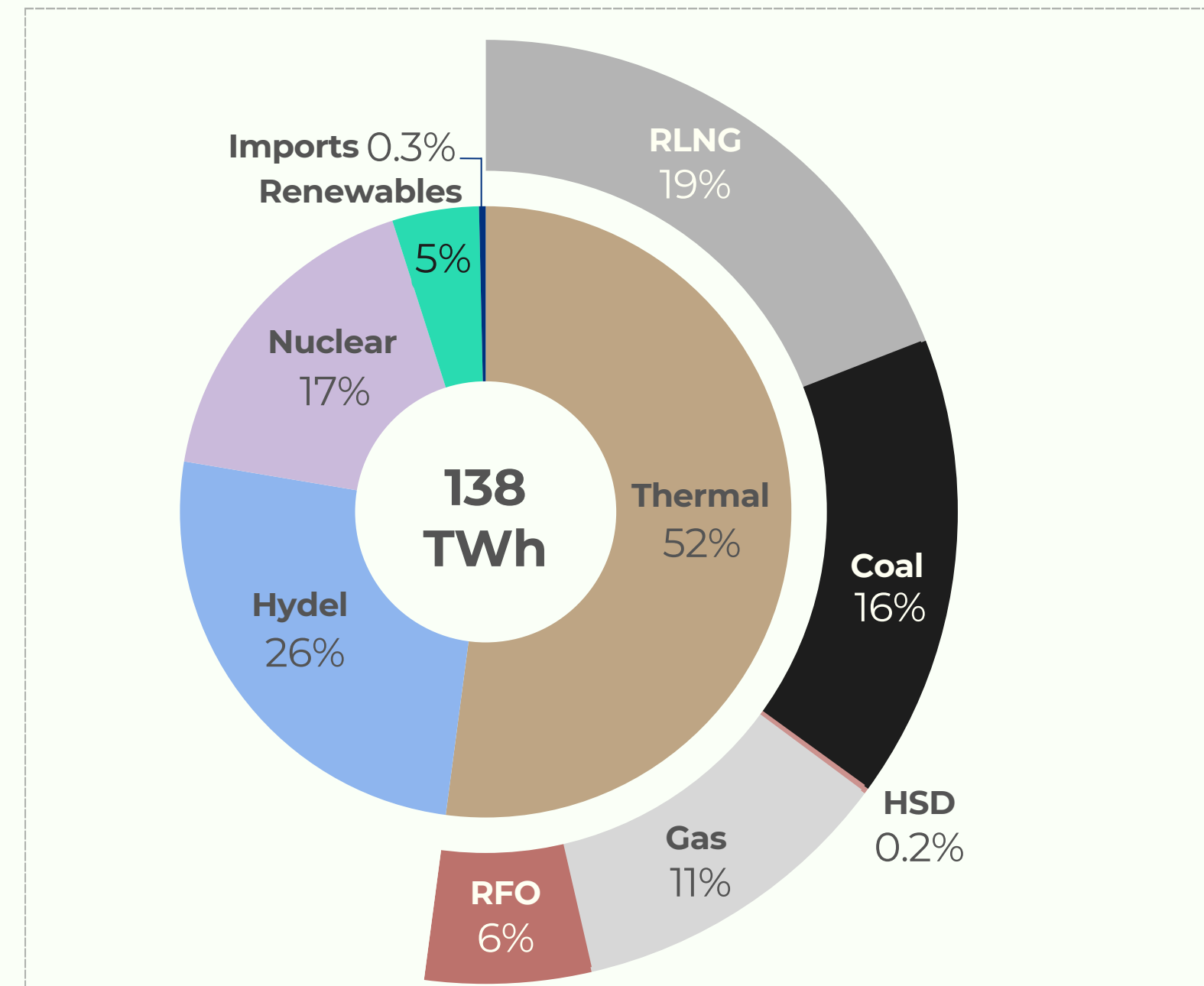


Despite the growth in generation capacity, electricity generation fell by 10.4%.

During FY23, electricity generated was 138 TWh, representing a significant decline of **▼10.4%** on a YoY basis. This decline could be linked to higher fuel prices and macroeconomic stresses, following the Russia-Ukraine war, as generation from fossil fuels decreased compared to the previous year. The share of renewables, totaling 6.3 TWh in FY23, also decreased by **▼1.7%** on a YoY basis.



Yearly trends in electricity generation by source, 2004-2023

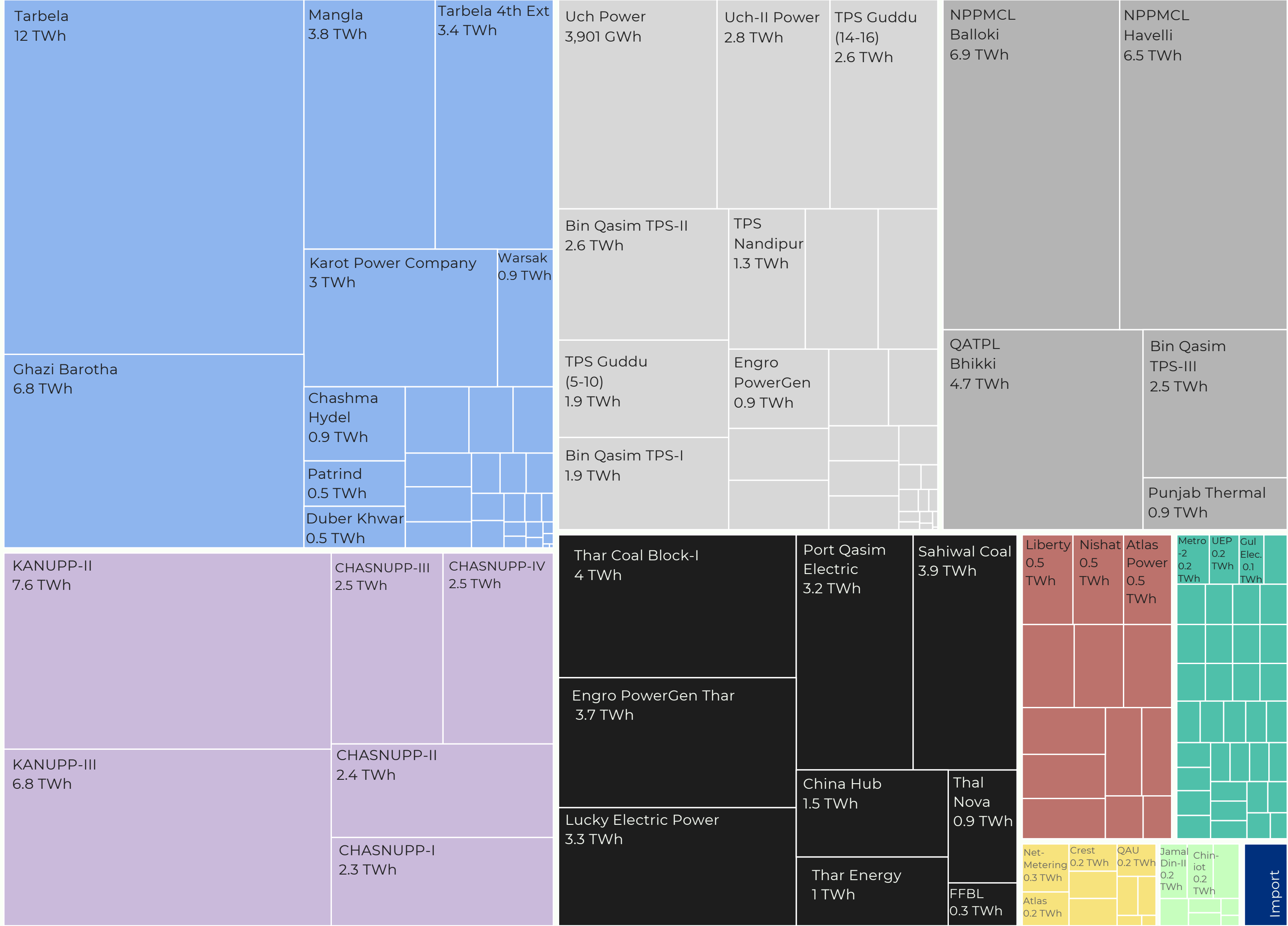


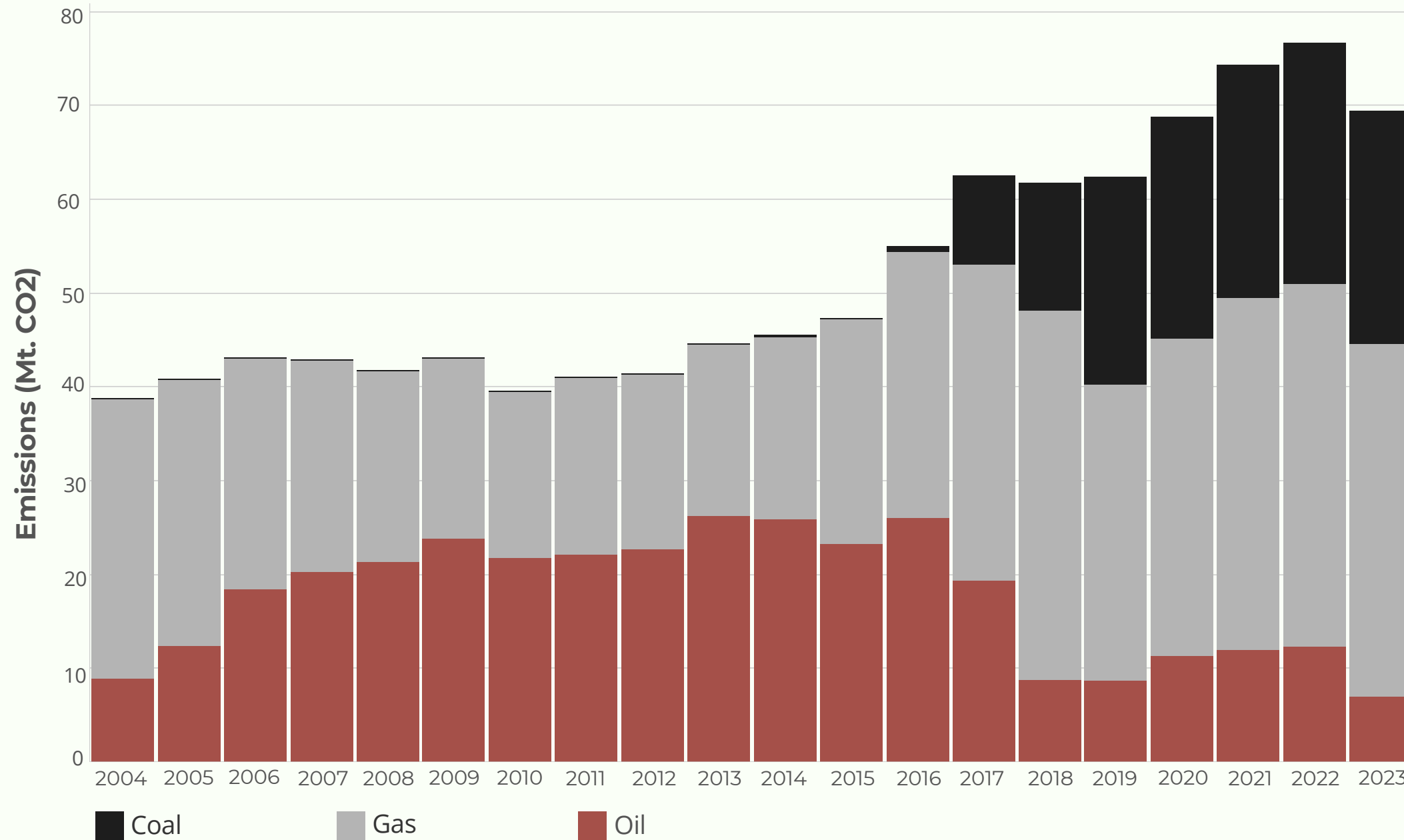
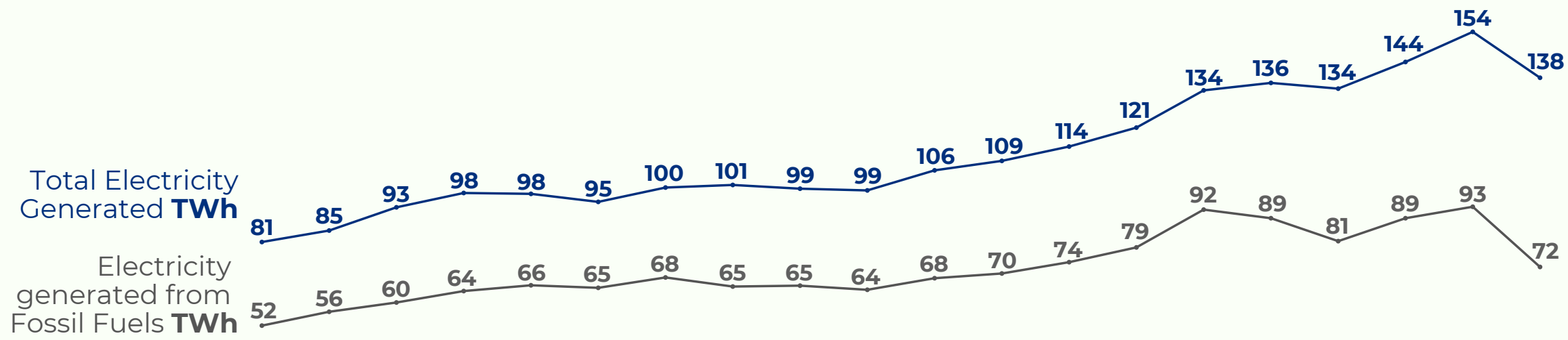
Electricity generated by energy sources in FY23



A quick look at where our power came from in FY23.

	Electricity Generation TWh	% Share
Hydel	35.2	26%
Nuclear	24.0	17%
Gas	23.6	17%
RLNG	21.4	16%
Coal	21.0	15%
RFO	5.5	4%
Wind	4.0	3%
Solar	1.3	1%
Bagasse	0.8	0.6%
Import	0.4	0.3%





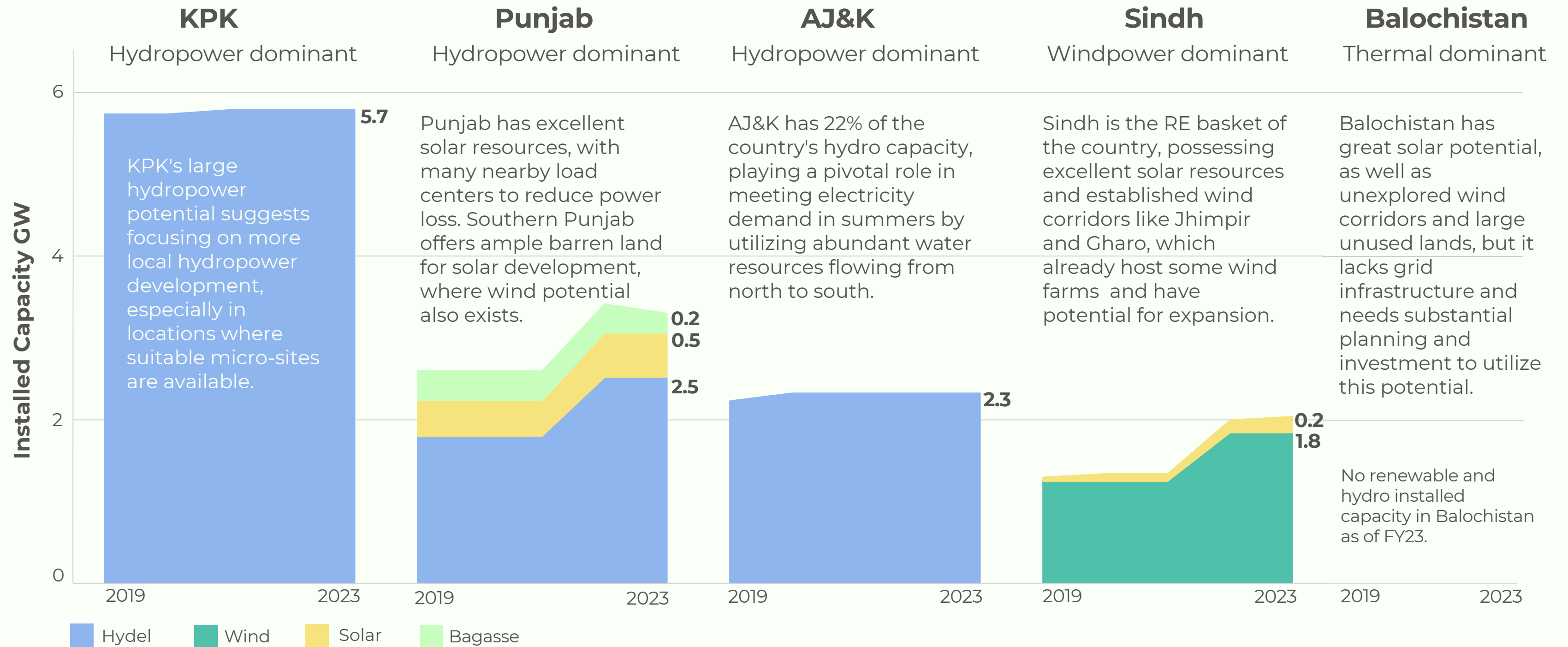
Yearly trend of electricity generation and CO2 emissions from fossil fuels, 2004-2023

Increasing reliance on fossil fuels for electricity generation continues to contribute to higher CO2 emissions.

Over the past few years, growing use of coal in the country's energy mix has resulted in increased emissions.

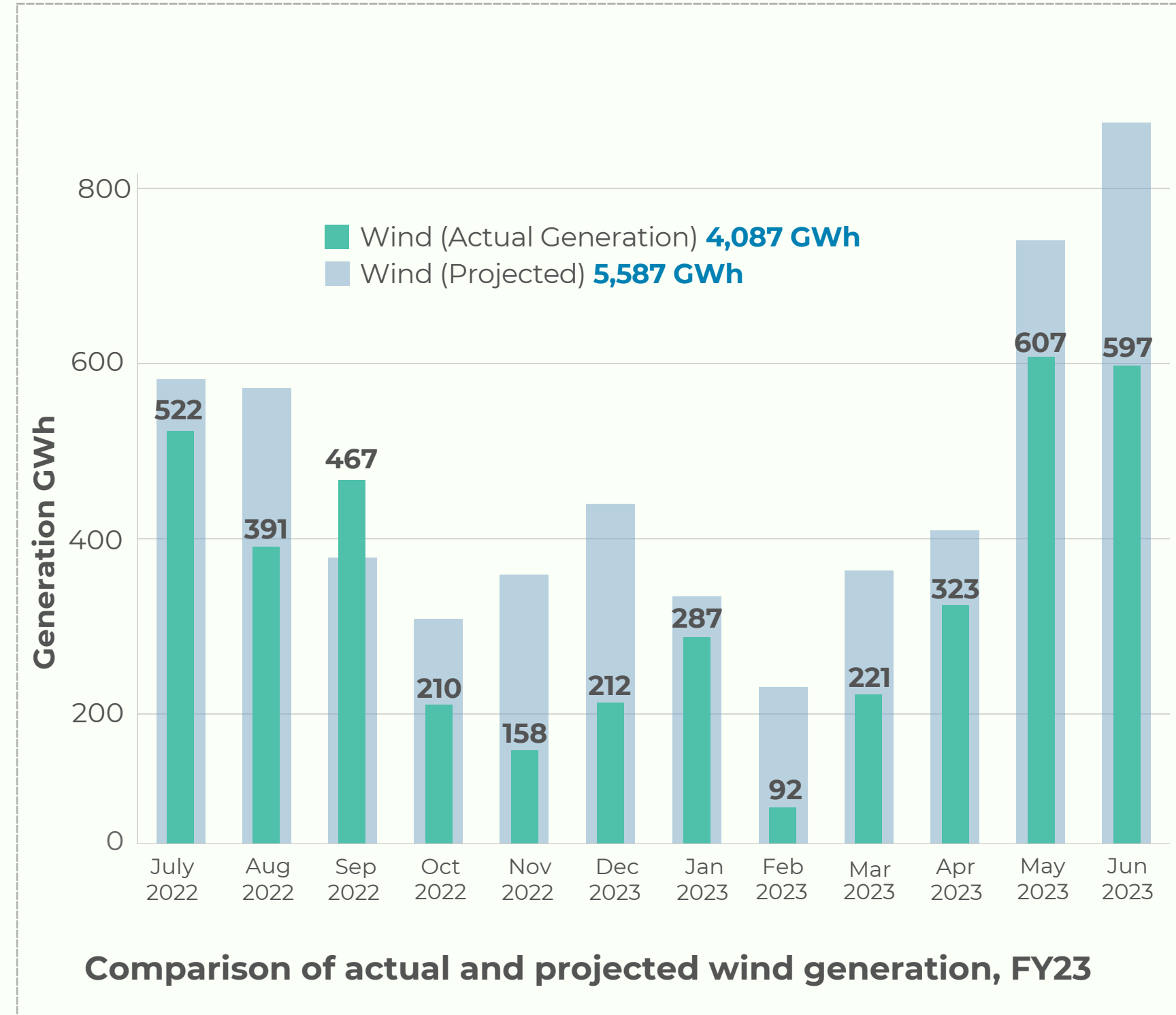
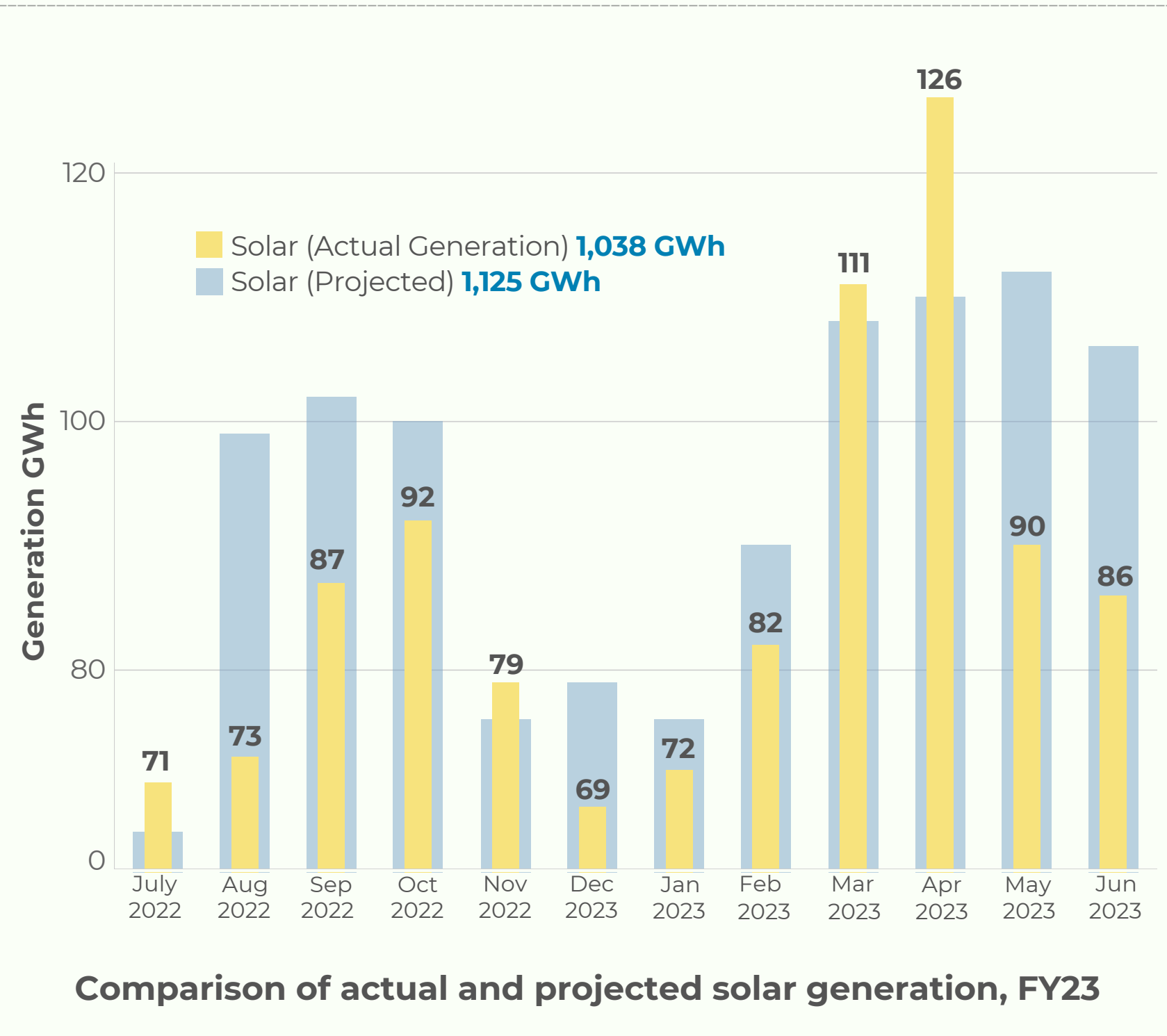
For FY23 however, reduced fuel imports due to imported fuel price volatility led to a modest decrease in emissions.

Pakistan's renewable and hydro power capacity stood at 13 GW in FY23, however, Balochistan's renewable resource potential remains untapped.



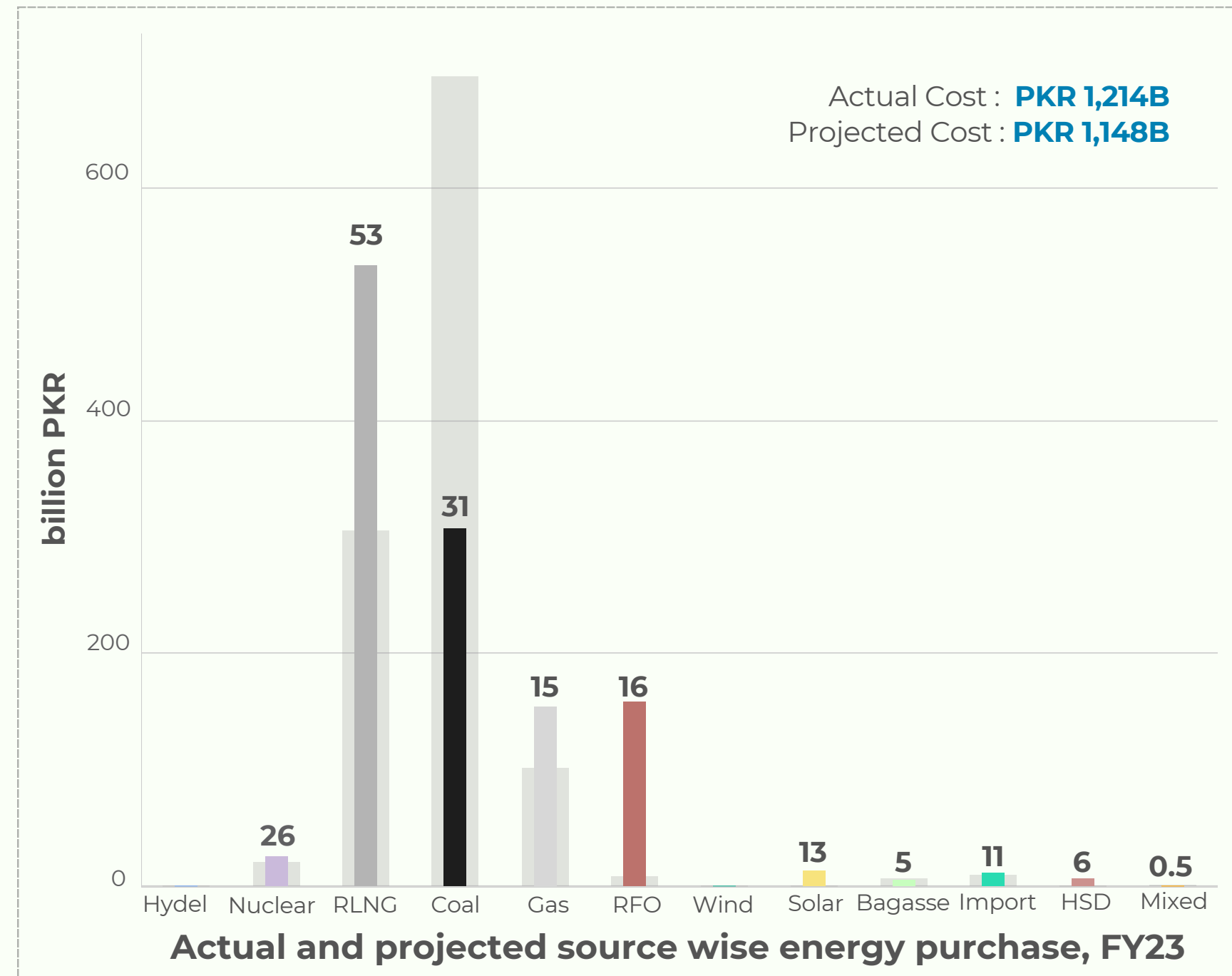
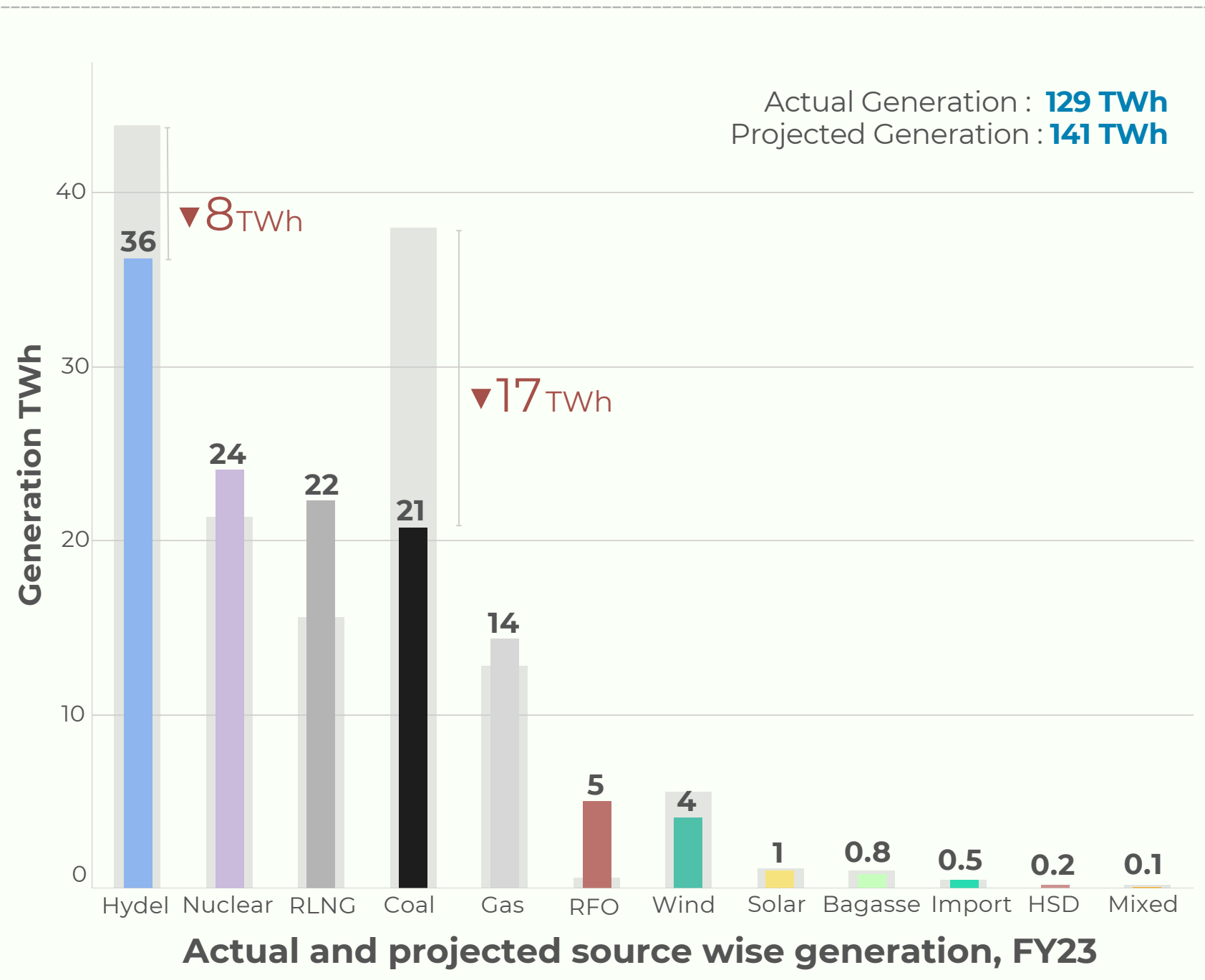
Yearly growth trends in renewables and hydropower across various provinces, 2019-2023

Actual RE generation across the fiscal year trailed the projected generation from wind and solar.



In FY23, electricity generation from Hydel and Coal sources was projected at 82 TWh; however, actual generation totaled 57 TWh, reflecting a 30% shortfall.

Reduced generation from coal and hydropower resulted in an over-reliance on RLNG, gas, and RFO, which subsequently led to higher costs for these thermal sources.

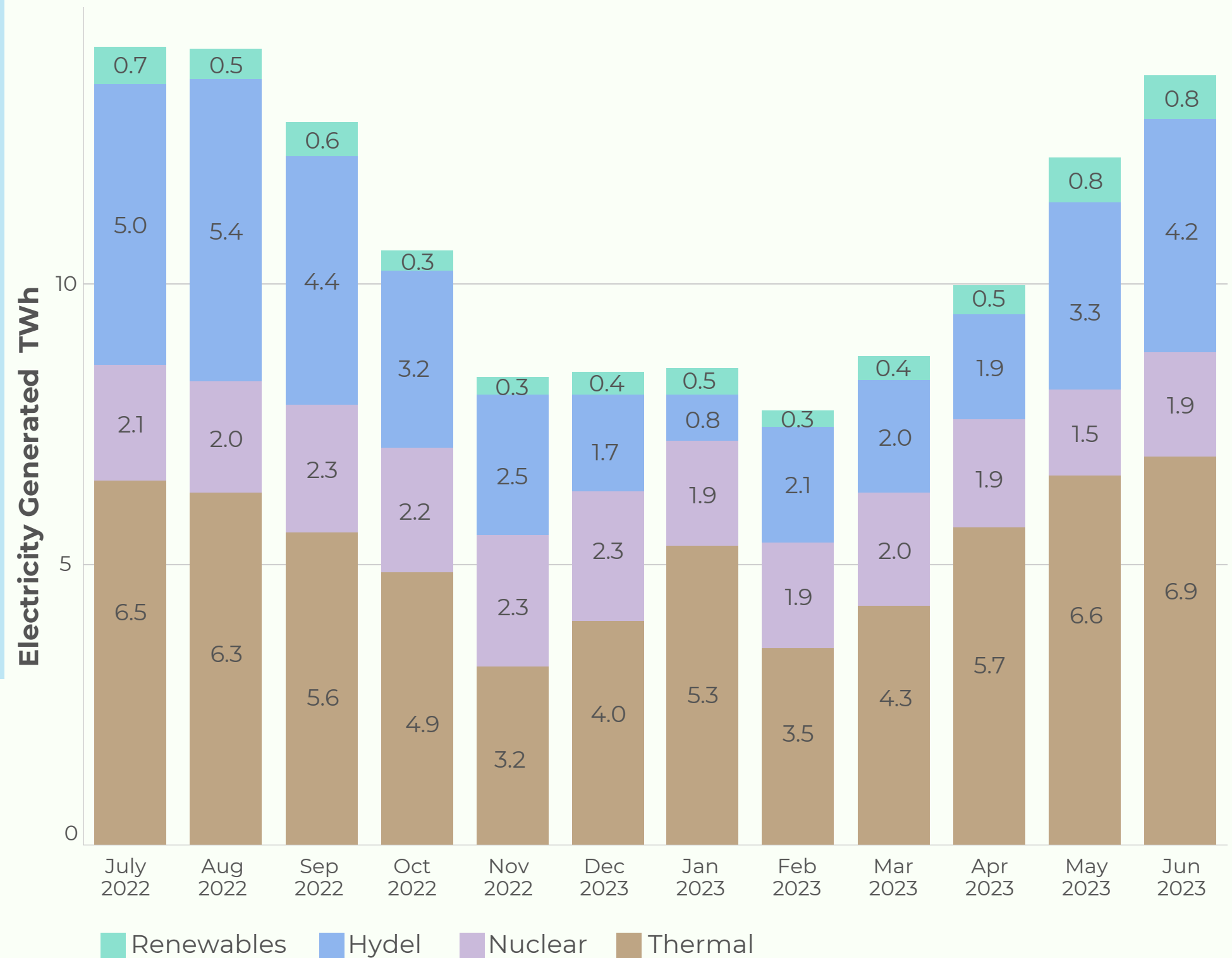


Note: Grey wider bars represents the projections. KE figures are not included in above graphs.

Renewables can play a significant role in meeting flexible load demand during months with seasonal hydro variation.

Pakistan’s peak demand occurs in summer when hydropower generation is high. During winter months, when hydro generation is low, thermal power generation primarily meets the demand. Renewable energy, such as solar and wind, can serve as reliable substitutes for flexible loads during periods of low hydroelectric generation and as an ideal complement during high demand in summer months.

Pumped storage can also be explored as a solution to address intermittency issues associated with wind and solar power generation, as well as to supplement peak demand.

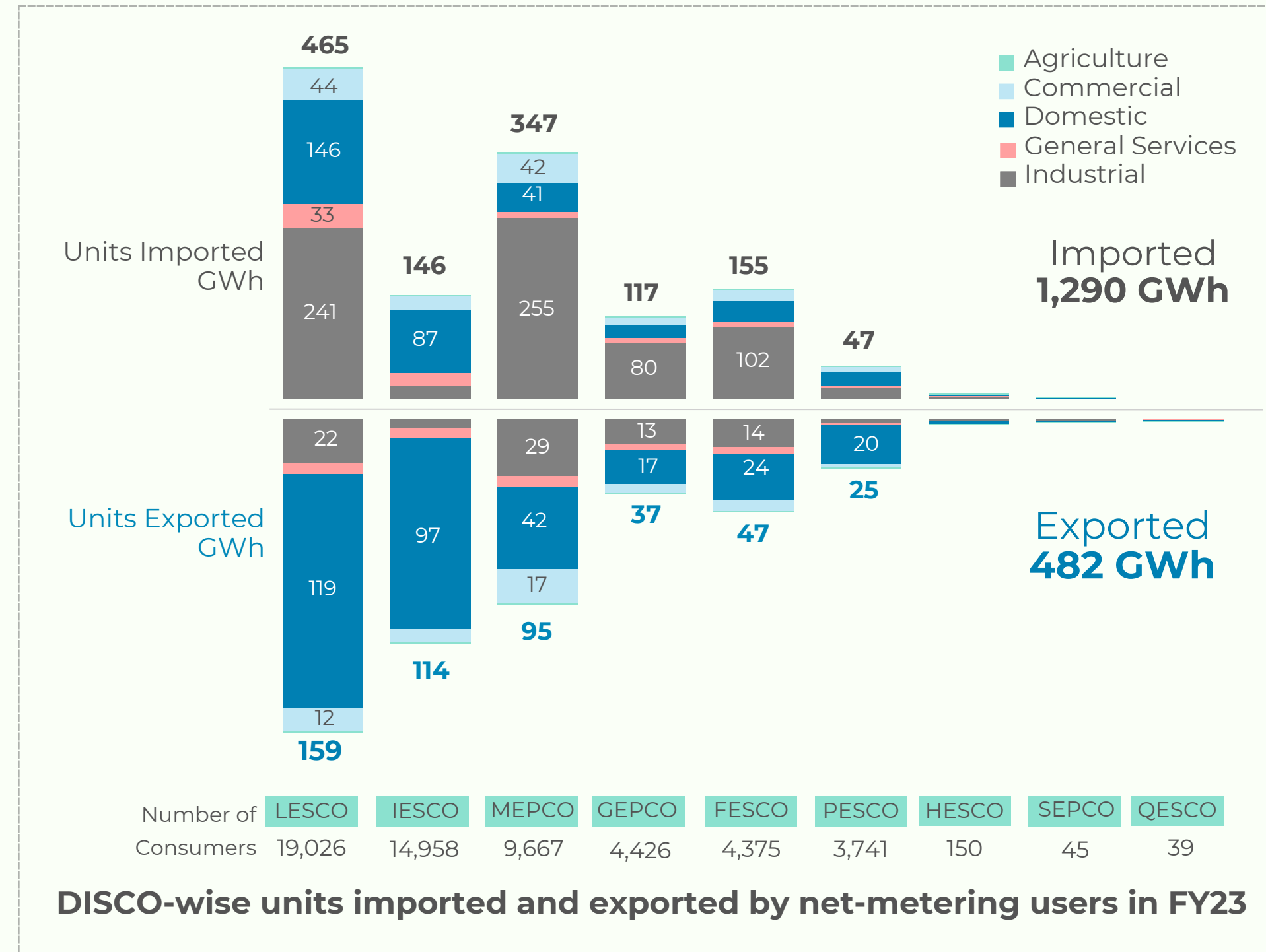
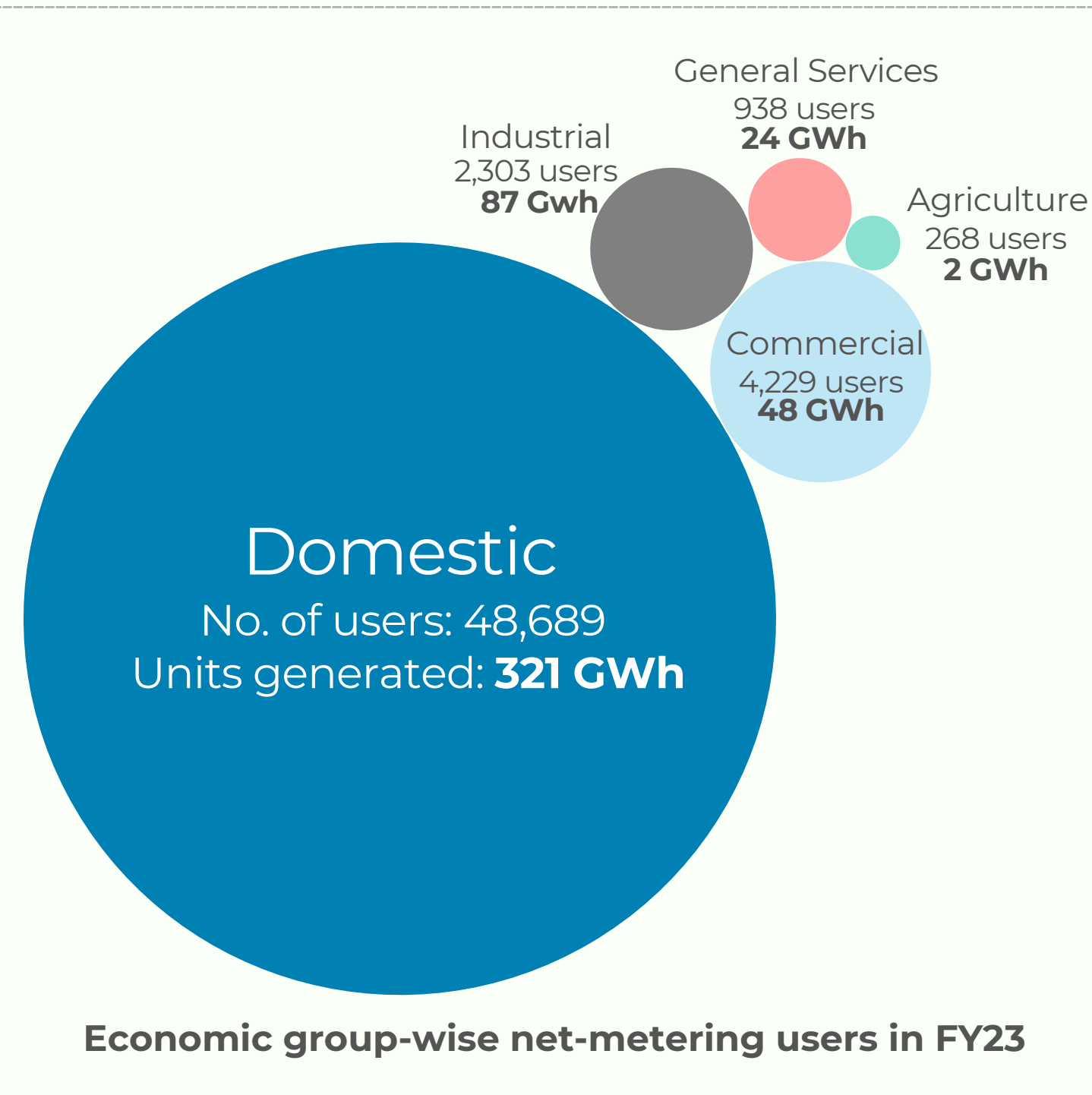


Note: Renewables represent electricity generated by solar, wind and bagasse.

Monthly source wise electricity generation in FY23

In FY23, net-metering users accounted for less than 1% share in total electricity generation.

The net-metering users nearly doubled in Pakistan on a YoY basis, with the accumulated generation by net-metering users in FY23 totaling 482 GWh, marking an increase of ▲220% YoY.





Karot Hydro Power
Hydro

732 MW

USD1720M
COD: 29-June-23

Location: Village Karot, District Rawalpindi, Punjab

Debt to Equity Ratio: Debt 80% : Equity 20%

Debt Servicing Schedule 12 Years

Electricity Generated in FY23: 3 TWh



Punjab Thermal
RLNG

1230 MW

USD708M
COD: 23-June-23

Location: Near Trimmu Barrage, District Jhang, Punjab

Debt to Equity Ratio: Debt 75% : Equity 25%

Debt Servicing Schedule 10 Years

Electricity Generated in FY23: 0.9 TWh



Thal Nova
Local Coal

330 MW

USD498M
COD: 17-Feb-23

Location: Thar Coal Fields Block-II, District Tharparkar, Sindh

Debt to Equity Ratio: Debt 75% : Equity 25%

Debt Servicing Schedule 10 Years

Electricity Generated in FY23: 0.9 TWh



Thar Block-I
Local Coal

1230 MW

USD1912M
COD: 5-Feb-23

Location: Thar Coal Fields Block-I, District Thar, Sindh

Debt to Equity Ratio: Debt 75% : Equity 25%

Debt Servicing Schedule 10 Years

Electricity Generated in FY23: 4 TWh



Thar Energy
Local Coal

330 MW

USD498M
COD: 1-Oct-22

Location: Thar Coal Block-II, District Tharparkar, Sindh

Debt to Equity Ratio: Debt 75% : Equity 25%

Debt Servicing Schedule 10 Years

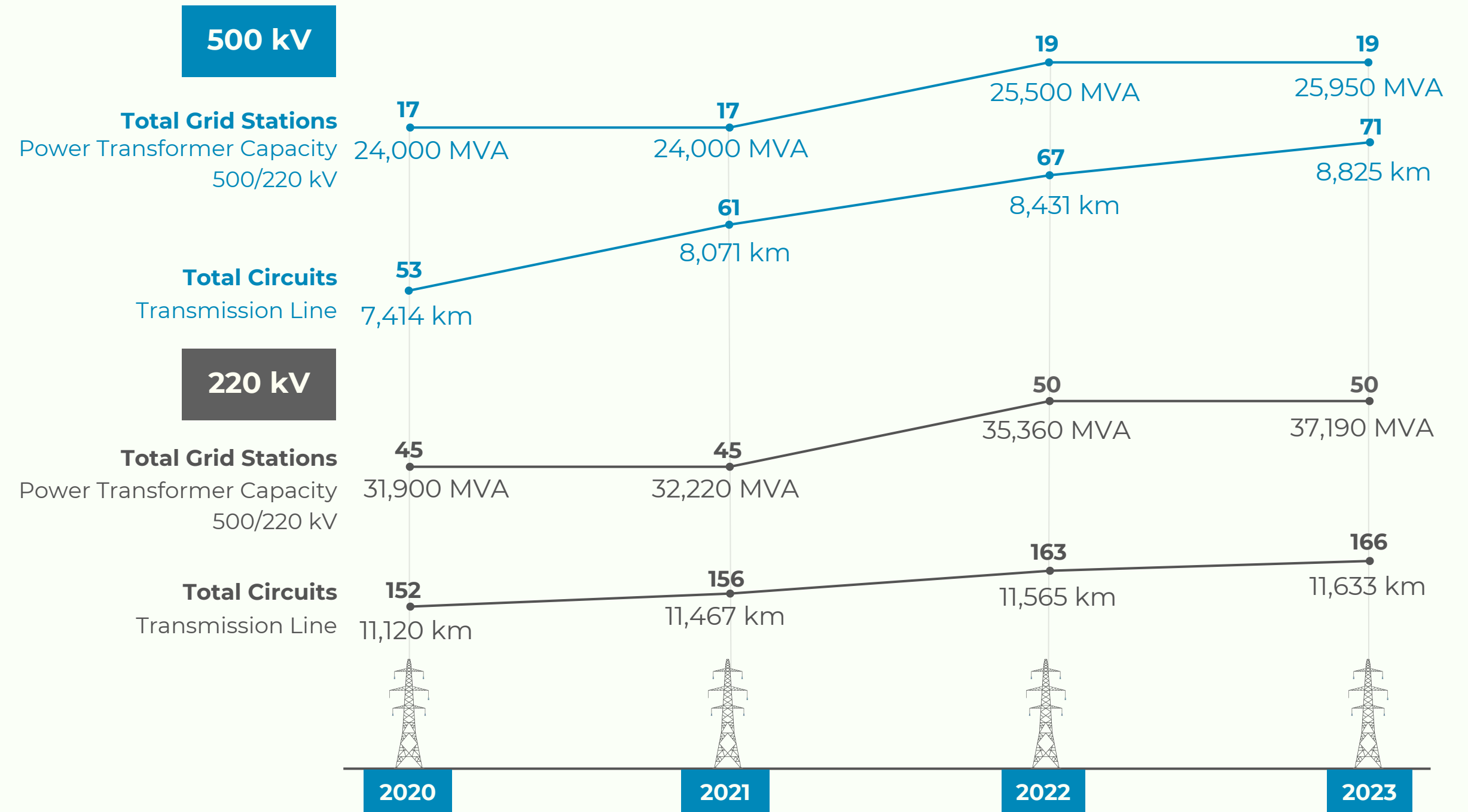
Electricity Generated in FY23: 1 TWh

New generation plants added in Pakistan in year 2022 & 2023

Transmission FY23

No new grid station was added to the NTDC system in FY23.

During FY23, NTDC incurred a **PKR 20B** loss due to its inability to evacuate electricity efficiently. NTDC aimed to expand its transmission system by 30% and increase total transformation capacity by 58% by 2026. The Transmission Investment Plan (TIP) for FY 2023-25 allocated **PKR 37B**, which was still awaiting approval from NEPRA by the end of FY23.



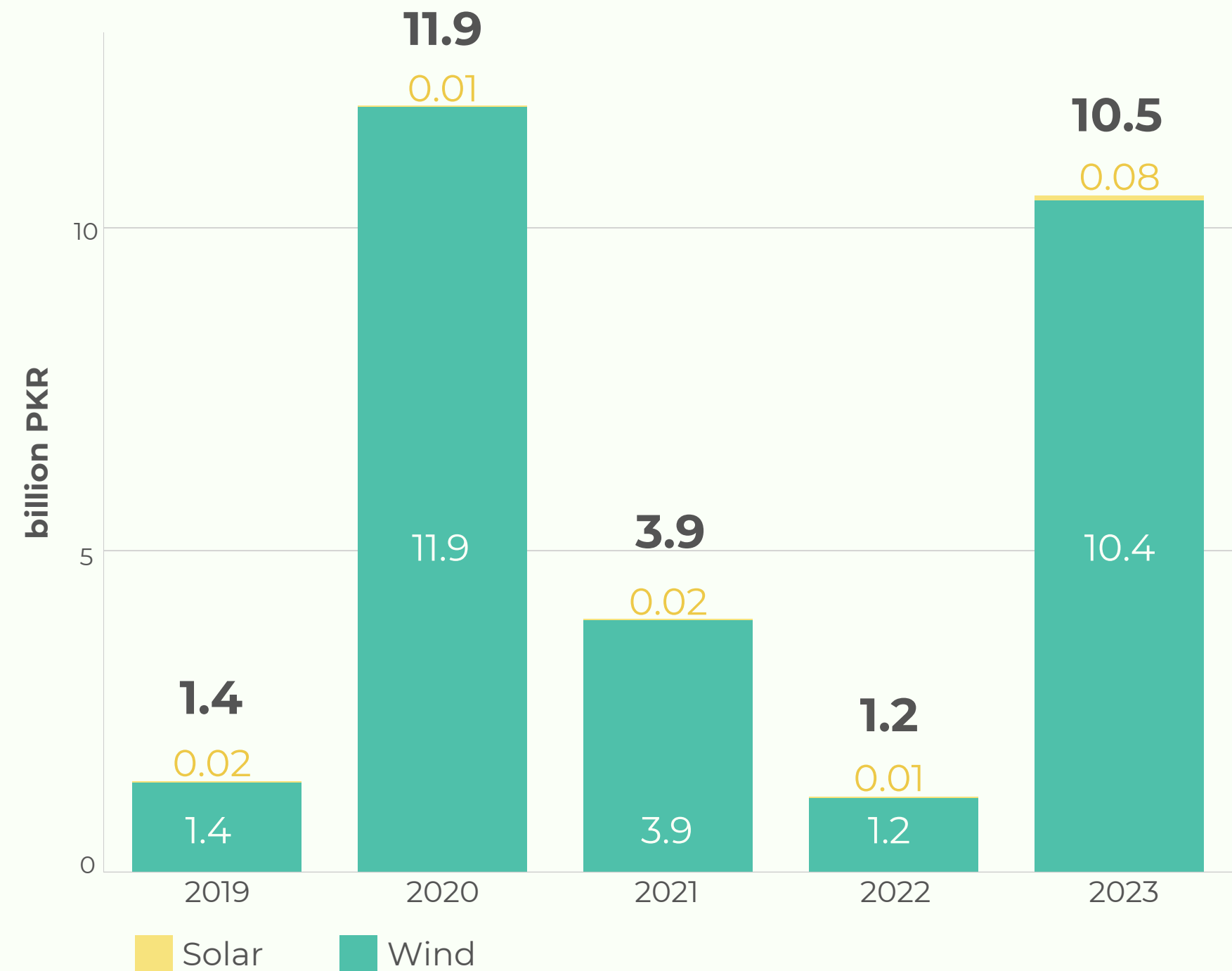
Year-wise expansion of NTDC network, 2020-2023

Wind curtailment: When the wind gets held back!

In FY23, the payment obligation for Non-Project Missed Volume (NPMV) rose significantly to PKR 10.5B, up from PKR 1.2B in FY22. Excessive curtailment due to transmission constraints has greatly undermined investor confidence.

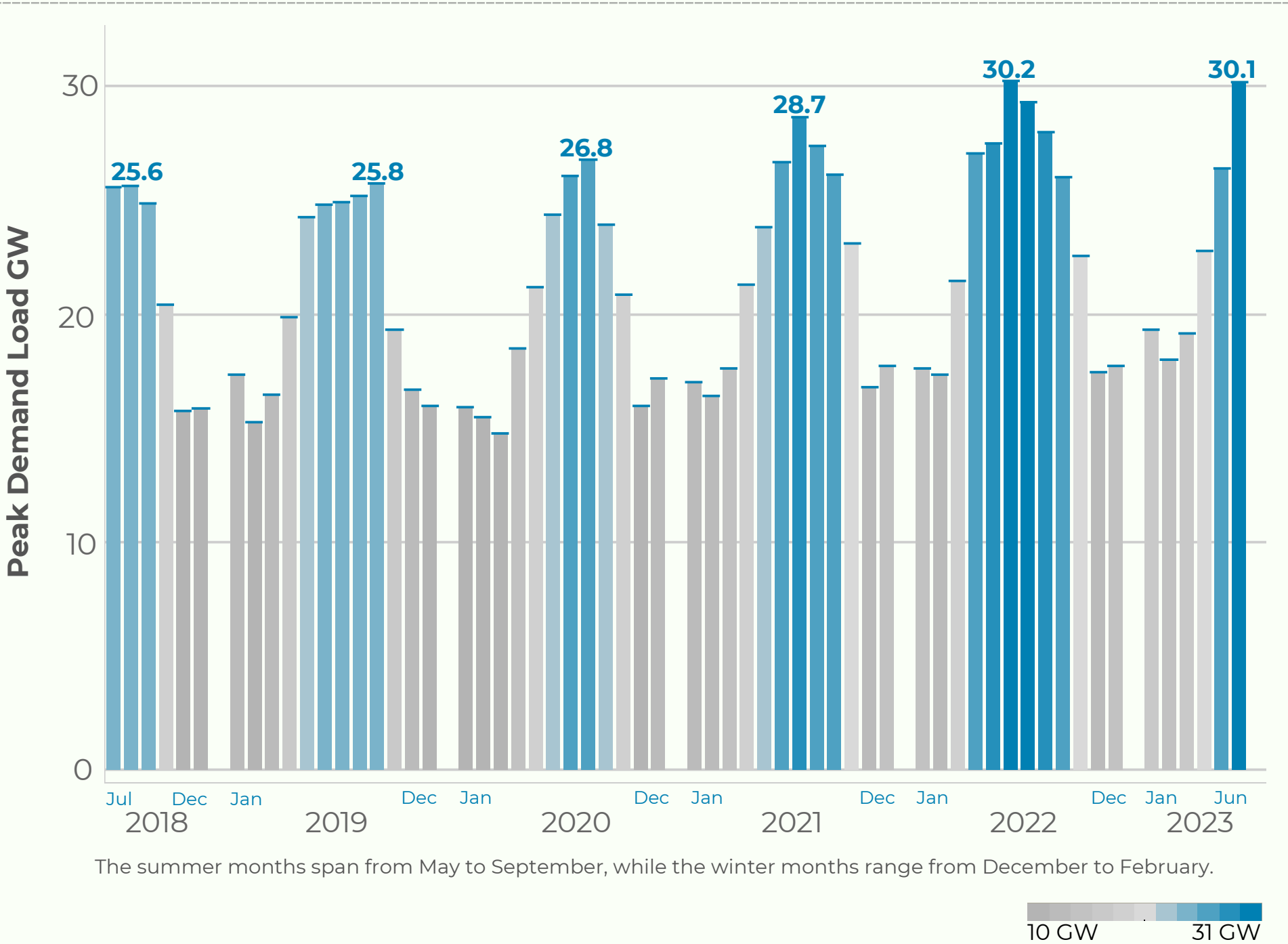
Rather than paying for unused electricity through NPMV, those funds could be allocated towards the transmission capacity of the network, allowing for better integration of cheaper RE sources.

The existing power transfer interface between the south and north cannot handle the full generation capacity available in the south, which includes 1,845 MW from wind energy. To avoid power curtailment, upgrading this south-to-north transmission interface is essential. Therefore, the construction of a 500 kV DC Matiari-Moro- R.Y. Khan overhead line is prioritized in the Transmission System Expansion Plan.



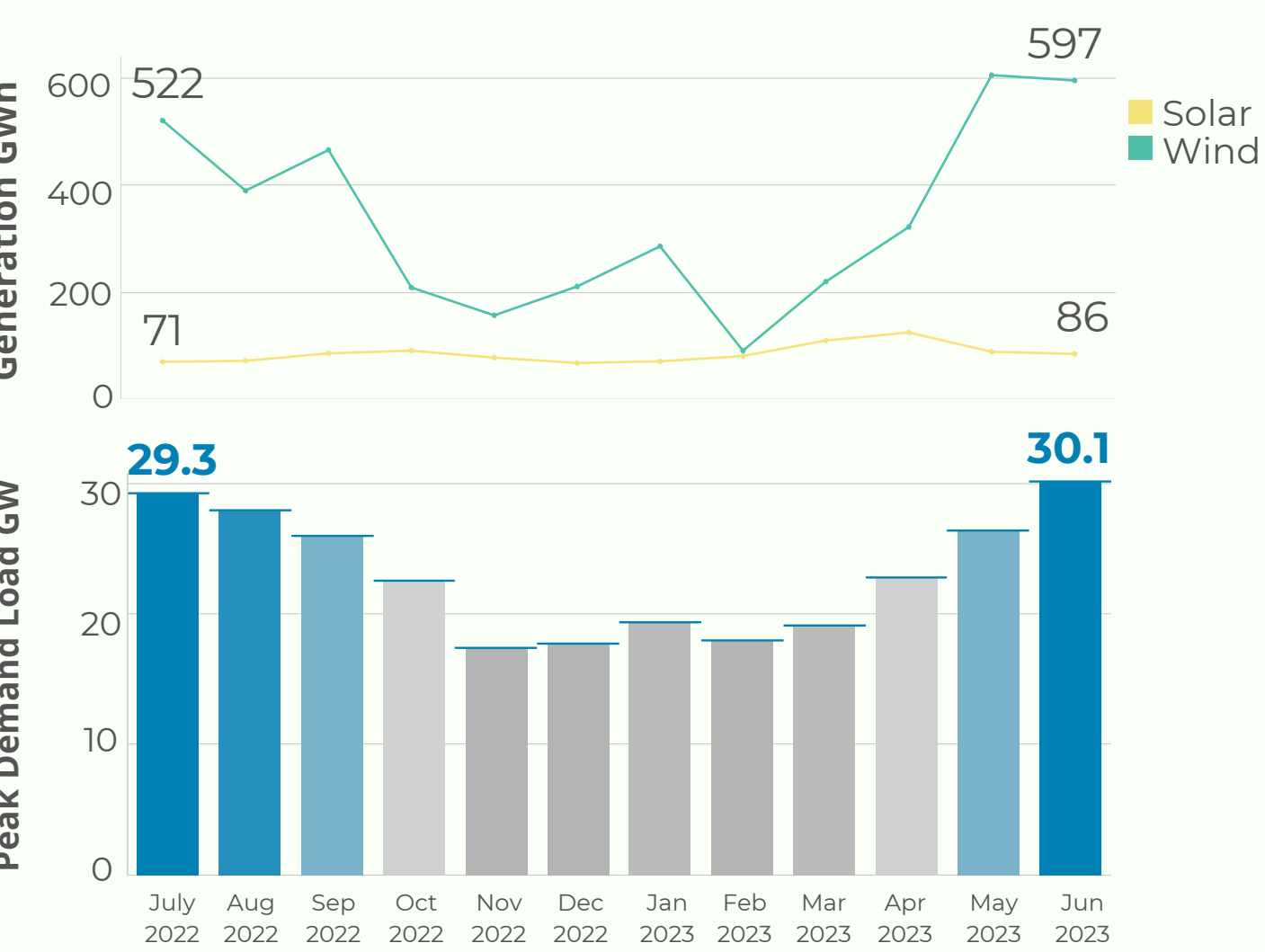
Yearly trend of payment on account of NPMV, 2019-2023

Over the years, peak demand load has continued to increase during summer, while winter demand stagnates below 20 GW.

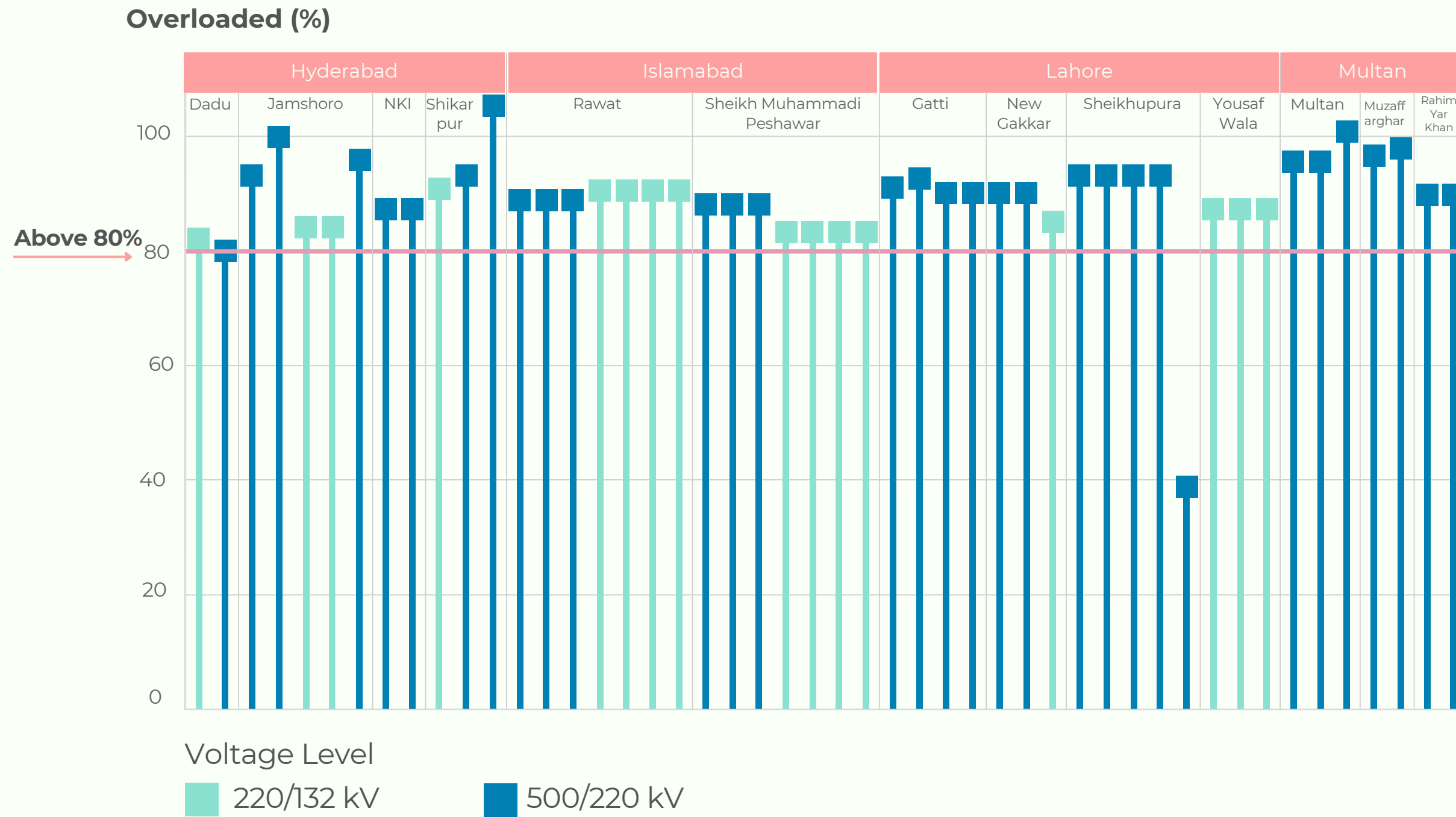


Peak load demand trend, 2018-2023

During summer, peak demand is usually met through expensive imported fuel-based "Peaker Plants," which remain idle outside of peak periods. A more effective solution for managing peak demand in summer could be the utilization of RE hybrid solutions.



Load demand and generation profile of solar and wind, FY23



Region-wise overloaded transformers installed at 500kV grid stations, FY23

Overloaded transformers at 500kV grid stations are struggling to keep up with the current demand

The congestion of key grids, like Gatti, Multan, and Sheikhupura has forced the use of expensive power plants and violated grid protocols. Priority should be given to the transmission augmentation outlined in the Transmission System Expansion Plan (TSEP) to address issues with overloaded grid stations.

Transformers installed at 500 kV Grid Stations

500/220 kV Transformers

Total : 47

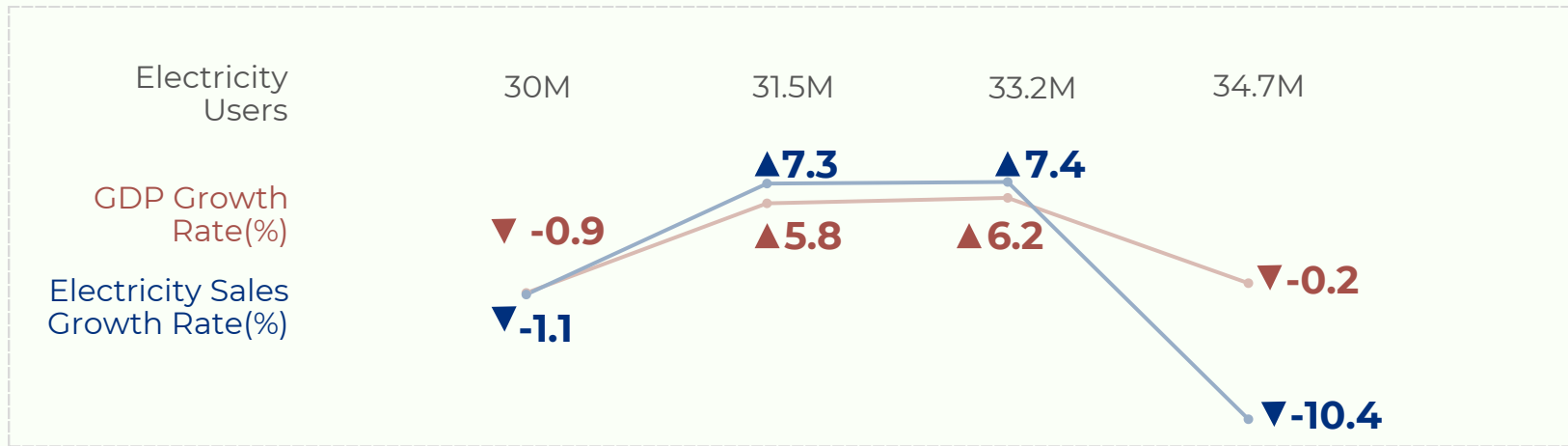
Overloaded: 31

220/132 kV Transformers

Total : 38

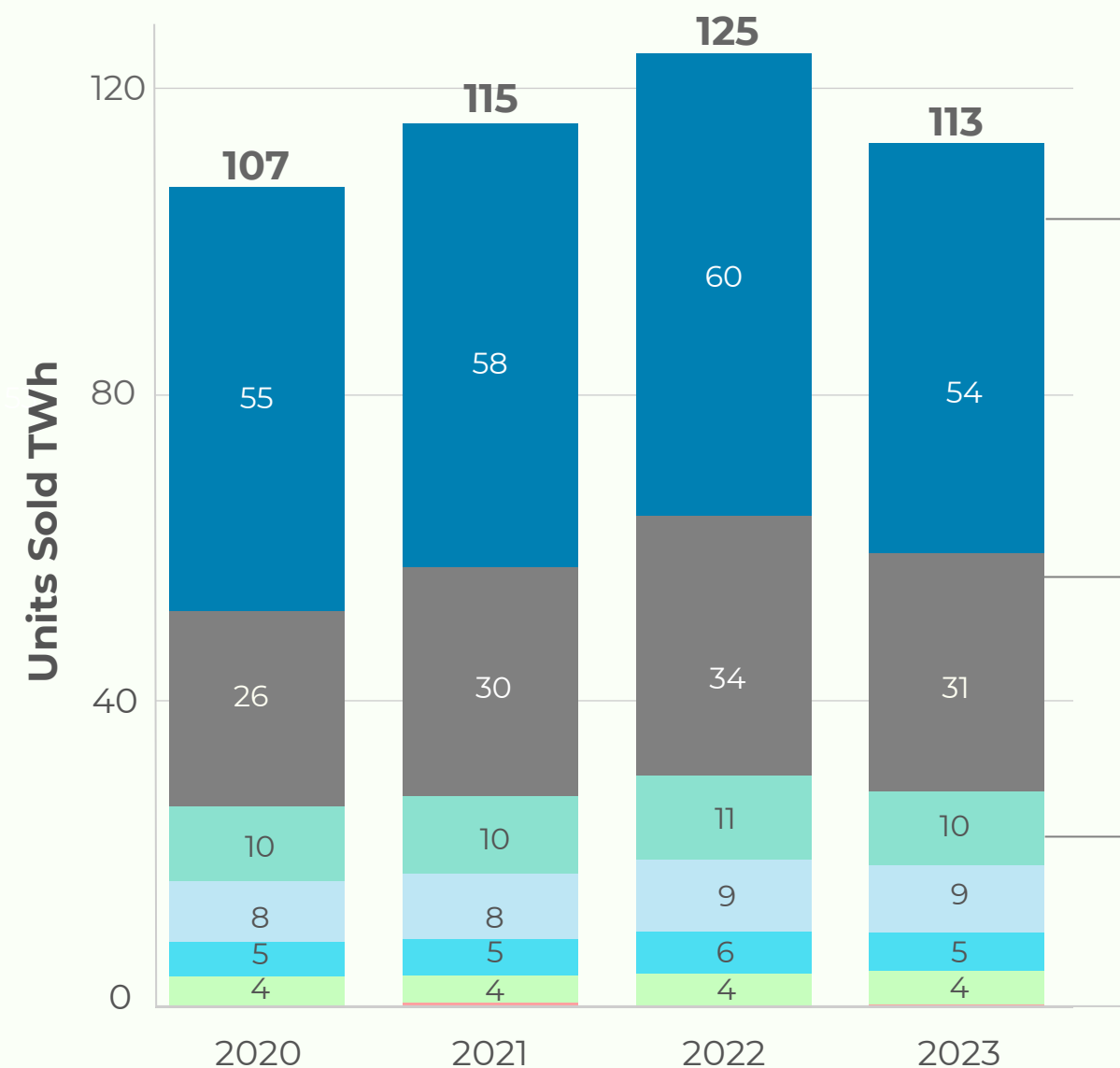
Overloaded: 16

Distribution FY23



Pakistan experienced a significant 10.4% drop in electricity sales in the FY23.

There was a **▲4.5%** growth in the number of consumers; however, the sales figures decreased by **▼10.40%**. This decline in electricity sales suggests a further under-utilization of the "take-or-pay" generation capacity.



Trend of units sold, 2020-2023

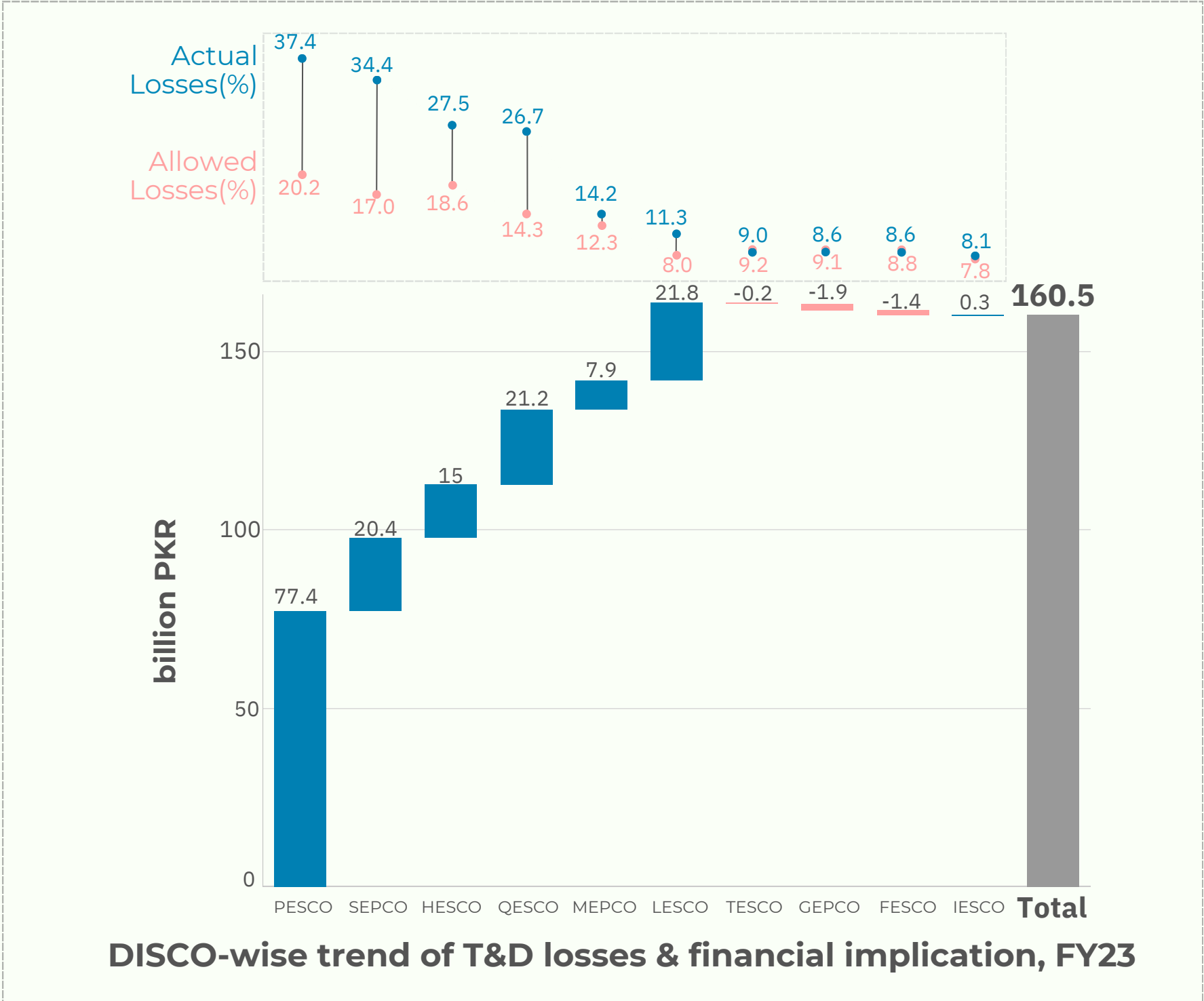
Due to high electricity costs, consumers attempted to reduce their electricity usage and increasingly turned toward distributed generation via rooftop solar installations.

In FY23, macroeconomic conditions and the lack of GDP growth affected electricity consumption in the industrial sector. Another contributing factor was industries shifting towards captive and solar power generation.

Agriculture is gradually transitioning from reliance on the grid to the adoption of solar tube wells.

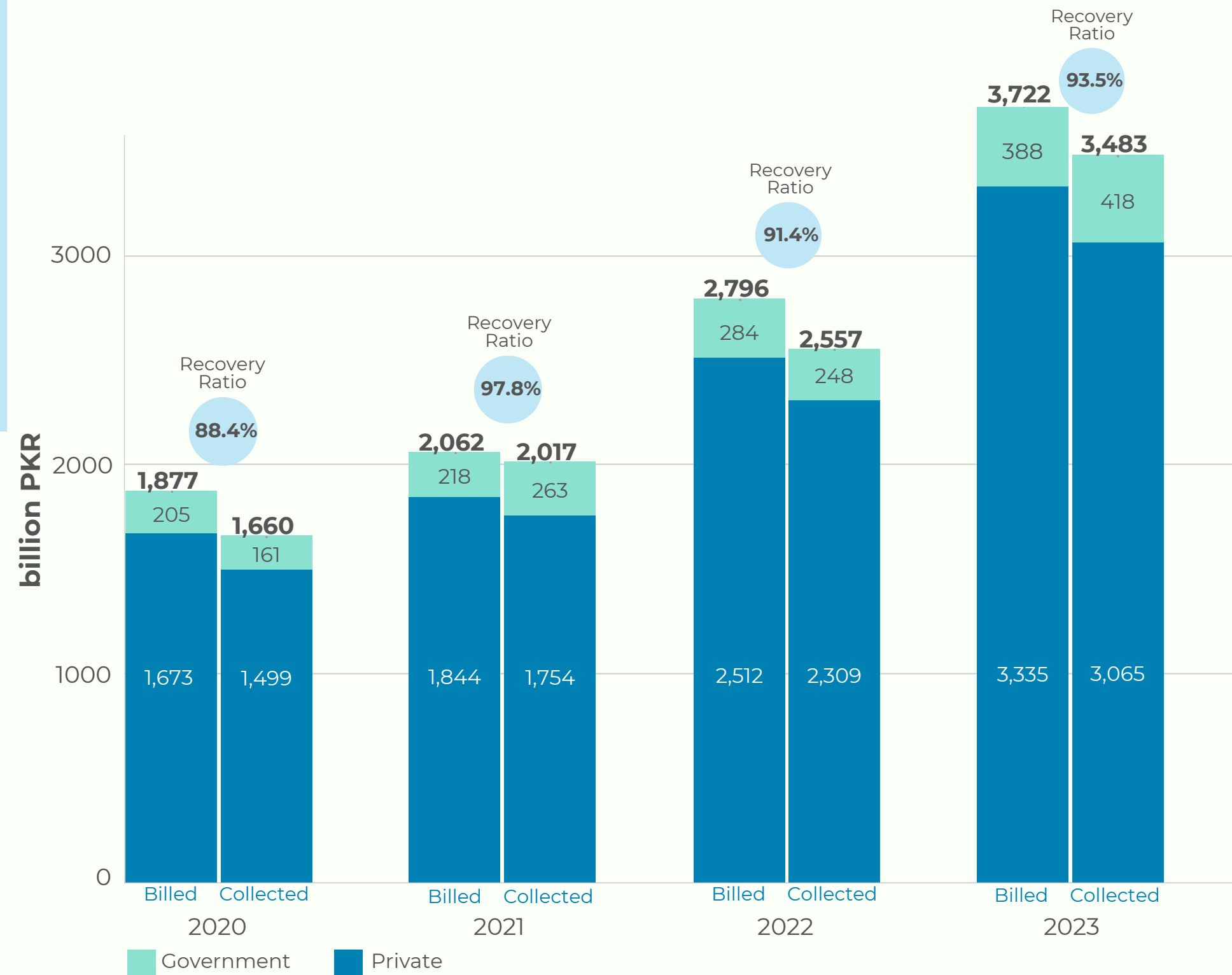
In FY23, T&D losses of 16.5% added PKR 160.5B to the Circular Debt.

While there has been some improvement in actual losses in the annual trend, the disparity between allowed losses and the increased cost of electricity units has led to higher cost implications.



In FY23, the collection ratio saw an improvement of ▲2.2% YoY.

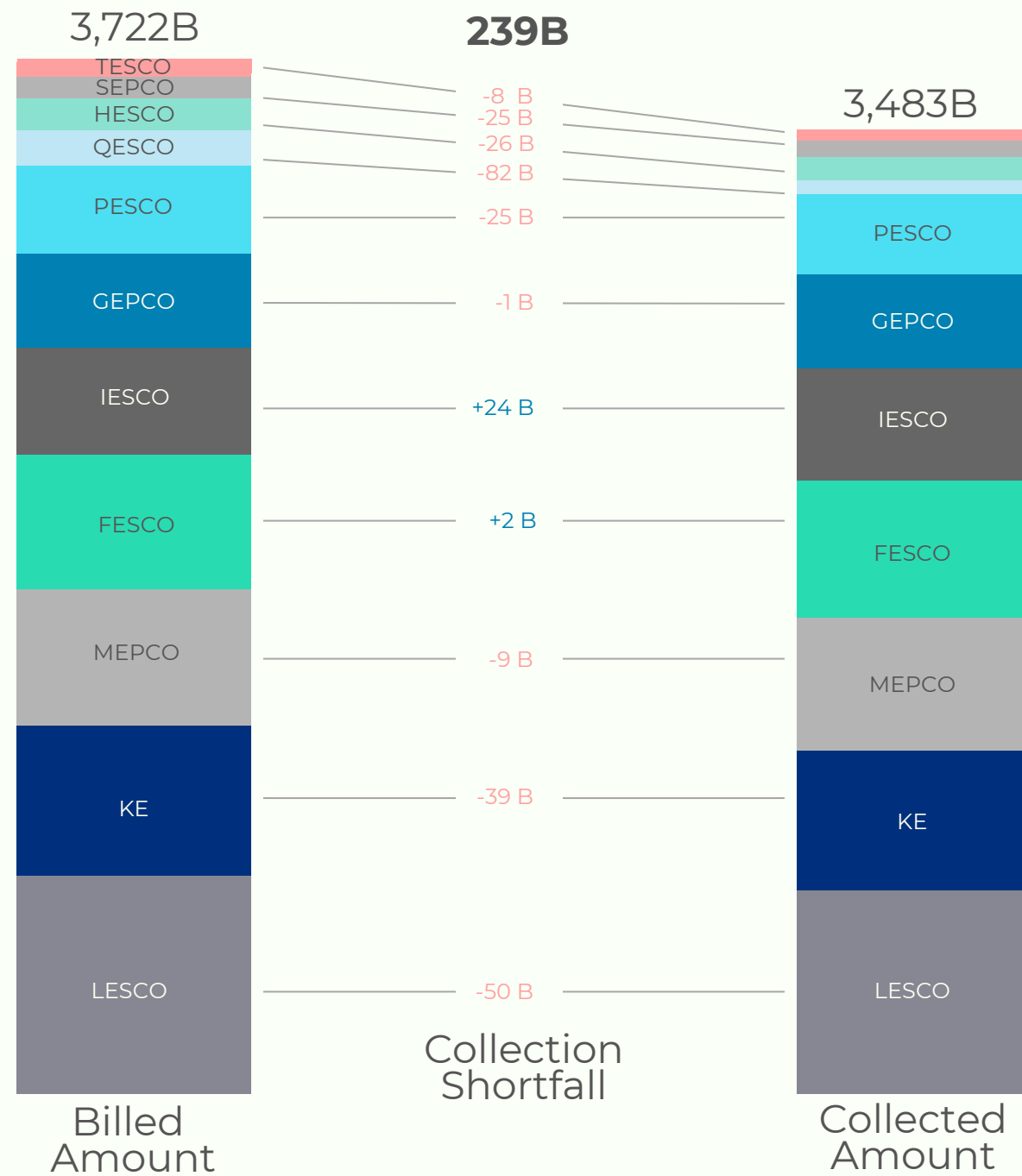
When KE and DISCOs data are analyzed together, a slight improvement is observed in the recovery ratio. Additionally, payments from the government sector also showed improvement in the reported fiscal year.



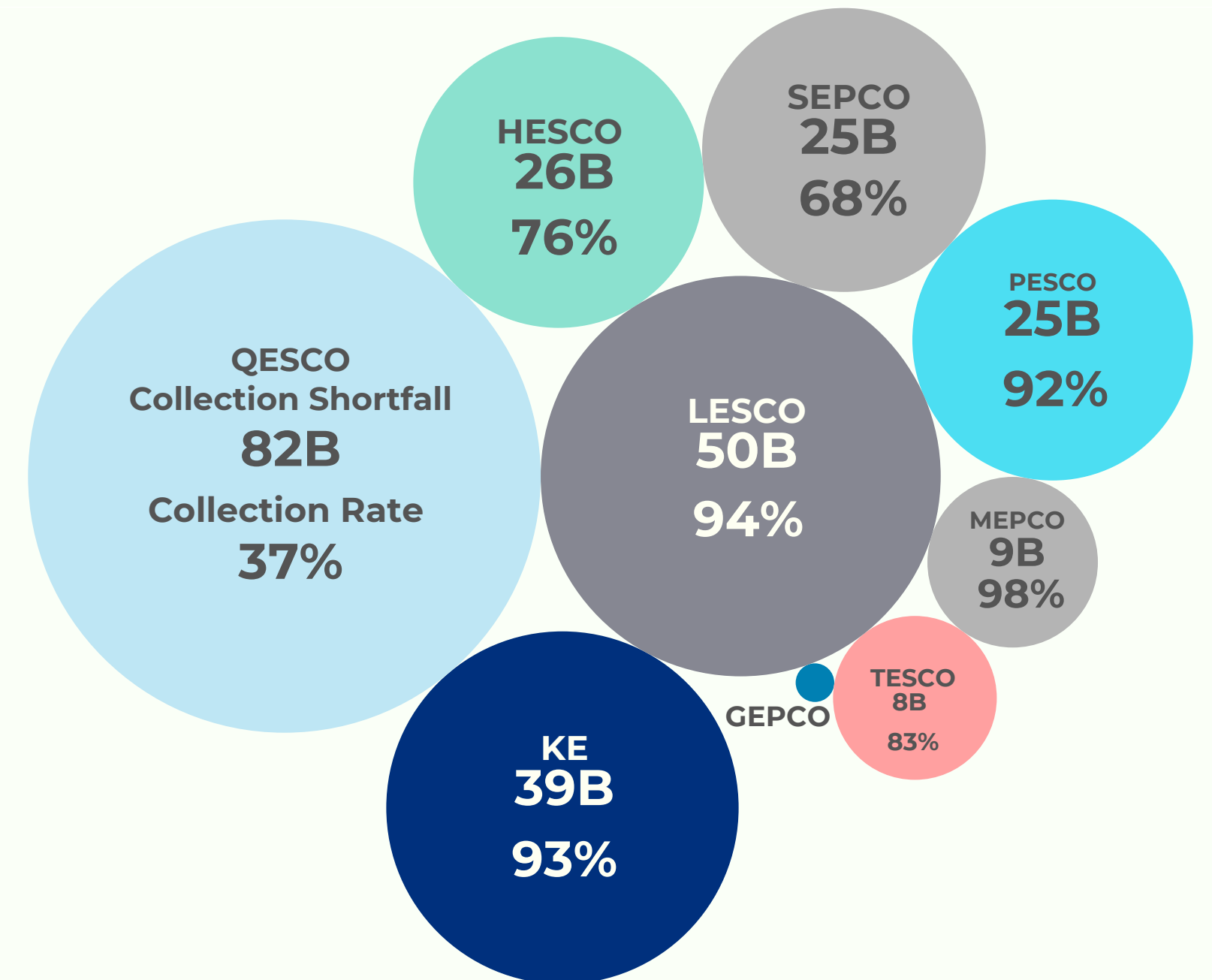
Note: above graph includes both DISCOs and KE numbers

Yearly trend of billing, collection and recovery, 2020-23

In FY23, a collection shortfall of PKR 239B was reported. The highest collection losses were reported in QESCO region with 37% collection rate.



Comparison of amount billed and collected in FY23 across different DISCOs

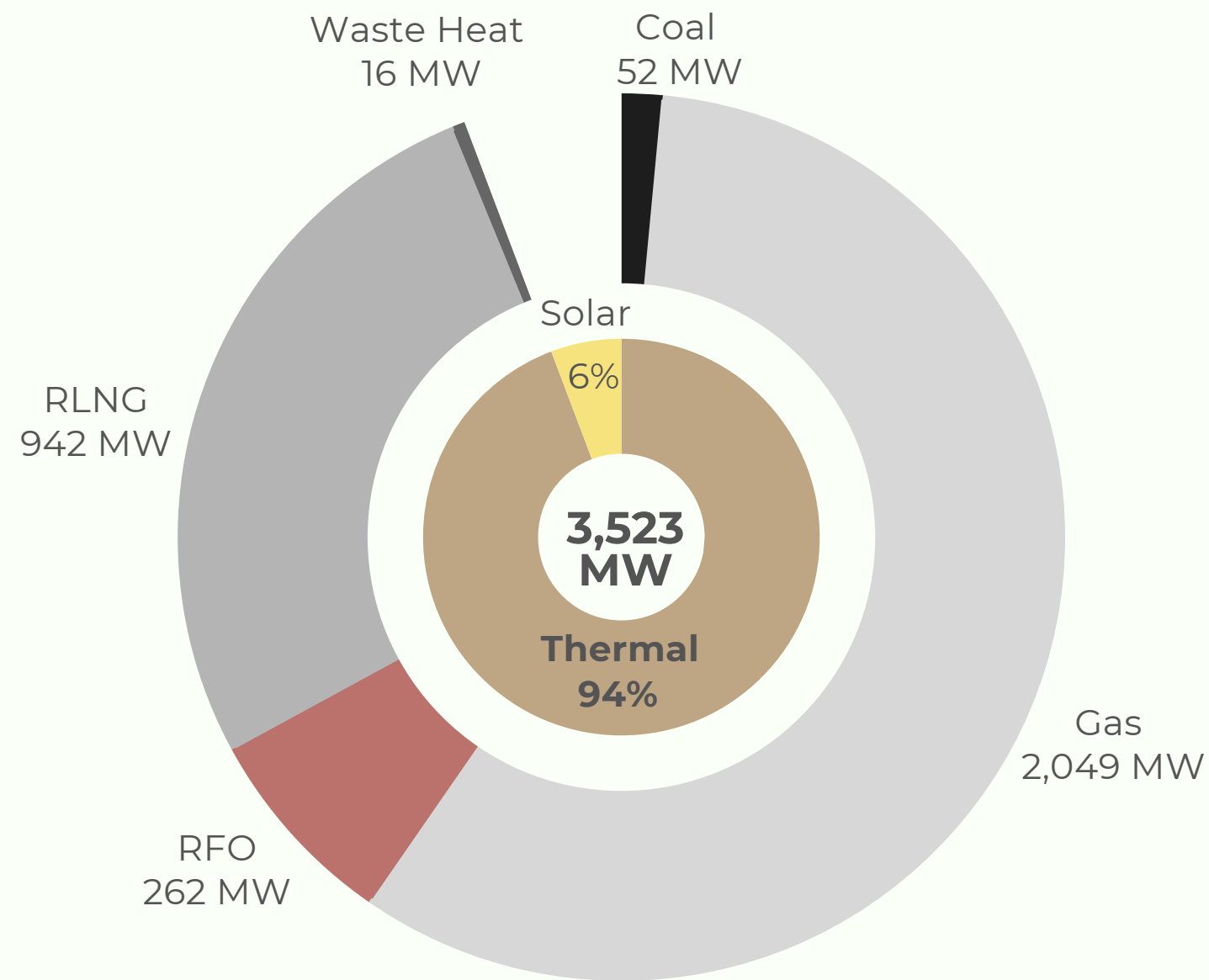


DISCO-wise breakdown of collection shortfall in FY23

Case Study: K-Electric

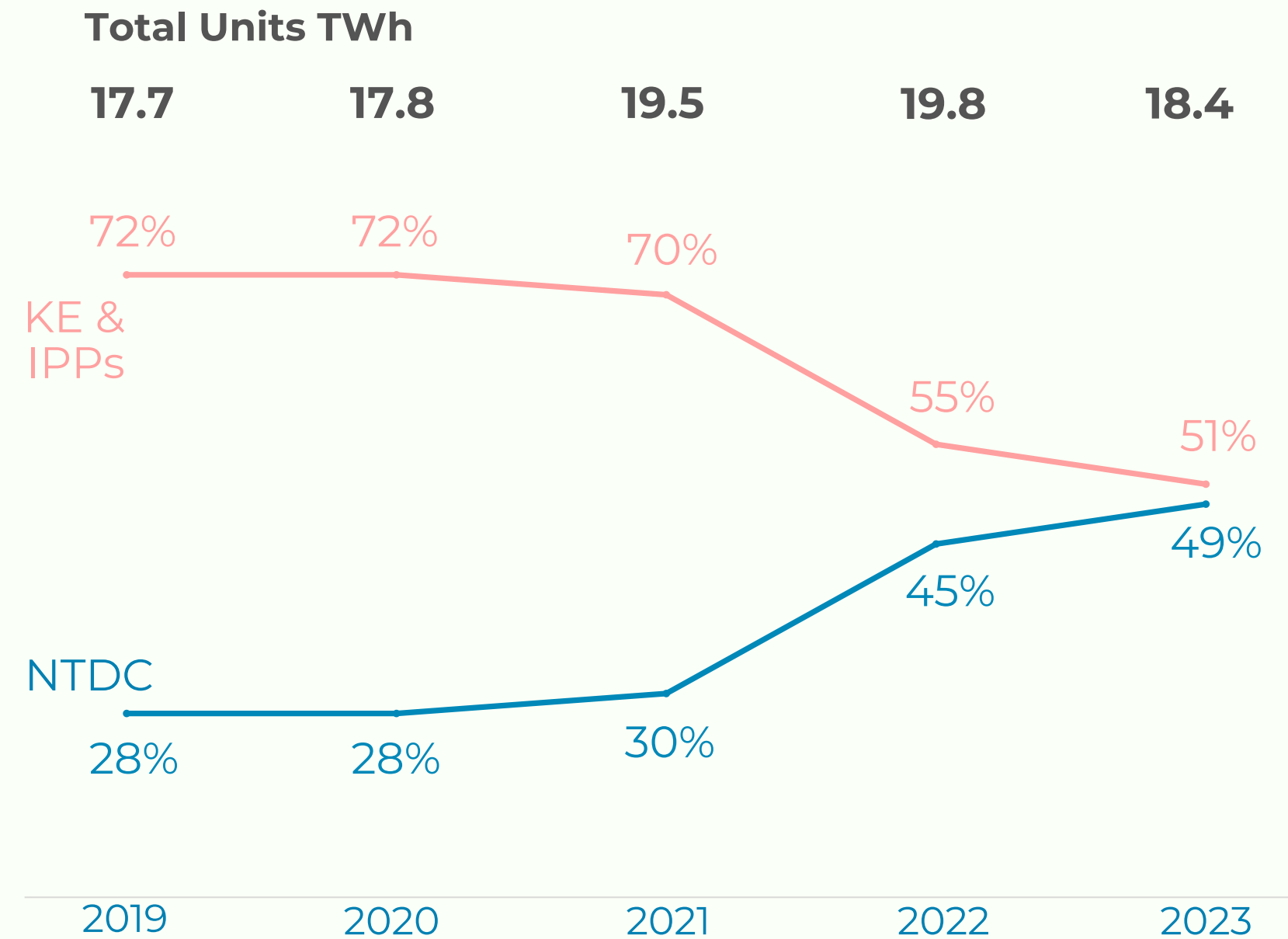
Due to high costs from its thermal-dominant generation mix, KE's reliance on NTDC power supply increased.

Under the power acquisition program, KE's base rate was 11.1 cents, compared to NTDC's 8.2 cents. NTDC has committed to supplying 2050 MW of electricity to KE from July 2024 at a more cost-effective rate to meet its rising demand.



Breakdown of KE's installed capacity, FY23

Most dual-fuel power plants now rely on RLNG due to gas availability issues.



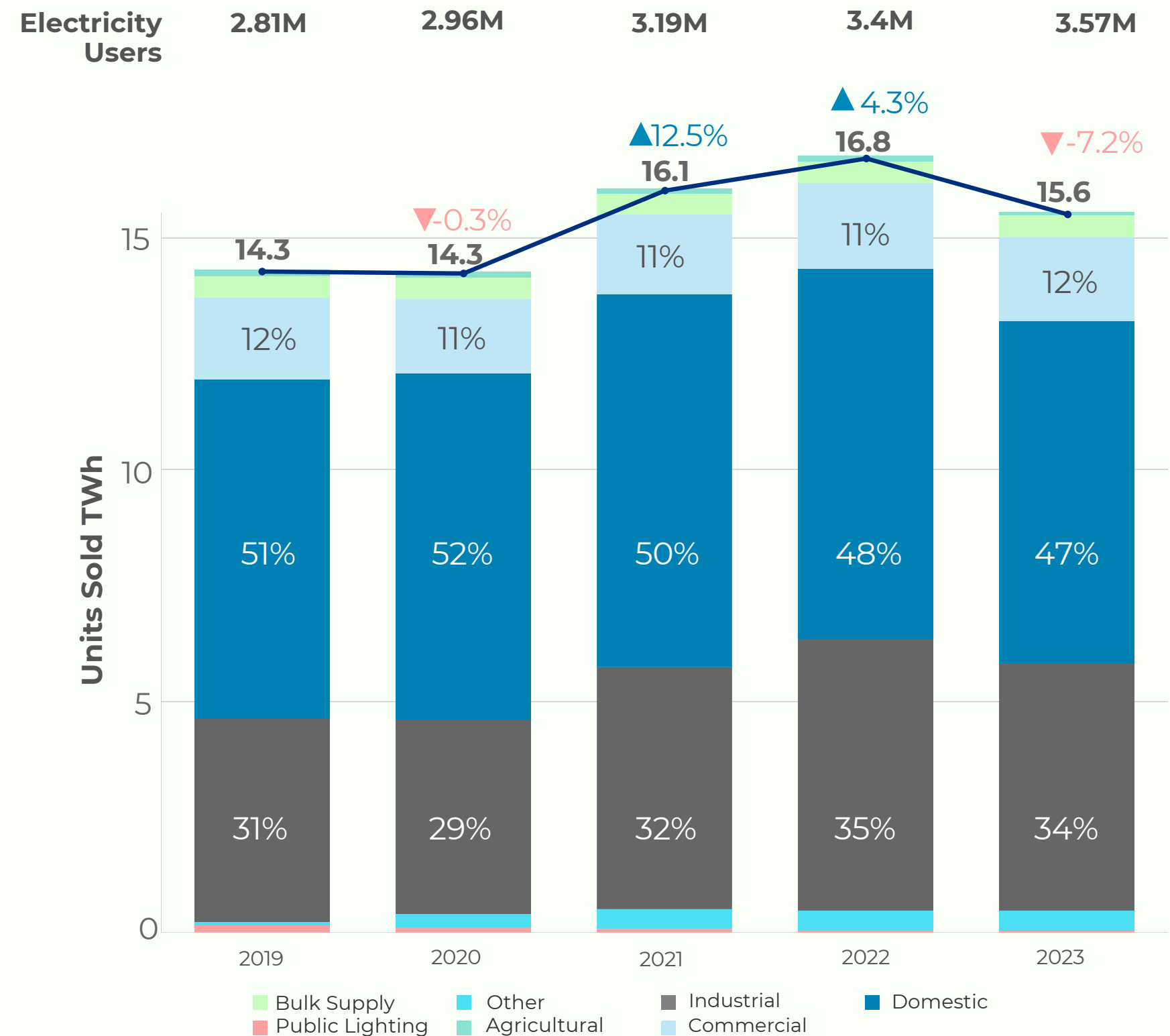
KE's reliance on NTDC for power supply, 2019-2023

FY23 marked a sharp decline in KE annual electricity sales growth!

Within KE, electricity sales decreased to 15.5 TWh i.e. **▼7.2%** in FY23, as compared to 16.8 TWh in FY22.

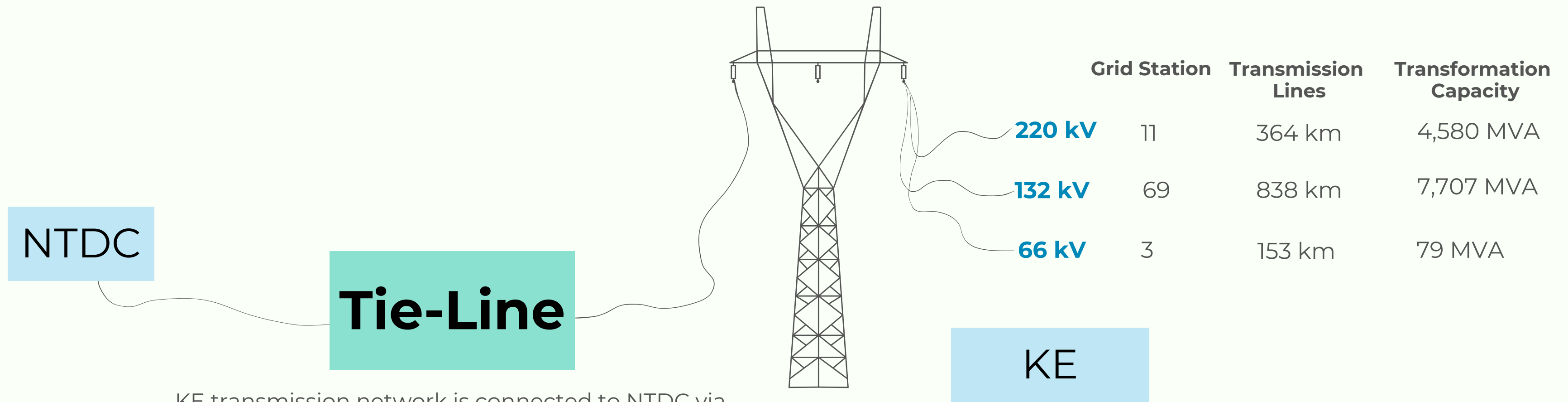
Industrial consumers make up just 0.6% of the KE total customer base, yet they consumed 34% of the electricity sold in the KE region in FY23.

Meeting the clean energy requirements of industrial consumers and addressing Scope 2 emissions, along with the Carbon Border Adjustment Mechanism (CBAM), requires clean and dependable energy sources for the industrial hub of Pakistan.



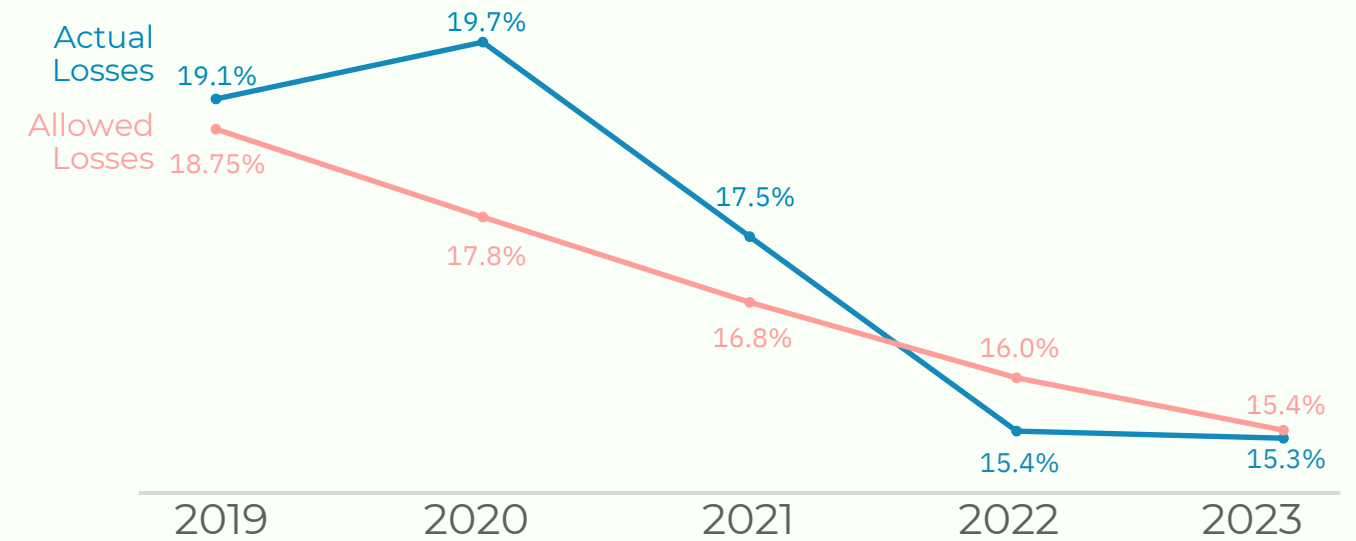
Trend of units sold in K-Electric, 2019-2023

KE's Transmission Infrastructure: Keeping Karachi Connected!



KE transmission network is connected to NTDC via Tie-Line with import capacity upto 1100 MW.

With new nuclear generation facilities like K2 and K3 and coal-based plants coming online, interconnection capacity between the National Grid and KE needs to be enhanced.



T&D losses in KE, 2019-2023

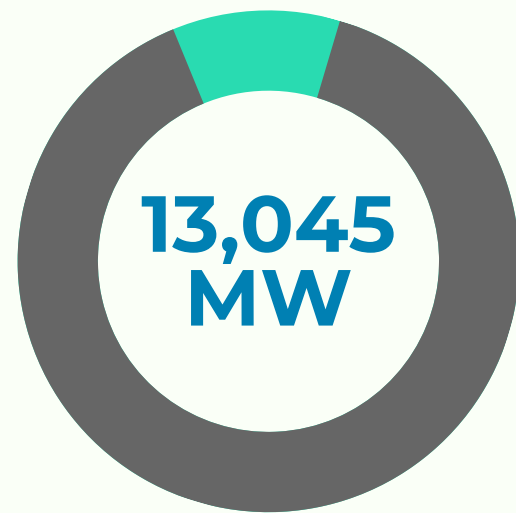
Case Study: CPEC Projects

CPEC projects played a pivotal role by generating 16% of Pakistan's electricity in FY23.

To address Pakistan's energy shortage, CPEC focused on developing coal, hydro, solar, and wind energy projects across the country, along with the 660 kV High Voltage Direct Current (HVDC) Pak Matiari-Lahore transmission line.

Capacity Additions

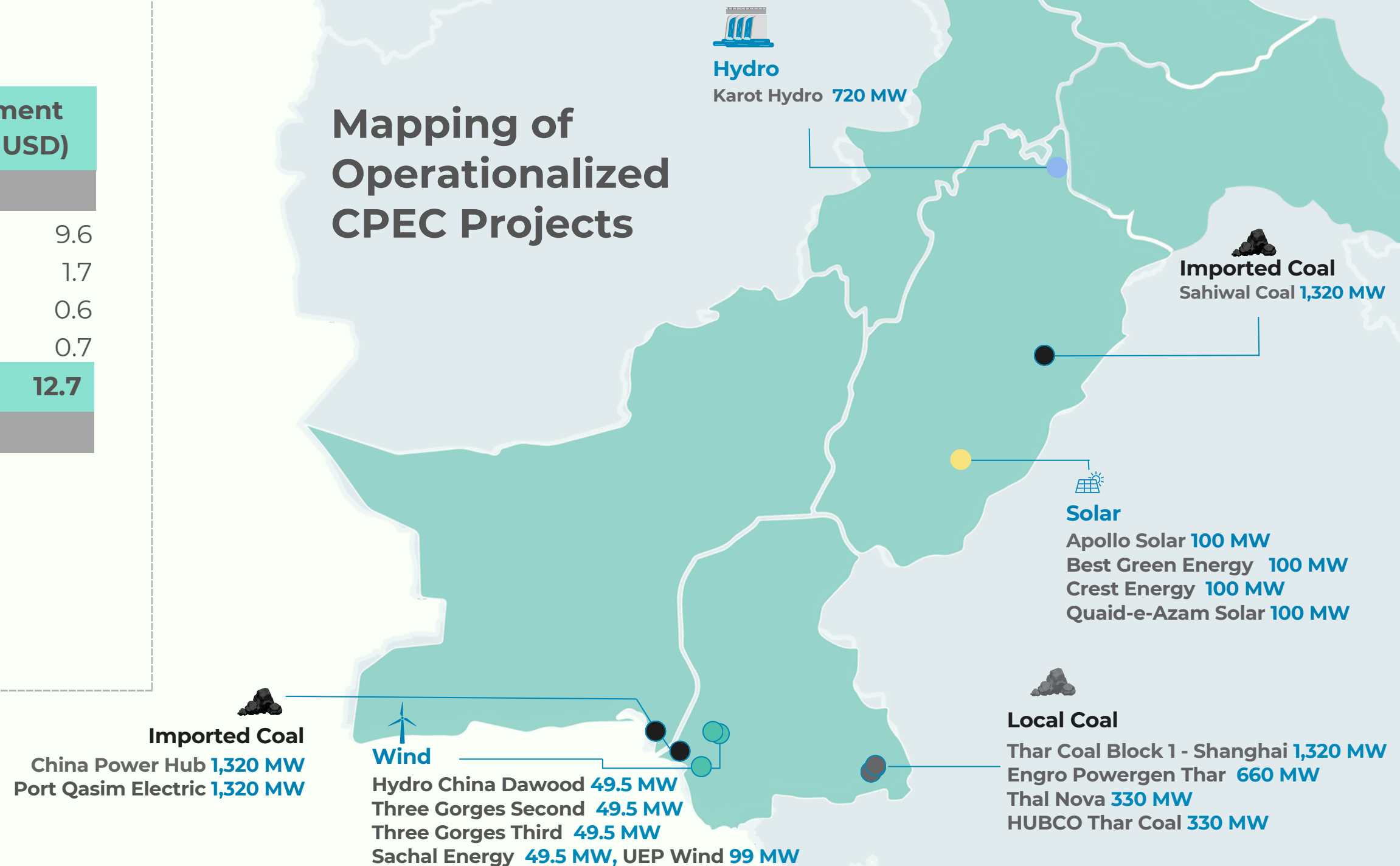
11% - 1,397 MW
Renewable Projects



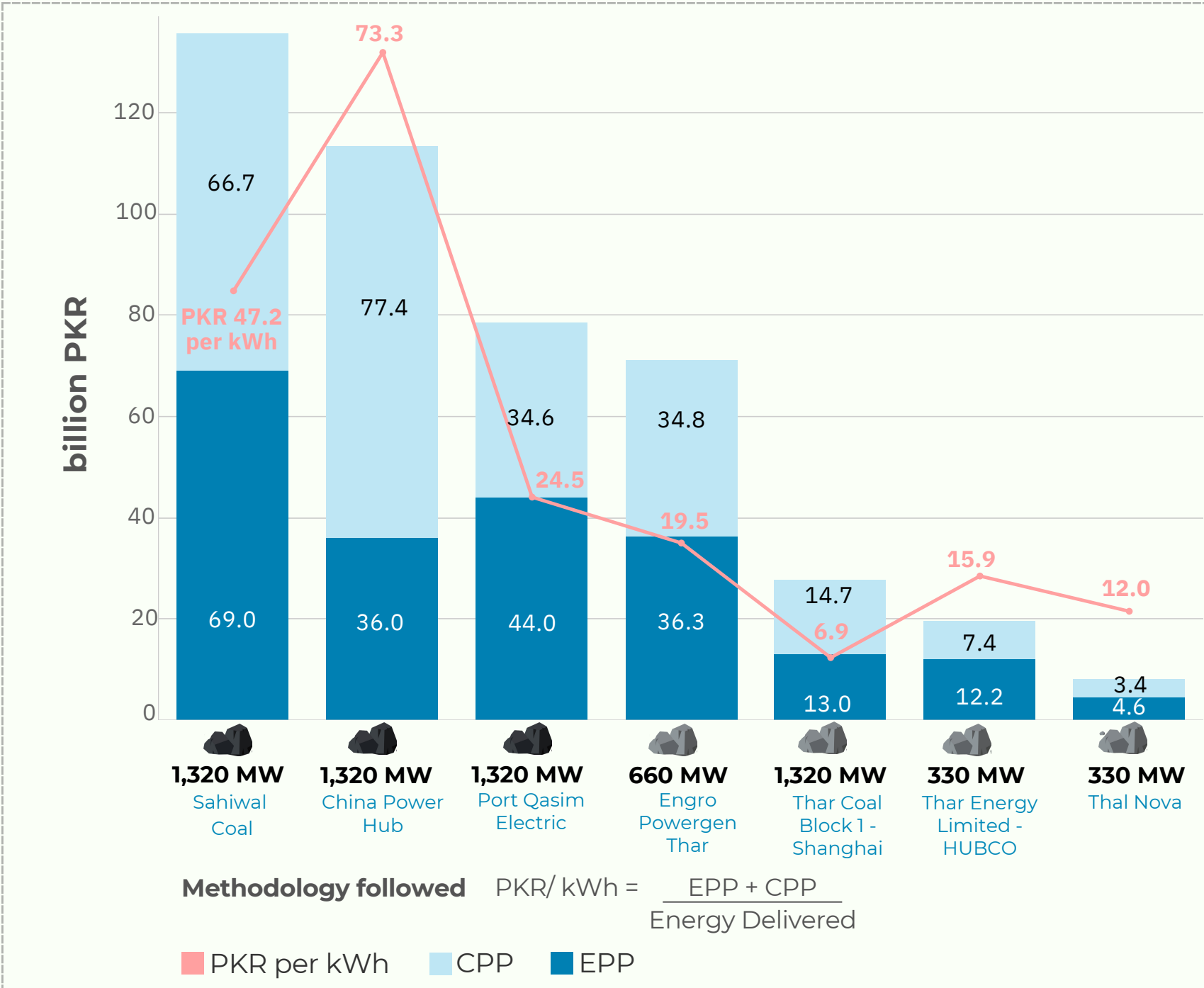
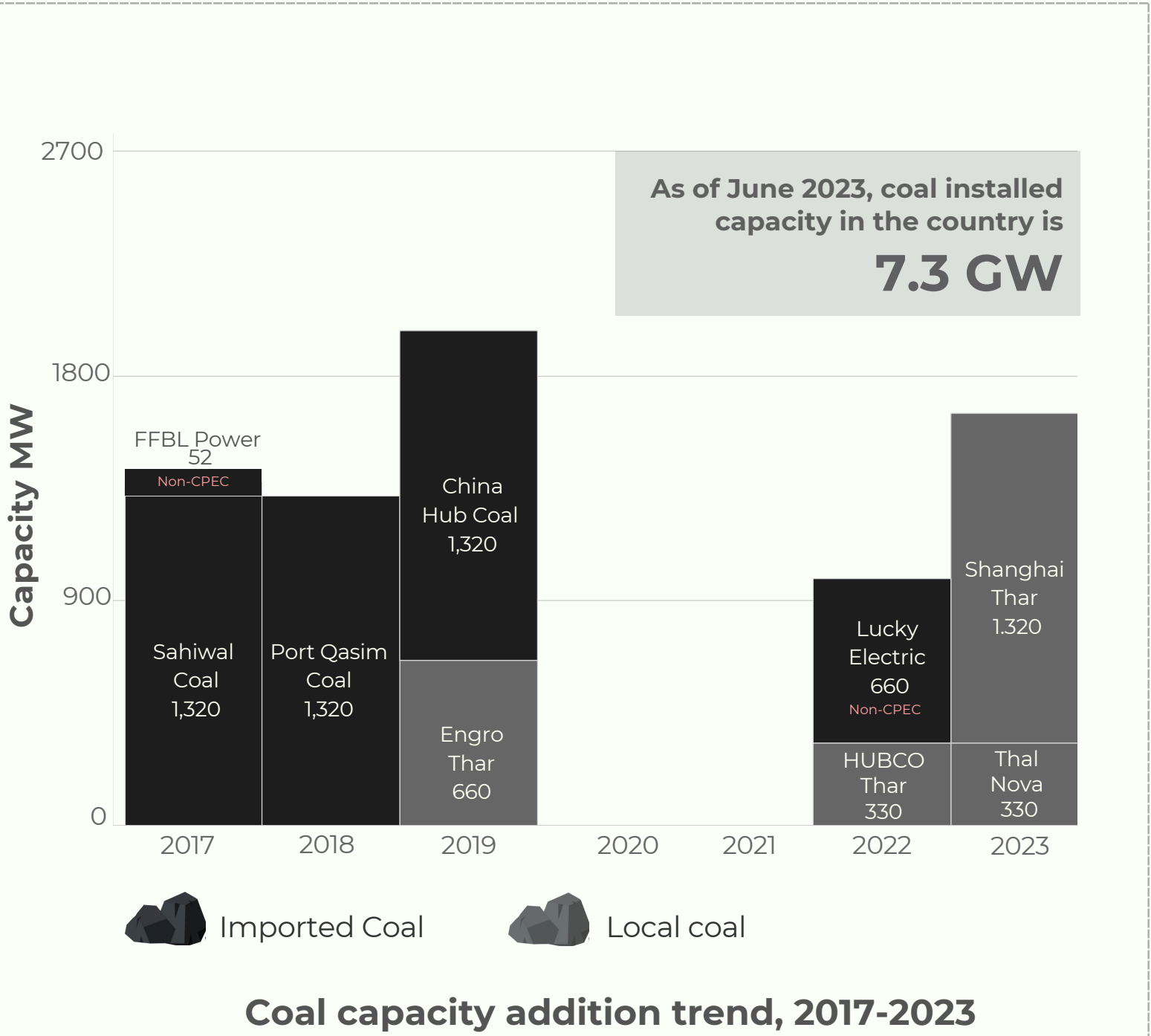
89% - 11,648 MW
Fossil Fuel Projects

Capacity Additions (MW)	Investment (billion USD)
Operational Projects	
Coal 6,600	9.6
Hydel 720	1.7
Solar 400	0.6
Wind 297	0.7
8,017 MW	12.7
Pipeline Projects	
Hydel 2,708	
Coal 1,620	
Solar 600	
Wind 100	
5,028 MW	

Mapping of Operationalized CPEC Projects



In FY23, the country had 7.3 GW of coal capacity, with a 90% share from CPEC projects. Global fuel price hikes increased costs for imported fuel-based coal power plants.



The country's transmission capacity increased with the addition of the Pak Matiari-Lahore transmission line; however, the average utilization of the line remained at 40% in FY23.

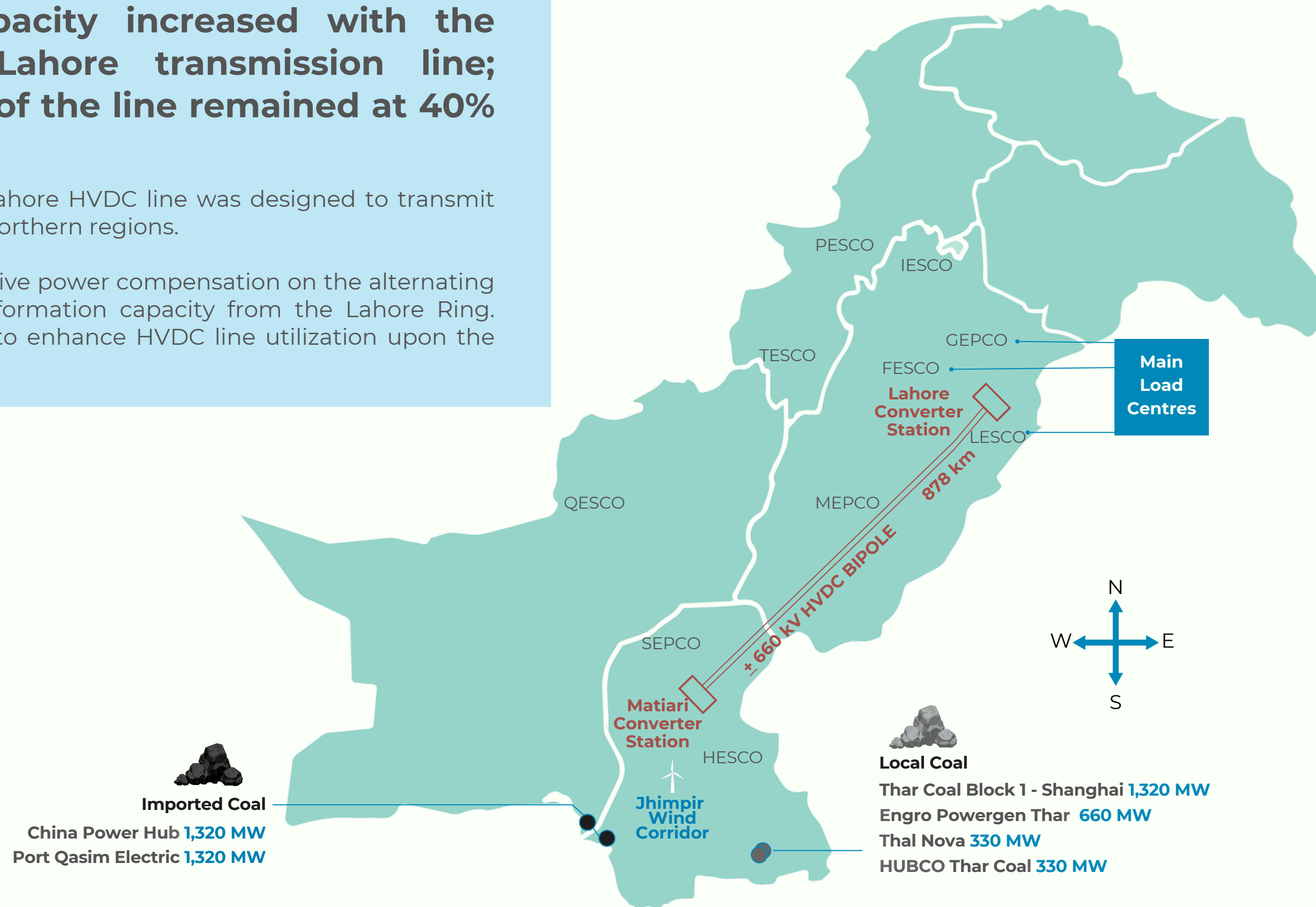
Commissioned in September 2021, the Matiari to Lahore HVDC line was designed to transmit power from southern coal-based thermal plants to northern regions.

Current full utilization is limited by inadequate reactive power compensation on the alternating current (AC) corridor, as well as insufficient transformation capacity from the Lahore Ring. Progress on the Lahore North project is expected to enhance HVDC line utilization upon the completion of the grid station.

FY23

Energy delivered: 13.5 GWh
 Losses: 2.7% losses
 Avg. utilization: 39.6%
 Invoiced Amount:
 PKR 73.3B

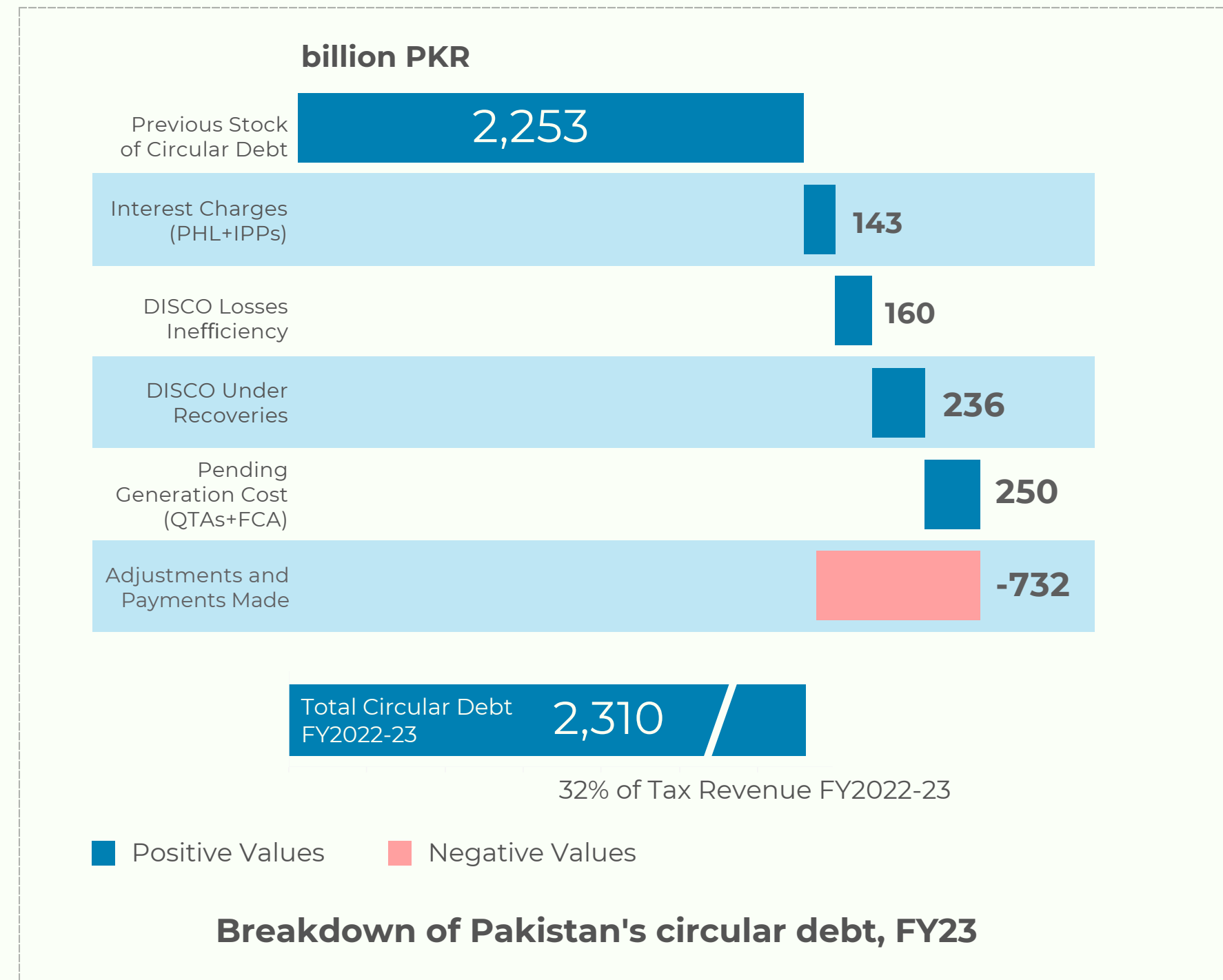
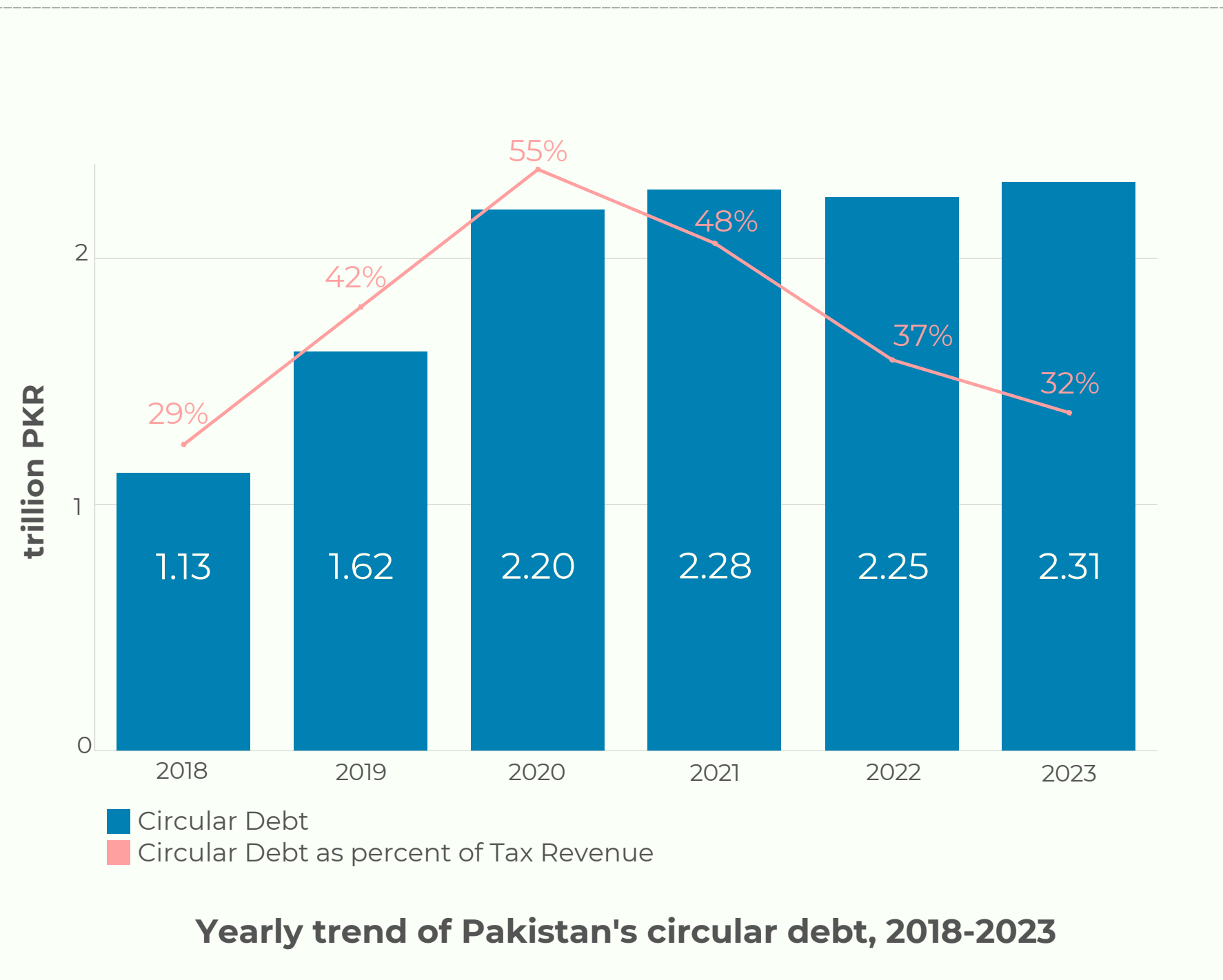
Company: Pak Matiari-Lahore Transmission Company Limited (PMLTC)
 Contract Type: Take or Pay
 Length : 878 km
 Capacity: 4,000 MW



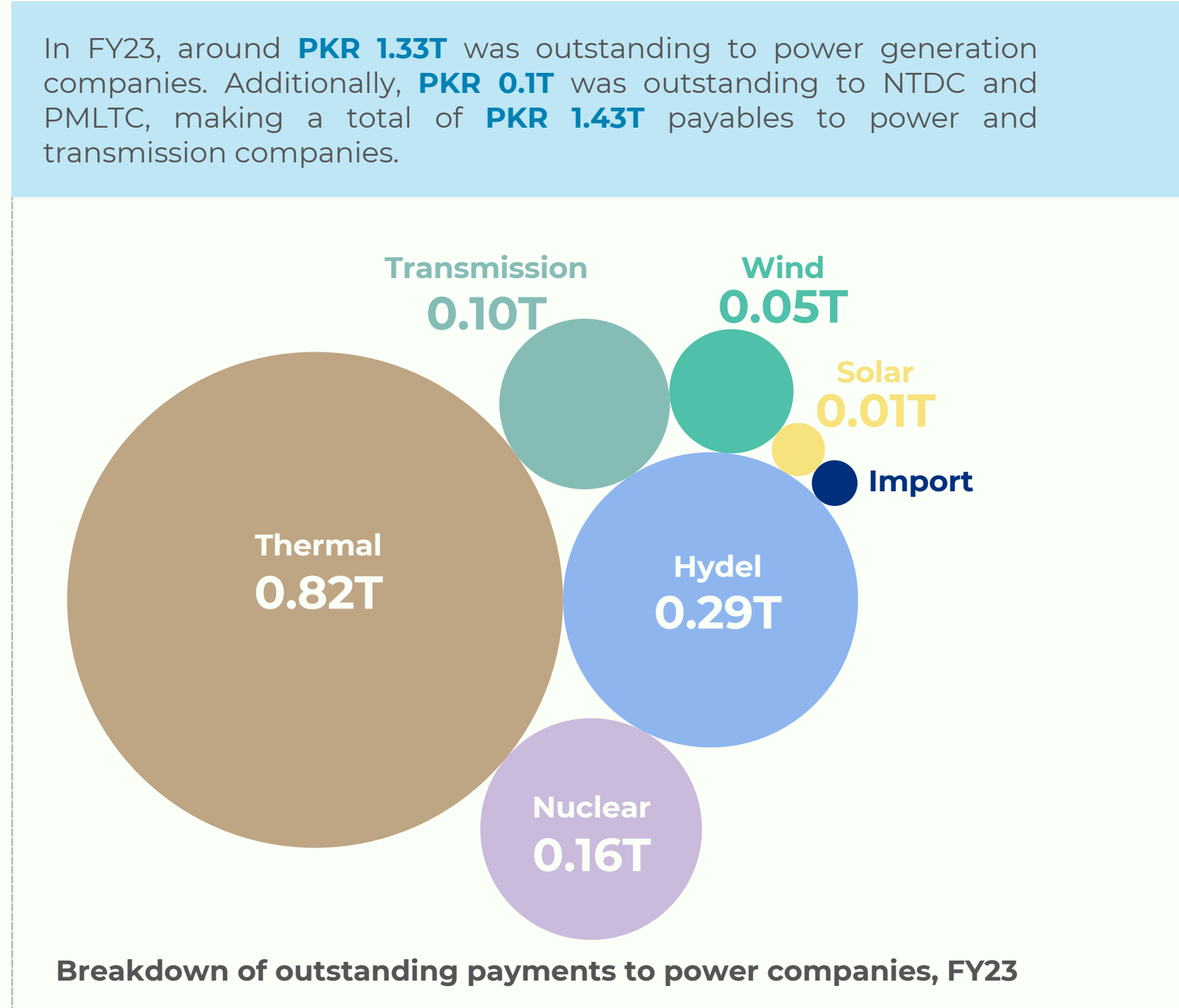
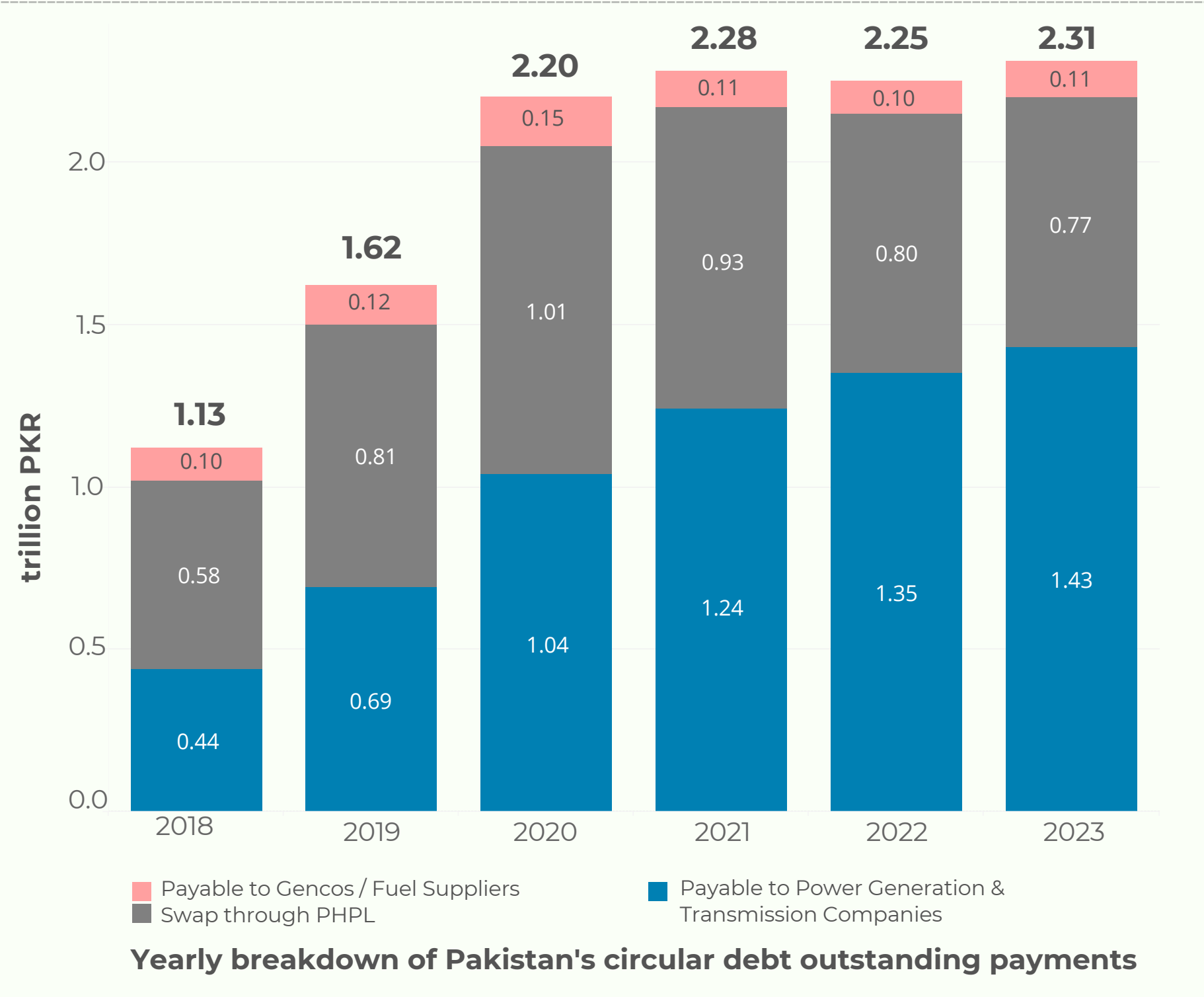
Case Study: Circular Debt

The circular debt issue escalated with the induction of "take-or-pay" contracts in FY19, which were intended to alleviate energy shortages.

As of January 2024, the power sector's circular debt has reached **PKR 2.6T**, with an additional **PKR 463B** accrued since June 2023.



In FY23, 64% of the Circular Debt comprises of amounts payable to power generation companies.



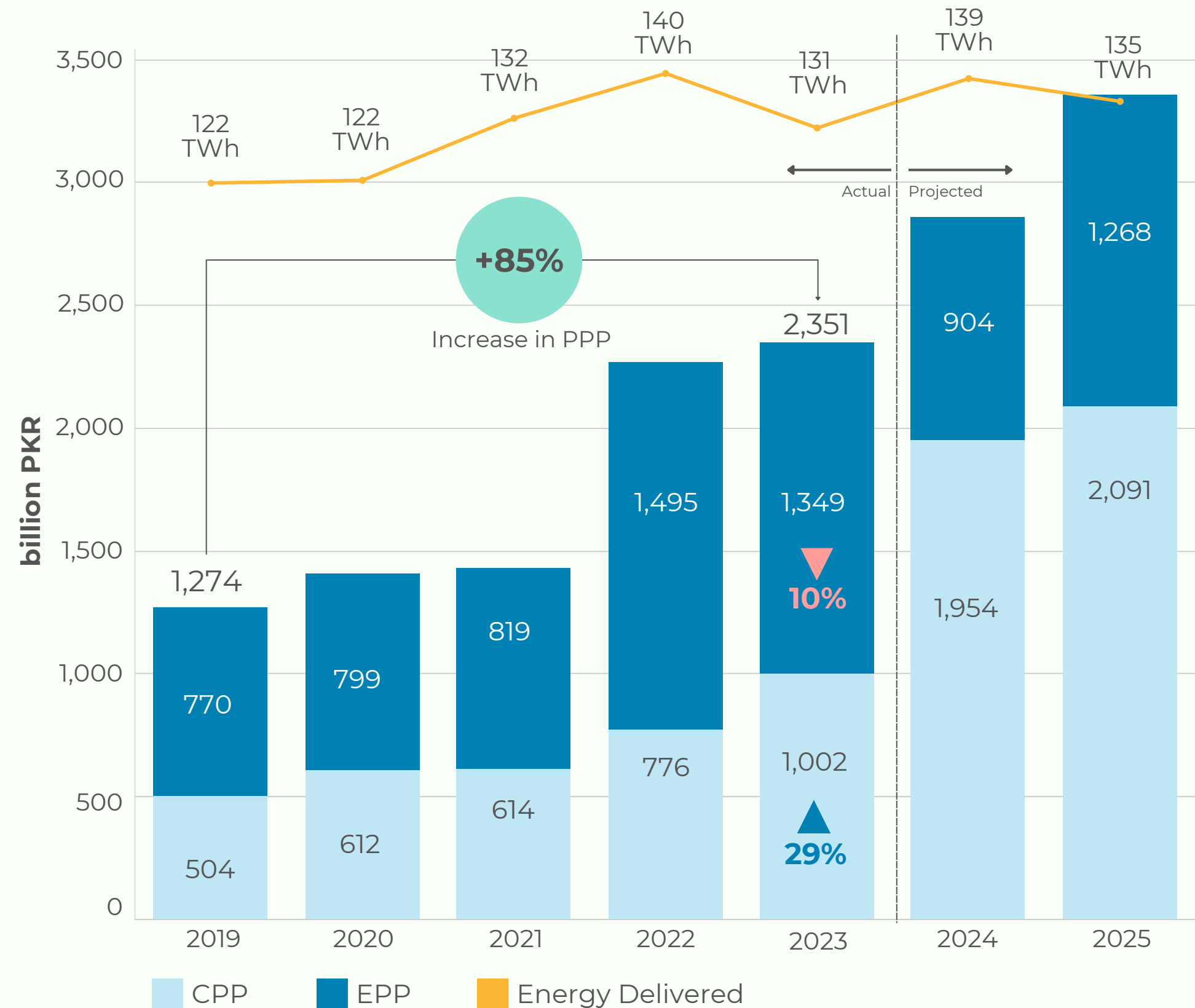
Financial Overview FY23

In FY23, capacity payments saw a 29% YoY increase, emerging as a significant factor in driving up power tariffs across the country.

The exchange rate parity is one of the major factors impacting electricity prices in Pakistan. Since the country's power sector costs are predominantly tied to the dollar, fluctuations in the exchange rate directly influence energy and capacity charges in the generation segment.

Sales-growth policies are crucial now, especially with capacity payments increasing annually. The recent 10.4% drop in sales in FY23 highlights the complexity of the situation.

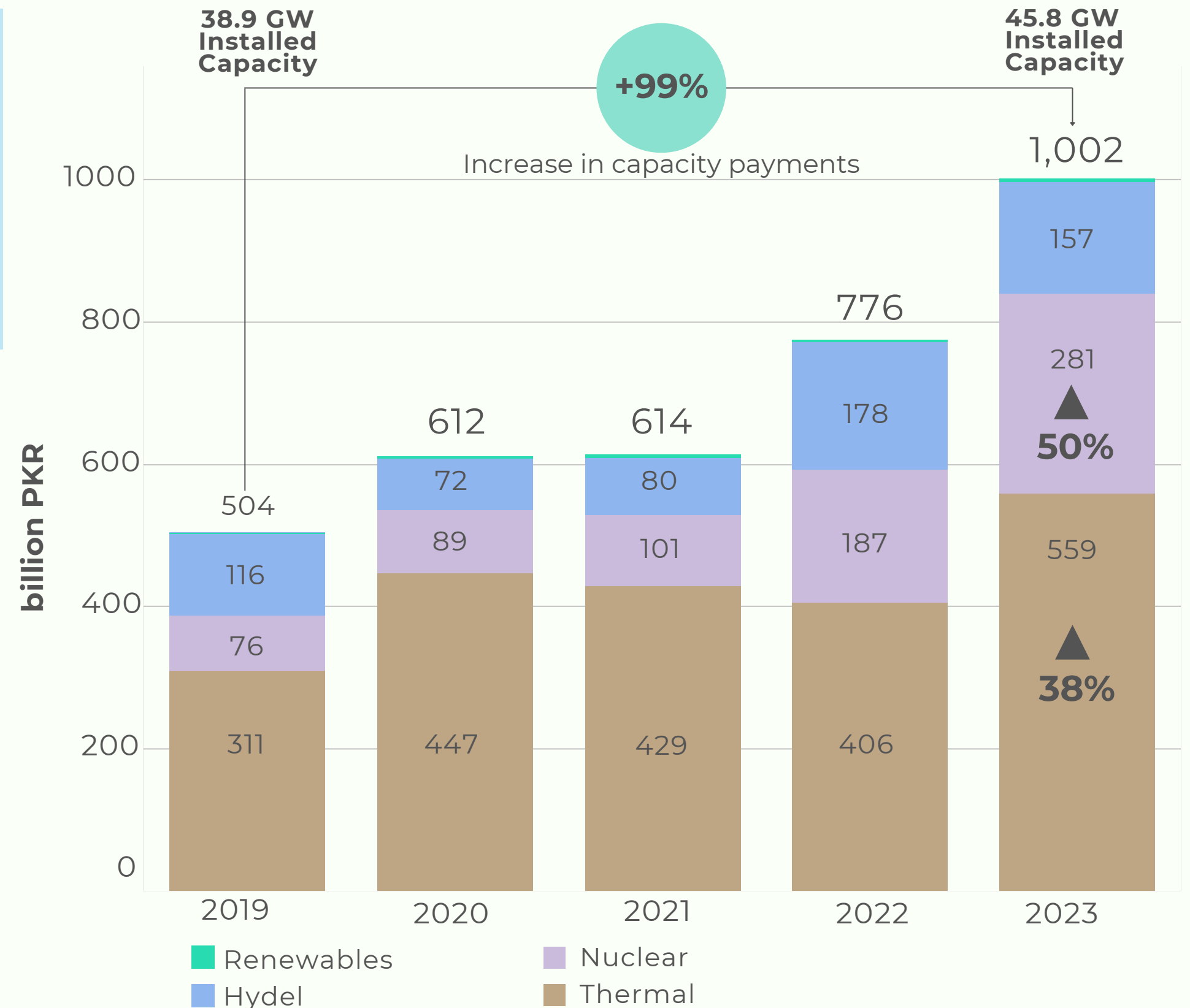
Efforts should focus on bringing all consumers back to the National Grid. The current approach will not ensure the long-term viability of the sector, as a shrinking consumer base will further strain the system's cost recovery.



Energy purchase price and energy delivered trend, 2019-2025

In FY23, the capacity payments for nuclear and thermal energy increased to PKR 840B.

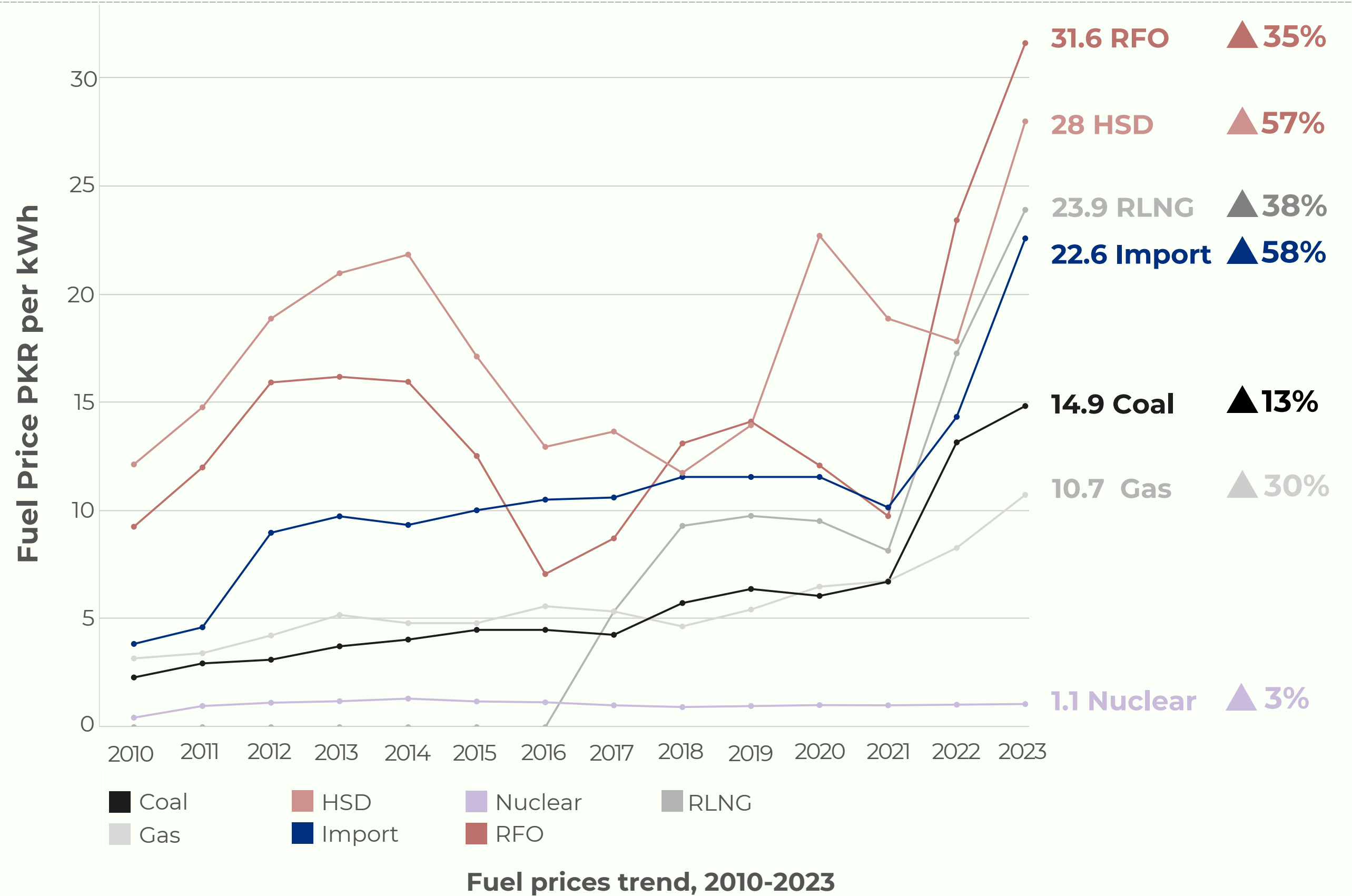
In FY23, the thermal share increased by ▲38% YoY, and nuclear's share in capacity payments increased by ▲50% on YoY basis.



Capacity purchase price trends by energy type, 2019-2023

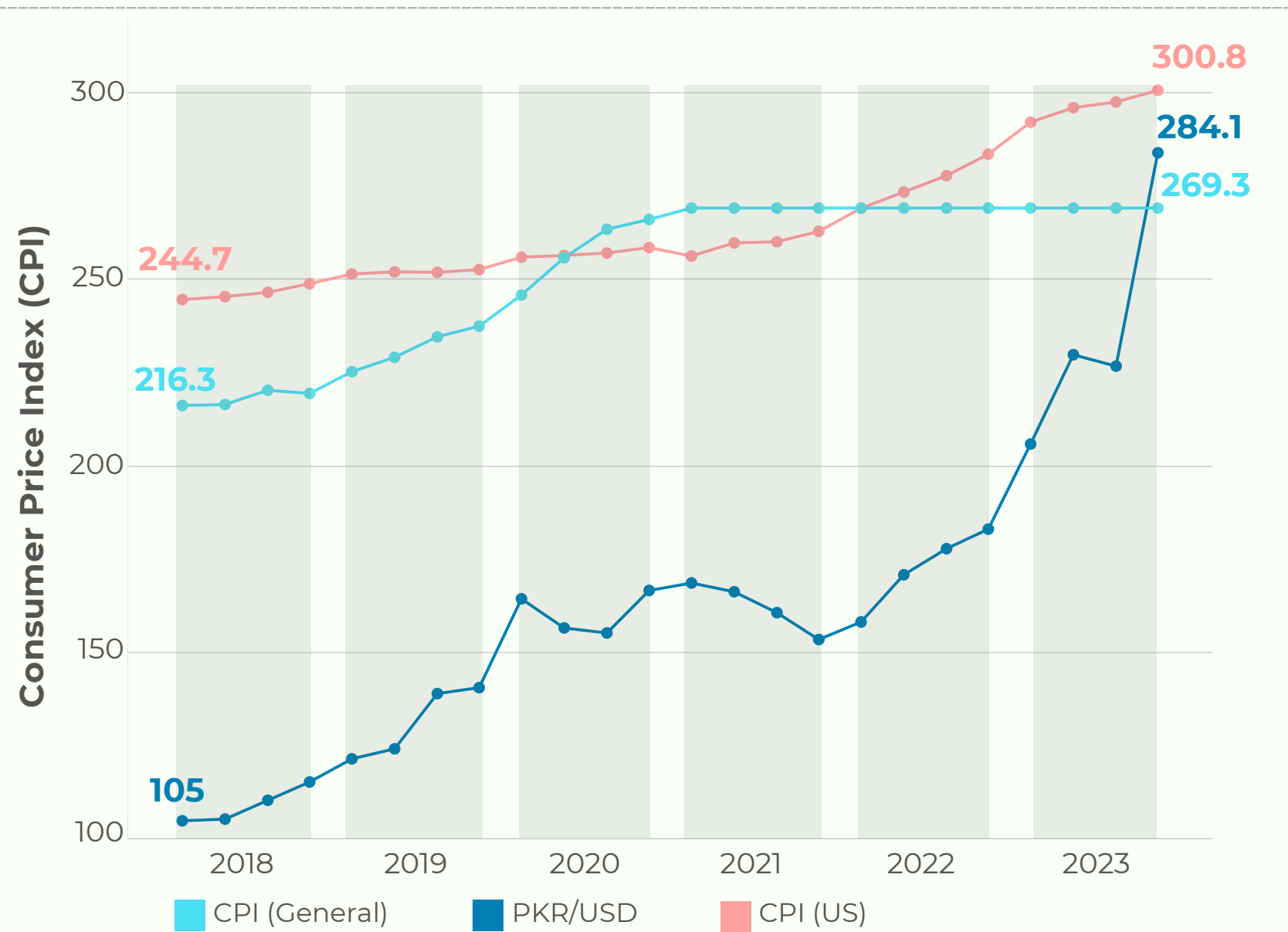
The Russia-Ukraine war disrupted global energy supplies, causing a significant price hike!

Due to the war and Pakistan's reliance on imported fuel, inflation had surged. Higher fuel and energy prices had placed additional financial pressure on both consumers and businesses

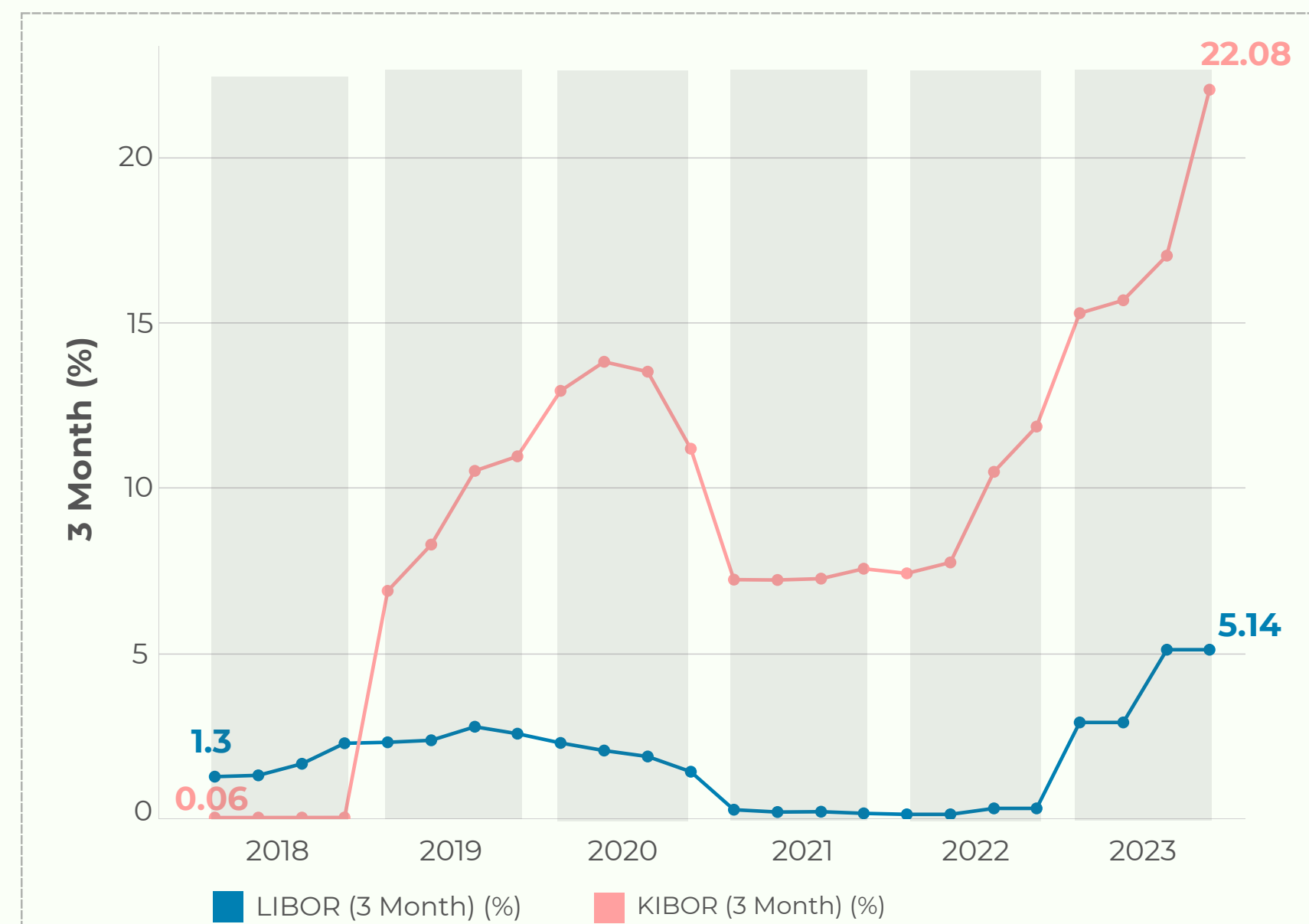


Economic Pulse Check: The Latest on CPI, KIBOR, and LIBOR Trends.

Global and domestic inflation rates have increased significantly since 2021, prompting central banks worldwide to aggressively tighten monetary policy by rapidly raising interest rates. In Pakistan, there is an anomaly in the Consumer Price Index (CPI) data due to a change in the base year for calculations. NEPRA continued using old CPI figures until June 2023, as they did not immediately adopt the new base year (i.e. 2015-16) implemented by the Pakistan Bureau of Statistics (PBS) in July 2020.



CPI General & CPI US year-wise trend, 2018-2023



KIBOR & LIBOR yearly trend, 2018-2023

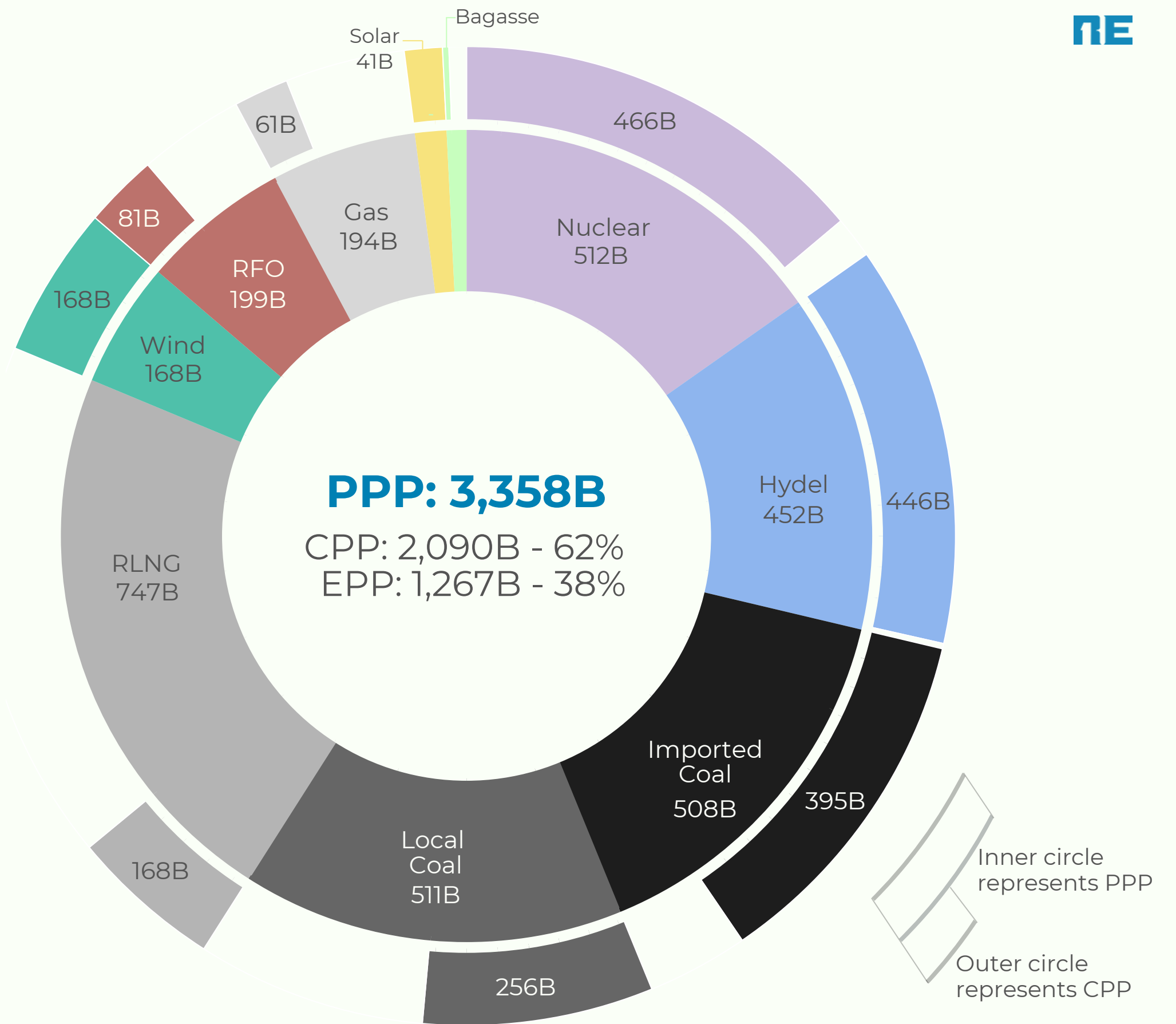
The Power Purchase Price for FY25 is forecasted to reach PKR 3.3T, ▲17.5% YoY, corresponding to an energy generation of 134 TWh ▼3% YoY.

The Power Purchase Price (PPP) comprises of:

- Energy Purchase Price (**EPP**) that comprises fuel charges and variable operations and maintenance charges.
- Capacity Purchase Price (**CPP**) are payments to the power producers to cover their cost of availability of its capacity, regardless of the power generation.

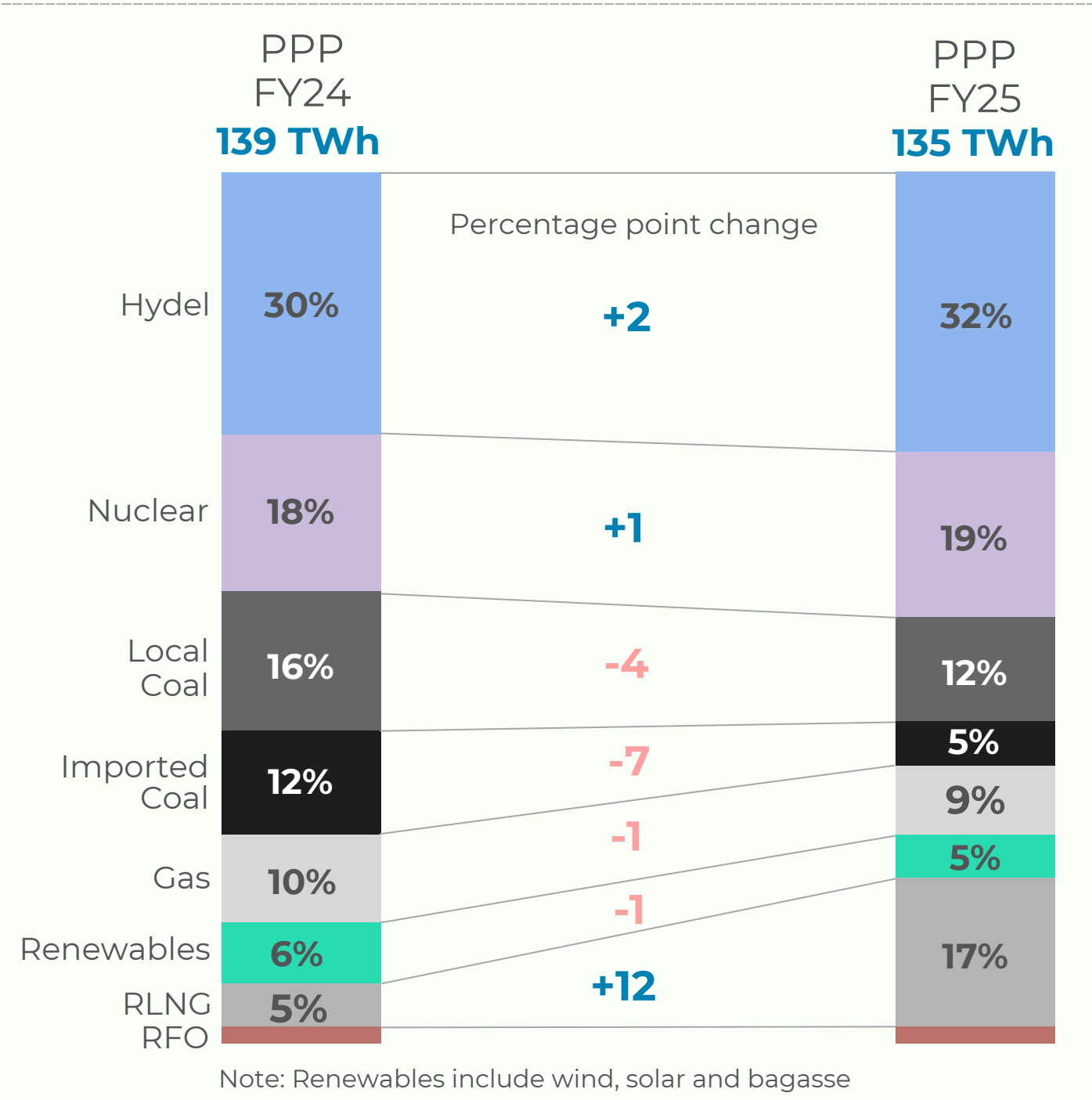
The variation in projected fuel costs or changes in the generation mix is adjusted through monthly **Fuel Cost Adjustment (FCA)**.

In contrast, any variations in projected capacity charges, Use of System Charges (UoSC), or Market Operator fees, among others, are adjusted through **Quarterly Adjustments (QTA)**.

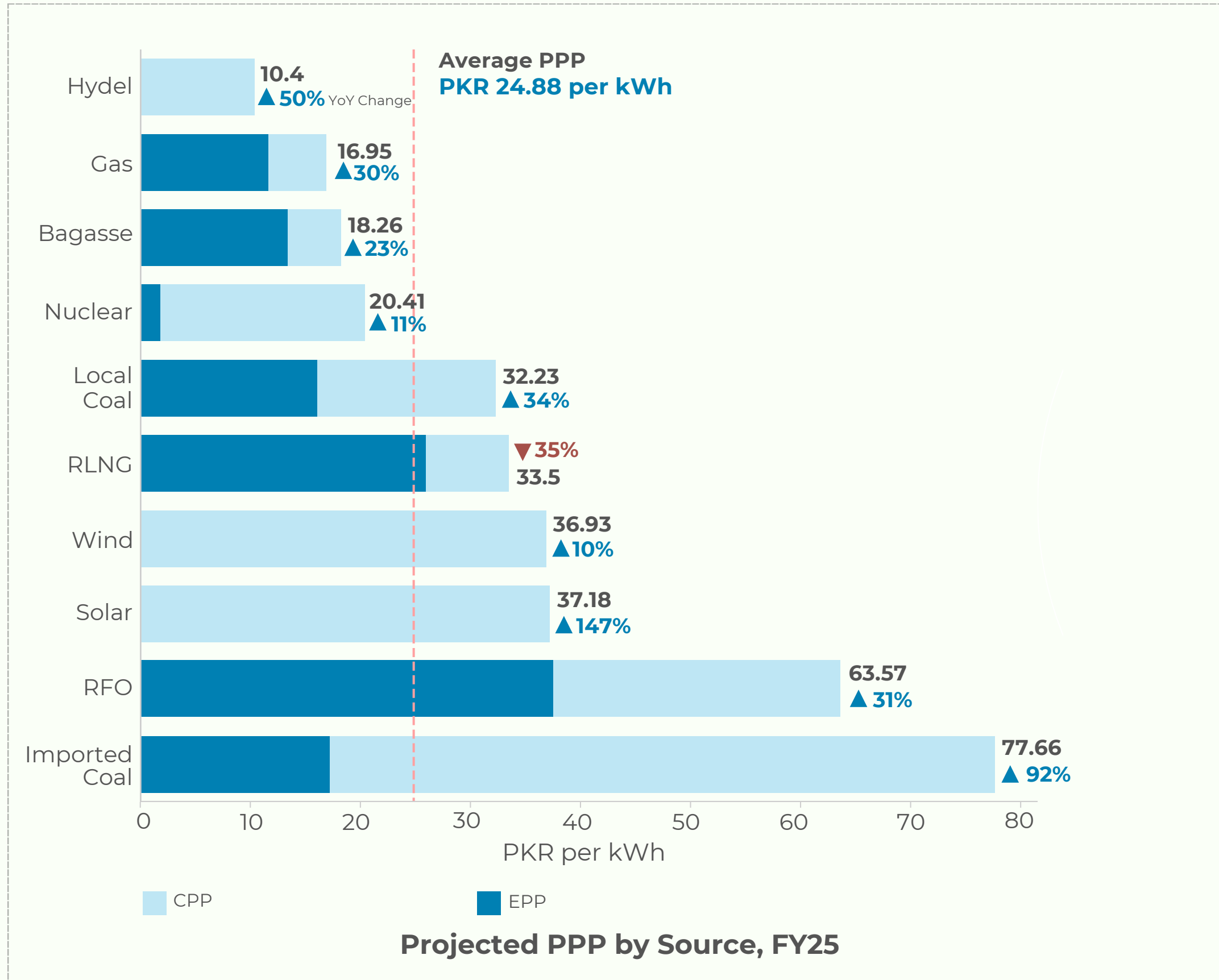


Energy source-wise break-down of projected power purchase price, FY25

Power Purchase Projection for FY25



PPP comparison of FY24 and FY25



Projected PPP by Source, FY25



Outlook

- Thermal power made up 63% of the installed capacity as of FY23, with most plants dependent on imported fuel. This reliance is expected to continue impacting power generation in the coming years.
- The Pak-Matiari transmission line has increased evacuation capacity from south to north, but its underutilization and other transmission constraints remain challenges that need to be addressed. To resolve these issues, transmission system upgrades advised under the TSEP should be expedited to alleviate network constraints and address wind power curtailment.
- Capacity payments rose from PKR 776B in FY22 to PKR 1,002B in FY23, a 29% YoY increase, and are expected to hit PKR 2,091B by FY25. To ease this financial burden, the government should renegotiate contracts with power producers and consider early retirement of underutilized plants as well as those nearing the end of their contracts.
- Consumer tariffs have risen significantly and are expected to continue increasing. If this trend continues, reliance on the National Grid will decrease, reducing demand and potentially pushing utilities into a "utility death spiral" worsening DISCO's financial health and complicating the government's management or privatization efforts.
- Accelerating the integration of renewable energy can curb rising electricity costs by reducing reliance on imported fossil fuels, lowering the electricity tariff, and decreasing the import bill.

AC	Alternating Current	LIBOR	London Interbank Offered Rate
B	Billion	LESCO	Lahore Electric Supply Company Limited
CHASNUPP	Chashma Nuclear Power Plant	LPG	Liquefied Petroleum Gas
CPEC	China–Pakistan Economic Corridor	M	Million
CPP	Capacity Purchase Price	NDTC	National Transmission and Despatch Company Limited
CPI	Consumer Price Index	NPMV	Non-Project Missed Volume
CPPs	Captative Power Plants	PESCO	Peshawar Electric Supply Company Limited
CPPA	Central Power Purchasing Agency	PHPL	Power Holding Private Limited
DC	Direct Current	PHL	Power Holding Limited
EPP	Energy Purchase Price	PKR	Pakistani Rupees
FCA	Fuel Cost Adjustment	PMTLC	Pak Matiari-Lahore Transmission Company Limited
FESCO	Faisalabad Electric Supply Company Limited	PPP	Power Purchase Price
FY	Fiscal Year	QESCO	Quetta Electric Supply Company Limited
GENCO	Generation Company	QTA	Quarterly Adjustments
GEPCO	Gujranwala Electric Power Company Limited	RE	Renewable Energy
GW	Giga Watt	RF	Renewables First
HESCO	Hyderabad Electric Supply Company Limited	RFO	Residual Fuel Oil
HSD	High-Speed Diesel	RLNG	Re-Gasified Liquid Nitrogen Gas
HVDC	High Voltage Direct Current	SEPCO	Sukkur Electric Power Company Limited
IPPs	Independent Power Producers	SPP	Small Power Producer
IESCO	Islamabad Electric Supply Company Limited	TESCO	Tribal Area Electricity Supply Company Limited
KE	K-Electric Limited	T&D	Transmission and Distribution
kV	Kilo-Volt	TOE	Tons of Oil Equivalent
km	Kilometer	TSEP	Transmission System Expansion Plan
kWh	Kilo-Watt Hour	TWh	Tera-watt Hour
K2	Karachi Nuclear Power Plant 2	USD	United States Dollar
K3	Karachi Nuclear Power Plant 3	VRE	Variable Renewable Energy
KANUPP	Karachi Nuclear Power Plant	YoY	Year on Year
KIBOR	Karachi Interbank Offered Rate		

Abbreviations

Renewables First (RF) is a think tank for energy and environment. Our work addresses critical energy and natural resource issues with the aim to make energy and climate transitions just and inclusive.



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