Pakistan Power Sector
Issues, Challenges and Opportunities

Shahid Saghir
Ex. Chief Engineer
Pakistan Atomic Energy Commission

26th Symposium "Energy Crises in Pakistan"
December 17, 2022
Pakistan Academy of Engineering

Contents

An Overview of Energy Sector

- *Pakistan per capita energy consumption of 644 kWh which is only 18% of the world average, 7% of developed countries, 12% of China, and 66% of India.*
- *Energy consumption per unit of GDP in Pakistan is more than double to that of the world average and more than five times to that of Japan and the UK. Pakistan consumes 15 percent more energy than India for each USD of GDP.*
- *Electricity contributes about 27% of overall energy mix of 80 Million TOE.*
- *Electricity is not available to the 50 million of population.*
- *Pakistan is using nearly 16 % of the total hydropower, 4.8 % of the total wind energy, and nearly 1.4 % of the total solar energy potential.*
- *Thar coal is contributing 1320 MW while imported coal contribution in electricity generation is 3960 MW.*

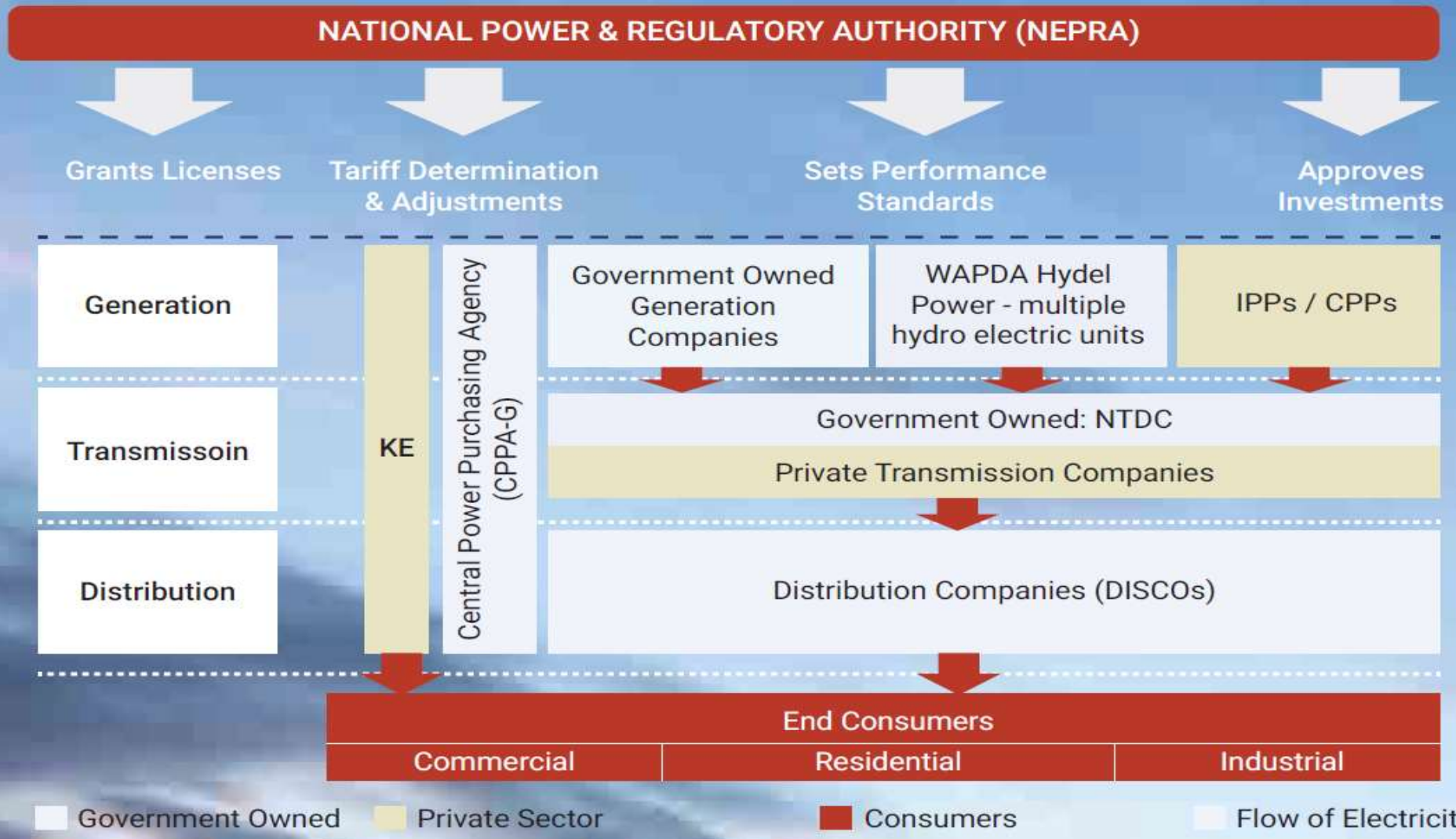
An Overview of Energy Sector

Effects of Energy Crises on Power Sector

- *Pakistan has consumed 79.8% of total oil reserved and 66.6% of gas reserves.*
- *Oil and Gas contributes about 67% of overall primary energy mix. 80% of oil and 20% to 25% gas is imported.*
- *Thermal Power Plants, which contributes about 60% of total generation are extremely vulnerable to price shocks and supply disruptions, high fuel costs.*
- *Pakistan's fuel import bill surged to USD 23 billion (Total import bill of USD 80 billion) and current account deficit of USD 17.4 billion in the FY 2021-22.*
- *Currently, with dangerously low foreign exchange reserves of USD billion 12.58 (around USD 6.72 billion in SBP and USD 5.867 billion in commercial banks) , Pakistan has now exposed to energy insecurity due to fear of default and energy supply disruptions.*

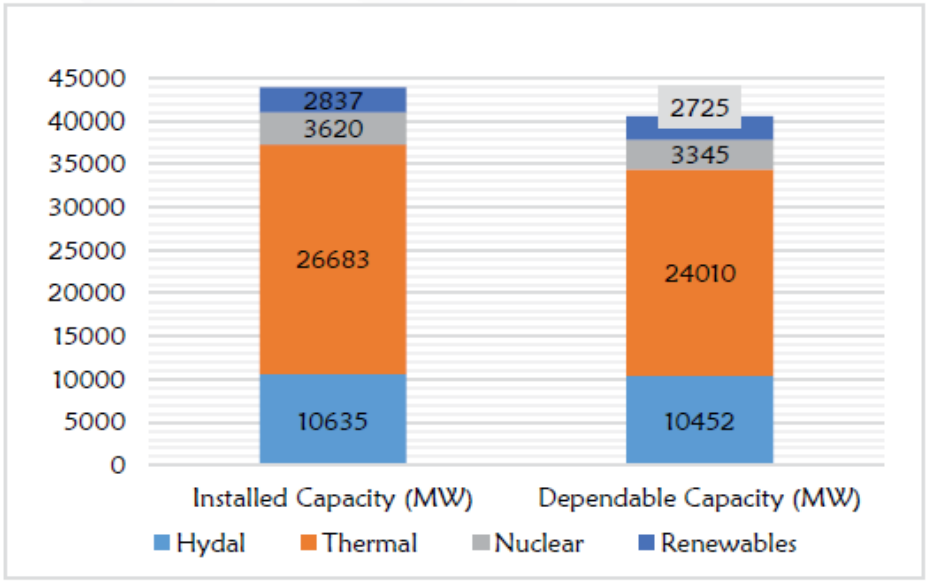
An Overview of Power Sector

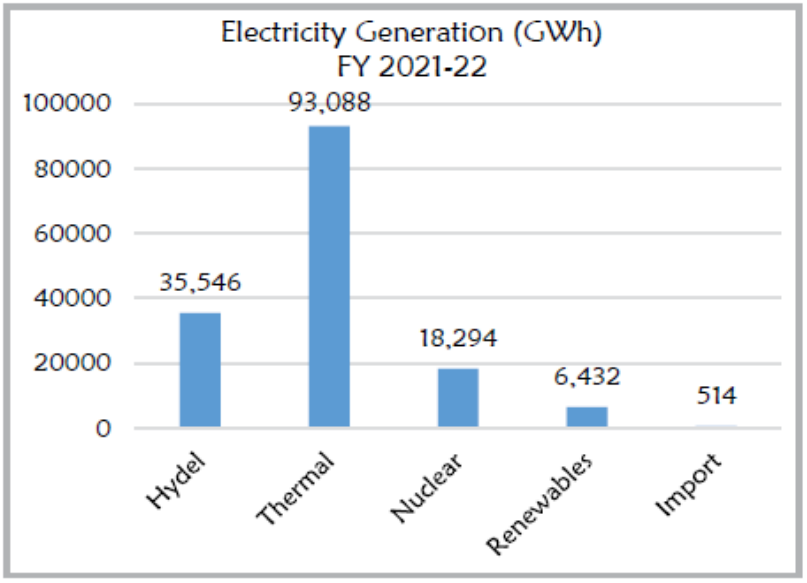
Power Sector Structure



An Overview of Power Sector

Installed Capacity and Electricity Generation





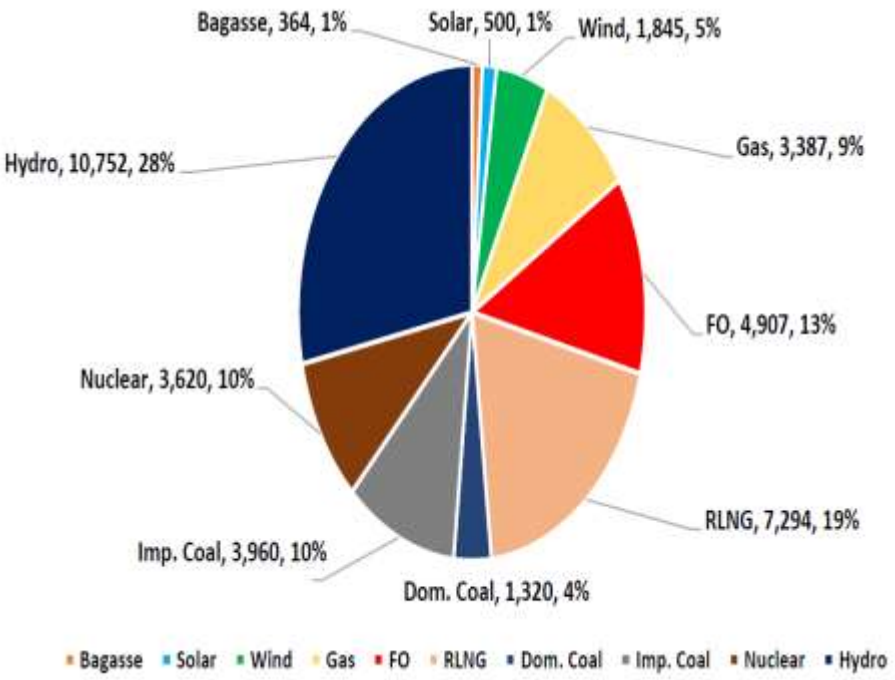
- *The installed capacity of Pakistan is 43775 MW which includes 40813 MW (93.23%) in CPPA-G and 2912 MW (6.77%) in KE system.*
- *During FY 2021-22, a peak demand was 28,253 during June-2022, the peak demand of the country came down to 15, 962 MW in December-2021.*
- *Total installed in the public sector is 23045 MW (52.64%) and 20730 MW (47.36%) in Privat sector.*

An Overview of Power Sector

Fuel Mix

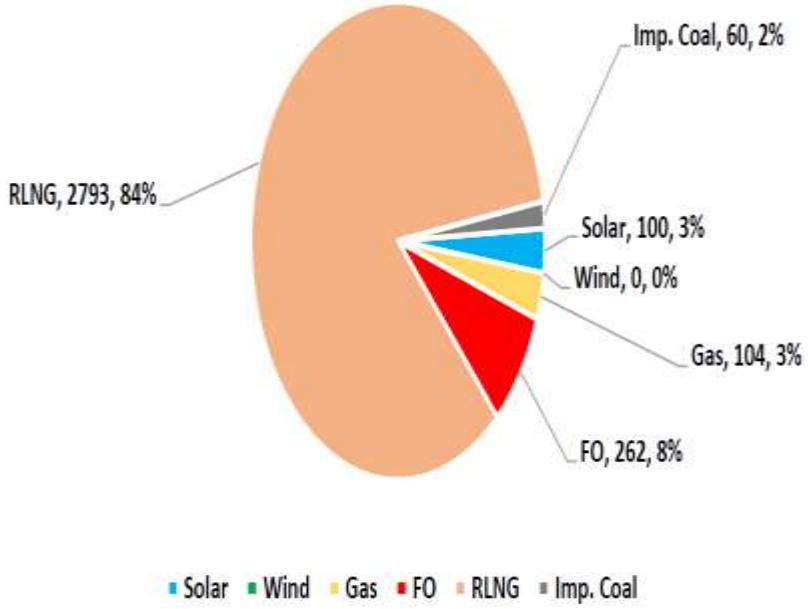
CPPA-G System

40813 MW



KE System

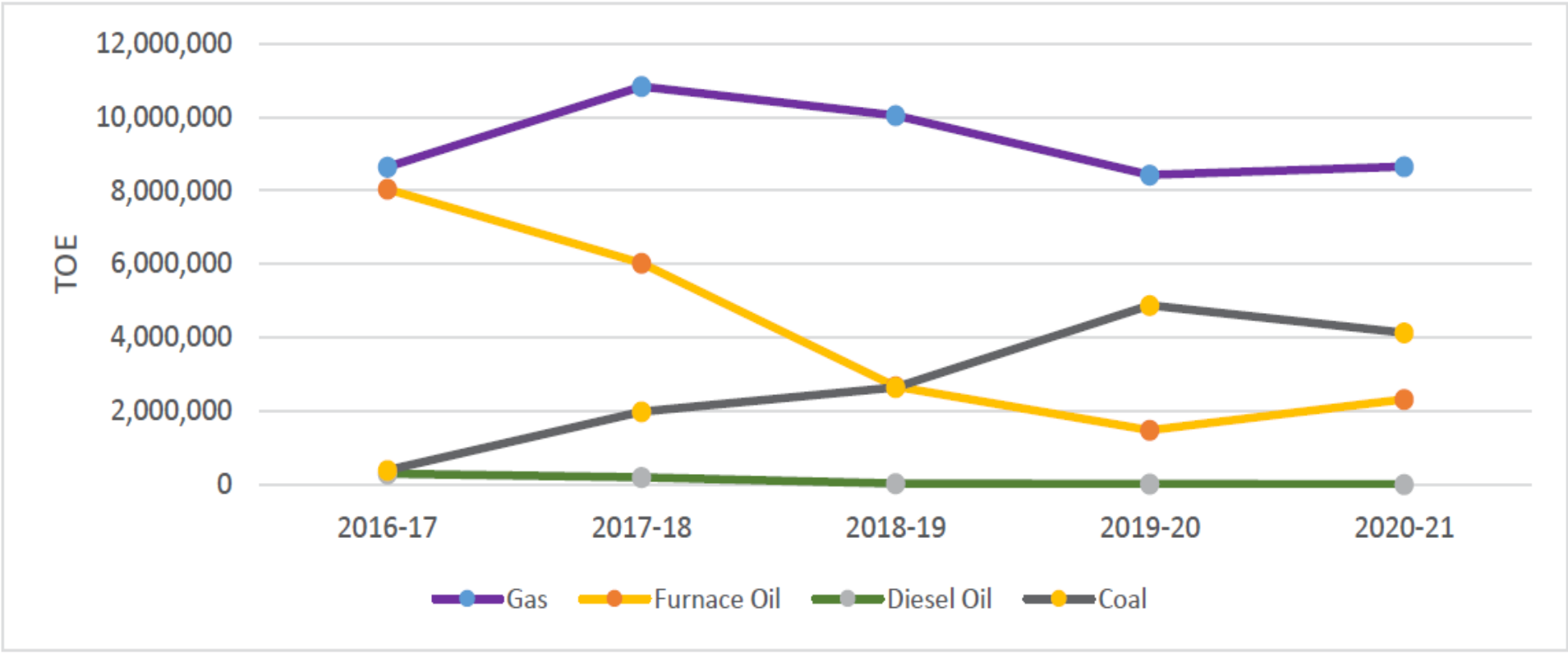
2912 MW



An Overview of Power Sector

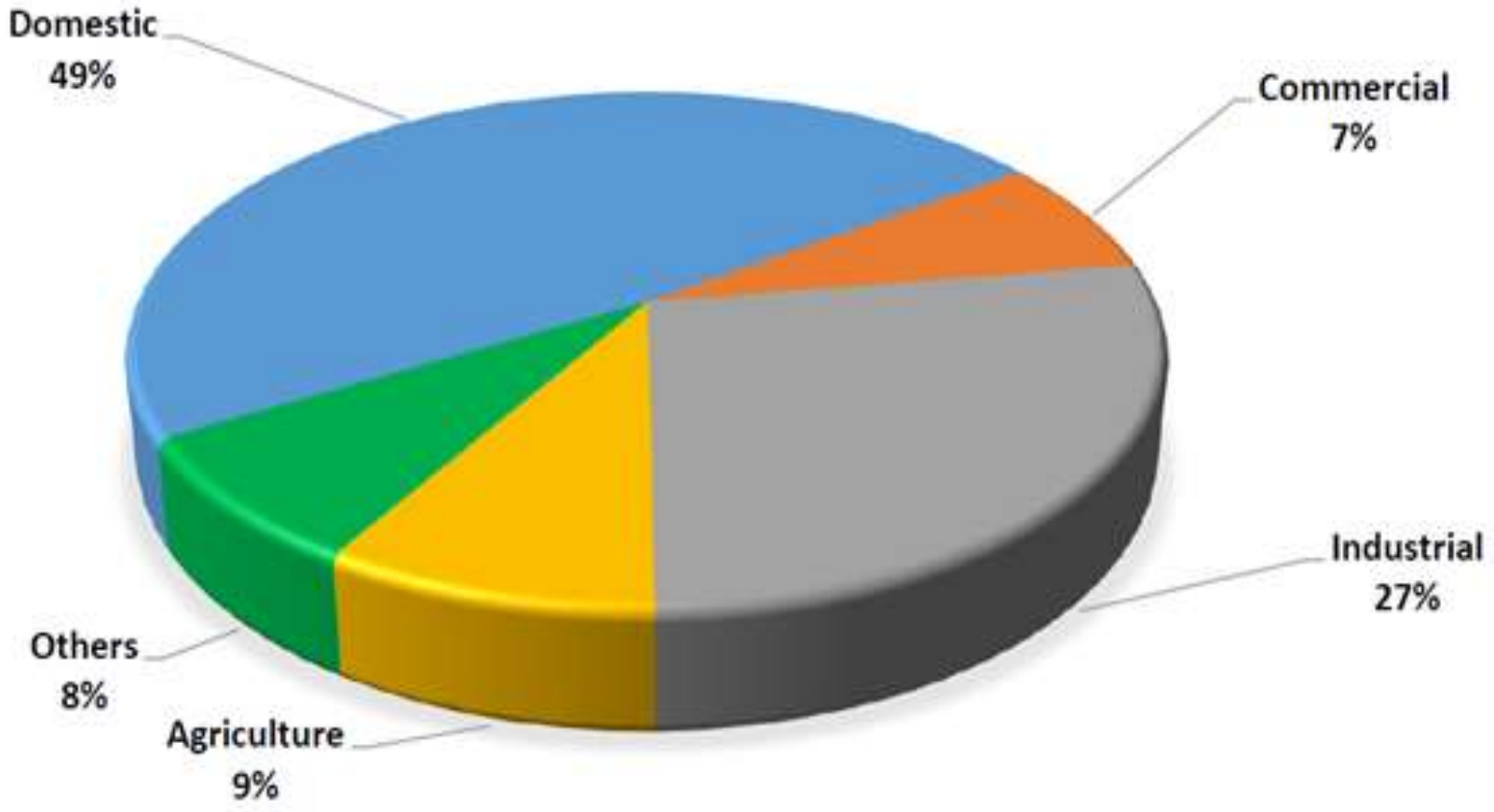
Fuel Consumption for Thermal Power Generation (% share in TOE)

Gas	Furnace Oil	Coal
57.34	15.32	27.34



An Overview of Power Sector

Percentage Mix of Electricity Consumers



An Overview of Power Sector

Main Electricity Statistics of Pakistan (2021-22)

Systems	Installed Capacity (MW)	Peak Demand (MW)	T&D Losses (%)	Av. Sale Price (Rs./kWh)	Per Capita Energy Consumption (kWh)
CPPA-G	40813	28754	19.75	22.5	610
K-Electric	2912	3670	15.35	23.34	1044

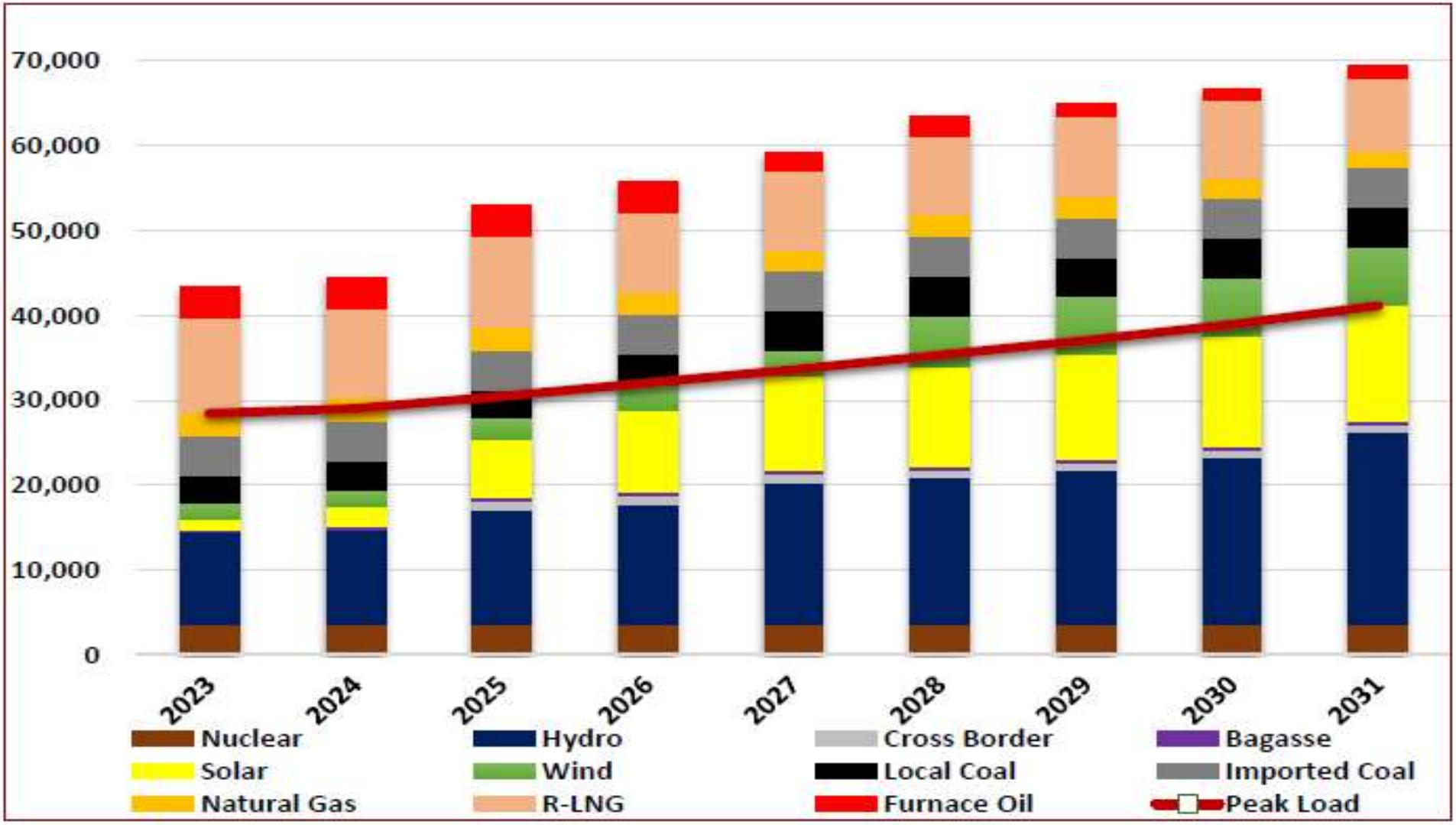
An Overview of Power Sector

Future Energy Demand under Low, Normal and High GDP Growth Rate

FY	Low		Normal		High	
	Energy	Peak Demand	Energy	Peak Demand	Energy	Peak Demand
	GWh	MW	GWh	MW	GWh	MW
2021-22*	153,866	26,945	153,866	26,945	153,866	26,945
2022-23	155,919	28,351	156,379	28,436	156,904	28,532
2023-24	163,166	28,836	164,394	29,054	165,840	29,310
2024-25	169,733	30,168	172,056	30,583	174,841	31,081
2025-26	176,681	31,440	180,396	32,105	184,897	32,909
2026-27	183,271	32,722	188,651	33,688	195,241	34,865
2027-28	190,366	34,120	197,651	35,430	206,693	37,053
2028-29	197,288	35,489	206,693	37,191	218,524	39,321
2029-30	204,729	36,955	216,444	39,086	231,394	41,786
2030-31	214,233	38,744	228,505	41,338	246,925	44,668
CAGR (2022-2031)	3.75%	4.12%	4.49%	4.87%	5.40%	5.78%

Low, normal and high GDP growth rate of 3.40%, 4.30%, and 5.42%

An Overview of Power Sector



Installed Capacity Vs Peak Demand 2022-23 to 2030-31

Issues and Challenges

Crises of Governance

- *Current crises in power sector is not the shortage of electricity as it used to be but the crises of governance.*
- *Circular debt and high cost of electricity are the major challenges.*
- *As of 30-06-2022, the circular debt stood at Rs. 2,252,750 million.*
- *High cost of electricity is negatively impacting the sustainable development of the country and social life of low-income groups specifically.*

Issues and Challenges

Major Contributors of High Cost of Electricity

1. ***Capacity Payments***
2. ***High Cost of Generation***
3. ***Transmission and Distribution Losses***
4. ***Inefficiencies of DISCOs***

Issues and Challenges

Capacity Payments

- *Capacity payments are paid to install base load power plants with plant factor exceeding 85%.*
- *Most of the PPAs with base load thermal plants are capacity based 'Take or Pay' contracts.*
- *The utilization factor of 30,303 MW base load 'Take or Pay' thermal power plants under CPPA-G system remain at 46% during FY 2021-22.*
- *During FY 2021-22, the total capacity payments against 43,775 MW installed capacity remained around Rs. 721 billion. This figure is projected to rise beyond PKR 1.45 trillion by 2023.*

Issues and Challenges

Capacity Payments

Factors Contributing to Capacity Payments

- *Over Optimistic Demand Forecasting and Poor Planning*
- *Shortage of Fuel*
- *Unavailability of Transmission Corridors*
- *Weak Demand Side Management*

Issues and Challenges

High Cost of Generation

Factors Contributing the High Cost of Generation

- ***Unbalance Fuel Mix***
- ***High Cost of Fuel***
- ***Plant Operation in Violation of Economic Merit Order***
- ***Lower performance of Old Power Plants***
- ***Operation of Thermal Plants on Part Load***

Issues and Challenges

Transmission Losses

- *During 2021-22, financial impact of violation of EMO due to transmission constraints has been calculated as Rs. 3.67 billion.*
- *The NTDC has allowed 2.5% T&T losses for FY 2021-22. The actual T&T losses reported were 2.63% with lost units of 3,696 GWh having a cost effect around Rs. 72 billion.*
- *The capacity payments of PMLTC during the period 01-09-2021 to 30-06-2022 was Rs. 49 billion (Utilization Factor of 36%).*
- *The PMLTC has been allowed 4.3% T&T losses. The actual T&T losses reported by PMLTC for the FY 2021-22 are 2.87%.*

Issues and Challenges

Inefficiencies of DISCOs

- *During FY 2021-22, the allowed T&D losses for DISCOs were 13. 41% whereas actual losses were 17.13%, Due to the difference of 3.72%, the financial loss on this account have been worked out around Rs. 113 billion.*

- *During 2021-22, the receivable amount in terms of percentage was around 90.51%, thus incurring the loss of Rs. 230 billion of the billed amounts. This whole contributes to the accumulation of circular debt.*

Major Challenges

Overall Losses in FY 2021-22

Category	Amount Rs. (Billion)
Capacity Payments	721
T&D losses of DISCOs above the allowable limit of 13.41% (Actual 17.13%)	113
T&T losses of NTDC above the allowable limit of 2.5% (Actual 2.63%)	0.182
Capacity payments of 660 kV HVDC Transmission Line (PMLTC)	49
Part Load Adjustment Charges (PLAC)	41.74
Receivable amount of DISCOs	230
Total	**1155**

The Way Forward

1. ***Restructuring of Generation Sector***
   - *Gradually Phase Out old and inefficient Thermal Power Plants*
   - *Increase the Share of Locally Produced Coal-Based Power Plants*
   - *Increase the Share of Renewable Energy*
2. ***Better Management of Supply Chain of Primary Fuels***
3. ***Upgradation of National Grid and Distribution Networks***
4. ***Restructuring of DISCOs***
5. ***Transition Toward Competitive Trading Bilateral Contract Markets***

The Way Forward

Restructuring of Generation Sector

Gradually Phase Out Old / Inefficient Thermal Power Plants

- *7,339 MW of the existing thermal power projects are scheduled to be retired from NTDC system during the planning horizon of the IGCEP 2022-31.*

- *A total of 682 MW capacity is going to be retired from K-E system in the upcoming years.*

The Way Forward

Restructuring of Generation Sector

Increase the Share of Thar Coal-Based Power Plants

- *Coal price in international market is about $ 400 per ton, while Thar coal is available at only $ 40 per ton.*
- *Cost of electricity is Rs17 per kWh from thar coal as compared to the Rs. 24 per kW produced by LNG, and Rs. 37 per kWh from imported coal.*
- *Currently, total generation from local Thar coal is 1,320 MW.*
- *Thar Coal Power Project (2×660 MW) under China-Pakistan Economic Corridor (CPEC) would start generation in 2022-23.*
- *A proposal is under consideration to convert imported coal-based power plants to thar coal.*

The Way Forward

Restructuring of Generation Sector

Increase the Share of Renewable Energy

- *GOP RE Policy envisages generating 60 % of energy from renewable resources by 2030. (Currently 35 % from RE)*
- *Currently, 10542 MWe is being generated through hydel power.*
- *The share of hydel energy would be enhanced from 10542 MW to 12,366 MW by 2025 in first phase and in next phase it would be jacked up to 20,591MW till 2028-29.*
- *Currently, 1335 MW is being generated through wind power and 10 projects of total 510 MW capacity are under construction.*
- *Six solar power projects totaling 430 MW initiated commercial operations.*
- *GOP is targeting at least 1 million customers and adding approximately 3000 MW of solar power through net metering.*

The Way Forward

Better Management of Supply Chain of Primary Fuels

- *Government is the only player in the LNG-importing business.*
- *Procedural delays in making import decisions due to bureaucratic hurdles. PPRA Rules do not allow to take benefit from low prices in the spot market.*
- *During the FY 2021-22, due to unavailability of RLNG, comparatively inefficient plants have been operated having a financial impact of Rs.19,332 million.*
- *Enhancement of gas transmission and distribution infrastructure, development of storage facility of RLNG is required to ensure required volume of RLNG at competitive, affordable and predictable rates.*

The Way Forward

Upgradation of Transmission/Distribution Network

- *Efforts should be made for development of a robust transmission network which complements generation plans for smooth dispersal of power between generating stations and load centers.*
- *Plant producing cheaper electricity on near vicinity of KE are underutilized. Interconnection capacity of grid systems adjacent to these power plants should be enhanced.*
- *Efforts should be made to remove congestions points (Sarfraz Nagar, Gatti, New Multan, Peeran Ghaib, Lahore-Shiekhupura) which have been affecting the economic dispatch and operations of the power plants.*

The Way Forward

Restructuring of DISCOS

- *The default of Discos has exceeded Rs. 250 billion due to lack of ability to collect the dues from consumers.*
- *Experts have advised privatization or outsourcing their operations and maintenance in public-private participation.*
- *The Ministry of Energy is considering an advisory council of power sector to address the management issues of distribution companies.*

The Way Forward

Transition Toward Competitive Trading Bilateral Contract Market (CTBCM)

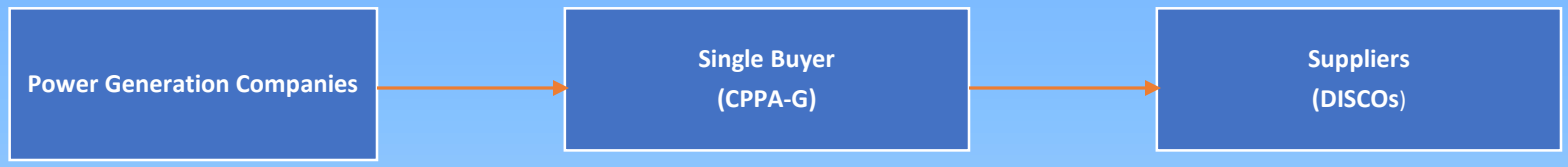
Main Objectives of CTBCM

- *Single seller and single buyer market model has failed to reduce generation cost, inefficiencies of transmission/distribution network, and optimum recovery from consumers.*
- *CTBCM model is being introduced to deregulate and liberalize power market with the inclusion of private parentship with public entities.*
- *In existing model CPPA has the mandate for centralized settlement of payments, including procurement of power, managing payment system and invoicing to DISCOs.*
- *Under CTBCM model, power generating facilities would be selling the energy and capacity to the bulk power consumers and suppliers bound through the contract administrated by market operators.*

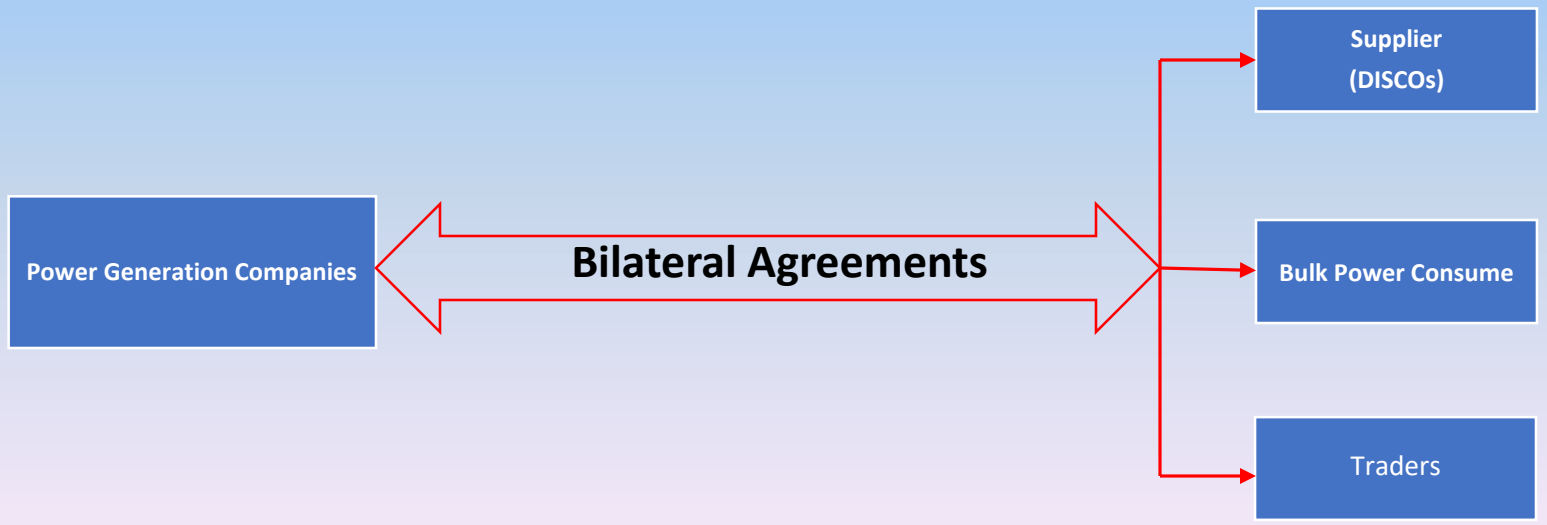
The Way Forward

Transition Toward Competitive Trading Bilateral Contract Market (CTBCM)

Existing Single Buyer Model



Proposed Multiple Buyers Sellers Model



Conclusion

Pakistan power sector is full of uncertainties and still far away from maturity. The impact of overall losses is huge on the economy. The situation is likely to deteriorate further in coming years and it may lead to de-industrialization and challenges of food security. The solutions of current problems require huge commitment of all stake holders specially GOP.

Thank You

References:

1. *State of the industry report-2022 by NEPRA*
2. *Indicative Generation Capacity Expansion Plan (IGCEP) 2021-31 by NTDC*
3. *National Electricity Policy 2021 by GOP*

ANNEXTURES

Year-wise Details of the Circular Debt (Provisional) (Rs. in Million)

S. No.	Description	FY 2017-18	FY 2018-19	FY 2019-20	FY 2020-21	FY 2021-22
1	Due for Payments against verified invoices of Power Generation Companies	441,412	694,261	1,038,115	1,244,835	1,351,023
2	Payable to GENCOs (Invoices based)	16,419	17,464	48,040	-	-
3	Payable s to Fuel Suppliers by GENCOs	86,067	100,677	105,092	105,314	101,473
	Total (Payables to IPPs/GENCOs)	**543,898**	**812,402**	**1,143,207**	**1,350,149**	**1,452,497**
4	Energy Payable Swap by GOP through Loan from Commercial Banks by Power Holding (Pvt.) Limited	582,863	805,787	1,007,218	930,000	800,253
Grand Total (Circular Debt)		**1,126,761**	**1,618,189**	**2,150,425**	**2,280,149**	**2,252,750**

Merit Order for Power Generation Plants (CPPA-G System)

(Based on the revised fuel prices effective from 22-06-2022)

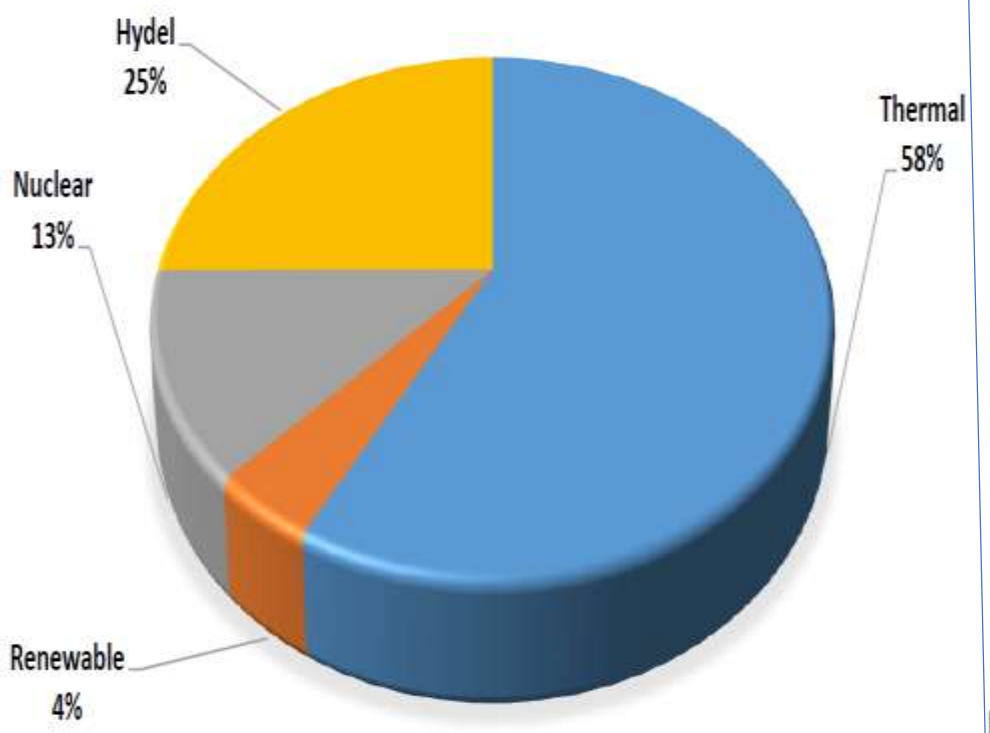
Merit No.	Plant Groups	Fuel Type	Fuel Cost (Rs./kWh)	VO&M Cost (Rs./kWh)	Specific Cost (Rs./kWh)
1	UCH (upto 152,375 MWh)	Gas	1.57846	0.44489	2.099853
2	LIBERTY Power (Upto 61,904 MWh)	Gas	2.4573	0.5495	3.0068
3	Engro Power Thar	Coal	2.5253	1.1053	3.6306
4	747 MW GUDDU (CCP)	Gas	5.9451	0.6616	6.6067
5	KAPCOB-I	Gas	6.80852	0.4403453	7.248865
6	Guddu (CCP)B-I (Unit 11-13)	Gas	7.3127	0.0689	7.3816
7	Foundation Power	Gas	6.9081474	0.7164	7.624547
8	GTPS FaisalabadB-IV (Unit 5-9)	Gas	7.769	0.1625	7.9315
9	KAPCOB-II	Gas	7.46781	0.5150697	7.98288
10	Engro PowerGen	Gas	7.366216	0.6332	7.999416
11	Guddu (CCP)B-II (Unit 5-10)	Gas	8.125	0.0689	8.1939
12	UCH-II	Gas	7.9203209	0.4153	8.335621
13	UCH (above 152,375 MWh)	Gas	7.9032	0.44489	8.424593
14	KAPCOB-III	Gas	7.72358	0.9928217	8.716402
15	HCPC	Gas	6.71361	0.8375	9.43771
16	747 MW GUDDU (OC)	Gas	8.8726	0.6616	9.5342
17	MuzaffargarhB-II (Unit 4)	Gas	9.4689	0.1625	9.6314
18	MuzaffargarhB-I (Unit -3)	Gas	9.4823	0.1625	9.6448
19	JamshoroB-II (Unit 4)	Gas	9.6567	0.0925	9.7492
20	MuzaffargarhB-I (Unit -1)	Gas	9.6844	0.1625	9.8469
21	JamshoroB-II (Unit 3)	Gas	9.8616	0.0925	9.9541
22	MuzaffargarhB-I (Unit -2)	Gas	9.812	0.1625	9.9745
23	JamshoroB-II (Unit 2)	Gas	10.1263	0.0925	10.2188
24	MuzaffargarhB-III (Unit -5)	Gas	10.0636	0.1625	10.2261
25	MuzaffargarhB-III (Unit -6)	Gas	10.3298	0.1625	10.4923
26	KAPCOB-I (S/Cycl)	Gas	10.21278	0.4403453	10.65313
27	Guddu(W/oCCP)B-I (Unit 11-13)	Gas	10.96905	0.0689	11.03795
28	KAPCOB-II (S/Cycl)	Gas	11.201715	0.5150697	11.71678
29	JamshoroB-II (Unit 4)	Mix.(*****)	12.0645	0.0925	12.157
30	Guddu(W/oCCP)B-II (Unit 5-10)	Gas	12.1875	0.0689	12.2564
31	JamshoroB-II (Unit 3)	Mix.(*****)	12.3295	0.0925	12.422
32	KAPCOB-III (S/Cycl)	Gas	11.58537	0.9928217	12.57819
33	JamshoroB-II (Unit 2)	Mix.(*****)	12.6655	0.0925	12.758
34	LIBERTY Power (Above 61,904 MWh)	Gas	12.2866	0.5495	12.8361
35	Lucky Electric Power Company	Coal	16.27	0.2167	16.4867
36	NPPMC - HBS (CC)	RLNG	24.28125444	0.2362	24.51745
37	NPPMC - Baloki (CC)	RLNG	24.43606364	0.2635	24.69956
38	JamshoroB-II (Unit 4)	Mix.(**)	24.69135	0.0925	24.78385

LOAD FORECAST (2022-31)

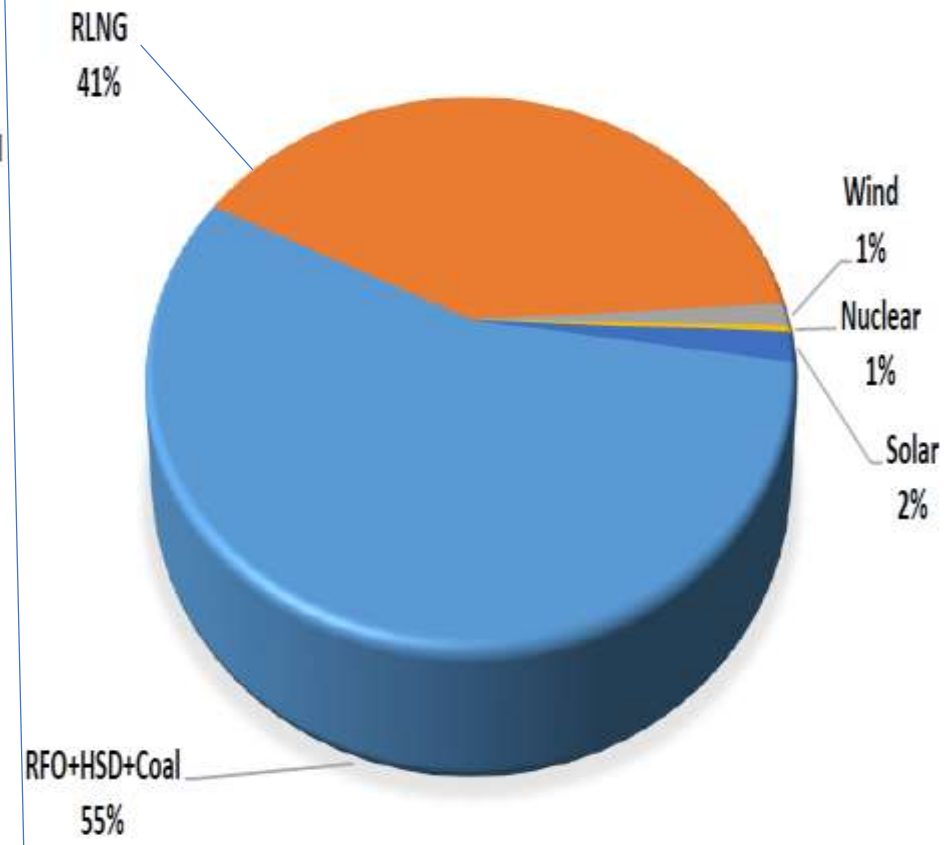
FY	Low		Normal		High	
	Energy	Peak Demand	Energy	Peak Demand	Energy	Peak Demand
	GWh	MW	GWh	MW	GWh	MW
2021-22*	153,866	26,945	153,866	26,945	153,866	26,945
2022-23	155,919	28,351	156,379	28,436	156,904	28,532
2023-24	163,166	28,836	164,394	29,054	165,840	29,310
2024-25	169,733	30,168	172,056	30,583	174,841	31,081
2025-26	176,681	31,440	180,396	32,105	184,897	32,909
2026-27	183,271	32,722	188,651	33,688	195,241	34,865
2027-28	190,366	34,120	197,651	35,430	206,693	37,053
2028-29	197,288	35,489	206,693	37,191	218,524	39,321
2029-30	204,729	36,955	216,444	39,086	231,394	41,786
2030-31	214,233	38,744	228,505	41,338	246,925	44,668
CAGR (2022-2031)	3.75%	4.12%	4.49%	4.87%	5.40%	5.78%

Low, normal and high GDP growth rate of 3.40%, 4.30%, and 5.42%

NTDC System Annual Energy Generation (2021-22)



KE System Annual Energy Generation (2021-22)



Transmission and Distribution Losses of DISCO's

DISCO	FY 2021-22 (Units in GWh)			Target Losses (%)	Actual Losses (%)		Amount of Actual Units Lost (Rs. in billion)
	Purchase	Sold	Lost	2021-22	2020-21	2021-22	2021-22
PESCO	16560	10355	6205	20.73	38.18	37.47	153.80
TESCO	2284	2071	213	9.31	9.58	9.33	3.70
IESCO	13027	11961	1066	8.15	8.54	8.18	21.90
GEPCO	12678	11528	1150	9.2	9.23	9.07	24.70
LESCO	28334	25070	3264	9.08	11.96	11.52	72.70
FESCO	17512	15918	1594	9.34	9.28	9.10	33.40
MEPCO	22548	19202	3346	12.79	14.93	14.84	75.10
HESCO	6010	4034	1976	19.07	38.55	32.88	45.00
SEPCO	4489	2890	1599	17.41	35.27	35.62	43.70
QESCO	6716	4831	1885	14.49	27.92	28.07	46.30
Overall Average	**130158**	**107860**	**22298**	**13.41**	**17.95**	**17.13**	**520.30**

Demand and Supply Figures

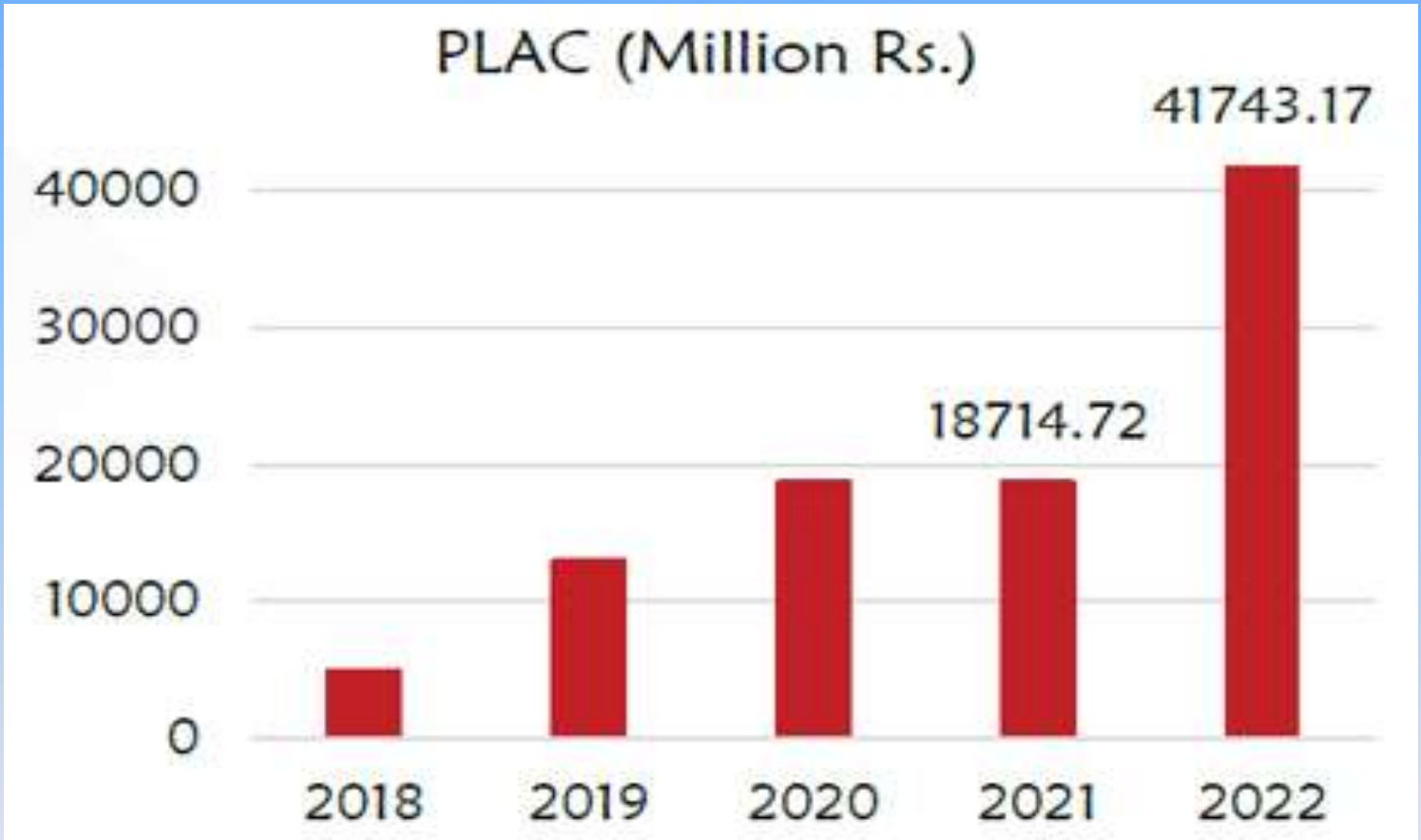
Actual Figures

FY ending 30th June	Generation Capability (MW)	Demand During NTDC's System Peak Hours (MW) (including KE Supply)	Surplus/ (Deficit) (MW)
2018	23,766	26,741	-2,975
2019	24,565*	25,627*	-1,062
2020	27,780*	26,252*	1,528
2021	27,819*	28,253*	-434
2022	27,748*	24,564	3,184

Projected Figures

FY ending 30th June	Planned Generation Capability as per NTDC (MW)	NTDC Projected Demand Growth Rate (%)	NTDC's Projected Demand during Peak Hours (MW)	Surplus/ (Deficit) (MW)
2023	34,729	4.9	25,779	8,950
2024	37,226	8.7	28,027	9,199
2025	40,213	4.9	29,389	10,824
2026	43,380	4.8	30,814	12,566
2027	44,950	4.7	32,276	12,674

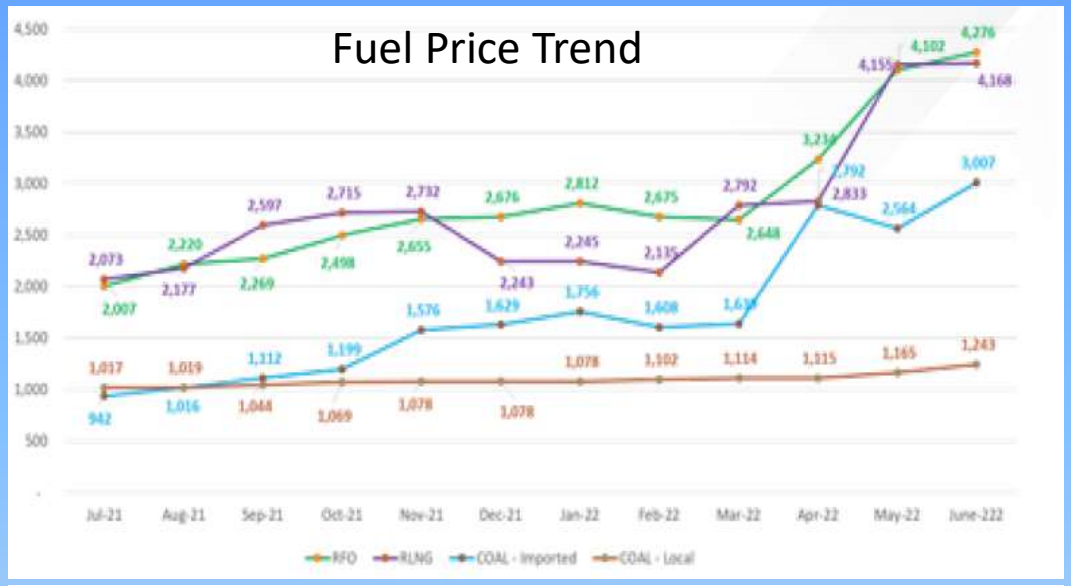
Part Load Adjustment Charges (PLAC)



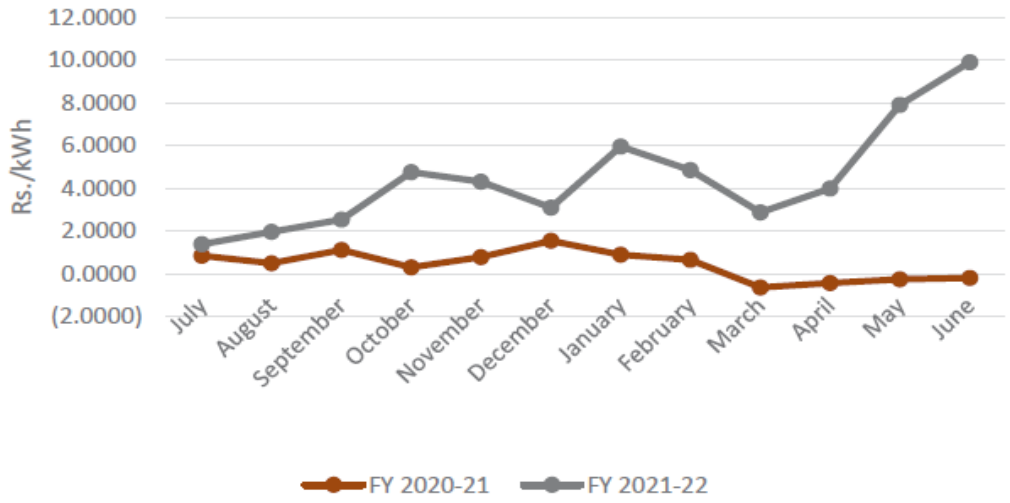
Average Per Unit Capacity Payments for Few Power Plants under CPPA-G System

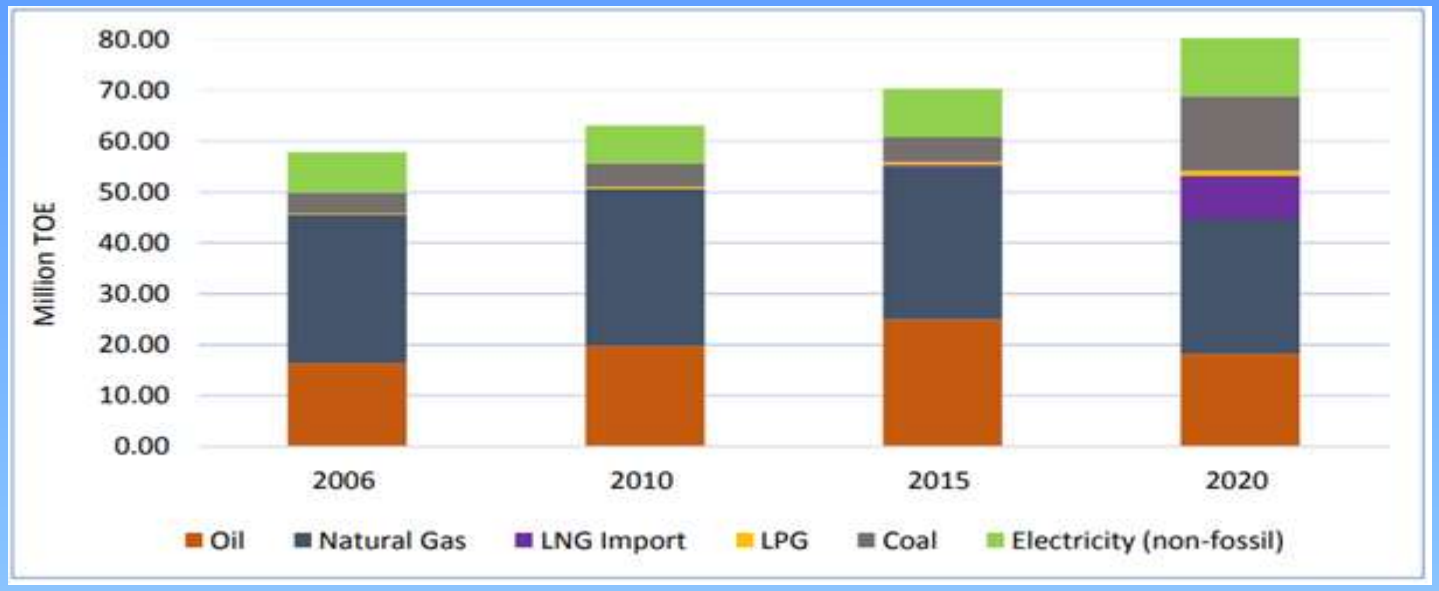
S. No.	Power Plant	Dependable Capacity (MW)	Electricity Generation (GWh)	Capacity Payment (Rs. Million)	Per Unit Capacity Payment (Rs./kWh)	Utilization Factor (%)
1	Hub Power	1,200	1,343.33	25,441.27	18.94	12.78
2	GENCO-I	649	245.51	3,381.92	13.78	4.32
3	Rousch Power	395	495.9	4,607.02	9.29	14.33
4	Sahiwal Coal	1,243	6,882.11	55,710.15	8.09	63.20
5	Halmore Power	199	675.91	4,612.32	6.82	38.77
6	Saba Power	126	329.67	2,208.02	6.70	29.87

Fuel Price Trend

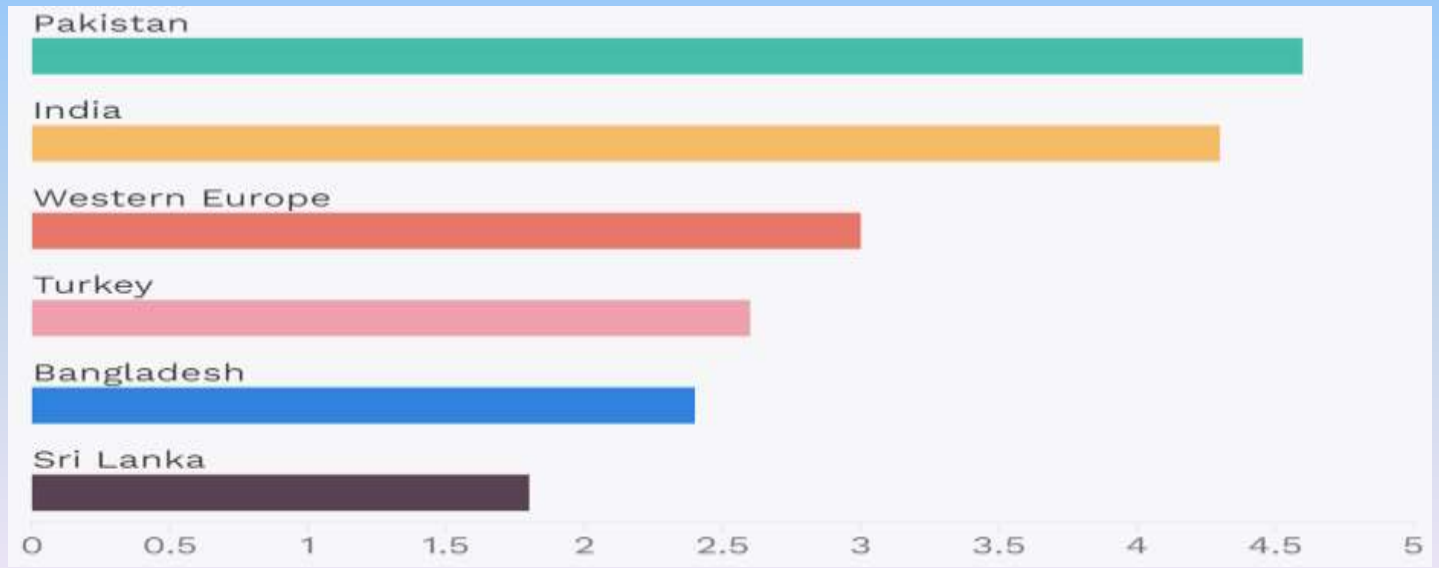


FCAs Allowed





Pakistan Primary Energy By Source



Energy Intensity (Megajoules per Unit of GDP)

660 kV HVDC Matiari-Lahore Transmission Line (4000 MW capacity)