Power Purchase Price Forecast

A Report by Central Power Purchasing Agency

FY 2019-20

Central Power Purchasing Agency (CPPA)

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ACRONYMS AND ABBREVIATIONS

CPI	Consumer Price Index
CPP	Capacity Purchase Price
CPPA	Central Power Purchasing Agency
DISCO	Distribution Company
DM	Distribution Margin
EPP	Energy Purchase Price
FESCO	Faisalabad Electric Supply Company
FY	Fiscal Year
FY2019	Fiscal Year (July 2019 - June 2020)
GDP	Gross Domestic Product
GENCo	Generation Companies
GEPCO	Gujranwala Electric Supply Company
GOP	Government of Pakistan
GWh	Giga Watt Hour
HESCO	Hyderabad Electric Supply Company
HSD	High Speed Diesel
IESCO	Islamabad Electric Supply Company
IGCEP	Indicative Generation Capacity Expansion Plan
IPP	Independent Power Producer
KE	Karachi Electric Ltd.
KIBOR	Karachi Inter Bank Offer Rate
KV	Kilo Volts
kWh	Kilo Watt Hour
LESCO	Lahore Electric Supply Company
LIBOR	London Inter Bank Offer Rate
MEPCO	Multan Electric Supply Company
MoE	Ministry of Energy
MoF	Market Operation Fee
MW	Mega Watt
O&M	Operation & Maintenance
PMS	Power Market Survey
PPAA	Power Procurement Agency Agreement
PPP	Power Purchase Price
PYA	Prior Year Adjustment
QESCO	Quetta Electric Supply Company
SCED	Security constrained Economic Dispatch
SDDP	Stochastic Dual Dynamic Programming
UoSC	Use of System Charge
CAGR	Compound Annual Growth Rate
SIR	State of Industry Report
NEPRA	National Electric Power Regulatory Authority

NEPRA	National Electric Power Regulatory Authority
NEO	Net Electrical Output
SO	System Operator
NTDCL	National Transmission and Dispatch Company Limited
GSA	Gas Supply Agreement
PESCO	Peshawar Electric Supply Company
PAEC	Pakistan Atomic Energy Commission
USEIAR	United State Energy Information Administration Reports
MT	Metric Ton
RFO	Residual Fuel Oil
PSO	Pakistan State Oil
RLNG	Re-gasified Liquefied Natural Gas
OGRA	Oil & Gas Regulatory Authority
STEOR	Short Term Energy Outlook Report
MMBTU	Million British Thermal Unit
OPF	Optimal power flow
SEPCO	Sukkur Electric Supply Company
RoE	Return on Equity
Mln.Rs	Million Rupees
TESCO	Tribal Area Electricity Supply Company
USAID	United States Agency for International Development
WAPDA	Water and Power Development Authority

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Executive Summary

EXECUTIVE SUMMARY

Regulatory framework for the power sector of Pakistan envisages formulation of the monthly references of the generation, transmission and market operation cost, collectively the **Power Purchase Price (PPP),** to be allocated from the Central Pool to the Distribution Companies through a Transfer Price Mechanism that will serve as basis for determining the tariff of the distribution Companies for the regulated consumers.

Central Power Purchasing Agency (CPPA G), being the agent of the distribution companies, is purchasing power/energy for and on behalf of the distribution companies through the contracts with the generation companies and transferring the cost of Energy & Capacity in accordance with the transfer price mechanism approved by the NEPRA.

In order to assist the Authority for ascertaining the monthly references of Energy Purchase Price & Capacity Purchase Price including the UoSC & MOF (collectively the "PPP") through schedule of regulatory proceedings, CPPA G has prepared the PPP model that reports the projections of monthly references for the year 2019-20, while taking into consideration the existing peculiarities of the entire value chain of the power sector. Moreover, this report also provides the future outlook of the sector up to 2025.

The EPP has been calculated using state-of-the-art hydrothermal dispatch modelling tool name Stochastic Dual Dynamic Programming Tool (SDDP) that projects 21-blocks-segregated monthly dispatch of the central pool of CPPA G for the entire study horizon taking into consideration demand profiles, load duration curve of system and demand projections, existing generation portfolio capacities & availabilities, upcoming generation additions, Fuel and O&M Prices, Fuel contracts, Must-Run Obligations, transmission constraints , hydrology, wind, solar & bagasse profiles etc. while ensuring least-cost stochastic operating policy of a hydrothermal system. Moreover the CPP has been projected using the references of the capacity of each generation utility established/determined by the regulator/contracts while indexing to the projected values. Further, this report in addition to projecting the monthly references also provides for inter-alia, (a) estimated future generation from different sources, (b) estimated fuel requirement including the imported fuel, (c) PPP references for each Ex-WAPDA Distribution Companies (d) Yearly references up to 2024-25 etc. This report also highlights the financial effect of the transmission constraints on the PPP.

Based upon the different sensitivity analysis taking into consideration the load factors, demand projections, generation portfolio and transmission constraints, the following table depicts the monthly references of our estimated base case (FY 2019-20 with transmission constraints) for the system:

The same references has been depicted in the bar chart as under:

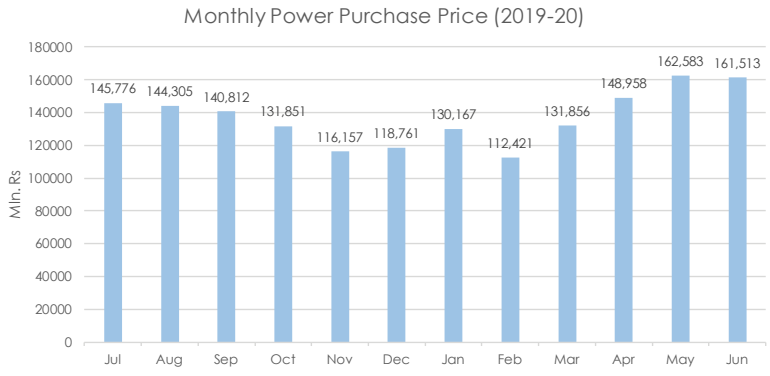


Figure 1 Monthly Power Purchase Price (Million Rs.)

Moreover different scenarios based upon demand projections, transmission network etc. have been placed in the last two chapters along with their subsequent allocation for due consideration and informed decision.

	Months	EPP (Mln Rs.)	CPP (Mln Rs.)	PPP (Mln Rs.)	EPP (Rs/kWh)	CPP (Rs/kWh)	PPP (Rs/kWh)
FY (2019-20)	Jul	78,633	67,143	145,776	5.36	4.58	9.93
	Aug	71,940	72,365	144,305	4.84	4.87	9.72
	Sep	60,101	80,711	140,812	4.42	5.93	10.35
	Oct	54,669	77,182	131,851	5.26	7.43	12.69
	Nov	39,706	76,451	116,157	4.65	8.96	13.61
	Dec	43,685	75,076	118,761	5.00	8.60	13.60
	Jan	56,020	74,147	130,167	6.23	8.24	14.47
	Feb	37,774	74,647	112,421	4.78	9.45	14.23
	Mar	54,722	77,134	131,856	5.57	7.85	13.42
	Apr	71,751	77,207	148,958	6.36	6.84	13.20
	May	85,518	77,064	162,583	6.45	5.81	12.26
	Jun	83,467	78,045	161,513	6.00	5.61	11.62
	Total	**737,986**	**907,174**	**1,645,160**	**5.43**	**6.67**	**12.10**

Table 1 Monthly Power Purchase Price Projections

**At Wholesale Level, Excluding Transmission Losses*

01 Introduction

1.1 BACKGROUND

1.2 OBJECTIVE AND SCOPE OF REPORT

1 INTRODUCTION

1.1 BACKGROUND

Pursuant to the applicable legal and regulatory framework for the power sector of Pakistan, the tariff of each component of the value chain of the sector i.e. generation, transmission and distribution is determined through the regulatory proceedings and the cost of all three kinds of tariff is recovered through the retail tariffs of the Distribution Companies ("DISCOs"). The tariff of each distribution licensee is assessed based on the stipulations/provisions, inter-alia, of the Regulations for the Generation, Transmission & Distribution of Electric Power Act 1997 "NEPRA ACT" (amended in 2018) and NEPRA Tariff Standards and Procedure Rules 1998. The revenue requirement of each DISCO is broadly assessed under the following heads:

a. *Projected Power Purchase Price;*
b. *Distribution Margin;*
c. *Prior Period Adjustment;*

- It is pertinent to mention here that the major portion of the end-consumer tariff is comprised of the Power Purchase Price, which sweeps around 80-85 % of the per unit rate of the end consumer. The Power Purchase Price ("PPP") has been defined as under in the regulatory framework:

Power Purchase Price *means the generation cost and transmission cost to be worked out and allocated from CPPA / NTDC pool to distribution companies in accordance with transfer price mechanism approved by the Authority plus power purchase by distribution companies through bilateral contracts duly approved by the Authority*

- Central Power Purchasing Agency, being the Market Operator as placed in NEPRA Electric Power Regulatory (Market Operator, Registration, Standards and Procedure) Rules, 2015 ("Market Rules"), is responsible for performing the operations and responsibilities in accordance with the applicable legal and regulatory framework, which inter-alia includes, procurement of power for and on behalf of discos, Billing, Settlement, Development of competitive power market etc. CPPA G through Power Procurement Agency Agreement ("PPAA") is procuring power for and on behalf of DISCOs and transferring the cost of central pool of power procurement (including the Use of System Charge and Market Operation Fee) through the Transfer Price Mechanism established under the Commercial Code.

- "NEPRA guidelines for the determination of Consumer End Tariff (Methodology and Process) 2015" broadly bifurcates schedule of regulatory proceedings into the following two areas:

a. Regulatory proceedings for the approval of Planning document;
b. Regulatory proceedings for the rate case and tariff determination;

Per chronological order, the planning documents are envisaged to be approved first which shall serve as basis for the subsequent and informed determination of the rate case and tariffs. For the determination of the end consumer, the regulatory framework envisages setting of the monthly references of the PPP which shall be used as reference for the determination of the tariff for each DISCO. The formula for the determination of PPP is placed as under:

PPP = EPP + CPP + UoSC + MoF

1.2 OBJECTIVE AND SCOPE OF REPORT

CPPA G being the agent of distribution companies and pursuant to the enabling provisions of the "NEPRA guidelines for the determination of Consumer End Tariff (Methodology and Process) 2015" has devised a PPP Simulation Model through state-of the-art dispatch tool and a PPP report which will assist in establishing the monthly references of PPP for the year 2019-20 for each DISCO based on their monthly Energy & Capacity demand projections, in accordance with the transfer price Mechanism established under the commercial code. At the same time, different scenarios have been simulated based on demand, Transmission Network etc. and the corresponding PPP has been presented for each scenario for due consideration of the regulator and accordingly to arrive at the informed decision.

Furthermore, this report also presents the mid-term outlook (up to 2024-25 based on PMS demand projections) of the power sector of Pakistan in terms of Cost of Energy & Capacity of the central pool, Yearly PPP, Energy Mix, Fuel requirements etc. The medium term scope of the report also provides a ground for the optimization of the fuel requirements, tariff trends, impact analysis, benefits/implication of different initiatives etc. The outcome of this report may also help DISCOs to prepare their medium term business plan which will eventually help to improve predictability of the sector as a whole.

Moreover, this report has been formulated for the first time for submission to the regulator. The valuable inputs & further scenarios can be incorporated and the results may be provided accordingly for the informed decisions.

02

Methodology for Power Purchase Price Forecast Model

2 METHODOLOGY FOR POWER PURCHASE PRICE FORECAST MODEL

This section deals with process flow and integration of different components of this model that eventually yield PPP projections. The central database repository has been maintained in excel. This data feeds the respective modules for processing and generation of outputs. Standardized data for demand, generating stations and Transmission network, are inputted in SDDP which generates the dispatch results on the basis of Security constrained Economic Dispatch (SCED) using Stochastic and Probabilistic Algorithms, thus computing the energy purchase price in the standardized format. There is an Application layer developed in Excel which serves as a medium for processing output results from SDDP. At the same time, the CPP computation module has been formulated in the excel which projects CPP on monthly basis as a function of the input assumption matrix. Based upon the EPP and CPP computations as explained under EPP & CPP forecast chapters respectively, the monthly PPP references of the system are worked out in the model and monthly fuel mix are established. Similarly, the PPP is then allocated to the individual DISCOs based on the pre-determined load factors and the Transfer Price Mechanism established in the commercial code. All the respective outputs from the respective modules are displayed in the output display Interface. Apart from EPP, CPP and PPP, output Interface also provide other useful information such as Energy Balance, Capacity Balance, Fuel Consumptions/requirements, Must-Run Status, Energy Mix etc. The figure # 2 explains the Process flow of the model.

ASSUMPTION SET :

The computation of results is based on the set of some assumptions parameters. All the input data is also reflected based on these assumptions. The underlying Assumptions set for this report is:

- System Demand Data configurations are based on PMS (Power Market Survey) based projections from FY 2019-25 and the actual results of calendar year 2018 for scenario analysis of PPP formulation for each disco (Details explained under demand forecast section).
- Reference Data for generating Stations has been taken from NEPRA's Determinations (Explained under Generation Section).
- Load Per Bus data is taken for 24 hours data captured during summer season.
- The UoSC has been assumed as Rs. 148.33/kW/Month and MoF has been assumed to be Rs.1.6592 kW/Month
- For the part of Indexations in relevant components of tariff, the following assumptions has been considered.

Parameter	Value
Exchange Rate (US$)	150
US-CPI	255.09
Local CPI	242.48
LIBOR	3.64%
KIBOR	12%

Table 2 Assumptions

- Monthly fuel price projections for the year 2019-20 have been catered for PPP forecast (details have been explained under fuel price projection section).

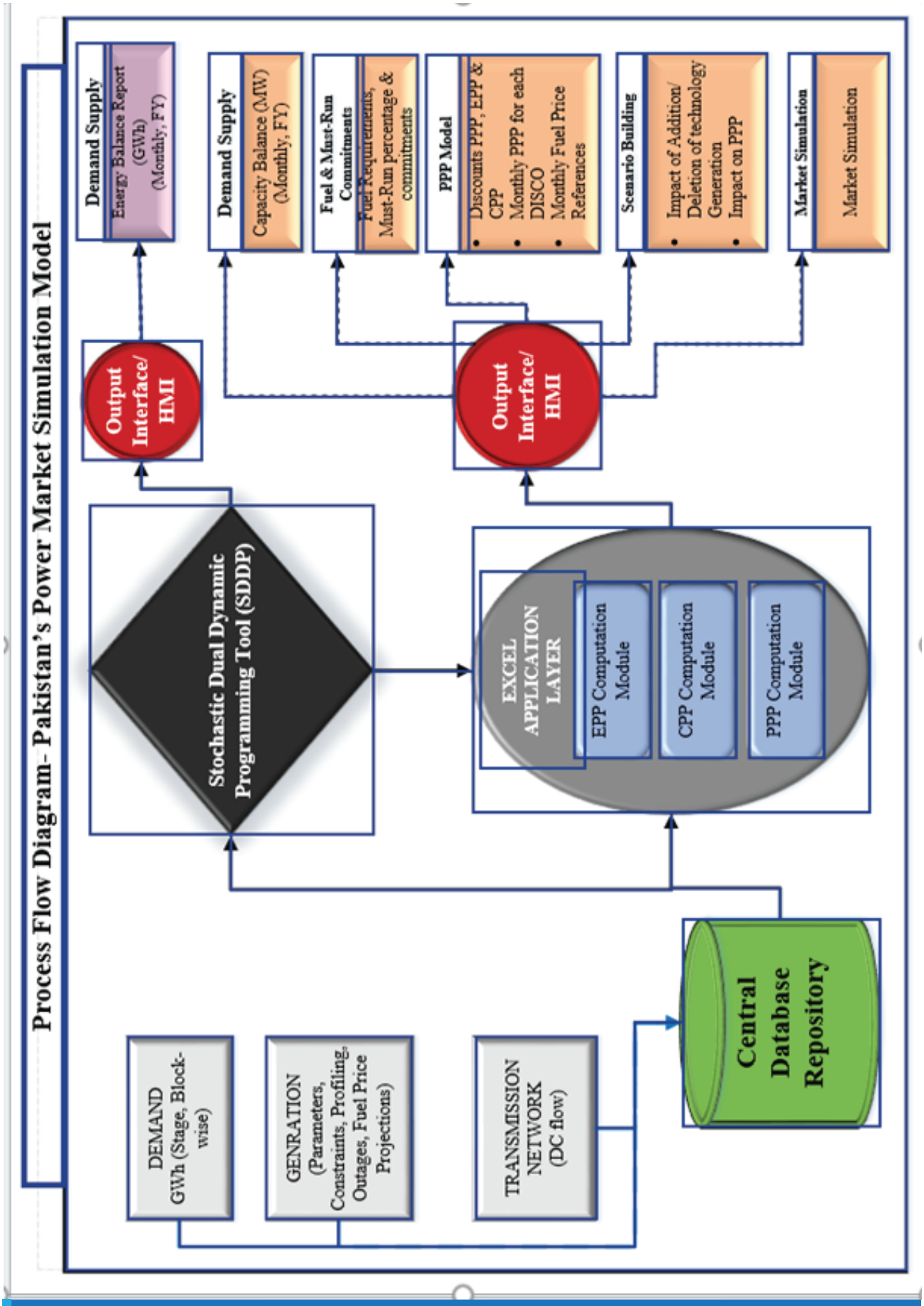


Figure 2 Pocess Flow Diagram

03 Demand Forecast

3.1 DEMAND FORECAST METHODOLOGY

3.2 DEMAND CHARACTERISTICS

3.3 REPRESENTATION OF ENERGY AND PEAK CAPACITY DEMAND

3 DEMAND FORECAST

Demand Forecasting bears a critical role in electricity industry of any sector owing to the planning and operational perspective. A great variety of methods for predicting electricity demand are being used by electrical companies, which are applicable to short-term, medium-term or long-term forecasting.

Changing electrical demand arises from complex interactions between personal, corporative and socio-economic factors underlying in a certain system. In such a dynamic environment, ordinary forecasting techniques are not sufficient enough, hence more sophisticated methods are needed. The core objective is to effectively untangle all the factors that lead to demand change and to reflect all the underlying causes accounting for change in demand. For the accomplishment of the targeted objective, the root level underlying details associated with multiple personal and social factors should be injected into complex predictive models for processing.

Power market survey Model (PMS) forms the basis of medium-term forecasting and does cater for factors associated with different categories of consumers like loss rates, Load factors etc. As per DPC 5 of the distribution planning code, it is the prime responsibility of the DISCO to prepare their short- and medium-term forecasts. Because the PMS forecast is based on a mix of end-use, trend projection and known consumer expansion plans, it cannot be used reliably to predict demand over the longer term. This model had not been created to predict impacts of changes in growth rates of different economic sectors over time, changes in both the absolute and relative prices of electricity, or changes in the relationships between income growth and electricity growth over time as a result of market saturation and technological change. Therefore, long term forecast based on regression analysis (currently under preparation based on three scenarios, Low, Normal and High GDP growth) is normally used for long term generation planning.

3.1 DEMAND FORECAST METHODOLOGY

The demand forecast has been predicted on the basis of Power Market Survey Methodology and the model used is called Power Market Survey (PMS) model. This model is a form of end use model which provides energy and power projection for system, all distribution companies and all substations within each distribution company. It starts forecast of a DISCO from the tariff-wise energy consumption at feeder level collected by the respective DISCO.

The procedure is as follows:
a) Tariff-wise growth rates are applied to the feeder-wise energy consumption and then future expected load under the service area of this feeder is added to calculate the total energy consumption for the next forecast year.

b) In the next step, consumption of each tariff category is converted to peak demand by using different load factors. The total demand of this feeder is then computed by using proper diversity/coincidence factors.
c) 11 KV Loss rates are applied to the sale figures at feeder level to calculate the units sent out and peak demand of the feeder.

d) The energy & demand of all the feeders of a particular substation are added to calculate the energy sent out and peak demand of that substation.

e) 132 KV loss rates are applied to the energy and demand of all the substations in a DISCO and then accumulated to form the energy and demand forecast for a DISCO for all the forecast years by applying some diversity.

The energy and demand of all the DISCOs are then combined (with some diversity) to form the system level forecast.

3.2 DEMAND CHARACTERISTICS

The electricity demand of a Demographical Area speaks of its social standards, Economic growth, geographical variations and demography of the population. Understanding and forecasting of load characteristics have been complex due to its dependency on large number of factors which affects it i.e. weather conditions, geographical diversity, sunrise/sunset times, seasonal diversity, Load shedding, Electricity Tariffs etc. The detailed study of the electricity consumption invokes the knowledge of its trend and seasonality which can be exploited to extrapolate the demand characteristics.

Pakistan does belong to demographic location having immense seasonal variations resulting in diversified electricity consumption patterns where system's peak demand hits during summer season i.e. during the month of June and July and the minimum demand hits during winter season i.e. during the month of December and January.

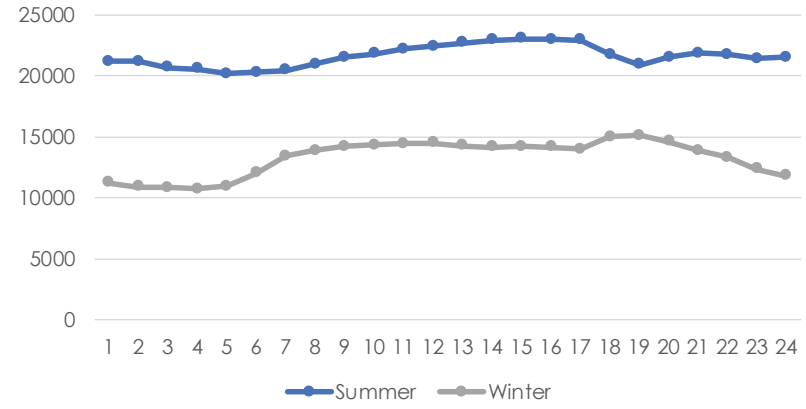


Figure 3 Seasonal Load Profiles (MW)

Apart from these seasonal characteristics of demand, there are huge deviations in demand consumption patterns among different classes of consumer's i.e. domestic consumers load profile will be different from industrial and agricultural consumer profiles.

Accordingly, the demand profile and the load duration curve of the system has been accounted for to segregate monthly demands into 21 distinct blocks through ***K-mean clustering algorithm for linear piece wise sampling*** of the demand thus yielding more precise per-block energy contribution by each generation source resulting in a more accurate dispatch result for the computation of EPP. Mapping of block-wise demand in the tool has been explained in the chapter 5.

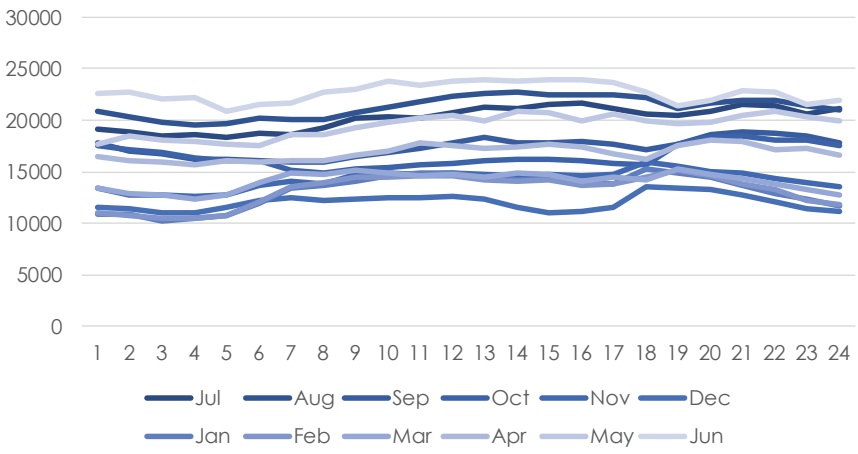


Figure 4 Monthly Load Profiles (MW)

3.3 REPRESENTATION OF ENERGY AND PEAK CAPACITY DEMAND

Annual and monthly peak demands have been forecasted based on the projections of the report of Power Market Survey (PMS) for the year 2016-17. Similarly, the monthly energy demand of PMS has been taken as input in the dispatch tool of PPP mode. The two scenarios have been considered for the demand projections.

3.3.1 PMS BASED DEMAND (SCENARIO 1)

The exact PMS projections for monthly demand of capacity and energy is being used and populated in the dispatch tool for the formulation of monthly PPP for the base year 2019-20 and the annual PPP references up to the study horizon of 2024-25. The monthly capacity and energy demand projections have been placed in Table 3 & 4 respectively for reference.

Year	July	August	September	October	November	December	January	February	March	April	May	June
2018-19	25,030	25,030	24,767	23,186	17,389	17,389	16,862	16,599	19,234	22,132	24,240	26,348
2019-20	26,049	26,049	25,775	24,130	18,097	18,097	17,549	17,275	20,017	23,033	25,226	27,420
2020-21	27,171	27,171	26,885	25,169	18,877	18,877	18,305	18,019	20,879	24,025	26,313	28,601
2021-22	28,331	28,331	28,033	26,243	19,683	19,683	19,086	18,788	21,770	25,051	27,436	29,822
2022-23	29,540	29,540	29,229	27,364	20,523	20,523	19,901	19,590	22,699	26,120	28,608	31,095
2023-24	30,808	30,808	30,484	28,538	21,403	21,403	20,755	20,431	23,674	27,241	29,835	32,429
2024-25	32,125	32,125	31,787	29,758	22,318	22,318	21,642	21,304	24,685	28,405	31,110	33,816

Table 3 Forecasted Peak Demand (MW)

Year	July	August	September	October	November	December	January	February	March	April	May	June	Total
2018-19	15,616	15,336	14,510	12,579	9,410	9,524	9,375	8,683	10,775	11,972	14,759	15,520	148,059
2019-20	16,301	16,010	15,147	13,131	9,824	9,942	9,787	9,064	11,248	12,497	15,407	16,201	154,559
2020-21	17,020	16,715	15,814	13,710	10,256	10,380	10,218	9,464	11,744	13,048	16,086	16,915	161,370
2021-22	17,787	17,468	16,527	14,328	10,719	10,848	10,678	9,890	12,273	13,636	16,811	17,678	168,643
2022-23	18,580	18,247	17,264	14,967	11,197	11,332	11,155	10,331	12,820	14,244	17,560	18,466	176,163
2023-24	19,413	19,065	18,038	15,638	11,699	11,840	11,655	10,794	13,395	14,883	18,348	19,294	184,062
2024-25	20,271	19,909	18,836	16,329	12,216	12,364	12,170	11,272	13,987	15,541	19,159	20,147	192,201

Table 4 Forecasted Monthly Energy (GWh)

3.3.2 ACTUAL DEMAND (SCENARIO 2)

The actual energy demand for the past five fiscal years have been used as reference and projected based on CAGR for estimating the energy demand references for the year 2019-20.

Accordingly, the monthly energy demand projections worked out have been placed in table 5.

Year	July	August	September	October	November	December	January	February	March	April	May	June	Total
2019-20	14,275	14,450	13,230	10,107	8,306	8,493	8,753	7,686	9,556	10,974	12,901	13,525	132,256

Table 5 Forecasted Monthly Energy (GWh)

04

Generation Portfolio of Pakistan's Power Structure

4.1 HYDEL GENERATION

2.2 THERMAL GENERATION

4.3 RENEWABLE GENERATION

4.4 NUCLEAR GENERATION

4 POWER GENERATION OF PAKISTAN STRUCTURE

The generation sector of Pakistan has witnessed a major transformation over the last five years (2013-2018), by moving towards a reliable supply system through large base-load power plants using indigenous and imported coal and through highly efficient gas-based plants. A number of large hydropower plants have also achieved completion, whereas till date around 1,500 MW of solar and wind power plants, have also been inducted to encourage and subsequently enhance share of clean energy in the overall energy mix. Furnace Oil-based power generation plants which remained face of Pakistan power sector for over three decades, have been planned to be phased out over next few years and it is expected that the share of furnace oil-based energy will decline from around 30% to a negligible level in the overall mix in the coming years. However, these plants, as per contractual obligation, will be available in the system for energy security purposes.

Over the past few years the policy makers in Pakistan have recognized and made concerted efforts for development in the power sector in general and generation sector in particular. Sufficient generation capacity has already been added in the system resulting in considerable improvement in load-shedding position all over the country. As per records, further generation capacity at different stages of implementation, will also be added over the next three years. Evacuation of power from these facilities has put extra burden on transmission and distribution sectors. Infrastructure deficit and absence of performance improvement in these sectors may hamper the economic benefits foreseen due to huge investment in the generation facilities.

The power sector of Pakistan is a mix of thermal, hydro, nuclear and renewable energy power plants.

This chapter provides a detailed insight about the assumptions and considerations incorporated in the building of the generation part of the PPP model. As this report does not deal with the expansion plan and reasoning thereof, the focus will be on the existing parameters and for the upcoming plants the focus will be only limited to the defined parameters as per policy and regulatory framework.

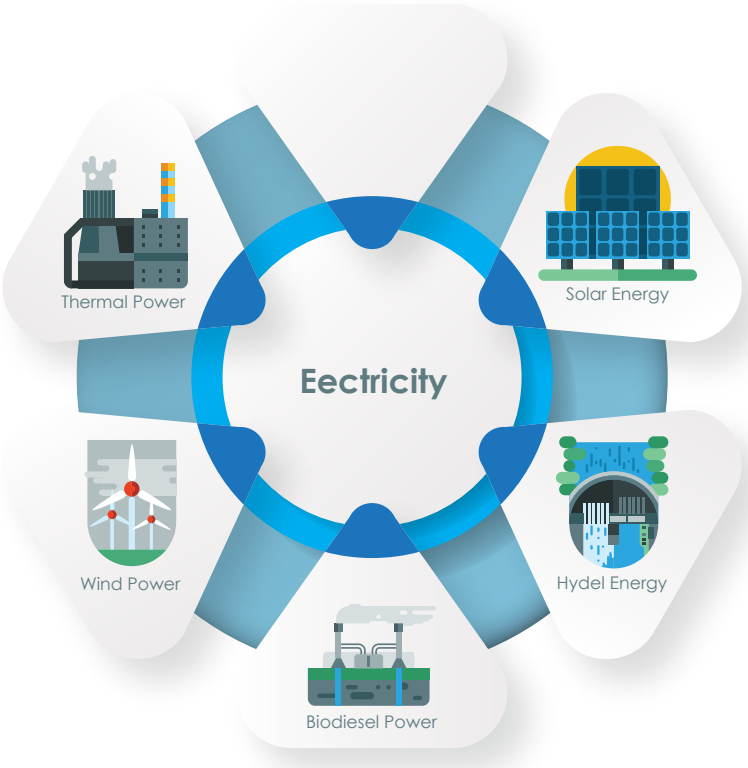


Figure 5 Generation Sources

4.1 HYDEL GENERATION

Large Hydro Power plants, coupled with water security & food security, remained the main source of energy supply in the country. The NEPRA's SIR 2017 predicts that large hydro share will increase to 15000 MW against the existing share of 8000MW.

The generation model for the hydropower can be broadly categorized into two categories:

a. WAPDA Hydro
b. Hydro IPP mode (including Small Hydro Plants)

4.1.1 WAPDA HYDRO

TECHNICAL PARAMETERS

These are the hydropower projects being operated/constructed by WAPDA. The hydrology of more than past 10 years has been used for electricity generation purposes, where available. The energy generation profile of these plants is attached at Annexure A.

Based on the compulsion of the daily indent by IRSA, the feature of water storage for a coordinated hydro-thermal dispatch based on water value that minimizes overall cost function has not been employed.

FINANCIAL PARAMETERS

These projects are funded by Govt and provide cheap electricity in the system. The reference tariff determinations of NEPRA has been used for PPP projections with proper indexation for each component to yield prevailing tariff charges.

4.1.2 HYDRO IPP MODE (INCLUDING SMALL HYDRO PLANTS)

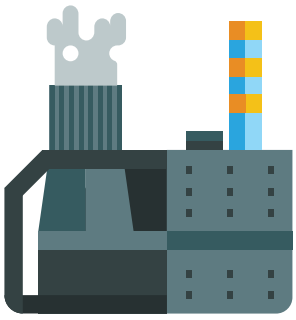
TECHNICAL PARAMETERS

These are run of the river projects with no firm capacity and provide energy to the system at the regulated price. Depending on the location, these plants provide energy as per hydrological profile. The hydrology also has dependence in some cases on the discharges of the upstream dam. Accordingly, the standard hydrology gauging stations have been defined in the generation model and each hydel plant has been mapped to one of the gauging stations for the estimation of the energy in each block to meet the respective blocked energy demand.

FINANCIAL PARAMETERS

The IPPs have front loaded tariff so the plants have various applicable rates for the study period of this report. Few plants have their debt service retired while other have portion of debt service for the study period. For the existing plants, the tariffs determined by the NEPRA have been used with proper indexation for each component to yield prevailing tariff charges. For the upcoming hydel plants, the tariff determination of the best-fit available case has been taken as reference for the projection purposes.

4.2 THERMAL GENERATION



As pointed out earlier, PPP sweeps the major portion of the end-consumer tariff portion and thermal generation sweeps the major part of the PPP component. For the purposes of this report the thermal plants in the system has been categorized as follows:

a. Thermal Generation by GENCOs
b. Thermal Generation - under 1994 Policy (RFO/Gas Plants)
c. RFO/Gas Plants - under 2002 Policy
d. RLNG Plants – under 2015 Policy
e. Imported Coal Plants – under 2015 Policy
f. Thar Coal Plants – under 2015 Policy

4.2.1 THERMAL GENERATION BY GENCOS

GENCOs are the public sector thermal generation units installed to meet the system demand.

TECHNICAL PARAMETERS

The heat rates and the available capacities based on the available data has been used for each GENCO. The maintenance outage based on the approved schedule by the System Operator for 2019 has been assumed and the same has been replicated for the study horizon.

FINANCIAL PARAMETERS

Mainly the capacity payments have been exhausted however NEPRA allows certain Capacity amount for the fixed cost. The NEPRA determined rates for the GENCO's has been assumed for the computation of EPP and CPP with proper indexation for each component to yield prevailing tariff charges.

4.2.2 THERMAL GENERATION (RFO/-GAS PLANTS) UNDER 1994 POLICY

1994 policy was first to provide for the private sector participation and the same have been modeled as per contractual stipulations.

TECHNICAL PARAMETERS

These plants have reasonable efficiency ranging from 35%-45% per their PPA. They are mostly RFO based power plants. The heat rates and the available capacities based on the available data has been used for each IPP under this category. The maintenance outage based on the approved schedule by the System Operator for 2019 has been assumed and the same has been replicated for the study horizon.

FINANCIAL PARAMETERS

The tariff negotiated and incorporated in the PPA has been used with proper indexation for each component. Front loaded cost of these projects has already been paid off.

4.2.3 THERMAL GENERATION (RFO/-GAS PLANTS) UNDER 2002 POLICY

TECHNICAL PARAMETERS

These plants have 45% efficiency and almost half of the capacity has dual fuel option for RFO and Gas.

The heat rates and the available capacities based on the available data has been used for each IPP under this category. The maintenance outage based on the approved schedule by the System Operator for 2019 has been assumed and the same has been replicated for the study horizon.

FINANCIAL PARAMETERS

The tariff determined by the NEPRA on the cost-plus basis has been assumed in PPP model for these power plants. The indexation mechanism has also been incorporated for projecting the indexed capacity and energy rates for these IPPs.

4.2.4 THERMAL GENERATION RLNG PLANTS UNDER 2015 POLICY

TECHNICAL PARAMETERS

These RLNG plants have efficiency of more than 60% and have higher availability factor of 92%. These plants have back to back Gas Supply arrangements and minimum 66% off take requirement up to 2031 as per Gas Supply Agreement (GSA). Accordingly, the fuel contracts have been mapped in the dispatch tool to ensure optimization of overall dispatch for yield minimum cost function, while taking into consideration take-or-pay fuel contracts for RLNG. The maintenance outage based on the approved schedule by the System Operator for 2019 has been assumed and the same has been replicated for the study horizon.

FINANCIAL PARAMETERS

The plants have front loaded tariff and tariff design is of CPP and EPP. The tariff determined by the NEPRA on the cost-plus basis has been assumed in PPP model for these power plants. The indexation mechanism has also been incorporated for projecting the indexed capacity and energy rates for these IPPs.

4.2.5 THERMAL GENERATION IMPORTED COAL PLANTS UNDER 2015 POLICY

TECHNICAL PARAMETERS

These Coal plants have efficiency of 39% and have higher availability factor of 85%. The plants have back to back Supply arrangement and minimum 50% off taka requirement for 5 years as per CSA. Accordingly, the fuel contracts have been mapped in the dispatch tool to ensure optimization of overall dispatch for yielding minimum cost function, while taking into consideration take-or-pay fuel contracts for imported coal power plant. The maintenance outage based on the approved schedule by the System Operator for 2019 has been assumed and the same has been replicated for the study horizon.

FINANCIAL PARAMETERS

The plants have front loaded tariff and tariff design is of CPP and EPP. The tariff determined by the NEPRA on the cost-plus basis has been assumed in PPP model for these power plants. The indexation mechanism has also been incorporated for projecting the indexed capacity and energy rates for these IPPs.

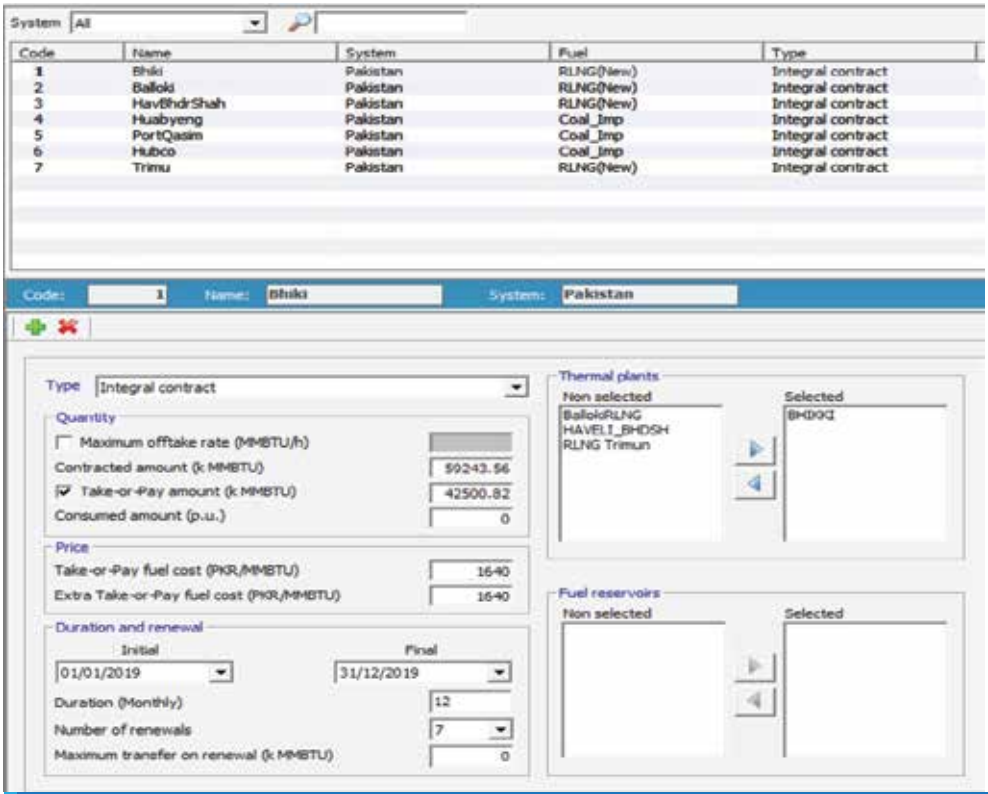


Figure 6 SDDP - Fuel Contract Configurations

4.2.6 THERMAL GENERATION THAR COAL PLANTS UNDER 2015 POLICY

TECHNICAL PARAMETERS

These coal-based power plants have efficiency of around 39% and has higher availability factor of 85%. These plants have back to back Supply arrangement with the coal mining companies.

FINANCIAL PARAMETERS

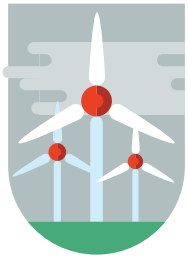
The plants have front loaded tariff and tariff design is of CPP and EPP. The mining cost has been assumed to be fixed in nature and accordingly included in the CPP for these power plants. The indexation mechanism has also been incorporated for projecting the indexed capacity and energy rates for these IPPs.

4.3 RENEWABLE GENERATION

Renewable generation has been categorized into the following categories for the purpose of this report:

a. *Wind*
b. *Solar*
c. *Bagasse/Biomass*

4.3.1 WIND GENERATION PROFILING



TECHNICAL PARAMETERS

Wind power plants have been defined in the Must-Run configuration in the dispatch tool of PPP Model. Standard renewable Stations have been defined in the model to depict the 21-blocks-seggregated monthly profile (as is the case of demand representation in the model) of wind power plants based upon their location (Jhimpir or Gharo Corridor) and the annual plant factor established by NEPRA in the respective tariff determination.

Consequently, each wind power plant has been assigned a renewable station based on their annual regulatory plant factor, thus ensuring realistic coordination of renewables with the hydro-thermal dispatch for the contribution of energy in the respective blocks as a function of respective demand.

Typical renewable profiles against different annual plant factors have been placed at Annex-B for reference.

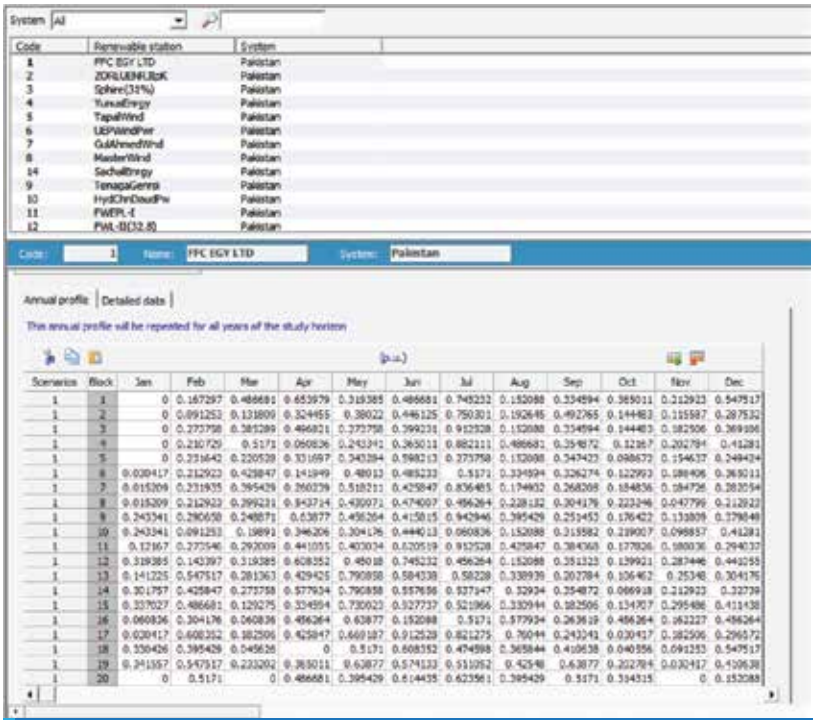
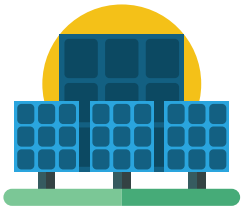


Figure 7 SDDP- Renewable profile configuration

FINANCIAL PARAMETERS

The tariff determined by NEPRA for each wind power plant has been taken as reference and indexed to projected values (where applicable) of Dollar, Libor, Kibor, CPI etc. for ascertaining their respective contribution in PPP.

4.3.2 SOLAR GENERATION



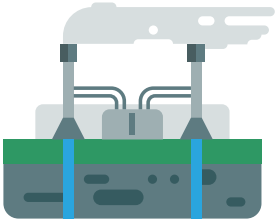
TECHNICAL PARAMETERS

Solar power plants have been defined in the Must-Run configuration in the dispatch tool of PPP Model. Standard renewable Station has been defined in the model to depict the 21-blocks-seggregated monthly profile (as is the case of demand representation in the model) of solar power plants and the annual plant factor established by NEPRA in the respective tariff determination.

FINANCIAL PARAMETERS

The tariff determined by NEPRA for each solar power plant has been taken as reference and indexed to projected values (where applicable) of Dollar, Libor, Kibor, CPI etc. for ascertaining their respective contribution in PPP.

4.3.3 BAGASSE GENERATION



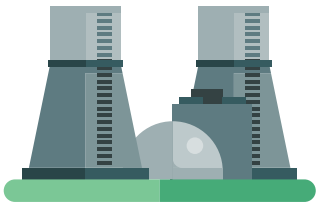
TECHNICAL PARAMETERS

Bagasse based power plants have been defined in the Must-Run configuration in the dispatch tool of PPP Model. It has been assumed that these plants have sufficient bagasse available to achieve the annual capacity factor of 45 %, as established in the upfront tariff for bagasse-based co-generation power plants. Moreover, for new bagasse plants, the annual capacity factor of 55 % (based on the new upfront determination of NEPRA in 2017) has been assumed with Must-Run condition.

FINANCIAL PARAMETERS

The tariff determined by NEPRA for each existing bagasse-based power plant has been taken as reference and indexed to projected values (where applicable) of Dollar, Libor, Kibor, CPI etc. for ascertaining their respective contribution in PPP. Moreover, the respective components of upfront tariff 2017 (indexed to projected values) has been taken for the future bagasse-based co-generation power plants.

4.4 NUCLEAR GENERATION



TECHNICAL PARAMETERS

Pakistan Atomic Energy Commission, interalia, undertakes the projects of nuclear power plants development, operation and maintenance in the country. Nuclear Power plants have been modelled as base-load. The maintenance outage based on the approved schedule by the System Operator for 2019 has been assumed and the same has been replicated for the study horizon.

FINANCIAL PARAMETERS

The tariff determined by NEPRA for each nuclear power plant has been taken as reference and indexed to projected values (where applicable) for ascertaining their respective contribution in PPP.

05

Energy Purchase Price

5.1 SDDP MODELING DISPATCH TOOL FOR ENERGY ESTIMATION

5 ENERGY PURCHASE PRICE

Energy Purchase Price refers to the price associated with dispatch and is comprised of Variable Operation and Maintenance cost, Fuels Costs etc. EPP previously was the dominated part of overall PPP, however owing to the induction of efficient thermal generation and must-run renewables & Hydel plants, the PPP is witnessing transition towards CPP dominance. The calculation of EPP does involves consideration of sensitive assumption including inter-alia, Must-Run commitments, Fuel Supply Contracts, Maintenance outages, generation profiles etc. The EPP has been further categorized into the following set:

- Hydro generation;
- Nuclear generation;
- Renewable generation;
- RLNG Plants (66% minimum energy off-take)
- Imported Coal Plants (50% minimum energy off-take)

Generation Subject to Merit Order (All the generation Excluding MUST Run Generation and Minimum Off-Take Rate Generation are subjected to merit order)

5.1 FUEL PRICE PROJECTION

For the purpose of computation of EPP, following two approaches have been adopted;

a) For the year 2019-20, the monthly reference of each month, each fuel price has been projected.

b) For the horizon of 2020-2025, the single price has been assumed for the whole study period.

METHODOLGY

In order to project the fuel prices of RFO, LNG, Gas, HSD and Coal we have analyzed US Energy Information Administration reports. Based on the information available in the aforementioned reports, the following scenarios have been prepared for projection of fuel prices in terms of Furnace Oil (HSFO), RLNG and Gas consideration of the Authority;

5.1.1. HSFO PRICE

HSFO price has been projected using two approaches which are discussed below;

HSFO PRICE (AS PER ACTUAL GROWTH FOR THE CALENDAR YEAR 2017-18)

Under this approach, HSFO prices for future have been projected by applying Cumulative average growth rate (CAGR) to HSFO prices for Calendar year 2017-18. By incorporating the actual variation of 3.96% for the calendar year 2017-18, the actual HSFO price works out to be Rs. 68,241/ MT (Ex-GST & Ex-Freight) as of 1st March 2019. As per PSO website, the average HSFO price works out as Rs.99,962/MT (Ex-GST & Ex-Freight). After incorporating average freight of around Rs.2,500/MT the total HSFO prices works out as Rs.102,8462/MT.

HSFO PRICE (STEO RFO – REPORT FOR DEC 2018)

To project HSFO prices, comparison of actual RFO prices as per PSO (ex-GST, ex-OMC margin, ex-Import incidental charges) vis a vis RFO prices of STEO Report (U.S. Energy Information Administration, 2018) has been made for the FY 2017-18. As per the comparison, PSO prices of RFO on average have been slightly higher i.e. US$0.24/gallon than RFO prices as per STEO Report (U.S. Energy Information Administration, 2018).

Accordingly, for making future projections, the impact of US$0.24/gallon has been incorporated in the RFO prices as projected by (U.S. Energy Information Administration, 2018) Report for the future 12 months. Afterwards, these projected prices have been adjusted with 1.74% import incidentals, 3.5% of OMC margin and conversion rate of Rs.150/$ and after incorporating average freight of around Rs.2,500/MT, the total HSFO prices works out as Rs.66,141/MT.

5.1.2. HSD PRICE

For projection of HSD prices, an increase of around 4.50% has been assumed on actual HSD price. After applying increase of 4.5% on the price effective from 1st March 2019 i.e. Rs. 95.24/ Liter (Ex-GST) as per PSO Website, the average HSD price works out as Rs.100.00/Liter (Ex-GST).

5.1.3. RLNG PRICE (STEO REPORT – BRENT CRUDE PROJECTIONS)

As per RLNG price notification issued by OGRA, RLNG price in Pakistan has been benchmarked with Brent Crude Oil Prices. In addition to this, Port charges, PSO import related actual costs, PSO Margin @2.5% of DES Price and Terminal Charges are added to final approved prices. Furthermore, the said price is adjusted with Transmission Losses and other Miscellaneous costs. These additional costs, on average works out to be around 21% of the benchmark price of Brent crude oil.

In order to fairly project the prices of RLNG, the projections of Brent Crude Oil as per the Short Term Energy Outlook (STEO) Report (U.S. Energy Information Administration, 2018) for the month of December 2018 have been considered. As per the STEO Report (U.S. Energy Information Administration, 2018), the Brent Crude Oil projected price comes out to be US$60-63/bbl.

By applying the aforementioned costs and various charges, the average RLNG price works out to be Rs.1,640/ MMBTU.

5.1.4. GAS PRICE

At present the Gas price as notified by OGRA is Rs. 729 / MMBTU inclusive of GIDC of Rs.100/MMBTU. For making PPP projections for future, the gas price has been kept constant at Rs.729/MMBTU.

5.1.5. BAGASSE PRICES

Previously Bagasse prices were indexed with the prices of coal, which was later changed for the new upcoming bagasse projects via revising the indexation mechanism. On this basis, the bagasse prices incorporated under this model have been considered flat i.e. Rs. 3000 Rs/MTON which will be 2% escalated after every two years.

5.1.6 COAL PRICE

Coal prices incorporated under this model, have been projected via working out the trend of prices being charged to coal power plants in the current regime (taking into consideration various charges i.e. jetty costs, coal transportation costs etc.), thus resulting in an average cost of Rs. 15,500 Rs/MTON which has been considered uniform for the whole study period.

Fuel	Unit	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Gas	Rs/MMBTU	729	729	729	729	729	729	729	729	729	729	729	729
RLNG	Rs/MMBTU	1,640	1,640	1,640	1,640	1,640	1,640	1,640	1,640	1,640	1,640	1,640	1,640
Coal_Imp	Rs/MTon	15,500	15,500	15,500	15,500	15,500	15,500	15,500	15,500	15,500	15,500	15,500	15,500
Coal_Local	Rs/MTon	2,152	2,152	2,152	2,152	2,152	2,152	2,152	2,152	2,152	2,152	2,152	2,152
RFO	Rs/MTon	66,547	69,313	69,829	66,531	66,576	64,985	64,985	64,985	64,985	64,985	64,985	64,985
HSD	Rs/Liter	100	100	100	100	100	100	100	100	100	100	100	100
Bagasse	Rs/MTon	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000

Table 6 Fuel Prices Forecast for year 2019-20

5.2 SDDP MODELING TOOL FOR ESTIMATING ENERGY DISPATCH

This is the one of the core modules that bears a very critical role for this PPP-Model. It makes use of a tool developed by PSR-incorporations named as SDDP (Stochastic Dual Dynamic Program). SDDP is a transmission constrained hydro thermal dispatch tool used for short, medium and long-term power system operational studies. It makes use of its statistic and probabilistic operations for calculating the least-cost stochastic policy of a power system taking into consideration the following aspects:

Operational Details of thermal plants (Generation constraints technical as well as commercial, Efficiency curves, Fuel consumption, Unit Commitment, Multi-fuel modes etc)
Operational details of hydel plants (Water inflows, Plant types both run of river and storage based, spillage limits, topologies, water balance etc.);
Hydrological uncertainty (Stochastic and deterministic inflow models, hydrological characteristics like seasonality, time dependence and climate changes etc.)
Detailed Transmission Network (Power flows, losses, import export limits, circuit limits etc.);
Load variation (load variations with respect to stage wise allocations);
Operational details of Renewable plants (operation factor, outage probabilities etc.);
Fuel Contracts (take or pay fuel contracts, free contracts etc.);
Renewable profiling;

Apart from least-cost generation policy, this tool calculates several economic indices like market and bus wise spot prices, system and bus wise load marginal costs, transmission congestion costs, wheeling rates etc. This tool does take an extensive and detailed input data for various generation technologies, stage wise demands for various systems, fuel configurations and detailed transmission network in a standardized format and generates a wide range of dynamic output in the form of graphs and CSV files. The detailed description of input and output files is given in the relevant sections. Currently, this tool for its diversified and dynamic characteristics is being used for operational studies, international interconnections and analysis of hydro-thermal dispatch more than 30 countries like USA, Canada, New Zealand, China, Brazil etc.

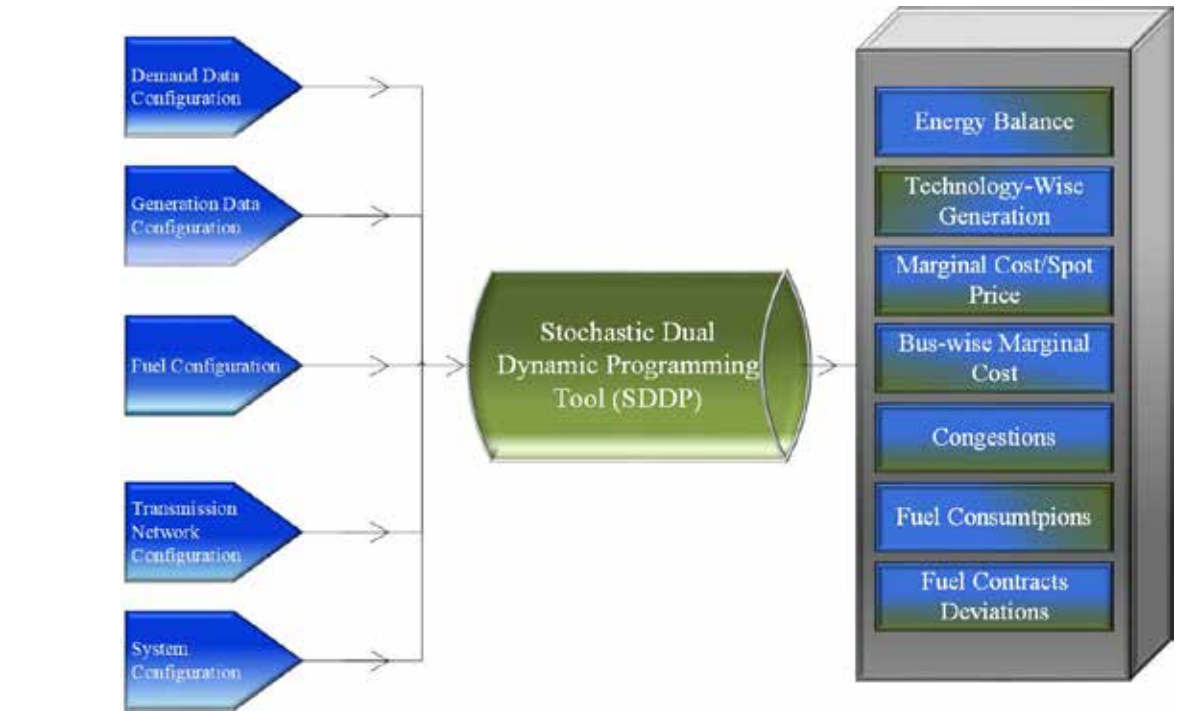


Figure 8 SDDP Flowchart

5.1.1 SET OF INPUTS

For running simulations via using SDDP, it requires a variety of inputs for modelling Demand, Generation and Transmission, to be fed in a standardized format compatible with the working environment of the tool. The format of a few input data depends upon the selection of stages and mode of operation i.e. block wise or hourly dispatch. All the categories of inputs and their standardized formats have been described below in a detailed manner.

A. DEMAND DATA CONFIGURATIONS

As described earlier, SDDP does require a few inputs to be in a standardized format depending upon the mode of operation, demand is one of the inputs belonging to the same category that are required to be modelled as per the mode of operation. For Hourly mode, SDDP requires stage wise hourly demand to be inputted in it. For block-wise operation, the hourly demand has been modelled using K-mean clustering algorithm for linear piece wise sampling of the hourly demand. This block-wise demand modulation is done via using external software i.e. MATLAB, Excel etc.

For this present case, block wise modelling of demand is done using 21 blocks per month. As the study period spans till 2024-25, therefore monthly block-wise data for 84 months has been input in the model. The detailed procedure for processing hourly data to block wise data is described below

PROCEDURE FOR BLOCK WISE MODELING

This part explains the procedure for transformation of Month Wise Hourly data into set of 21 load blocks.

1. The hourly demand for 744 hours is fetched from data base for each month of the year.
2. This hourly demand is then sorted in a descending order i.e. from highest to lowest.
3. On the basis of subsequent differences between consecutive demands, linear approximation of this curve is done using 21 load blocks.
5. For the projection of demand for future years, the same hourly data profiles are used for the respective months accounting for the impact of Projected Peak demands as well as Projected Energy.
6. This detailed block wise data i.e. 84 blocks per year is then inserted into SDDP-Module for the period of 2019-20 to 2024-25.

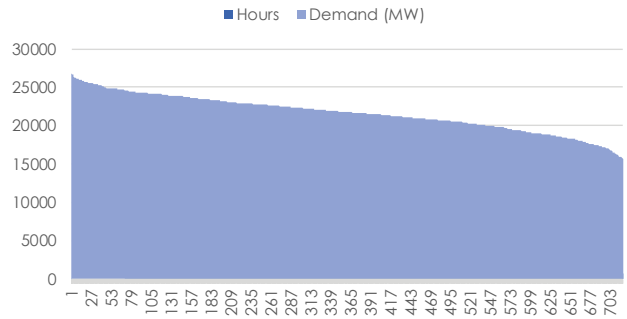


Figure 9 Sorted Demand (MW)

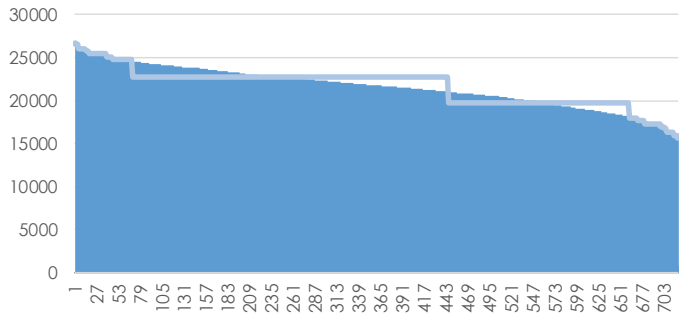


Figure 10 Sorted & Block-wise Demand (MW)

VARIABLE DURATION OF LOAD BLOCKS

Fixed duration of blocks is entered in the system configuration data which is over-written once the data for variable duration of blocks is entered in the complementary data tab. The data is entered for all the stages coming under the study period.

It is pertinent to mention here that the first block (representing the highest demand) is allocated a dedicated block to capture the peak of the respective month.

B. GENEARTION DATA CONFIGURATIONS

Generation data is the most detailed and diversified set of inputs matrix of SDDP. It is comprised of various technical and commercial parameters pertaining to various set of technologies including hydel, thermal and renewable as well. The basic data like generation limits, outage rates for all the three generation technologies is entered under basic data tab available in the control panel while the detailed data like maintenance scheduled outages, modifications, operative constraints are entered under complementary data tab.

(hours)

Year	Block	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2019	1	1	1	1	1	1	1	1	1	1	1	1	1
2019	2	4	9	4	4	7	4	4	6	6	5	4	54
2019	3	1	12	15	3	3	8	3	1	1	8	2	416
2019	4	1	416	1	1	1	1	16	8	3	11	6	7
2019	5	1	13	4	21	7	3	659	3	358	82	2	5
2019	6	1	3	4	6	65	21	6	6	117	46	6	1
2019	7	4	16	17	9	602	7	18	2	137	248	6	11
2019	8	2	15	16	24	36	24	4	11	7	221	32	3
2019	9	1	27	11	1	3	376	2	664	15	60	434	41
2019	10	1	1	636	592	1	216	1	9	8	5	47	28
2019	11	1	143	5	16	4	10	7	7	22	26	17	3
2019	12	2	7	2	5	5	8	5	1	20	5	3	4
2019	13	14	1	4	17	1	19	4	2	3	2	39	7
2019	14	440	1	3	4	1	3	1	5	6	5	37	38

Figure 11 SDDP-Variable Duration of Blocks

I. THERMAL PALNTS CONFIGURATIONS

Category of Thermal plants covers RFO based plants, HSD based plants, Gas based plants, Coal based plants, nuclear based plants and bagasse/biomass based plants. These plants have been added in the basic data tab while their detailed modifications have been incorporated in the complementary data tab. The thermal plant data is divided into two groups

1. Generator data group
2. Fuel Data

GENERATOR DATA GROUP

Generator data group consists of technical parameters like maximum generation limits, minimum generation limits, fuel type, Operation modes, Consumption etc. The relevant details of the thermal generation portfolio have been input in this tab. minimum & Maximum generation, outage rates and the main fuel has been modelled for all the thermal plants in this tab

There are two types of thermal plants.
1. Standard;
2. Normal

Nuclear and Bagasse based co-generation has been modelled as Must-Run while all other thermal power plants have been defined in standard category.

FUEL DATA

Under fuel data tab, the basic data associated with fuel inputs like fuel consumption and variable O&M has been input in the model.

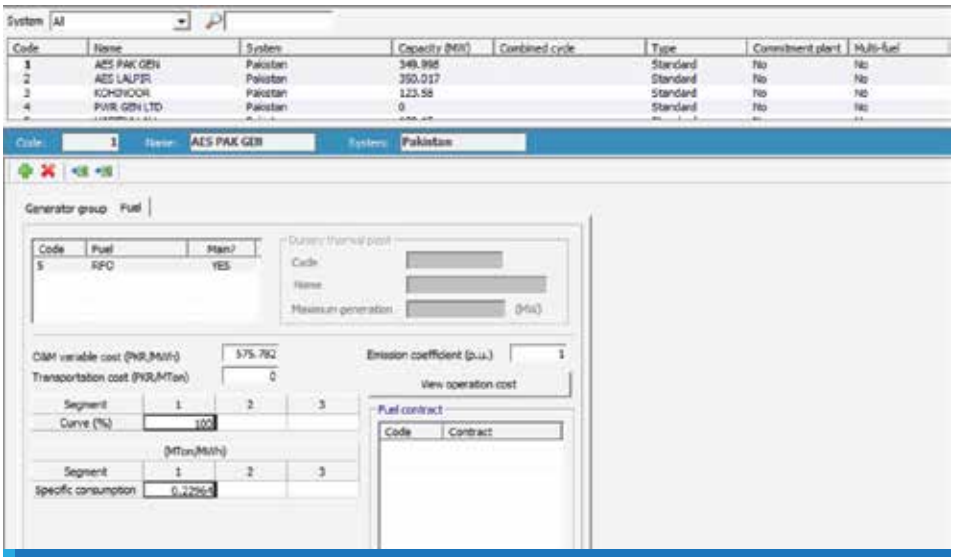


Figure 12 SDDP-Generator Data Group.

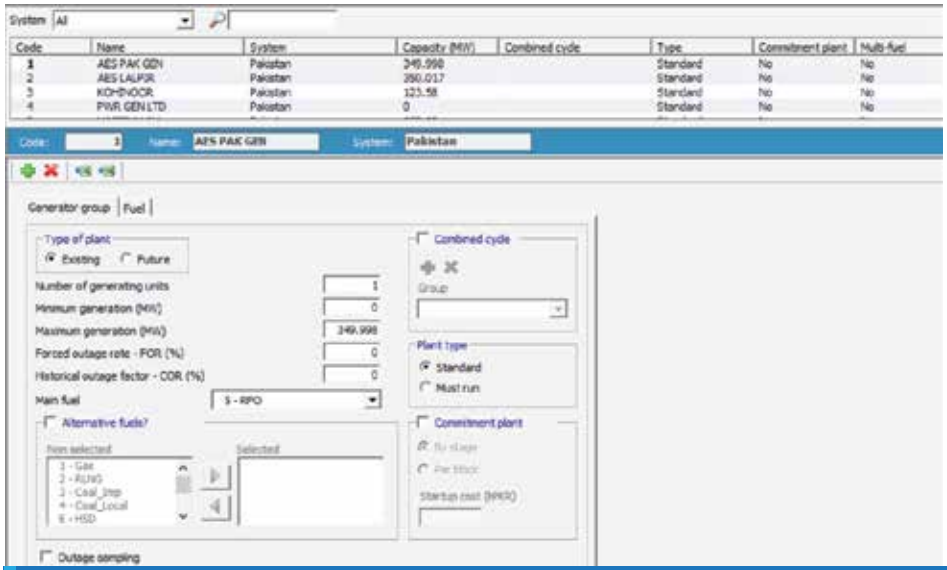


Figure 13 SDDP-Fuel Data Group

MAINTENANCE

Under the maintenance data tab, outage schedules for all plants have been added. The maintenance outage based on the approved schedule by the System Operator for 2019 has been assumed and the same has been replicated for the study horizon.

MODIFICATION

The modification of each plant based upon its date of kick-in, retirement and other plant specific parameters have been incorporated in the modification tab. Moreover, addition/retirement of any plant can be defined under complementary data for thermal plants. In addition to that, following parameters can be altered under this tab as shown in Figure 14.

II. HYDEL PLANTS CONFIGURATIONS

SDDP is a hydro-thermal dispatch tool having specialized characteristics for modelling hydel plants in a peculiar way while accounting for a diversified parameters like hydrological stats (Flows, Uncertainty, Seasonal Uncertainties) hence forecasting a stochastic generation policy. Hydel plants can be defined on the basis of following parameters:

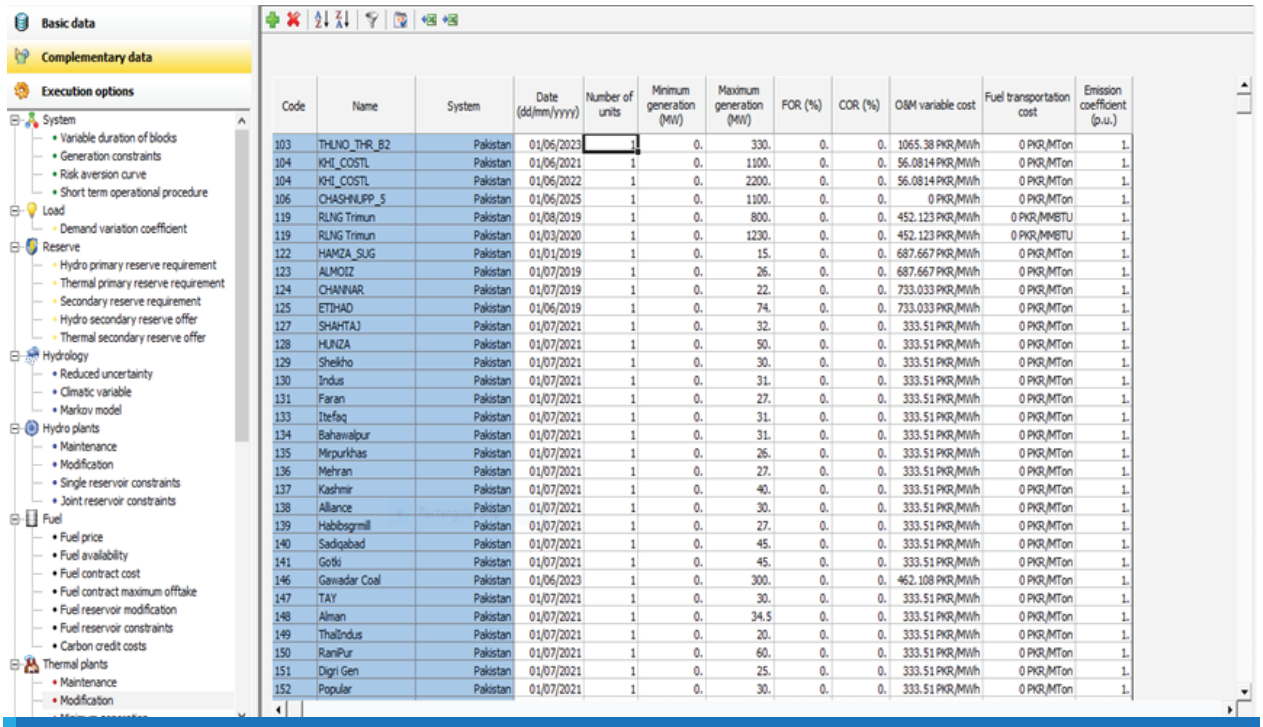
1. Generator group
2. Reservoir
3. Topology
4. Tables

GENERATOR GROUP

Basic Parameters of Hydel Generators have been modelled in this group, including inter-alia, Installed capacity, turbine flow, production coefficient etc. Similarly, the segregation of hydel plant based on existing or future has also been defined in this group.

RESERVOIR

This tab as the name indicates deals with modelling of the associated reservoir station with the respective hydel plant. All the hydro plants have been linked to the hydro gauging station in this tab to yield the estimated energy as a function of hydrology of the reference gauging station.



Code	Name	System	Date (dd/mm/yyyy)	Number of units	Minimum generation (MW)	Maximum generation (MW)	FOR (%)	COR (%)	O&M variable cost	Fuel transportation cost	Emission coefficient (p.u.)
103	THUNO_THR_B2	Pakistan	01/06/2023	1	0.	330.	0.	0.	1065.38 PKR/MWh	0 PKR/MTon	1.
104	KHI_COSTL	Pakistan	01/06/2021	1	0.	1100.	0.	0.	56.0814 PKR/MWh	0 PKR/MTon	1.
104	KHI_COSTL	Pakistan	01/06/2022	1	0.	2200.	0.	0.	56.0814 PKR/MWh	0 PKR/MTon	1.
106	CHASHNUPP_5	Pakistan	01/06/2025	1	0.	1100.	0.	0.	0 PKR/MWh	0 PKR/MTon	1.
119	RLNG Trimun	Pakistan	01/08/2019	1	0.	800.	0.	0.	452.123 PKR/MWh	0 PKR/MMBTU	1.
119	RLNG Trimun	Pakistan	01/03/2020	1	0.	1230.	0.	0.	452.123 PKR/MWh	0 PKR/MMBTU	1.
122	HAMZA_SUG	Pakistan	01/01/2019	1	0.	15.	0.	0.	687.667 PKR/MWh	0 PKR/MTon	1.
123	ALMOIZ	Pakistan	01/07/2019	1	0.	26.	0.	0.	687.667 PKR/MWh	0 PKR/MTon	1.
124	CHANNAR	Pakistan	01/07/2019	1	0.	22.	0.	0.	733.033 PKR/MWh	0 PKR/MTon	1.
125	ETIHAD	Pakistan	01/06/2019	1	0.	74.	0.	0.	733.033 PKR/MWh	0 PKR/MTon	1.
127	SHAHTAJ	Pakistan	01/07/2021	1	0.	32.	0.	0.	333.51 PKR/MWh	0 PKR/MTon	1.
128	HUNZA	Pakistan	01/07/2021	1	0.	50.	0.	0.	333.51 PKR/MWh	0 PKR/MTon	1.
129	Shekho	Pakistan	01/07/2021	1	0.	30.	0.	0.	333.51 PKR/MWh	0 PKR/MTon	1.
130	Indus	Pakistan	01/07/2021	1	0.	31.	0.	0.	333.51 PKR/MWh	0 PKR/MTon	1.
131	Faran	Pakistan	01/07/2021	1	0.	27.	0.	0.	333.51 PKR/MWh	0 PKR/MTon	1.
133	Itefaq	Pakistan	01/07/2021	1	0.	31.	0.	0.	333.51 PKR/MWh	0 PKR/MTon	1.
134	Bahawalpur	Pakistan	01/07/2021	1	0.	31.	0.	0.	333.51 PKR/MWh	0 PKR/MTon	1.
135	Mirpurkhas	Pakistan	01/07/2021	1	0.	26.	0.	0.	333.51 PKR/MWh	0 PKR/MTon	1.
136	Mehran	Pakistan	01/07/2021	1	0.	27.	0.	0.	333.51 PKR/MWh	0 PKR/MTon	1.
137	Kashmir	Pakistan	01/07/2021	1	0.	40.	0.	0.	333.51 PKR/MWh	0 PKR/MTon	1.
138	Alliance	Pakistan	01/07/2021	1	0.	30.	0.	0.	333.51 PKR/MWh	0 PKR/MTon	1.
139	Habibsgrmill	Pakistan	01/07/2021	1	0.	27.	0.	0.	333.51 PKR/MWh	0 PKR/MTon	1.
140	Sadiqabad	Pakistan	01/07/2021	1	0.	45.	0.	0.	333.51 PKR/MWh	0 PKR/MTon	1.
141	Gotki	Pakistan	01/07/2021	1	0.	45.	0.	0.	333.51 PKR/MWh	0 PKR/MTon	1.
146	Gawadar Coal	Pakistan	01/06/2023	1	0.	300.	0.	0.	462.108 PKR/MWh	0 PKR/MTon	1.
147	TAY	Pakistan	01/07/2021	1	0.	30.	0.	0.	333.51 PKR/MWh	0 PKR/MTon	1.
148	Alman	Pakistan	01/07/2021	1	0.	34.5	0.	0.	333.51 PKR/MWh	0 PKR/MTon	1.
149	ThalIndus	Pakistan	01/07/2021	1	0.	20.	0.	0.	333.51 PKR/MWh	0 PKR/MTon	1.
150	RaniPur	Pakistan	01/07/2021	1	0.	60.	0.	0.	333.51 PKR/MWh	0 PKR/MTon	1.
151	Digri Gen	Pakistan	01/07/2021	1	0.	25.	0.	0.	333.51 PKR/MWh	0 PKR/MTon	1.
152	Popular	Pakistan	01/07/2021	1	0.	30.	0.	0.	333.51 PKR/MWh	0 PKR/MTon	1.

Figure 14 SDDP-Thermal Plant-Modification

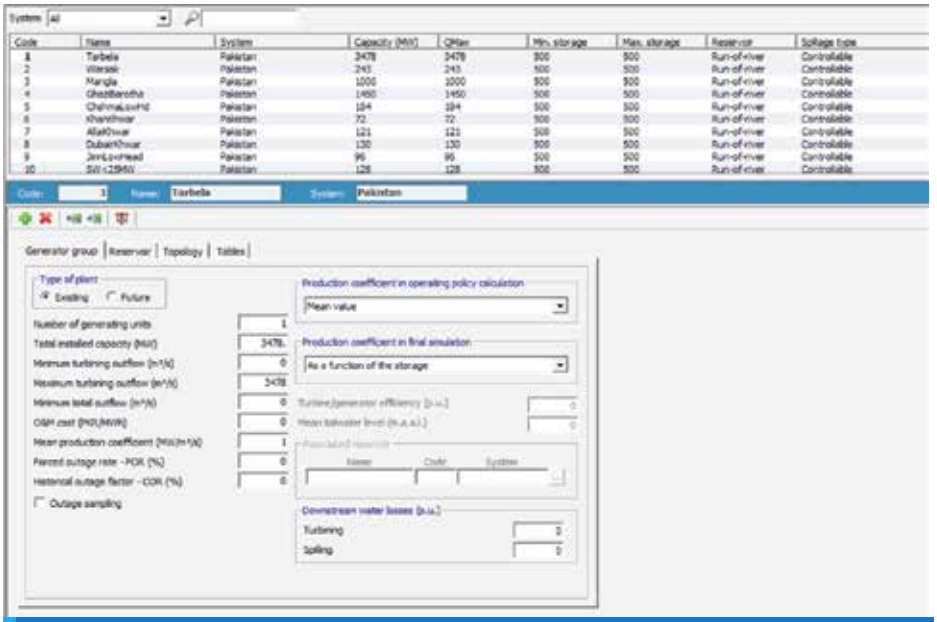
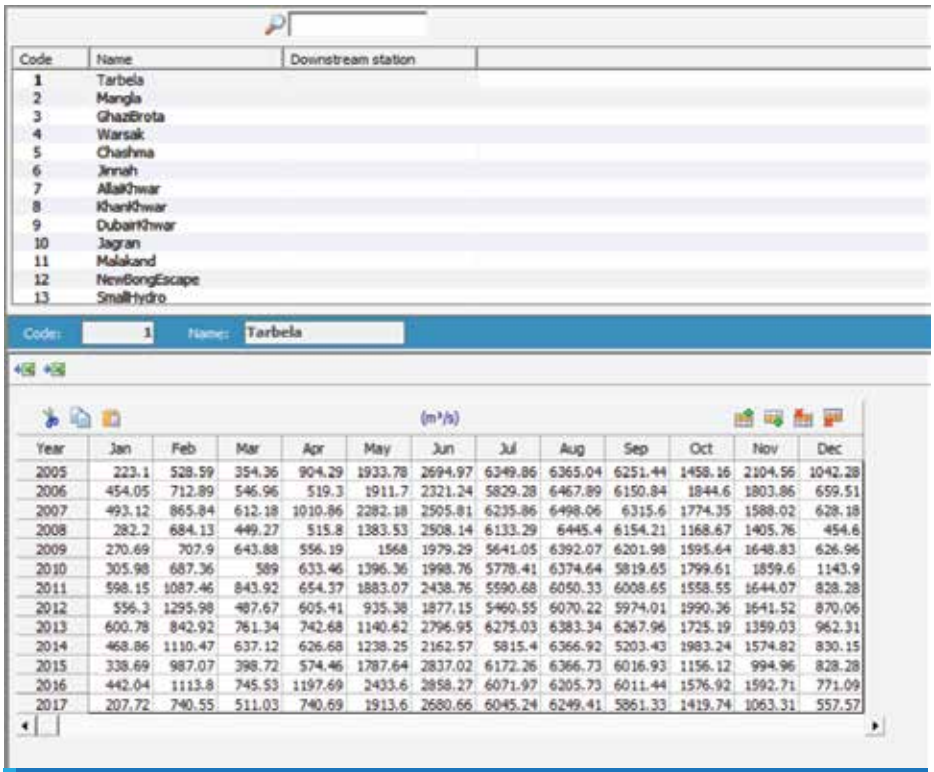


Figure 15 SDDP-Hydel Plants Configuration



Code	Name	Downstream station
1	Tarbela	
2	Mangla	
3	GhazBrota	
4	Warsak	
5	Chashma	
6	Jinnah	
7	AllaiKhwar	
8	KhanKhwar	
9	DubairKhwar	
10	Jagran	
11	Malakand	
12	NewBongEscape	
13	SmallHydro	

Code: 1 Name: Tarbela

(m³/s)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2005	223.1	528.59	354.36	904.29	1933.78	2694.97	6349.86	6365.04	6251.44	1458.16	2104.56	1042.28
2006	454.05	712.89	546.96	519.3	1911.7	2321.24	5829.28	6467.89	6150.84	1844.6	1803.86	659.51
2007	493.12	865.84	612.18	1010.86	2282.18	2505.81	6235.86	6498.06	6315.6	1774.35	1588.02	628.18
2008	282.2	684.13	449.27	515.8	1383.53	2508.14	6133.29	6445.4	6154.21	1168.67	1405.76	454.6
2009	270.69	707.9	643.88	556.19	1568	1979.29	5641.05	6392.07	6201.98	1595.64	1648.83	626.96
2010	305.98	687.36	589	633.46	1396.36	1998.76	5778.41	6374.64	5819.65	1799.61	1859.6	1143.9
2011	598.15	1087.46	843.92	654.37	1883.07	2438.76	5590.68	6050.33	6008.65	1558.55	1644.07	828.28
2012	556.3	1295.98	487.67	605.41	935.38	1877.15	5460.55	6070.22	5974.01	1990.36	1641.52	870.06
2013	600.78	842.92	761.34	742.68	1140.62	2796.95	6275.03	6383.34	6267.96	1725.19	1359.03	962.31
2014	468.86	1110.47	637.12	626.68	1238.25	2162.57	5815.4	6366.92	5203.43	1983.24	1574.82	830.15
2015	338.69	987.07	398.72	574.46	1787.64	2837.02	6172.26	6366.73	6016.93	1156.12	994.96	828.28
2016	442.04	1113.8	745.53	1197.69	2433.6	2858.27	6071.97	6205.73	6011.44	1576.92	1592.71	771.09
2017	207.72	740.55	511.03	740.69	1913.6	2680.66	6045.24	6249.41	5861.33	1419.74	1063.31	557.57

Figure 16 SDDP-Hydel Inflows

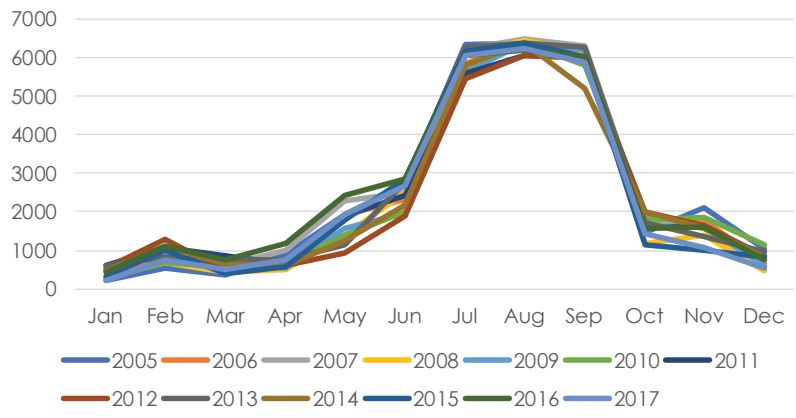


Figure 17 Historical Inflows

HYDROLGY

Hydrology is the flow of water within the system. SDDP has a profound way to model hydrology in a certain system and has the capability to stochastically forecast the future data in the light of past year hydrological profiles. The hydrological data is segregated under three sub-groups;

1. *Inflows*
2. *Reduced Uncertainty*
3. *Parameters Estimation*

In SDDP, the standard gauging stations has been defined and the historical inflow of each gauging station has been populated. The figure 17 placed below shows the hydrology flow mapped for one of the gauging stations defined in the SDDP.

The typical graph of the variation of hydrology mapped in the model has been depicted as under:

III. RENWEABLE PLANTS CONFIGURATION

Renewable plants in the SDDP.SDDP does have the option to model renewable generation as well. Renewables have been inherently defined as Must-Run in SDDP. Therefore, for each block of stage, the generation of renewables are subtracted from the energy demand and only the differential quantum is subjected to optimum hydro-thermal dispatch

RENWABLE STATIONS

The first step in renewable generation modelling is defining the renewable zones i.e. stations or sites at which multiple renewable power plants are installed. Accordingly, standard renewable stations have been defined for wind and solar plants based upon the annual capacity factor established in the tariff determination.

RENWABLE PROFILING MODULE

Renewable source profiling is done outside SDDP for mapping them into block wise data. This can be done via MATLAB, excel etc. The purpose of this module is the generation of block wise profile for renewable generation i.e. Wind and solar which is then fed into SDDP-module. The detailed working procedure for renewable profiling is explained below:

PROCEDURE

1. In the first step, the hourly generation data for respective renewable station is fetched from data base for a corresponding month.
2. This hourly data is then matched with the chronological demand data sorted from highest demand to lowest demand so to have corresponding generation of renewables for the specific block.
3. Following the match of the renewable generation profile with the corresponding demand profile, both are mapped to the 21 blocks.
4. Generation of corresponding hours in a block is averaged out to get the average availability during that block.
5. The same procedure is repeated for each month separately and this blocked data is compiled in a standardized format which is compatible with SDDP-module.
6. It is to be noted that the annual renewable generation profiling has been assumed to be same for the future years for the given plant factor.

Standard generation profiles of some renewable generator has been appended below for reference.

- Installed Capacity (Total capacity of plant)
- Operation Factor
- O&M Costs under this field, the cost of variable operation and maintenance cost associated with respective plant is inserted.
- Type: This filed defines the status of plant i.e. existing or future.

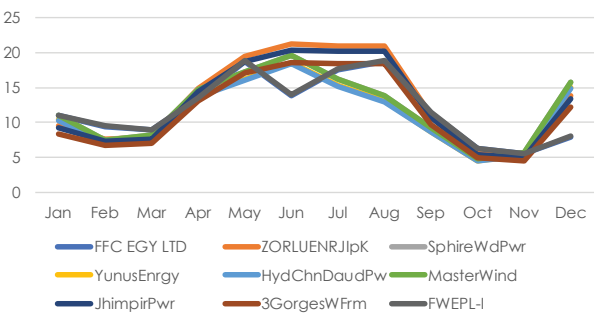


Figure 18 Renewable Generation

C. FUEL CONFIGURATIONS

Type of fuels for the system are defined under the FUEL DATA Tab available under basic Data. The fuels are specified using units defined by the users and their corresponding cost (Currency/Unit). The standard fuels defined in SDDP has been appended below with reference rates mention in the figure.

It is pertinent to mention here that these rates are for the reference purposes and the modification have been in the "Fuel Price" to project the monthly prices of fuel for dispatch purposes.

FUEL CONTRACT CONFIGURATION

SDDP is equipped with the provision to model fuel contracts. This is very import feature that has been employed in the dispatch model. Currently, there exists minimum energy take-or-pay contracts for RLNG and imported coal in the power sector of Pakistan. The minimum take-or-pay energy contract for RLNG is 66 % while for imported coal, this percentage has been locked at 50 % in the fuel supply agreement. Accordingly, these contracts have been modelled in the Fuel Contract Configuration. It is pertinent to mention here that these Fuel contracts establish the minimum dispatch that has to be considered for the generator linked with the fuel contracts. Any dispatch beyond the minimum dispatch is subject to the merit order so to minimize the overall objective function (Cost). Moreover, optimal dispatch of SDDP doesn't always result in the complete consumption of the assigned fuel contracts. In fact the criteria is to yield an eventual constellation that minimizes the overall cost function.

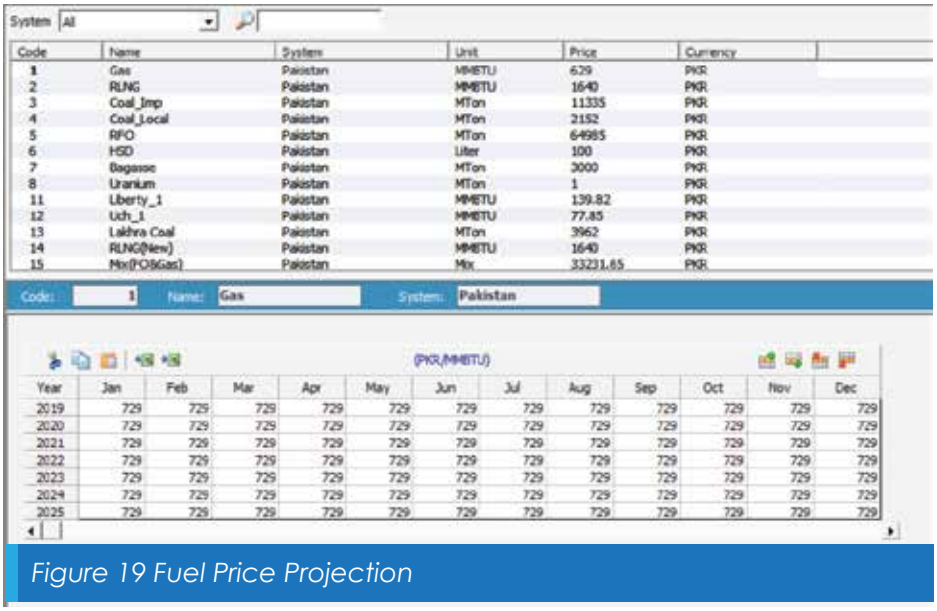


Figure 19 Fuel Price Projection

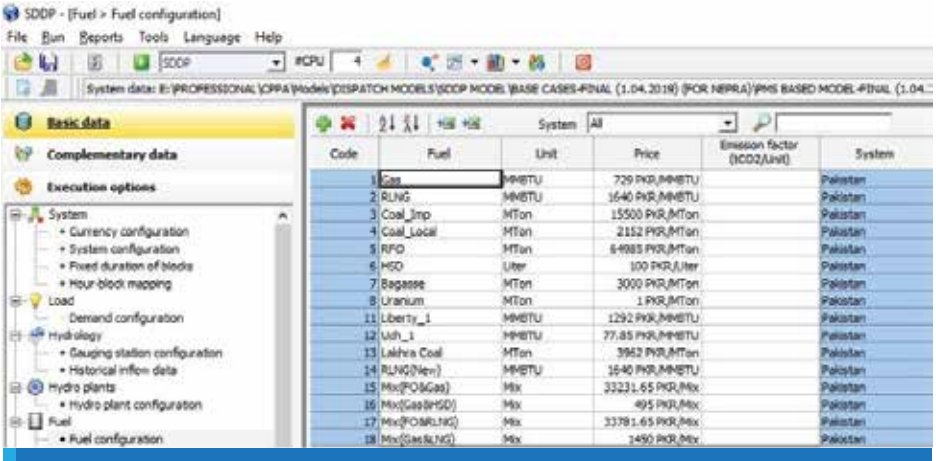


Figure 20 SDDP Fuel Configuration

D. TRANSMISSION DATA CONFIGURATIONS

Transmission network data can be modelled in this tool in an effective way. For solving Transmission networks, DC optimal power flow (OPF) has been employed to impact the overall objective function as a function of dispatch.
The 500 KV and 220 KV Transmission network has been modelled and where applicable, generation connected at 132 KV network has also been modelled. The converged case of PSSE has been used for modelling transmission network in the model. The following step wise approach was used in modelling transmission network.

BUS CONFIGURATION---

The first step in modelling transmission network is defining the buses in the network. Further, the generating stations have been mapped onto the respective buses as per the physical model of the power system.

LOAD PER BUS CONFIGURATION

load per bus corresponds to the distribution of demand across the whole network. Following definition of all buses, load connected with respective bus was defined in in a block manner. The participation factors for each bus are calculated on the basis of distribution of demand on each bus. The Load per bus data for some typical buses that are accommodated in the model is shown in the figure below.

This Load per bus data for all the buses reflected in 21 blocks is inputted in load per bus configuration tab under complementary data tab:

CIRCUIT DATA

Having defined the buses on the basis of generation and attached load on them, the critical part that comes is the circuit modelling i.e. the interconnection of buses. The Circuits are specified on the basis of Reactance %, Resistance %, Flow Limits (MW), operative states and AC Flow modelling parameters as well. The same has been modelled in the SDDP based on the available data from PSSE.

For modelling Pakistan's Power system, there is a total of 203 buses defined up to 132kv voltage level and a total of 419 circuit elements on the basis of which SDDP runs linear power flow model.

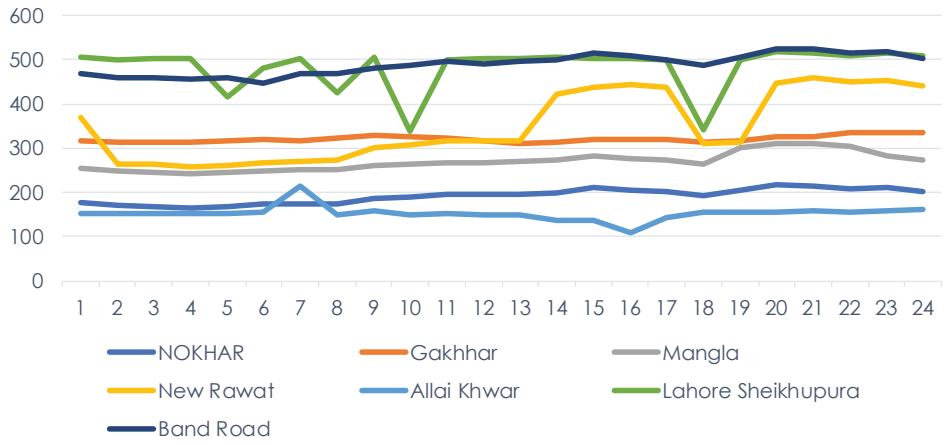


Figure 21 Load per BUS Data (MW)

E. SYSTEM DATA CONFIGURATIONS

System specifies the target study area for which the Dispatch needs to be optimized considering for the parameters like demand, Transmission network, Generation in that system. The system named "Pakistan" has been modelled for optimization purposes and the currency of Pakistani Rupee "PKR" has been used.

SYSTEM & CURRENCY CONFIGURATIONS

Basic sets of inputs, for defining a system is the name, identifier and currency for that system. It is defined under the basic data tab. For the case of Pakistan, we have named the system as Pakistan and the identifier is pk and the currency define for our system is PKR (Pakistani Rupee). All the calculations, Input data for generations, Fuel costs are entered in the same currency.

5.2.2 OUTPUTS

All the detailed results of the model SDDP are written to *. csv format files. These files are managed by a graphic interface available at the taskbar of the tool which produces Excel files with the desired result. The outputs of the Dispatch results of SDDP in the *.Csv files has been interfaced with the standard database and capacity purchase price model for projecting the PPP references for each month as already explained in chapter 2.

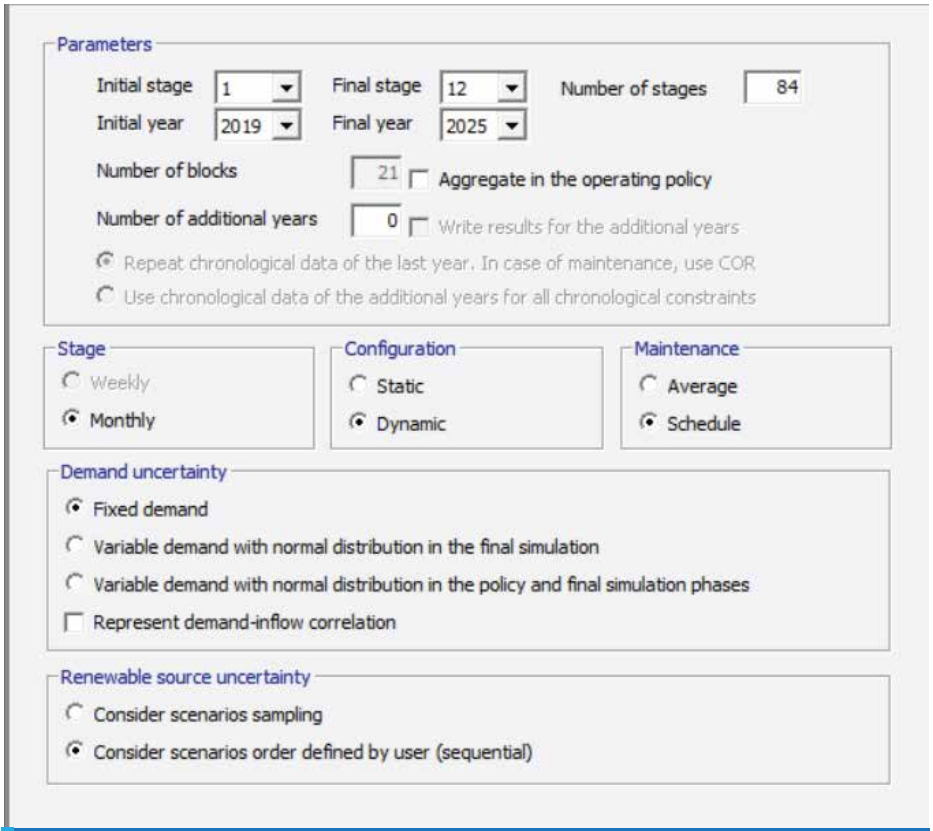


Figure 22 SDDP System Configuration

06

Capacity Purchase Price (CPP)

6.1 CPP FOR EXISTING GENERATION PLANTS

6.2 CPP FOR FUTURE GENERATION

6 CAPACITY PURCHASE PRICE

The capacity purchase price is major component of the cost in the prevailing regime of power sector which is comprised of fixed O&M, Return on Equity, debt servicing components etc. of the respective generators. During the past years CPP comprised 30% of total PPP but due to addition of large capacity in the system and front-loaded tariff structure prevailing in the country, the CPP has increased from 664 billion to 907 billion thus causing an increase in per unit CPP by more than 1.5 Rs/kWh.

The Capacity Purchase Price for the sake of this report has been further categorized as the capacity for the existing plants and the estimated capacity for the future plants.

	Months	CPP (Mln Rs.)	CPP (Rs/kWh)
FY (2019-20)	Jul	67,143	4.58
	Aug	72,365	4.87
	Sep	80,711	5.93
	Oct	77,182	7.43
	Nov	76,451	8.96
	Dec	75,076	8.60
	Jan	74,147	8.24
	Feb	74,647	9.45
	Mar	77,134	7.85
	Apr	77,207	6.84
	May	77,064	5.81
	Jun	78,045	5.61
	Total	**907,174**	**6.67**

Table 7 Monthly Capacity Purchase Price

**At Wholesale level, excluding Transmission losses*

6.1 CPP FOR EXISTING GENERATION PLANTS

CPP for the existing plants is the price calculated on the basis of NERPA determined tariff for each generation utility. The only applicable components have been accounted for in the formulation of CPP for each generator. The references CPP of each generation utility has been indexed for the dollar parity, CPI, Libor/Kibor etc. (whichever is applicable).

6.2 CPP FOR FUTURE GENERATION PLANTS

For the future plants that have not achieved commercial operations, the reference tariff of NEPRA has been taken as reference where available. For the power plants that have not being granted tariff from Authority, the reference tariff for the similar/comparable technologies has been assumed for the computation of CPP.

REFERENCES FOR EVALUATION OF CPP:

The following values of different components have been used for the evaluation of the indexed capacity for the study horizon.

Parameter	Value
Exchange Rate (US$)	150
US-CPI	255.09
Local CPI	242.48
LIBOR	3.64%
KIBOR	12%

Table 8 Assumptions

07

Power Purchase Price (PPP)

7.1 CASE 1: PPP PROJECTIONS (FY 2019-20) (WITH TRANSMISSION CONSTRAINTS)

7.2 CASE2: PPP PROJECTIONS FY (2019-20) (WITHOUT TRANSMISSION CONSTRAINTS)

7.3. CASE3: PPP PROJECTIONS FY (2019-25)

7 POWER PURCHASE PRICE (PPP)

This chapter explains the various scenarios that have been considered in the evaluation of PPP and the results of each scenario has been placed in the respective section.

It is pertinent to mention here that the per unit rate of Capacity Purchase Price (CPP) decreases with increase in volume while Per Unit Energy Purchase Price (EPP) increases with increase in volume used. Hence the number of units generated and transmitted for distribution to end consumer are very important as it has its implications on the end consumer tariffs. The electricity supply to end consumers is a regulated business, thus affordability and sustainability of supply to meet demand must be ensured which is further dependent upon many factors including:

a. *Availability of transmission network*
b. *Availability of distribution network*
c. *Commercial viability for supply to specific area of region*

SCENARIOS FOR PPP FORMUALATION:

The PPP Projections have been developed on the basis of three scenarios which has further been segregated based on the demand projections. It is pertinent to mention that each of the below mentioned cases has been mapped onto uniform scenarios of fuel price projections:

a. PPP Projections (FY 2019-20) (With Transmission Constraints)

i. PMS based Demand Projections (Scenario-1 of Chapter 3);
ii. Actual Demand based projec tions (Scenario-2 of Chapter 3);

b. PPP Projections (FY-2019-20) (W/O Transmission Constraints)

i. PMS based Demand Projections (Scenario-1 of Chapter 3);
ii. Actual Demand based projections (Scenario-2 of Chapter 3);

c. PPP Projections (FY 2019-25)

7.1 CASE 1: PPP PROJECTIONS (FY 2019-20) (WITH TRANSMISSION CONSTRAINTS)

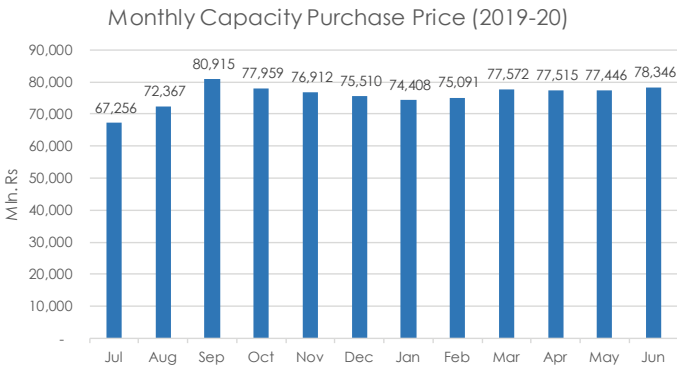
This scenario has been developed based on the practical realties, on the note of transmission constraints coupled with two demand scenarios explained above. As explained in precious sections, transmission network congestions result in dispatch of expensive generators while cheap generation remains idle owing to said constraints, thus increasing the overall energy Purchase Price for the system. This is captured via modelling Transmission Network of Pakistan in SDDP that depicts real-world constrained dispatch for the formulation of EPP. As described in the previous section, SDDP does DC Flow Analysis therefore its primary focus is the Demand supply Balance, not MVAR compensation, voltage Regulations etc. while in the physical system, there are generators who are dispatched only to regulate the Voltage level. In order to accurately predict the EPP of each month, the monthly fuel price projections have been assumed for the both scenarios. This Case has been segregated further on the basis of Demand Projections:

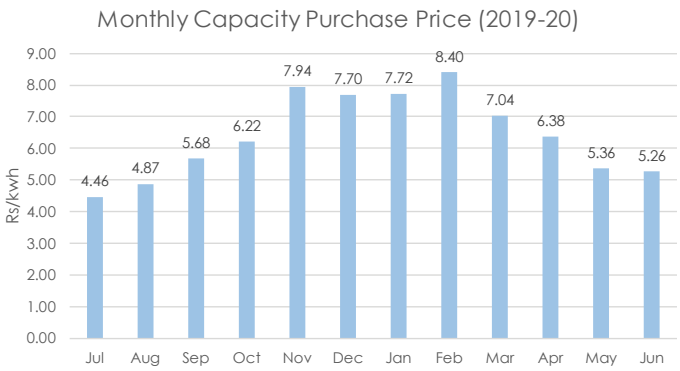
I) PMS BASED DEMAND PROJECTION:

Under this scenario, Capacity Purchase Price and Energy Purchase Price for the System have been formulated on the basis of demand numbers taken from PMS based results for the System. It is pertinent to mention here that the generation of 154,559 GWh (to meet the load requirements) could not be achieved with the existing transmission network as modelled in the SDDP tool for the FY 2019-20. Accordingly, the case has been modelled and the references have been established on the basis of the generation of 147,316 GWh. The Energy Mix and the Monthly references for the system with the said scenario have been appended in this section.

MONTHLY CAPACITY PURCHASE PRICE PROJECTIONS:

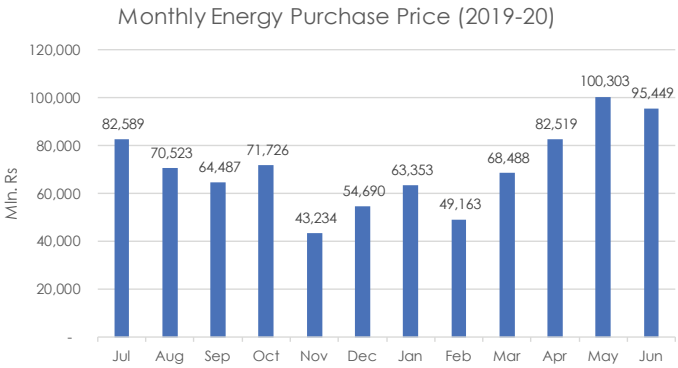
The CPP is distributed at uniform rate throughout the study period, except for month of August cause of addition of some Plants into the national grid.

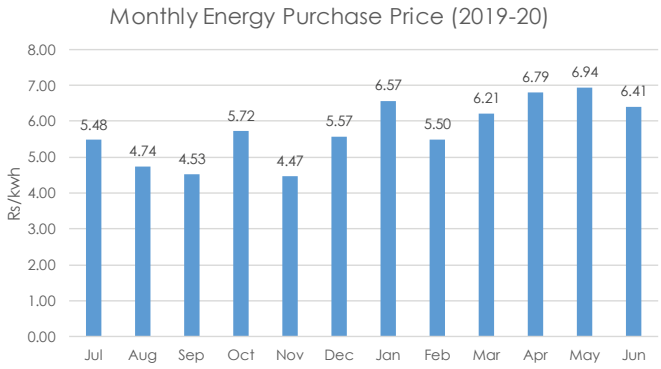




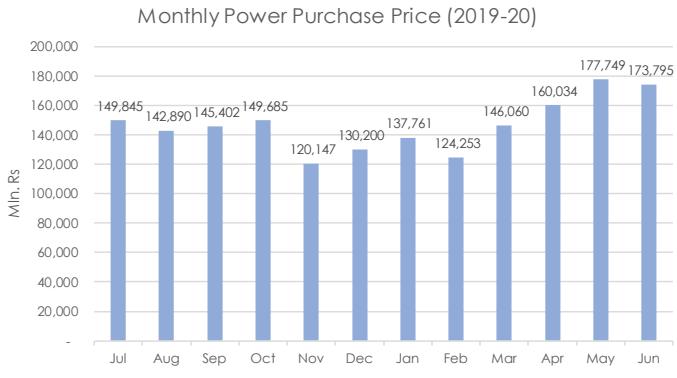
MONTHLY ENERGY PURCHASE PRICE PORJECTIONS:

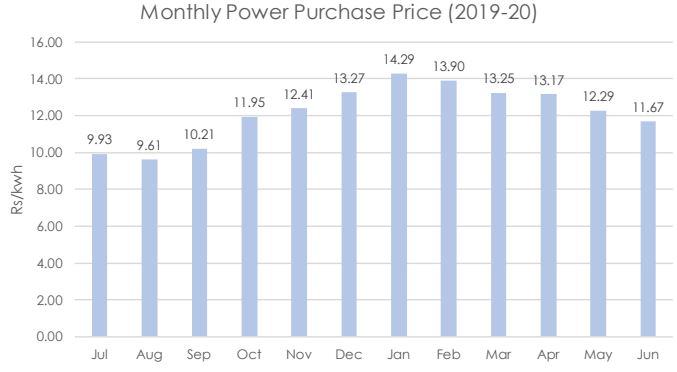
It can be clearly seen that during peak months for Jun-august, EPP is comparative-ly higher as compared to other months owing to the increased demand trends, Transmission network congestions as well as the dispatch of expensive generators.



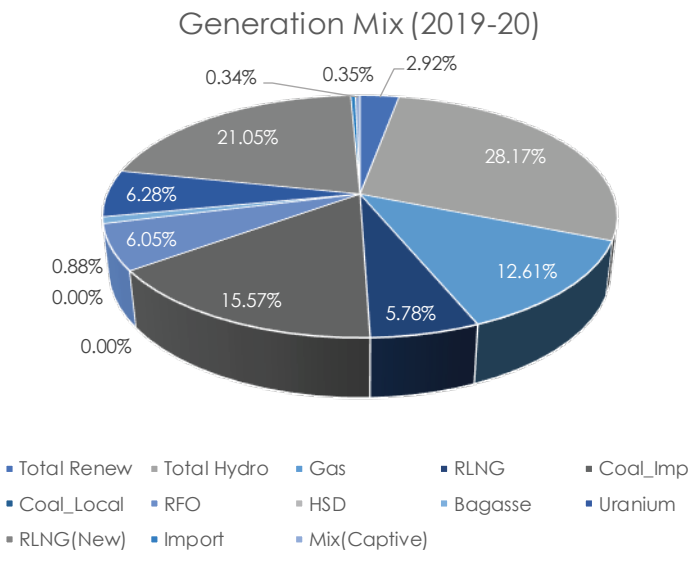


MONTHLY POWER PURCHASE PRICE PROJECTIONS:





GENERATION MIX:



MONTHLY REFERENCES:

The Monthly Fuel Price references for the (FY-2019-20) is placed as under:

JULY 2019-20

Projected Generation Mix(Technology)
July 2019-20

Code	Power Producer	Energy	Energy Charges	Energy Charges O&M	Energy Charges Fuel	Energy Charges O&M	Total
		GWh	Rs. /kWh	Rs. /kWh	Mln. Rs.	Mln. Rs.	
	Fuel						
1	Hydel	5,871			-	1,097.03	1,097
2	Coal	1,616	6.49	0.48	10,483.75	774.08	11,258
3	HSD	-	-	-	-	-	-
4	F.O.	1,235	13.58	0.88	16,774.76	1,082.94	17,858
5	Gas	1,312	4.49	0.68	5,884.95	890.31	6,775
6	Nuclear	768	1.02	0.08	785.28	59.19	844
7	Mixed	31	10.00	-	310.00	-	310
8	Import from Iran	43	6.11	-	262.52	-	263
9	Wind Power	439			-	-	-
10	Bagasse	-	-	-	-	-	-
11	Solar	29			-	-	-
12	RLNG	3,738	11.30	0.52	42,224.02	1,960.22	44,184
	Grand Total	**15,082**	**5.09**	**0.39**	**76,725.28**	**5,863.78**	**82,589**
	NTDC Losses	409					
	Net Delivered as p	14,673	5.2289	0.3996	76,725	5,864	82,589
	%	**2.71%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**

AUGUST 2019-20

Projected Generation Mix(Technology)
August 2019-20

Code	Power Producer Fuel	Energy	Energy Charges	Energy Charges O&M	Energy Charges Fuel	Energy Charges O&M	Total
		GWh	Rs. /kWh	Rs. /kWh	Mln. Rs.	Mln. Rs.	
	Fuel						
1	Hydel	5,910			-	1,092.01	1,092
2	Coal	1,886	6.72	0.48	12,674.37	898.15	13,573
3	HSD	-	-	-	-	-	-
4	F.O.	436	13.62	1.29	5,936.39	563.27	6,500
5	Gas	1,339	4.50	0.66	6,031.64	884.33	6,916
6	Nuclear	707	1.01	0.08	717.03	55.77	773
7	Mixed	32	10.00	-	320.00	-	320
8	Import from Iran	49	6.11	-	299.15	-	299
9	Wind Power	426			-	-	-
10	Bagasse	-	-	-	-	-	-
11	Solar	55			-	-	-
12	RLNG	4,023	9.77	0.44	39,297.32	1,753.67	41,051
	Grand Total	**14,863**	**4.39**	**0.35**	**65,275.89**	**5,247.21**	**70,523**
	NTDC Losses	403					
	Net Delivered as per (	14,460	4.5142	0.3629	65,276	5,247	70,523
	%	**2.71%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**

SEPTEMBER 2019-20

Projected Generation Mix(Technology)
September 2019-20

Code	Power Producer	Energy	Energy Charges	Energy Charges O&M	Energy Charges Fuel	Energy Charges O&M	Total
		GWh	Rs. /kWh	Rs. /kWh	Mln. Rs.	Mln. Rs.	
	Fuel						
1	Hydel	5,821			-	925.76	926
2	Coal	1,744	6.67	0.48	11,636.60	832.08	12,469
3	HSD	-	-	-	-	-	-
4	F.O.	523	14.57	0.89	7,620.11	465.42	8,086
5	Gas	1,291	4.44	0.67	5,726.91	864.92	6,592
6	Nuclear	897	1.04	0.07	932.69	65.93	999
7	Mixed	39	10.00	-	390.00	-	390
8	Import from Iran	46	6.11	-	280.83	-	281
9	Wind Power	248			-	-	-
10	Bagasse	-	-	-	-	-	-
11	Solar	113			-	-	-
12	RLNG	3,519	9.44	0.44	33,207.96	1,537.41	34,745
	Grand Total	**14,241**	**4.20**	**0.33**	**59,795.11**	**4,691.51**	**64,487**
	NTDC Losses	386					
	Net Delivered as p	13,855	4.3158	0.3386	59,795	4,692	64,487
	%	**2.71%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**

OCTOBER 2019-20

Projected Generation Mix(Technology)
October 2019-20

Code	Power Producer Fuel	Energy	Energy Charges	Energy Charges O&M	Energy Charges Fuel	Energy Charges O&M	Total
		GWh	Rs. /kWh	Rs. /kWh	Mln. Rs.	Mln. Rs.	
	Fuel						
1	Hydel	3,571			-	539.09	539
2	Coal	1,848	6.69	0.48	12,362.81	881.48	13,244
3	HSD	-	-	-	-	-	-
4	F.O.	673	14.75	0.77	9,928.92	515.75	10,445
5	Gas	1,775	5.53	0.45	9,821.76	795.14	10,617
6	Nuclear	927	1.04	0.07	963.78	68.13	1,032
7	Mixed	37	10.00	-	370.00	-	370
8	Import from Iran	45	6.11	-	274.73	-	275
9	Wind Power	124			-	-	-
10	Bagasse	-	-	-	-	-	-
11	Solar	31			-	-	-
12	RLNG	3,500	9.61	0.45	33,621.21	1,583.32	35,205
	Grand Total	**12,531**	**5.37**	**0.35**	**67,343.22**	**4,382.90**	**71,726**
	NTDC Losses	340					
	Net Delivered as per (	12,191	5.5238	0.3595	67,343	4,383	71,726
	%	**2.71%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**

NOVEMBER 2019-20

Projected Generation Mix(Technology)
November 2019-20

Code	Power Producer	Energy	Energy Charges	Energy Charges O&M	Energy Charges Fuel	Energy Charges O&M	Total
		GWh	Rs. /kWh	Rs. /kWh	Mln. Rs.	Mln. Rs.	
	Fuel						
1	Hydel	3,060			-	413.21	413
2	Coal	2,151	6.93	0.47	14,909.89	1,019.88	15,930
3	HSD	-	-	-	-	-	-
4	F.O.	298	12.79	0.87	3,811.72	259.17	4,071
5	Gas	1,058	4.51	0.65	4,772.00	687.22	5,459
6	Nuclear	854	1.04	0.07	887.79	60.38	948
7	Mixed	32			320.00	-	320
8	Import from Iran	38			231.99	-	232
9	Wind Power	131			-	-	-
10	Bagasse	214	5.71	0.70	1,222.10	149.63	1,372
11	Solar	105			-	-	-
12	RLNG	1,742	7.94	0.38	13,828.08	661.44	14,490
	Grand Total	**9,683**	**4.13**	**0.34**	**39,983.57**	**3,250.92**	**43,234**
	NTDC Losses	262					
	Net Delivered as p	9,421	4.2443	0.3451	39,984	3,251	43,234
	%	**2.71%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**

DECEMBER 2019-20

Projected Generation Mix(Technology)
December 2019-20

Code	Power Producer Fuel	Energy	Energy Charges	Energy Charges O&M	Energy Charges Fuel	Energy Charges O&M	Total
		GWh	Rs. /kWh	Rs. /kWh	Mln. Rs.	Mln. Rs.	
	Fuel						
1	Hydel	2,169			-	310.40	310
2	Coal	2,139	7.06	0.47	15,090.73	1,011.27	16,102
3	HSD	-	-	-	-	-	-
4	F.O.	255	12.65	0.93	3,224.95	236.96	3,462
5	Gas	465	2.79	0.98	1,298.13	457.79	1,756
6	Nuclear	703	1.04	0.06	731.73	39.43	771
7	Mixed	47			470.00	-	470
8	Import from Iran	35			213.68	-	214
9	Wind Power	327			-	-	-
10	Bagasse	222	5.72	0.70	1,269.18	155.39	1,425
11	Solar	24			-	-	-
12	RLNG	3,426	8.40	0.41	28,775.23	1,405.02	30,180
	Grand Total	**9,812**	**5.21**	**0.37**	**51,073.62**	**3,616.26**	**54,690**
	NTDC Losses	266					
	Net Delivered as per (	9,546	5.3502	0.3788	51,074	3,616	54,690
	%	**2.71%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**

Projected Generation Mix(Technology)
January 2019-20

Code	Power Producer	Energy	Energy Charges	Energy Charges O&M	Energy Charges Fuel	Energy Charges O&M	Total
		GWh	Rs. /kWh	Rs. /kWh	Mln. Rs.	Mln. Rs.	
	Fuel						
1	Hydel	1,105			-	215.80	216
2	Coal	2,155	6.93	0.47	14,943.95	1,021.59	15,966
3	HSD	-	-	-	-	-	-
4	F.O.	319	12.76	0.90	4,070.64	285.88	4,357
5	Gas	1,818	5.15	0.54	9,365.89	976.41	10,342
6	Nuclear	927	1.04	0.07	963.78	68.13	1,032
7	Mixed	52	10.00		520.00	-	520
8	Import from Iran	36	6.11		219.78	-	220
9	Wind Power	240			-	-	-
10	Bagasse	222	5.72	0.70	1,269.18	155.39	1,425
11	Solar	30			-	-	-
12	RLNG	2,734	10.21	0.50	27,915.75	1,360.35	29,276
	Grand Total	**9,638**	**6.15**	**0.42**	**59,268.97**	**4,083.54**	**63,353**
	NTDC Losses	261					
	Net Delivered as p	9,377	6.3208	0.4355	59,269	4,084	63,353
	%	**2.71%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**

JANUARY 2019-20

Projected Generation Mix(Technology)
February 2019-20

Code	Power Producer Fuel	Energy	Energy Charges	Energy Charges O&M	Energy Charges Fuel	Energy Charges O&M	Total
		GWh	Rs. /kWh	Rs. /kWh	Mln. Rs.	Mln. Rs.	
	Fuel						
1	Hydel	1,935			-	310.92	311
2	Coal	2,084	7.01	0.47	14,604.16	986.67	15,591
3	HSD	-	-	-	-	-	-
4	F.O.	384	12.71	0.87	4,879.67	335.12	5,215
5	Gas	1,603	4.98	0.56	7,983.16	903.95	8,887
6	Nuclear	837	1.04	0.07	870.51	61.53	932
7	Mixed	49	10.00		490.00	-	490
8	Import from Iran	34	6.11		207.57	-	208
9	Wind Power	183			-	-	-
10	Bagasse	200	5.73	0.70	1,146.36	140.35	1,287
11	Solar	108			-	-	-
12	RLNG	1,524	10.18	0.48	15,507.86	734.76	16,243
	Grand Total	**8,941**	**5.11**	**0.39**	**45,689.28**	**3,473.30**	**49,163**
	NTDC Losses	242					
	Net Delivered as per (	8,699	5.2524	0.3993	45,689	3,473	49,163
	%	**2.71%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**

FEBRUARY 2019-20

MARCH 2019-20

Projected Generation Mix(Technology)
March 2019-20

Code	Power Producer	Energy	Energy Charges	Energy Charges O&M	Energy Charges Fuel	Energy Charges O&M	Total
		GWh	Rs. /kWh	Rs. /kWh	Mln. Rs.	Mln. Rs.	
	Fuel						
1	Hydel	2,157			-	534.41	534
2	Coal	2,114	6.99	0.47	14,777.92	1,000.62	15,779
3	HSD	-	-	-	-	-	-
4	F.O.	493	12.90	0.94	6,360.32	464.33	6,825
5	Gas	1,900	5.27	0.52	10,003.98	990.31	10,994
6	Nuclear	927	1.04	0.07	963.78	68.13	1,032
7	Mixed	60			600.00	-	600
8	Import from Iran	40			244.20	-	244
9	Wind Power	196			-	-	-
10	Bagasse	222	5.72	0.70	1,269.18	155.39	1,425
11	Solar	24			-	-	-
12	RLNG	2,894	10.23	0.50	29,618.28	1,436.82	31,055
	Grand Total	**11,027**	**5.79**	**0.42**	**63,837.66**	**4,650.00**	**68,488**
	NTDC Losses	299					
	Net Delivered as p	10,728	5.9505	0.4334	63,838	4,650	68,488
	%	**2.71%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**

APRIL 2019-20

Projected Generation Mix(Technology)
April 2019-20

Code	Power Producer Fuel	Energy	Energy Charges	Energy Charges O&M	Energy Charges Fuel	Energy Charges O&M	Total
		GWh	Rs. /kWh	Rs. /kWh	Mln. Rs.	Mln. Rs.	
	Fuel						
1	Hydel	2,328			-	777.14	777
2	Coal	1,865	6.76	0.48	12,616.14	887.27	13,503
3	HSD	-	-	-	-	-	-
4	F.O.	975	12.88	1.02	12,557.43	995.81	13,553
5	Gas	1,668	5.23	0.53	8,723.26	879.20	9,602
6	Nuclear	686	1.03	0.08	707.52	54.10	762
7	Mixed	44			440.00	-	440
8	Import from Iran	47			286.94	-	287
9	Wind Power	338			-	-	-
10	Bagasse	215	5.71	0.70	1,228.24	150.38	1,379
11	Solar	110			-	-	-
12	RLNG	3,876	10.39	0.50	40,290.68	1,924.93	42,216
	Grand Total	**12,152**	**6.32**	**0.47**	**76,850.20**	**5,668.83**	**82,519**
	NTDC Losses	329					
	Net Delivered as per (	11,823	6.5003	0.4795	76,850	5,669	82,519
	%	**2.71%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**

Projected Generation Mix(Technology)
May 2019-20

Code	Power Producer	Energy	Energy Charges	Energy Charges O&M	Energy Charges Fuel	Energy Charges O&M	Total
		GWh	Rs. /kWh	Rs. /kWh	Mln. Rs.	Mln. Rs.	
	Fuel						
1	Hydel	3,401			-	898.51	899
2	Coal	1,740	6.44	0.48	11,201.99	833.02	12,035
3	HSD	-	-	-	-	-	-
4	F.O.	1,629	12.97	1.07	21,129.92	1,746.40	22,876
5	Gas	2,217	5.64	0.50	12,502.32	1,104.41	13,607
6	Nuclear	465	1.08	0.09	501.08	42.23	543
7	Mixed	41			410.00	-	410
8	Import from Iran	52			317.46	-	317
9	Wind Power	433			-	-	-
10	Bagasse	-	-	-	-	-	-
11	Solar	28			-	-	-
12	RLNG	4,454	10.64	0.50	47,408.46	2,206.74	49,615
	Grand Total	**14,460**	**6.46**	**0.47**	**93,471.23**	**6,831.32**	**100,303**
	NTDC Losses	392					
	Net Delivered as p	14,068	6.6442	0.4856	93,471	6,831	100,303
	%	**2.71%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**

MAY 2019-20

Projected Generation Mix(Technology)
June 2019-20

Code	Power Producer Fuel	Energy	Energy Charges	Energy Charges O&M	Energy Charges Fuel	Energy Charges O&M	Total
		GWh	Rs. /kWh	Rs. /kWh	Mln. Rs.	Mln. Rs.	
	Fuel						
1	Hydel	4,164			-	895.03	895
2	Coal	1,602	6.38	0.48	10,217.66	768.19	10,986
3	HSD	-	-	-	-	-	-
4	F.O.	1,696	12.92	0.94	21,906.49	1,595.68	23,502
5	Gas	2,132	5.55	0.50	11,843.14	1,055.78	12,899
6	Nuclear	548	1.06	0.08	580.00	46.34	626
7	Mixed	41			410.00	-	410
8	Import from Iran	53			323.57	-	324
9	Wind Power	460			-	-	-
10	Bagasse	-	-	-	-	-	-
11	Solar	103			-	-	-
12	RLNG	4,087	10.72	0.49	43,811.53	1,995.88	45,807
	Grand Total	**14,886**	**5.98**	**0.43**	**89,092.39**	**6,356.91**	**95,449**
	NTDC Losses	403					
	Net Delivered as per (	14,483	6.1517	0.4389	89,092	6,357	95,449
	%	**2.71%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**

JUNE 2019-20

II) ACTUAL DEMAND BASED PROJECTION:

For THIS section, the demand numbers reflected are the actual demand numbers for year 2018 along with the actual growth rates for the past two years, as explained in Demand Forecast section above. Monthly Capacity Purchase price, Monthly Energy Purchase Price, Monthly References, Generation Mix have been attached under this section:

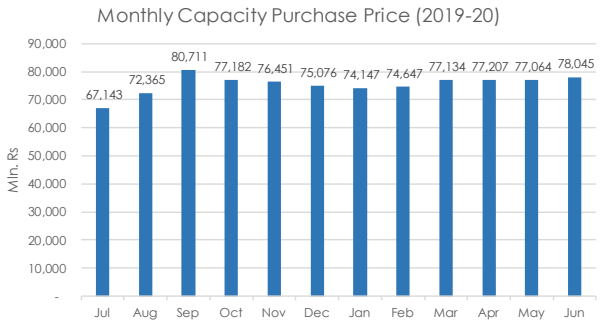
MONTHLY CAPACITY PURCHASE PRICE PROJECTIONS:

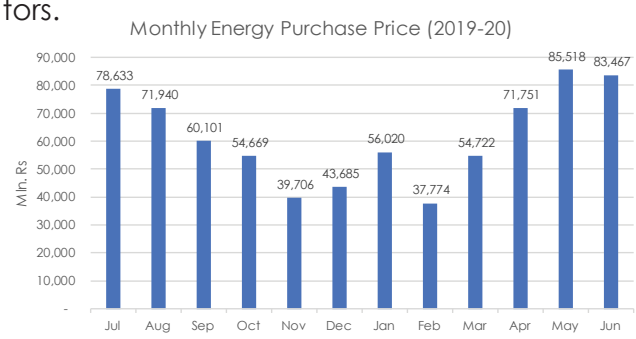
The Increase in per Unit Rate for CPP is owing to the lesser number units base i.e. lesser demand numbers as compared to PMS based Projections as can be seen from the graphs.

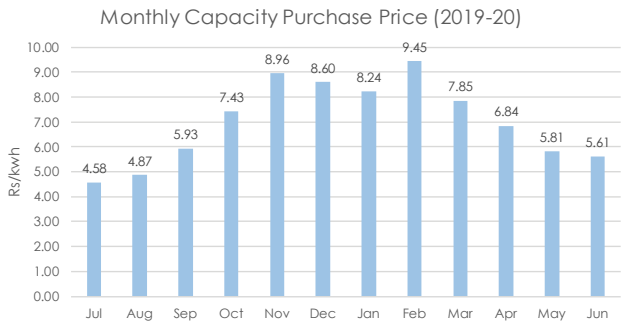
MONTHLY ENERGY PURCHASE PRICE PROJECTIONS:

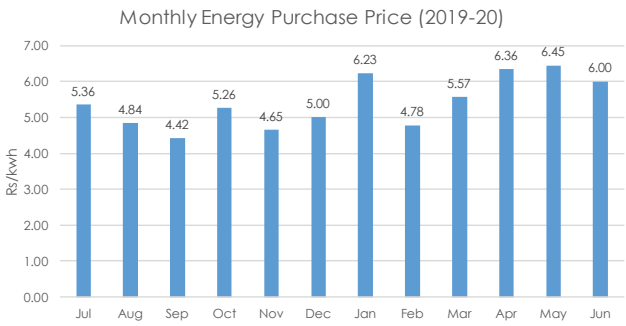
Similarly, Monthly Energy Purchase Price for the system is:

It can be clearly seen that during peak months for Jun-Aug, EPP is comparatively higher as compared to other months owing to the increased demand trends. Further as this a transmission constrained scenario, therefore EPP is slightly higher because of dispatch of expensive generators.

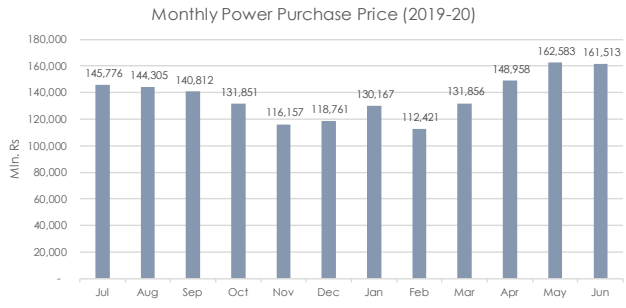


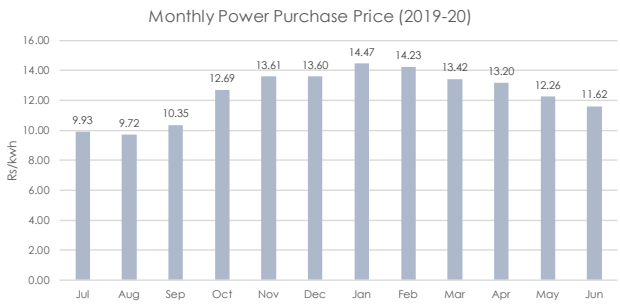




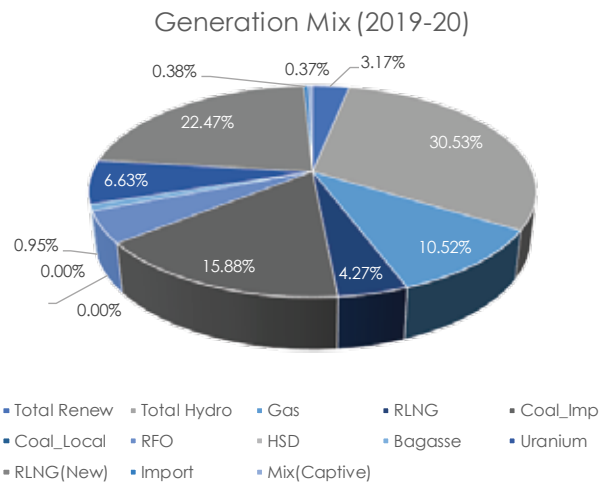


MONTHLY POWER PURCHASE PRICE PROJECTIONS:





GENERATION MIX:



MONTHLY REFERENCES:

The Monthly Fuel Price references for the (FY-2019-20) is placed as under:

Projected Generation Mix(Technology)
July 2019-20

Code	Power Producer	Energy	Energy Charges	Energy Charges O&M	Energy Charges Fuel	Energy Charges O&M	Total
		GWh	Rs. /kWh	Rs. /kWh	Mln. Rs.	Mln. Rs.	
	Fuel						
1	Hydel	5,876			-	1,098.17	1,098.17
2	Coal	1,694	6.57	0.48	11,122.61	809.86	11,932.46
3	HSD	-	-	-	-	-	-
4	F.O.	1,148	13.46	0.92	15,452.45	1,054.53	16,506.98
5	Gas	933	3.90	0.76	3,636.95	711.64	4,348.59
6	Nuclear	768	1.02	0.08	785.28	59.19	844.47
7	Mixed	31	10.00	-	310.00	-	310.00
8	Import from Iran	43	6.11	-	262.52	-	262.52
9	Wind Power	427			-	-	-
10	Bagasse	-	-	-	-	-	-
11	Solar	41			-	-	-
12	RLNG	3,712	11.15	0.52	41,394.00	1,936.29	43,330.29
	Grand Total	**14,673**	**4.97**	**0.39**	**72,964**	**5,670**	**78,633**
	NTDC Losses	398					
	Net Delivered as p	14,275	5.11	0.40	72,964	5,670	78,633
	%	**2.71%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**

JULY 2019-20

Projected Generation Mix(Technology)
August 2019-20

Code	Power Producer Fuel	Energy	Energy Charges	Energy Charges O&M	Energy Charges Fuel	Energy Charges O&M	Total
		GWh	Rs. /kWh	Rs. /kWh	Mln. Rs.	Mln. Rs.	
	Fuel						
1	Hydel	5,910			-	1,091.78	1,091.78
2	Coal	1,957	6.77	0.48	13,256.25	930.57	14,186.82
3	HSD	-	-	-	-	-	-
4	F.O.	434	13.63	1.30	5,914.15	562.20	6,476.35
5	Gas	912	3.95	0.75	3,601.59	688.49	4,290.08
6	Nuclear	707	1.01	0.08	717.03	55.77	772.80
7	Mixed	32	10.00	-	320.00	-	320.00
8	Import from Iran	49	6.11	-	299.15	-	299.15
9	Wind Power	420			-	-	-
10	Bagasse	-	-	-	-	-	-
11	Solar	61			-	-	-
12	RLNG	4,371	9.74	0.44	42,594.06	1,908.95	44,503.01
	Grand Total	**14,853**	**4.49**	**0.35**	**66,702**	**5,238**	**71,940**
	NTDC Losses	403					
	Net Delivered as per (	14,450	4.62	0.36	66,702	5,238	71,940
	%	**2.71%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**

AUGUST 2019-20

SEPTEMBER 2019-20

Projected Generation Mix(Technology)
September 2019-20

Code	Power Producer	Energy	Energy Charges	Energy Charges O&M	Energy Charges Fuel	Energy Charges O&M	Total
		GWh	Rs. /kWh	Rs. /kWh	Mln. Rs.	Mln. Rs.	
	Fuel						
1	Hydel	5,821			-	925.75	925.75
2	Coal	1,809	6.73	0.48	12,171.90	862.03	13,033.93
3	HSD	-	-	-	-	-	-
4	F.O.	346	14.29	1.05	4,943.86	362.10	5,305.96
5	Gas	487	3.01	0.96	1,466.98	467.17	1,934.15
6	Nuclear	897	1.04	0.07	932.69	65.93	998.62
7	Mixed	39	10.00	-	390.00	-	390.00
8	Import from Iran	46	6.11	-	280.83	-	280.83
9	Wind Power	264			-	-	-
10	Bagasse	-	-	-	-	-	-
11	Solar	97			-	-	-
12	RLNG	3,793	9.39	0.43	35,610.34	1,621.51	37,231.85
	Grand Total	**13,599**	**4.10**	**0.32**	**55,797**	**4,304**	**60,101**
	NTDC Losses	369					
	Net Delivered as p	13,230	4.22	0.33	55,797	4,304	60,101
	%	**2.71%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**

OCTOBER 2019-20

Projected Generation Mix(Technology)
October 2019-20

Code	Power Producer Fuel	Energy	Energy Charges	Energy Charges O&M	Energy Charges Fuel	Energy Charges O&M	Total
		GWh	Rs. /kWh	Rs. /kWh	Mln. Rs.	Mln. Rs.	
	Fuel						
1	Hydel	3,571			-	539.09	539.09
2	Coal	1,213	6.67	0.48	8,085.84	578.83	8,664.67
3	HSD	-	-	-	-	-	-
4	F.O.	635	14.85	0.74	9,431.68	467.77	9,899.45
5	Gas	1,165	5.53	0.45	6,447.99	524.82	6,972.81
6	Nuclear	849	1.04	0.08	880.39	63.75	944.13
7	Mixed	37	10.00	-	370.00	-	370.00
8	Import from Iran	45	6.11	-	274.73	-	274.73
9	Wind Power	124			-	-	-
10	Bagasse	-	-	-	-	-	-
11	Solar	31			-	-	-
12	RLNG	2,719	9.49	0.45	25,790.75	1,212.98	27,003.73
	Grand Total	**10,389**	**4.94**	**0.33**	**51,281**	**3,387**	**54,669**
	NTDC Losses	282					
	Net Delivered as per (	10,107	5.07	0.34	51,281	3,387	54,669
	%	**2.71%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**

Projected Generation Mix(Technology)
November 2019-20

Code	Power Producer	Energy	Energy Charges	Energy Charges O&M	Energy Charges Fuel	Energy Charges O&M	Total
		GWh	Rs. /kWh	Rs. /kWh	Mln. Rs.	Mln. Rs.	
	Fuel						
1	Hydel	3,060			-	413.21	413.21
2	Coal	1,117	6.51	0.48	7,267.69	533.31	7,800.99
3	HSD	-	-	-	-	-	-
4	F.O.	82	12.89	1.08	1,057.17	88.27	1,145.44
5	Gas	1	4.46	0.51	4.46	0.51	4.97
6	Nuclear	705	1.03	0.07	728.92	52.03	780.95
7	Mixed	32			320.00	-	320.00
8	Import from Iran	38			231.99	-	231.99
9	Wind Power	150			-	-	-
10	Bagasse	214	5.71	0.70	1,222.10	149.63	1,371.73
11	Solar	86			-	-	-
12	RLNG	3,052	8.64	0.42	26,366.87	1,269.62	27,636.48
	Grand Total	**8,537**	**4.36**	**0.29**	**37,199**	**2,507**	**39,706**
	NTDC Losses	231					
	Net Delivered as p	8,306	4.48	0.30	37,199	2,507	39,706
	%	**2.71%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**

NOVEMBER 2019-20

Projected Generation Mix(Technology)
December 2019-20

Code	Power Producer Fuel	Energy	Energy Charges	Energy Charges O&M	Energy Charges Fuel	Energy Charges O&M	Total
		GWh	Rs. /kWh	Rs. /kWh	Mln. Rs.	Mln. Rs.	
	Fuel						
1	Hydel	2,169			-	310.40	310.40
2	Coal	1,996	7.13	0.47	14,233.54	941.86	15,175.40
3	HSD	-	-	-	-	-	-
4	F.O.	135	12.76	0.97	1,722.65	131.56	1,854.22
5	Gas	373	2.24	1.11	836.45	413.20	1,249.65
6	Nuclear	703	1.04	0.06	731.78	39.43	771.21
7	Mixed	47			470.00	-	470.00
8	Import from Iran	35			213.68	-	213.68
9	Wind Power	324			-	-	-
10	Bagasse	222	5.72	0.70	1,269.18	155.39	1,424.57
11	Solar	27			-	-	-
12	RLNG	2,699	7.85	0.38	21,188.59	1,027.44	22,216.03
	Grand Total	**8,730**	**4.66**	**0.35**	**40,666**	**3,019**	**43,685**
	NTDC Losses	237					
	Net Delivered as per (	8,493	4.79	0.36	40,666	3,019	43,685
	%	**2.71%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**

DECEMBER 2019-20

JANUARY 2019-20

Projected Generation Mix(Technology)
January 2019-20

Code	Power Producer	Energy	Energy Charges	Energy Charges O&M	Energy Charges Fuel	Energy Charges O&M	Total
		GWh	Rs. /kWh	Rs. /kWh	Mln. Rs.	Mln. Rs.	
	Fuel						
1	Hydel	1,105			-	215.80	215.80
2	Coal	2,242	7.03	0.47	15,761.04	1,060.77	16,821.81
3	HSD	-	-	-	-	-	-
4	F.O.	221	12.62	0.87	2,788.35	193.15	2,981.50
5	Gas	1,736	5.02	0.56	8,706.98	968.80	9,675.78
6	Nuclear	927	1.04	0.07	963.78	68.13	1,031.91
7	Mixed	52	10.00		520.00	-	520.00
8	Import from Iran	36	6.11		219.78	-	219.78
9	Wind Power	235			-	-	-
10	Bagasse	222	5.72	0.70	1,269.18	155.39	1,424.57
11	Solar	35			-	-	-
12	RLNG	2,186	10.10	0.48	22,079.27	1,049.44	23,128.71
	Grand Total	**8,997**	**5.81**	**0.41**	**52,308**	**3,711**	**56,020**
	NTDC Losses	244					
	Net Delivered as p	8,753	5.98	0.42	52,308	3,711	56,020
	%	**2.71%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**

FEBRUARY 2019-20

Projected Generation Mix(Technology)
February 2019-20

Code	Power Producer Fuel	Energy	Energy Charges	Energy Charges O&M	Energy Charges Fuel	Energy Charges O&M	Total
		GWh	Rs. /kWh	Rs. /kWh	Mln. Rs.	Mln. Rs.	
	Fuel						
1	Hydel	1,935			-	310.92	310.92
2	Coal	2,004	7.04	0.47	14,103.87	947.76	15,051.63
3	HSD	-	-	-	-	-	-
4	F.O.	166	12.71	0.91	2,109.43	150.30	2,259.73
5	Gas	1,586	4.97	0.57	7,875.77	898.76	8,774.53
6	Nuclear	837	1.04	0.07	870.51	61.53	932.05
7	Mixed	49	10.00		490.00	-	490.00
8	Import from Iran	34	6.11		207.57	-	207.57
9	Wind Power	199			-	-	-
10	Bagasse	200	5.73	0.70	1,146.36	140.35	1,286.71
11	Solar	92			-	-	-
12	RLNG	798	10.13	0.47	8,083.39	377.24	8,460.63
	Grand Total	**7,900**	**4.42**	**0.37**	**34,887**	**2,887**	**37,774**
	NTDC Losses	214					
	Net Delivered as per (	7,686	4.54	0.38	34,887	2,887	37,774
	%	**2.71%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**

Projected Generation Mix(Technology)
March 2019-20

Code	Power Producer	Energy	Energy Charges	Energy Charges O&M	Energy Charges Fuel	Energy Charges O&M	Total
		GWh	Rs. /kWh	Rs. /kWh	Mln. Rs.	Mln. Rs.	
	Fuel						
1	Hydel	2,157			-	534.41	534.41
2	Coal	2,177	7.03	0.47	15,295.90	1,029.80	16,325.70
3	HSD	-	-	-	-	-	-
4	F.O.	287	12.70	0.92	3,644.57	264.10	3,908.67
5	Gas	1,790	5.09	0.55	9,119.95	979.25	10,099.20
6	Nuclear	927	1.04	0.07	963.78	68.13	1,031.91
7	Mixed	60			600.00	-	600.00
8	Import from Iran	40			244.20	-	244.20
9	Wind Power	193			-	-	-
10	Bagasse	222	5.72	0.70	1,269.18	155.39	1,424.57
11	Solar	27			-	-	-
12	RLNG	1,942	10.11	0.48	19,625.38	927.57	20,552.95
	Grand Total	**9,822**	**5.17**	**0.40**	**50,763**	**3,959**	**54,722**
	NTDC Losses	266					
	Net Delivered as p	9,556	5.31	0.41	50,763	3,959	54,722
	%	**2.71%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**

MARCH 2019-20

Projected Generation Mix(Technology)
April 2019-20

Code	Power Producer Fuel	Energy	Energy Charges	Energy Charges O&M	Energy Charges Fuel	Energy Charges O&M	Total
		GWh	Rs. /kWh	Rs. /kWh	Mln. Rs.	Mln. Rs.	
	Fuel						
1	Hydel	2,328			-	777.14	777.14
2	Coal	1,906	6.80	0.48	12,953.54	906.28	13,859.82
3	HSD	-	-	-	-	-	-
4	F.O.	570	12.67	0.94	7,220.83	535.60	7,756.43
5	Gas	1,469	4.88	0.59	7,175.39	862.49	8,037.88
6	Nuclear	686	1.03	0.08	707.52	54.10	761.63
7	Mixed	44			440.00	-	440.00
8	Import from Iran	47			286.94	-	286.94
9	Wind Power	350			-	-	-
10	Bagasse	215	5.71	0.70	1,228.24	150.38	1,378.62
11	Solar	98			-	-	-
12	RLNG	3,567	10.28	0.50	36,668.77	1,783.74	38,452.50
	Grand Total	**11,280**	**5.91**	**0.45**	**66,681**	**5,070**	**71,751**
	NTDC Losses	306					
	Net Delivered as per (	10,974	6.08	0.46	66,681	5,070	71,751
	%	**2.71%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**

APRIL 2019-20

MAY 2019-20

Projected Generation Mix(Technology)
May 2019-20

Code	Power Producer	Energy	Energy Charges	Energy Charges O&M	Energy Charges Fuel	Energy Charges O&M	Total
		GWh	Rs. /kWh	Rs. /kWh	Mln. Rs.	Mln. Rs.	
	Fuel						
1	Hydel	3,401			-	898.50	898.50
2	Coal	1,797	6.63	0.48	11,913.48	857.06	12,770.54
3	HSD	-	-	-	-	-	-
4	F.O.	1,214	13.04	1.03	15,830.41	1,253.24	17,083.65
5	Gas	1,951	5.18	0.52	10,101.55	1,014.39	11,115.94
6	Nuclear	465	1.08	0.09	501.08	42.23	543.32
7	Mixed	41			410.00	-	410.00
8	Import from Iran	52			317.46	-	317.46
9	Wind Power	421			-	-	-
10	Bagasse	-	-	-	-	-	-
11	Solar	40			-	-	-
12	RLNG	3,878	10.44	0.49	40,481.93	1,897.06	42,378.99
	Grand Total	**13,260**	**6.00**	**0.45**	**79,556**	**5,962**	**85,518**
	NTDC Losses	359					
	Net Delivered as p	12,901	6.17	0.46	79,556	5,962	85,518
	%	**2.71%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**

JUNE 2019-20

Projected Generation Mix(Technology)
June 2019-20

Code	Power Producer Fuel	Energy	Energy Charges	Energy Charges O&M	Energy Charges Fuel	Energy Charges O&M	Total
		GWh	Rs. /kWh	Rs. /kWh	Mln. Rs.	Mln. Rs.	
	Fuel						
1	Hydel	4,164			-	895.03	895.03
2	Coal	1,674	6.57	0.48	11,003.84	799.22	11,803.06
3	HSD	-	-	-	-	-	-
4	F.O.	1,300	13.13	1.00	17,074.08	1,300.03	18,374.11
5	Gas	1,916	5.20	0.52	9,954.19	996.01	10,950.21
6	Nuclear	548	1.06	0.08	580.00	46.34	626.34
7	Mixed	41			410.00	-	410.00
8	Import from Iran	53			323.57	-	323.57
9	Wind Power	471			-	-	-
10	Bagasse	-	-	-	-	-	-
11	Solar	92			-	-	-
12	RLNG	3,643	10.52	0.49	38,314.20	1,770.93	40,085.14
	Grand Total	**13,902**	**5.59**	**0.42**	**77,660**	**5,808**	**83,467**
	NTDC Losses	377					
	Net Delivered as per (	13,525	5.74	0.43	77,660	5,808	83,467
	%	**2.71%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**

7.2 CASE2: PPP PROJECTIONS FY (2019-20) (WITHOUT TRANS-MISSION CONSTRAINTS)

This scenario has been developed to estimate the impact of transmission constraints as well as load shedding on the Power Purchase Price (PPP) while considering the same assumption set as that of previous scenario apart from demand and transmission network. In the previous scenario demand catered the impact of ATC based load shed while in this case, demand numbers are same as that of PMS based Projections. Apart from this, the present scenario is simulated without linear power flow analysis i.e. single bus analysis thus pointing out the status of KPIs (Key performance Indicators) associated with the performance of power sector at masses ultimately enabling the policy makers for taking the informed and well -versed decision to make this sector sustainable.

I) PMS BASED DEMAND PROJECTION:

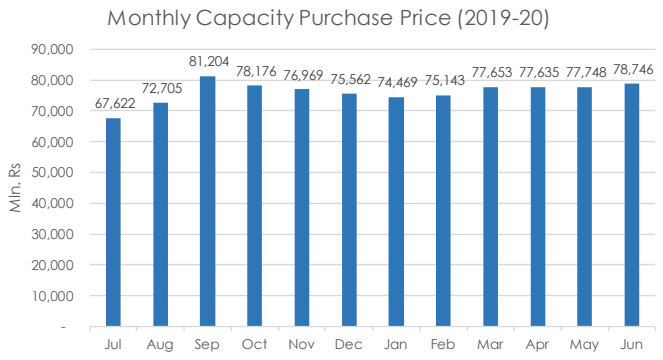
Under this Demand Scenario, Capacity Purchase Price and Energy Purchase Price for the system has been formulated on the basis of demand numbers taken from PMS based Results for System as well as Distribution Companies. Further, Energy Mix, Monthly References etc. for the system have also been attached under this section.

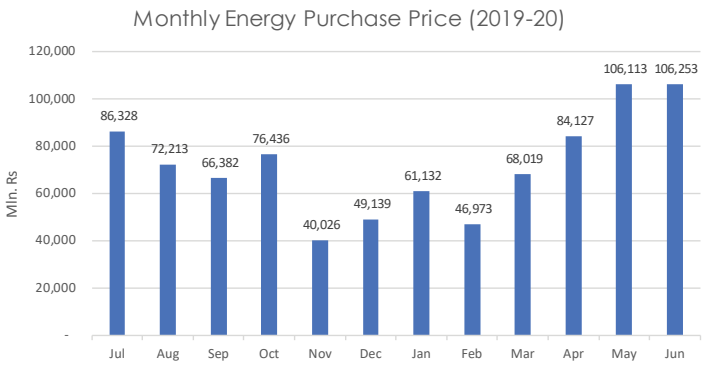
MONTHLY CAPACITY PURCHASE PRICE PROJECTIONS:

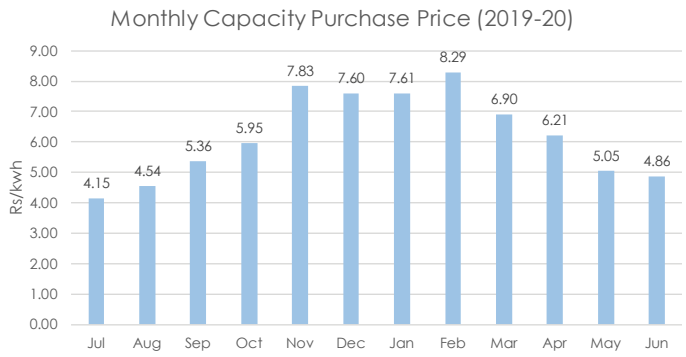
The CPP is distributed at uniform rates throughout the study period, except for month of July owing to addition of some plant. The variation in per unit CPP is owing to the demand numbers for respective months.

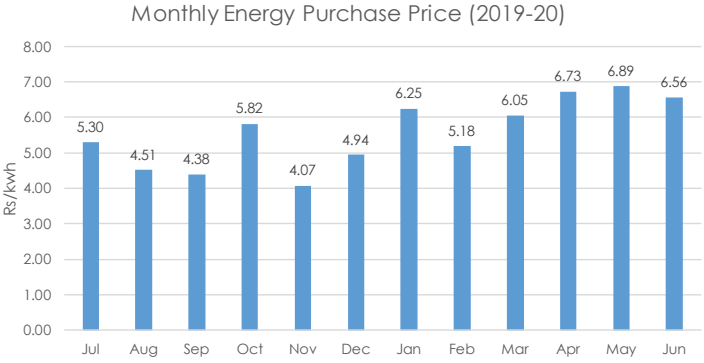
MONTHLY ENERGY PURCHASE PRICE PROJECTIONS:

It can be clearly seen that during peak months for Jun-Aug, EPP is comparatively higher as compared to other months owing to the increased demand trends. Further as this is a transmission constrained scenario, therefore EPP is slightly higher because of dispatch of expensive generators.



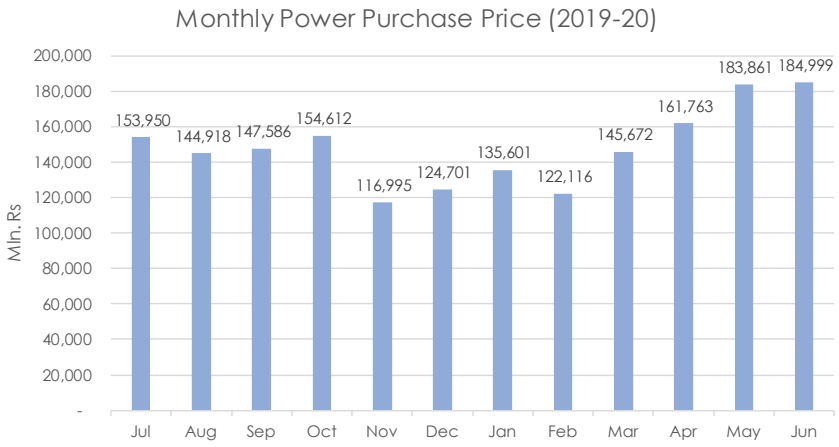


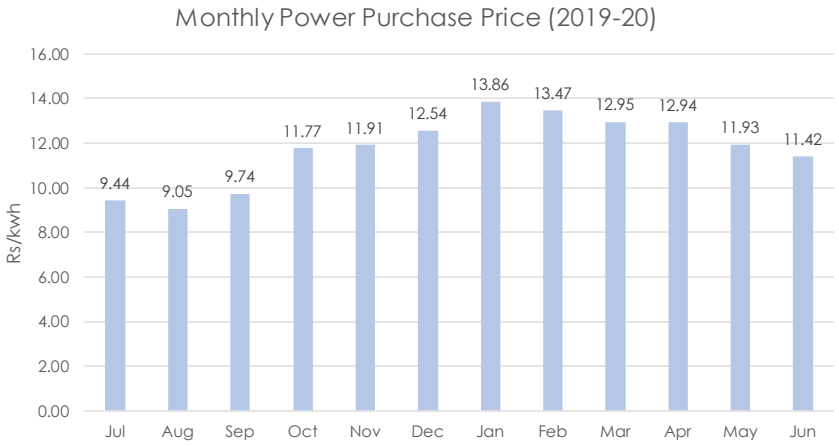


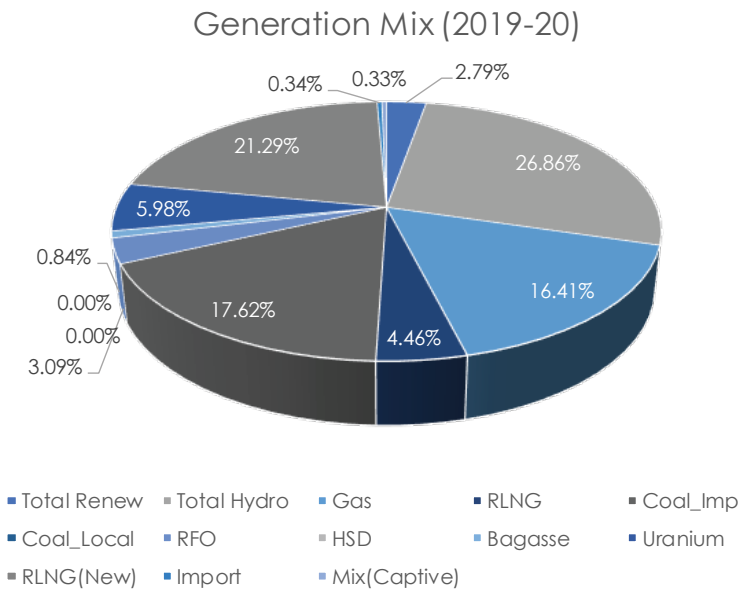


MONTHLY POWER PURCHASE PRICE PROJECTIONS

The overall Power Purchase Price for the system is:







MONTHLY REFERENCES

The Monthly Fuel Price references for the (FY-2019-20) is placed as under:

Projected Generation Mix(Technology)
July 2019-20

Code	Power Producer	Energy	Energy Charges	Energy Charges O&M	Energy Charges Fuel	Energy Charges O&M	Total
		GWh	Rs. /kWh	Rs. /kWh	Mln. Rs.	Mln. Rs.	
	Fuel						
1	Hydel	5,879			-	1,099.17	1,099
2	Coal	2,315	7.00	0.47	16,213.96	1,097.01	17,311
3	HSD	-	-	-	-	-	-
4	F.O.	623	12.80	1.04	7,973.62	648.38	8,622
5	Gas	2,305	5.77	0.48	13,304.29	1,106.23	14,411
6	Nuclear	768	1.02	0.08	785.28	59.19	844
7	Mixed	31	10.00	-	310.00	-	310
8	Import from Iran	43	6.11	-	262.52	-	263
9	Wind Power	439			-	-	-
10	Bagasse	-	-	-	-	-	-
11	Solar	29			-	-	-
12	RLNG	3,869	10.75	0.48	41,604.51	1,863.64	43,468
	Grand Total	**16,301**	**4.94**	**0.36**	**80,454.18**	**5,873.62**	**86,328**
	NTDC Losses	442					
	Net Delivered as p	15,859	5.0730	0.3704	80,454	5,874	86,328
	%	**2.71%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**

JULY 2019-20

Projected Generation Mix(Technology)
August 2019-20

Code	Power Producer Fuel	Energy	Energy Charges	Energy Charges O&M	Energy Charges Fuel	Energy Charges O&M	Total
		GWh	Rs. /kWh	Rs. /kWh	Mn. Rs.	Mn. Rs.	
	Fuel						
1	Hydel	5,917			-	1,093.41	1,093
2	Coal	2,714	6.89	0.47	18,691.36	1,288.58	19,980
3	HSD	-	-	-	-	-	-
4	F.O.	27	13.19	1.25	356.06	33.71	390
5	Gas	2,350	5.77	0.48	13,564.43	1,122.72	14,687
6	Nuclear	707	1.01	0.08	717.03	55.77	773
7	Mixed	32	10.00	-	320.00	-	320
8	Import from Iran	49	6.11	-	299.15	-	299
9	Wind Power	426			-	-	-
10	Bagasse	-	-	-	-	-	-
11	Solar	56			-	-	-
12	RLNG	3,732	8.88	0.41	33,158.26	1,512.05	34,670
	Grand Total	**16,010**	**4.19**	**0.32**	**67,106.28**	**5,106.25**	**72,213**
	NTDC Losses	434					
	Net Delivered as per	15,576	4.3083	0.3278	67,106	5,106	72,213
	%	**2.71%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**

AUGUST 2019-20

SEPTEMBER 2019-20

Projected Generation Mix(Technology)
September 2019-20

Code	Power Producer	Energy	Energy Charges	Energy Charges O&M	Energy Charges Fuel	Energy Charges O&M	Total
		GWh	Rs. /kWh	Rs. /kWh	Mln. Rs.	Mln. Rs.	
	Fuel						
1	Hydel	5,821			-	925.76	926
2	Coal	1,813	6.73	0.48	12,201.25	864.26	13,066
3	HSD	-	-	-	-	-	-
4	F.O.	14	13.51	1.20	189.08	16.76	206
5	Gas	2,322	5.76	0.48	13,378.18	1,106.37	14,485
6	Nuclear	897	1.04	0.07	932.69	65.93	999
7	Mixed	39	10.00	-	390.00	-	390
8	Import from Iran	46	6.11	-	280.83	-	281
9	Wind Power	250			-	-	-
10	Bagasse	-	-	-	-	-	-
11	Solar	111			-	-	-
12	RLNG	3,834	8.98	0.41	34,446.76	1,583.91	36,031
	Grand Total	**15,147**	**4.08**	**0.30**	**61,818.79**	**4,562.99**	**66,382**
	NTDC Losses	411					
	Net Delivered as p	14,736	4.1950	0.3096	61,819	4,563	66,382
	%	**2.71%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**

OCTOBER 2019-20

Projected Generation Mix(Technology)
October 2019-20

Code	Power Producer Fuel	Energy	Energy Charges	Energy Charges O&M	Energy Charges Fuel	Energy Charges O&M	Total
		GWh	Rs. /kWh	Rs. /kWh	Mln. Rs.	Mln. Rs.	
	Fuel						
1	Hydel	3,571			-	539.09	539
2	Coal	1,910	6.74	0.48	12,867.18	909.93	13,777
3	HSD	-	-	-	-	-	-
4	F.O.	717	13.88	0.95	9,952.92	680.91	10,634
5	Gas	2,011	5.94	0.43	11,937.98	857.84	12,796
6	Nuclear	927	1.04	0.07	963.78	68.13	1,032
7	Mixed	37	10.00	-	370.00	-	370
8	Import from Iran	45	6.11	-	274.73	-	275
9	Wind Power	124			-	-	-
10	Bagasse	-	-	-	-	-	-
11	Solar	31			-	-	-
12	RLNG	3,758	9.42	0.43	35,403.37	1,610.09	37,013
	Grand Total	**13,131**	**5.47**	**0.36**	**71,769.95**	**4,665.99**	**76,436**
	NTDC Losses	356					
	Net Delivered as per	12,775	5.6180	0.3652	71,770	4,666	76,436
	%	**2.71%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**

NOIVEMBER 2019-20

Projected Generation Mix(Technology)
November 2019-20

Code	Power Producer	Energy	Energy Charges	Energy Charges O&M	Energy Charges Fuel	Energy Charges O&M	Total
		GWh	Rs. /kWh	Rs. /kWh	Mln. Rs.	Mln. Rs.	
	Fuel						
1	Hydel	3,060			-	413.21	413
2	Coal	2,227	7.01	0.47	15,608.99	1,054.17	16,663
3	HSD	-	-	-	-	-	-
4	F.O.	-	-	-	-	-	-
5	Gas	1,891	5.54	0.46	10,481.52	873.18	11,355
6	Nuclear	854	1.04	0.07	887.79	60.38	948
7	Mixed	32			320.00	-	320
8	Import from Iran	38			231.99	-	232
9	Wind Power	131			-	-	-
10	Bagasse	214	5.71	0.70	1,222.10	149.63	1,372
11	Solar	105			-	-	-
12	RLNG	1,273	6.53	0.32	8,317.57	405.19	8,723
	Grand Total	**9,825**	**3.77**	**0.30**	**37,069.95**	**2,955.76**	**40,026**
	NTDC Losses	266					
	Net Delivered as p	9,559	3.8781	0.3092	37,070	2,956	40,026
	%	**2.71%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**

DECEMBER 2019-20

Projected Generation Mix(Technology)
December 2019-20

Code	Power Producer Fuel	Energy	Energy Charges	Energy Charges O&M	Energy Charges Fuel	Energy Charges O&M	Total
		GWh	Rs. /kWh	Rs. /kWh	Mln. Rs.	Mln. Rs.	
	Fuel						
1	Hydel	2,169			-	310.40	310
2	Coal	1,609	6.38	0.48	10,259.73	771.46	11,031
3	HSD	-	-	-	-	-	-
4	F.O.	-	-	-	-	-	-
5	Gas	2,034	5.48	0.47	11,138.05	956.74	12,095
6	Nuclear	703	1.04	0.06	731.78	39.43	771
7	Mixed	47			470.00	-	470
8	Import from Iran	35			213.68	-	214
9	Wind Power	327			-	-	-
10	Bagasse	222	5.72	0.70	1,269.18	155.39	1,425
11	Solar	24			-	-	-
12	RLNG	2,771	7.86	0.38	21,769.92	1,053.16	22,823
	Grand Total	**9,941**	**4.61**	**0.33**	**45,852.33**	**3,286.58**	**49,139**
	NTDC Losses	269					
	Net Delivered as per	9,672	4.7409	0.3398	45,852	3,287	49,139
	%	**2.71%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**

JANUARY 2019-20

Projected Generation Mix(Technology)
January 2019-20

Code	Power Producer	Energy	Energy Charges	Energy Charges O&M	Energy Charges Fuel	Energy Charges O&M	Total
		GWh	Rs. /kWh	Rs. /kWh	Mln. Rs.	Mn. Rs.	
	Fuel						
1	Hydel	1,105			-	215.80	216
2	Coal	2,480	6.76	0.48	16,769.96	1,180.53	17,950
3	HSD	-	-	-	-	-	-
4	F.O.	-	-	-	-	-	-
5	Gas	2,064	5.38	0.50	11,112.94	1,029.92	12,143
6	Nuclear	927	1.04	0.07	963.78	68.13	1,032
7	Mixed	52	10.00		520.00	-	520
8	Import from Iran	36	6.11		219.78	-	220
9	Wind Power	240			-	-	-
10	Bagasse	222	5.72	0.70	1,269.18	155.39	1,425
11	Solar	30			-	-	-
12	RLNG	2,630	10.02	0.48	26,363.69	1,262.91	27,627
	Grand Total	**9,786**	**5.85**	**0.40**	**57,219.33**	**3,912.68**	**61,132**
	NTDC Losses	265					
	Net Delivered as p	9,521	6.0100	0.4110	57,219	3,913	61,132
	%	**2.71%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**

FEBRUARY 2019-20

Projected Generation Mix(Technology)
February 2019-20

Code	Power Producer Fuel	Energy	Energy Charges	Energy Charges O&M	Energy Charges Fuel	Energy Charges O&M	Total
		GWh	Rs. /kWh	Rs. /kWh	Mln. Rs.	Mln. Rs.	
	Fuel						
1	Hydel	1,935			-	310.92	311
2	Coal	2,395	6.85	0.48	16,416.72	1,137.73	17,554
3	HSD	-	-	-	-	-	-
4	F.O.	-	-	-	-	-	-
5	Gas	1,851	5.30	0.51	9,803.93	949.32	10,753
6	Nuclear	837	1.04	0.07	870.51	61.53	932
7	Mixed	49	10.00		490.00	-	490
8	Import from Iran	34	6.11		207.57	-	208
9	Wind Power	185			-	-	-
10	Bagasse	200	5.73	0.70	1,146.36	140.35	1,287
11	Solar	107			-	-	-
12	RLNG	1,470	10.02	0.48	14,727.26	711.28	15,439
	Grand Total	**9,063**	**4.82**	**0.37**	**43,662.35**	**3,311.14**	**46,973**
	NTDC Losses	246					
	Net Delivered as per	8,817	4.9519	0.3755	43,662	3,311	46,973
	%	**2.71%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**

MARCH 2019-20

Projected Generation Mix(Technology)
March 2019-20

Code	Power Producer	Energy	Energy Charges	Energy Charges O&M	Energy Charges Fuel	Energy Charges O&M	Total
		GWh	Rs. /kWh	Rs. /kWh	Mn. Rs.	Mn. Rs.	
	Fuel						
1	Hydel	2,157			-	534.41	534
2	Coal	2,207	7.04	0.47	15,543.36	1,043.74	16,587
3	HSD	-	-	-	-	-	-
4	F.O.	-	-	-	-	-	-
5	Gas	2,041	5.40	0.51	11,017.68	1,037.71	12,055
6	Nuclear	927	1.04	0.07	963.78	68.13	1,032
7	Mixed	60			600.00	-	600
8	Import from Iran	40			244.20	-	244
9	Wind Power	196			-	-	-
10	Bagasse	222	5.72	0.70	1,269.18	155.39	1,425
11	Solar	24			-	-	-
12	RLNG	3,374	10.06	0.48	33,934.67	1,607.07	35,542
	Grand Total	**11,248**	**5.65**	**0.40**	**63,572.88**	**4,446.44**	**68,019**
	NTDC Losses	305					
	Net Delivered as p	10,943	5.8094	0.4063	63,573	4,446	68,019
	%	**2.71%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**

APRIL 2019-20

Projected Generation Mix(Technology)
April 2019-20

Code	Power Producer Fuel	Energy	Energy Charges	Energy Charges O&M	Energy Charges Fuel	Energy Charges O&M	Total
		GWh	Rs. /kWh	Rs. /kWh	Mln. Rs.	Mln. Rs.	
	Fuel						
1	Hydel	2,328			-	777.14	777
2	Coal	2,243	7.00	0.47	15,708.38	1,061.90	16,770
3	HSD	-	-	-	-	-	-
4	F.O.	586	12.60	1.00	7,383.20	585.70	7,969
5	Gas	1,814	5.62	0.52	10,186.38	949.94	11,136
6	Nuclear	686	1.03	0.08	707.52	54.10	762
7	Mixed	44			440.00	-	440
8	Import from Iran	47			286.94	-	287
9	Wind Power	338			-	-	-
10	Bagasse	215	5.71	0.70	1,228.24	150.38	1,379
11	Solar	110			-	-	-
12	RLNG	4,086	10.44	0.48	42,638.49	1,969.02	44,608
	Grand Total	**12,497**	**6.29**	**0.44**	**78,579.15**	**5,548.18**	**84,127**
	NTDC Losses	339					
	Net Delivered as per	12,158	6.4630	0.4563	78,579	5,548	84,127
	%	**2.71%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**

MAY 2019-20

Projected Generation Mix(Technology)
May 2019-20

Code	Power Producer	Energy	Energy Charges	Energy Charges O&M	Energy Charges Fuel	Energy Charges O&M	Total
		GWh	Rs. /kWh	Rs. /kWh	Mn. Rs.	Mn. Rs.	
	Fuel						
1	Hydel	3,401			-	898.53	899
2	Coal	2,687	6.89	0.47	18,504.12	1,275.85	19,780
3	HSD	-	-	-	-	-	-
4	F.O.	1,297	12.85	1.11	16,662.85	1,438.33	18,101
5	Gas	2,361	5.72	0.48	13,510.15	1,134.20	14,644
6	Nuclear	465	1.08	0.09	501.08	42.23	543
7	Mixed	41			410.00	-	410
8	Import from Iran	52			317.46	-	317
9	Wind Power	433			-	-	-
10	Bagasse	-	-	-	-	-	-
11	Solar	28			-	-	-
12	RLNG	4,642	10.60	0.48	49,209.65	2,208.82	51,418
	Grand Total	**15,407**	**6.43**	**0.45**	**99,115.32**	**6,997.96**	**106,113**
	NTDC Losses	418					
	Net Delivered as p	14,989	6.6124	0.4669	99,115	6,998	106,113
	%	**2.71%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**

JUNE 2019-20

Projected Generation Mix(Technology)
June 2019-20

Code	Power Producer Fuel	Energy	Energy Charges	Energy Charges O&M	Energy Charges Fuel	Energy Charges O&M	Total
		GWh	Rs. /kWh	Rs. /kWh	Mn. Rs.	Mn. Rs.	
	Fuel						
1	Hydel	4,164			-	895.08	895
2	Coal	2,628	6.89	0.47	18,096.40	1,247.64	19,344
3	HSD	-	-	-	-	-	-
4	F.O.	1,515	13.27	0.92	20,107.70	1,398.07	21,506
5	Gas	2,321	5.75	0.48	13,339.38	1,106.58	14,446
6	Nuclear	548	1.06	0.08	580.00	46.34	626
7	Mixed	41			410.00	-	410
8	Import from Iran	53			323.57	-	324
9	Wind Power	460			-	-	-
10	Bagasse	-	-	-	-	-	-
11	Solar	103			-	-	-
12	RLNG	4,369	10.66	0.48	46,593.95	2,108.02	48,702
	Grand Total	**16,202**	**6.14**	**0.42**	**99,451.00**	**6,801.71**	**106,253**
	NTDC Losses	439					
	Net Delivered as per	15,763	6.3092	0.4315	99,451	6,802	106,253
	%	**2.71%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**

II) ACTUAL DEMAND BASED PROJECTION

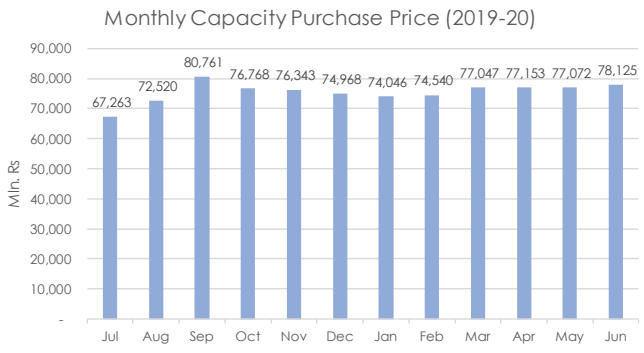
For this section, the demand numbers reflected are the actual demand numbers for year 2018 along with the actual growth rates for the past two years, as explained in Demand Forecast section above. Monthly Capacity Purchase price, Monthly Energy Purchase Price, Monthly References, Generation Mix have been attached under this section:

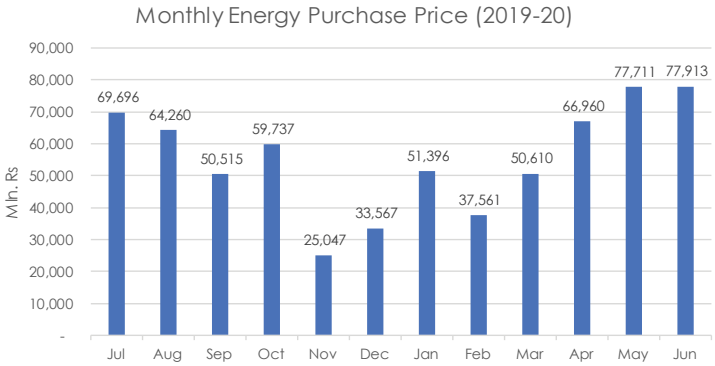
MONTHLY CAPACITY PURCHASE PRICE PROJECTIONS

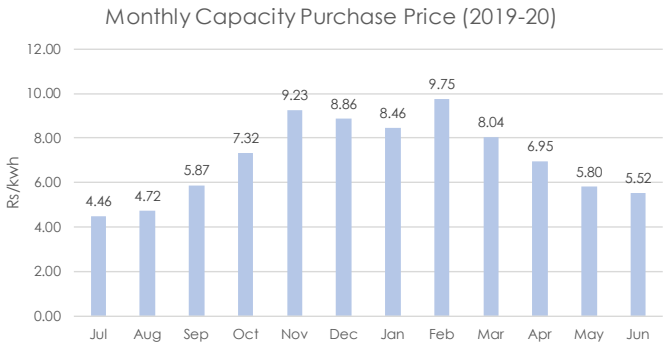
The only difference occurring in this scenario with actual demand numbers is the per unit CPP variation owing to change in Demand Numbers as compared to previous case.

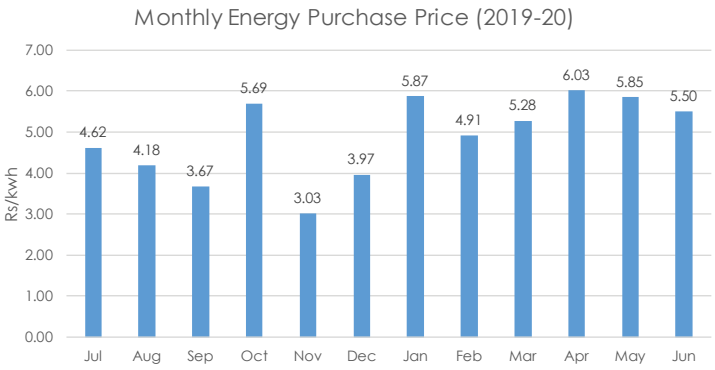
MONTHLY ENERGY PURCHASE PRICE PORJECTIONS

It can be clearly seen that during peak months for Jun-august, EPP is comparatively higher as compared to other months owing to the increased demand trends. As explained in previous section, Energy Purchase Price variations are subjected to change in demand numbers on the basis of which monthly References will change accordingly.

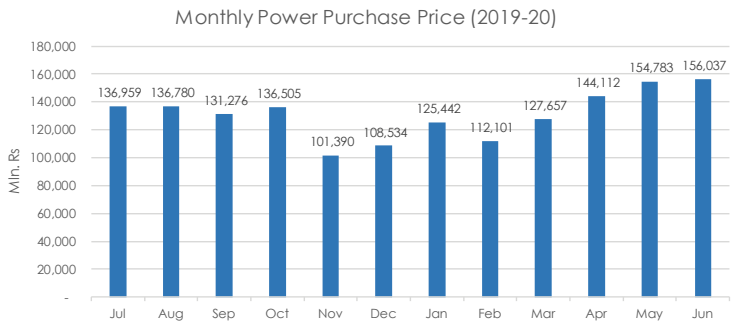


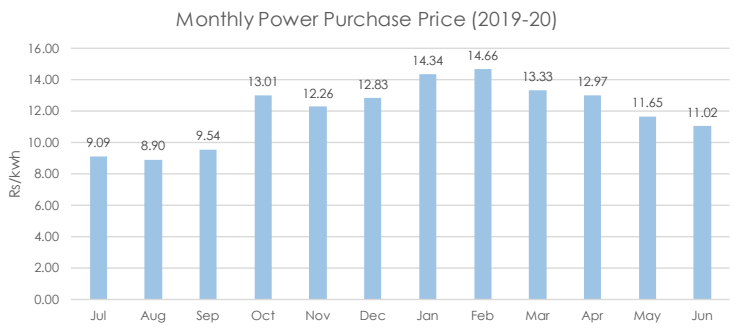




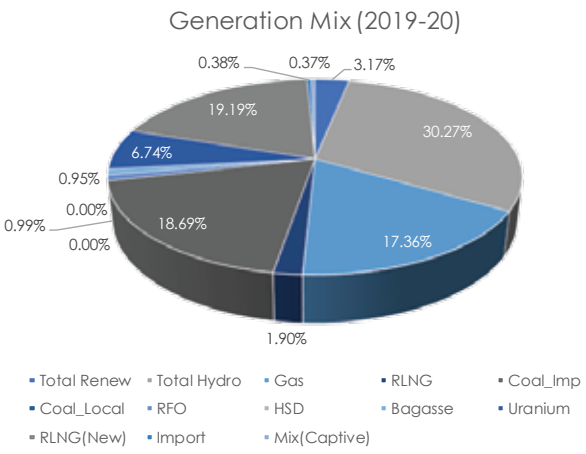


MONTHLY POWER PURCHASE PRICE PROJECTIONS:





GENERATION MIX:



MONTHLY REFERENCES:

The Monthly Fuel Price references for the (FY-2019-20) is placed as under:

JULY 2019-20

Projected Generation Mix(Technology)
July 2019-20

Code	Power Producer	Energy	Energy Charges	Energy Charges O&M	Energy Charges Fuel	Energy Charges O&M	Total
		GWh	Rs. /kWh	Rs. /kWh	Mln. Rs.	Mln. Rs.	
	Fuel						
1	Hydel	5,879			-	1,099.17	1,099.17
2	Coal	2,315	7.00	0.47	16,213.96	1,097.01	17,310.97
3	HSD	-	-	-	-	-	-
4	F.O.	40	13.05	1.06	521.89	42.40	564.29
5	Gas	2,305	5.77	0.48	13,304.29	1,106.23	14,410.52
6	Nuclear	768	1.02	0.08	785.28	59.19	844.47
7	Mixed	31	10.00	-	310.00	-	310.00
8	Import from Iran	43	6.11	-	262.52	-	262.52
9	Wind Power	427			-	-	-
10	Bagasse	-	-	-	-	-	-
11	Solar	41			-	-	-
12	RLNG	3,223	10.34	0.48	33,339.78	1,554.73	34,894.51
	Grand Total	**15,072**	**4.30**	**0.33**	**64,738**	**4,959**	**69,696**
	NTDC Losses	409					
	Net Delivered as p	14,663	4.41	0.34	64,738	4,959	69,696
	%	**2.71%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**

AUGUST 2019-20

Projected Generation Mix(Technology)
August 2019-20

Code	Power Producer Fuel	Energy	Energy Charges	Energy Charges O&M	Energy Charges Fuel	Energy Charges O&M	Total
		GWh	Rs. /kWh	Rs. /kWh	Mln. Rs.	Mln. Rs.	
	Fuel						
1	Hydel	5,917			-	1,093.41	1,093.41
2	Coal	2,715	6.89	0.47	18,699.61	1,289.22	19,988.83
3	HSD	-	-	-	-	-	-
4	F.O.	27	13.19	1.25	356.06	33.71	389.77
5	Gas	2,350	5.77	0.48	13,562.11	1,122.70	14,684.81
6	Nuclear	707	1.01	0.08	717.03	55.77	772.80
7	Mixed	32	10.00	-	320.00	-	320.00
8	Import from Iran	49	6.11	-	299.15	-	299.15
9	Wind Power	420			-	-	-
10	Bagasse	-	-	-	-	-	-
11	Solar	62			-	-	-
12	RLNG	3,085	8.27	0.39	25,505.55	1,205.83	26,711.37
	Grand Total	**15,364**	**3.87**	**0.31**	**59,459**	**4,801**	**64,260**
	NTDC Losses	416					
	Net Delivered as per	14,948	3.98	0.32	59,459	4,801	64,260
	%	**2.71%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**

SEPTEMBER 2019-20

Projected Generation Mix(Technology)
September 2019-20

Code	Power Producer	Energy	Energy Charges	Energy Charges O&M	Energy Charges Fuel	Energy Charges O&M	Total
		GWh	Rs. /kWh	Rs. /kWh	Mln. Rs.	Mln. Rs.	
	Fuel						
1	Hydel	5,821			-	925.76	925.76
2	Coal	1,813	6.73	0.48	12,201.25	864.26	13,065.51
3	HSD	-	-	-	-	-	-
4	F.O.	14	13.51	1.20	189.08	16.76	205.84
5	Gas	2,244	5.61	0.48	12,588.61	1,067.23	13,655.84
6	Nuclear	897	1.04	0.07	932.69	65.93	998.62
7	Mixed	39	10.00	-	390.00	-	390.00
8	Import from Iran	46	6.11	-	280.83	-	280.83
9	Wind Power	266			-	-	-
10	Bagasse	-	-	-	-	-	-
11	Solar	95			-	-	-
12	RLNG	2,522	7.95	0.37	20,050.19	941.99	20,992.18
	Grand Total	**13,757**	**3.39**	**0.28**	**46,633**	**3,882**	**50,515**
	NTDC Losses	373					
	Net Delivered as p	13,384	3.48	0.29	46,633	3,882	50,515
	%	**2.71%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**

OCTOBER 2019-20

Projected Generation Mix(Technology)
October 2019-20

Code	Power Producer Fuel	Energy	Energy Charges	Energy Charges O&M	Energy Charges Fuel	Energy Charges O&M	Total
		GWh	Rs. /kWh	Rs. /kWh	Mn. Rs.	Mn. Rs.	
	Fuel						
1	Hydel	3,208			-	512.78	512.78
2	Coal	1,273	6.74	0.48	8,578.12	606.62	9,184.73
3	HSD	-	-	-	-	-	-
4	F.O.	717	13.88	0.95	9,952.92	680.91	10,633.83
5	Gas	1,375	6.04	0.43	8,309.33	589.28	8,898.61
6	Nuclear	849	1.04	0.08	880.39	63.75	944.13
7	Mixed	37	10.00	-	370.00	-	370.00
8	Import from Iran	45	6.11	-	274.73	-	274.73
9	Wind Power	124			-	-	-
10	Bagasse	-	-	-	-	-	-
11	Solar	31			-	-	-
12	RLNG	2,835	9.76	0.44	27,681.87	1,236.54	28,918.41
	Grand Total	**10,494**	**5.34**	**0.35**	**56,047**	**3,690**	**59,737**
	NTDC Losses	284					
	Net Delivered as per	10,210	5.49	0.36	56,047	3,690	59,737
	%	**2.71%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**

NOVEMBER 2019-20

Projected Generation Mix(Technology)
November 2019-20

Code	Power Producer	Energy	Energy Charges	Energy Charges O&M	Energy Charges Fuel	Energy Charges O&M	Total
		GWh	Rs. /kWh	Rs. /kWh	Mln. Rs.	Mln. Rs.	
	Fuel						
1	Hydel	3,060			-	413.21	413.21
2	Coal	1,878	6.46	0.48	12,126.82	899.51	13,026.33
3	HSD	-	-	-	-	-	-
4	F.O.	-	-	-	-	-	-
5	Gas	1,494	5.09	0.55	7,600.11	826.31	8,426.43
6	Nuclear	854	1.04	0.07	887.79	60.38	948.17
7	Mixed	32			320.00	-	320.00
8	Import from Iran	38			231.99	-	231.99
9	Wind Power	150			-	-	-
10	Bagasse	214	5.71	0.70	1,222.10	149.63	1,371.73
11	Solar	86			-	-	-
12	RLNG	464	0.64	0.03	294.68	14.36	309.04
	Grand Total	**8,270**	**2.74**	**0.29**	**22,683**	**2,363**	**25,047**
	NTDC Losses	224					
	Net Delivered as p	8,046	2.82	0.29	22,683	2,363	25,047
	%	**2.71%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**

DECEMBER 2019-20

Projected Generation Mix(Technology)
December 2019-20

Code	Power Producer Fuel	Energy	Energy Charges	Energy Charges O&M	Energy Charges Fuel	Energy Charges O&M	Total
		GWh	Rs. /kWh	Rs. /kWh	Mln. Rs.	Mln. Rs.	
	Fuel						
1	Hydel	2,169			-	310.40	310.40
2	Coal	2,382	6.98	0.47	16,632.67	1,128.46	17,761.13
3	HSD	-	-	-	-	-	-
4	F.O.	-	-	-	-	-	-
5	Gas	1,604	5.02	0.56	8,058.61	899.51	8,958.12
6	Nuclear	703	1.04	0.06	731.78	39.43	771.21
7	Mixed	47			470.00	-	470.00
8	Import from Iran	35			213.68	-	213.68
9	Wind Power	324			-	-	-
10	Bagasse	222	5.72	0.70	1,269.18	155.39	1,424.57
11	Solar	27			-	-	-
12	RLNG	946	3.69	0.18	3,487.95	169.63	3,657.58
	Grand Total	**8,459**	**3.65**	**0.32**	**30,864**	**2,703**	**33,567**
	NTDC Losses	229					
	Net Delivered as per	8,230	3.75	0.33	30,864	2,703	33,567
	%	**2.71%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**

Projected Generation Mix (Technology)
January 2019-20

Code	Power Producer	Energy	Energy Charges	Energy Charges O&M	Energy Charges Fuel	Energy Charges O&M	Total
		GWh	Rs. /kWh	Rs. /kWh	Mln. Rs.	Mln. Rs.	
	Fuel						
1	Hydel	1,105			-	215.80	215.80
2	Coal	2,283	7.02	0.47	16,017.24	1,081.60	17,098.84
3	HSD	-	-	-	-	-	-
4	F.O.	-	-	-	-	-	-
5	Gas	2,064	5.38	0.50	11,112.94	1,029.92	12,142.86
6	Nuclear	927	1.04	0.07	963.78	68.13	1,031.91
7	Mixed	52	10.00		520.00	-	520.00
8	Import from Iran	36	6.11		219.78	-	219.78
9	Wind Power	235			-	-	-
10	Bagasse	222	5.72	0.70	1,269.18	155.39	1,424.57
11	Solar	35			-	-	-
12	RLNG	1,789	9.99	0.48	17,877.66	864.77	18,742.43
	Grand Total	**8,748**	**5.48**	**0.39**	**47,981**	**3,416**	**51,396**
	NTDC Losses	237					
	Net Delivered as p	8,511	5.64	0.40	47,981	3,416	51,396
	%	**2.71%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**

JANUARY 2019-20

Projected Generation Mix(Technology)
February 2019-20

Code	Power Producer Fuel	Energy	Energy Charges	Energy Charges O&M	Energy Charges Fuel	Energy Charges O&M	Total
		GWh	Rs. /kWh	Rs. /kWh	Mln. Rs.	Mln. Rs.	
	Fuel						
1	Hydel	1,935			-	310.92	310.92
2	Coal	997	7.88	0.47	7,857.31	463.96	8,321.27
3	HSD	-	-	-	-	-	-
4	F.O.	-	-	-	-	-	-
5	Gas	1,851	5.30	0.51	9,807.74	949.36	10,757.10
6	Nuclear	837	1.04	0.07	870.51	61.53	932.05
7	Mixed	49	10.00		490.00	-	490.00
8	Import from Iran	34	6.11		207.57	-	207.57
9	Wind Power	201			-	-	-
10	Bagasse	200	5.73	0.70	1,146.36	140.35	1,286.71
11	Solar	91			-	-	-
12	RLNG	1,453	10.02	0.48	14,552.05	702.98	15,255.03
	Grand Total	**7,648**	**4.57**	**0.34**	**34,932**	**2,629**	**37,561**
	NTDC Losses	207					
	Net Delivered as per	7,441	4.69	0.35	34,932	2,629	37,561
	%	**2.71%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**

FEBRUARY 2019-20

MARCH 2019-20

Projected Generation Mix(Technology)
March 2019-20

Code	Power Producer	Energy	Energy Charges	Energy Charges O&M	Energy Charges Fuel	Energy Charges O&M	Total
		GWh	Rs. /kWh	Rs. /kWh	Mn. Rs.	Mn. Rs.	
	Fuel						
1	Hydel	2,157			-	534.41	534.41
2	Coal	2,187	7.05	0.47	15,420.07	1,034.15	16,454.21
3	HSD	-	-	-	-	-	-
4	F.O.	-	-	-	-	-	-
5	Gas	1,978	5.29	0.52	10,472.96	1,030.73	11,503.69
6	Nuclear	927	1.04	0.07	963.78	68.13	1,031.91
7	Mixed	60			600.00	-	600.00
8	Import from Iran	40			244.20	-	244.20
9	Wind Power	193			-	-	-
10	Bagasse	222	5.72	0.70	1,269.18	155.39	1,424.57
11	Solar	27			-	-	-
12	RLNG	1,791	10.02	0.48	17,950.27	866.55	18,816.83
	Grand Total	**9,582**	**4.90**	**0.39**	**46,920**	**3,689**	**50,610**
	NTDC Losses	260					
	Net Delivered as p	9,322	5.03	0.40	46,920	3,689	50,610
	%	**2.71%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**

APRIL 2019-20

Projected Generation Mix(Technology)
April 2019-20

Code	Power Producer Fuel	Energy	Energy Charges	Energy Charges O&M	Energy Charges Fuel	Energy Charges O&M	Total
		GWh	Rs. /kWh	Rs. /kWh	Mln. Rs.	Mln. Rs.	
	Fuel						
1	Hydel	2,328			-	777.14	777.14
2	Coal	2,243	7.00	0.47	15,708.38	1,061.90	16,770.28
3	HSD	-	-	-	-	-	-
4	F.O.	167	13.07	1.05	2,182.16	174.52	2,356.69
5	Gas	1,676	5.24	0.53	8,780.75	880.25	9,661.01
6	Nuclear	686	1.03	0.08	707.52	54.10	761.63
7	Mixed	44			440.00	-	440.00
8	Import from Iran	47			286.94	-	286.94
9	Wind Power	350			-	-	-
10	Bagasse	215	5.71	0.70	1,228.24	150.38	1,378.62
11	Solar	98			-	-	-
12	RLNG	3,254	10.13	0.48	32,969.24	1,558.07	34,527.31
	Grand Total	**11,108**	**5.61**	**0.42**	**62,303**	**4,656**	**66,960**
	NTDC Losses	301					
	Net Delivered as per	10,807	5.77	0.43	62,303	4,656	66,960
	%	**2.71%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**

MAY 2019-20

Projected Generation Mix(Technology)
May 2019-20

Code	Power Producer	Energy	Energy Charges	Energy Charges O&M	Energy Charges Fuel	Energy Charges O&M	Total
		GWh	Rs. /kWh	Rs. /kWh	Mn. Rs.	Mn. Rs.	
	Fuel						
1	Hydel	3,401			-	898.55	898.55
2	Coal	2,691	6.89	0.47	18,534.02	1,277.36	19,811.38
3	HSD	-	-	-	-	-	-
4	F.O.	190	12.95	1.08	2,460.58	205.60	2,666.18
5	Gas	2,334	5.67	0.48	13,244.66	1,120.96	14,365.62
6	Nuclear	465	1.08	0.09	501.08	42.23	543.32
7	Mixed	41			410.00	-	410.00
8	Import from Iran	52			317.46	-	317.46
9	Wind Power	421			-	-	-
10	Bagasse	-	-	-	-	-	-
11	Solar	40			-	-	-
12	RLNG	3,648	10.13	0.48	36,961.66	1,736.91	38,698.57
	Grand Total	**13,283**	**5.45**	**0.40**	**72,429**	**5,282**	**77,711**
	NTDC Losses	360					
	Net Delivered as p	12,923	5.60	0.41	72,429	5,282	77,711
	%	**2.71%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**

JUNE 2019-20

Projected Generation Mix(Technology)
June 2019-20

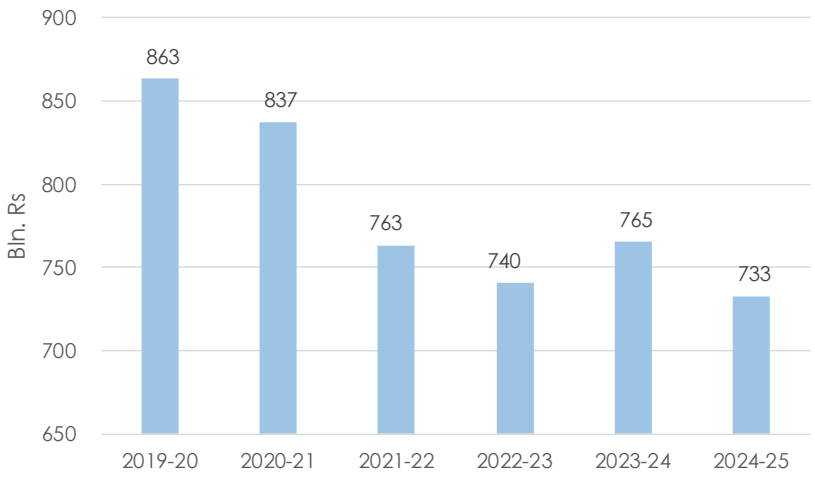
Code	Power Producer Fuel	Energy	Energy Charges	Energy Charges O&M	Energy Charges Fuel	Energy Charges O&M	Total
		GWh	Rs. /kWh	Rs. /kWh	Mln. Rs.	Mln. Rs.	
	Fuel						
1	Hydel	4,164			-	895.08	895.08
2	Coal	2,628	6.89	0.47	18,096.40	1,247.64	19,344.03
3	HSD	-	-	-	-	-	-
4	F.O.	189	13.27	0.95	2,507.17	178.79	2,685.96
5	Gas	2,321	5.75	0.48	13,339.38	1,106.58	14,445.96
6	Nuclear	548	1.06	0.08	580.00	46.34	626.34
7	Mixed	41			410.00	-	410.00
8	Import from Iran	53			323.57	-	323.57
9	Wind Power	471			-	-	-
10	Bagasse	-	-	-	-	-	-
11	Solar	92			-	-	-
12	RLNG	3,650	10.26	0.48	37,434.11	1,747.55	39,181.66
	Grand Total	**14,157**	**5.13**	**0.37**	**72,691**	**5,222**	**77,913**
	NTDC Losses	384					
	Net Delivered as per	13,773	5.28	0.38	72,691	5,222	77,913
	%	**2.71%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**

7.3 CASE3: PPP PROJECTIONS FY (2019-25)

Under this section power purchase price projection for the study period of this report i.e. (FY 2019-20 to 2024-25) has been given for the system as whole. The assumption set for this scenario is considered to be the same as that of previous scenarios, excluding the impact of transmission network constraints as well as Load shed. Under this scenario, impact of fuel price projections on system's pool price, Generation mix, Must Run Fuel Commitments and Contractual Deviations, Technology wise Impact of addition of new capacity etc. are attached under.

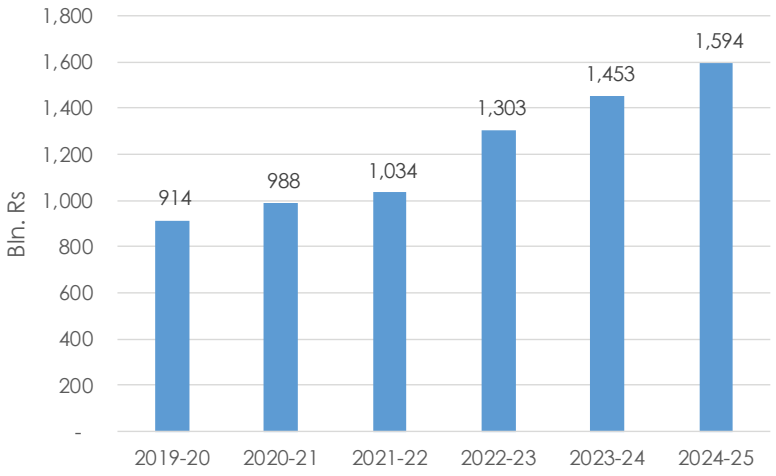
ENERGY PURCHASE PRICE PROJECTIONS

With the growth in demand numbers over the horizon of 2019-25, EPP projection trends as per depicted in figures below follow a decline with the addition of efficient as well as cheap generation in the system.



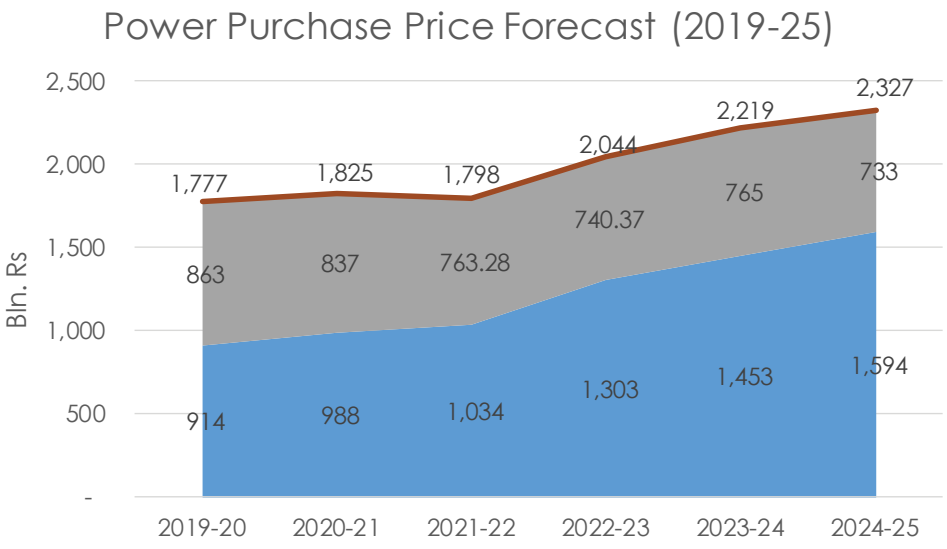
CAPACITY PURCHASE PRICE PROJECTIONS

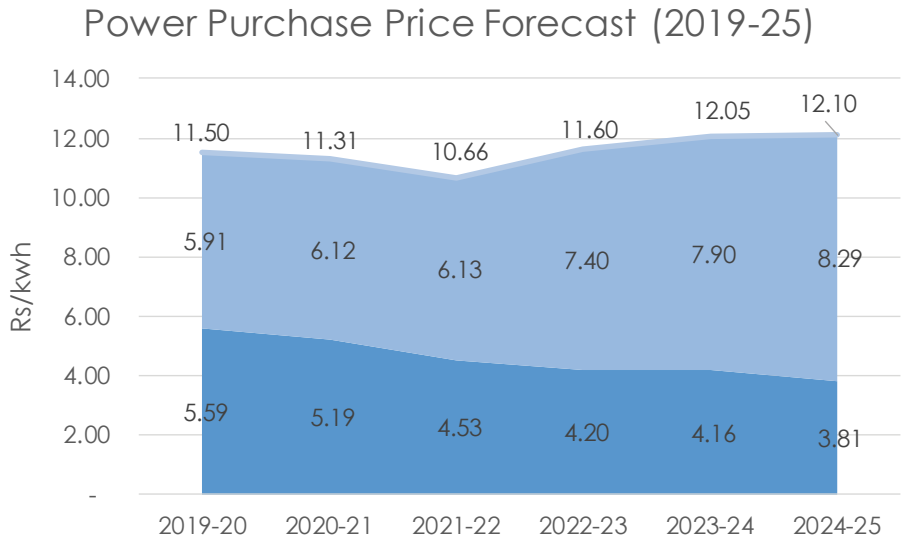
With the addition of number of generating stations to cope up with the demand projections, there appears an elevating trend in Capacity Purchase Prices over the span of 5 years as can be seen under the graphs attached below.



POWER PURCHASE PRICE PROJECTIONS

With the Elevation in CPP projections trends and decline in EPP projections, the overall PPP projections will follow CPP trend owing to its larger contribution as compared to EPP in manner shown in figure below :





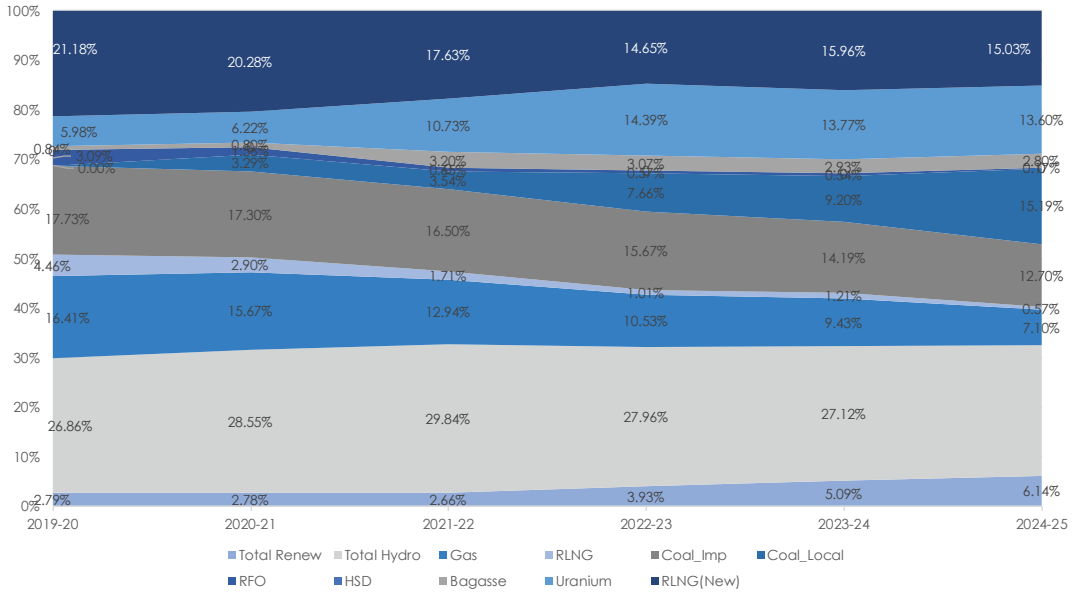
ENERGY MIX PROJECTIONS

The optimum energy mix as per projected via SDDP, for least cost economic dispatch has been attached under the table below, where renewables and hydel share does increase for the first two study years making up to 30% of total generation. On the other hand, the share of local coal substantially increases because of its lower cost of generation as compared to other technologies. Rlng's share do decrease sequentially for the study period thus compromising fuel commitments up to some extent as well.

	%age					
Technology (Fuel)	***2019-20***	***2020-21***	***2021-22***	***2022-23***	***2023-24***	***2024-25***
Total Renew	2.79%	2.78%	2.66%	3.93%	5.09%	6.14%
Total Hydro	26.86%	28.55%	29.84%	27.96%	27.12%	26.16%
Gas	16.41%	15.67%	12.94%	10.53%	9.43%	7.10%
RLNG	4.46%	2.90%	1.71%	1.01%	1.21%	0.57%
Coal_Imp	17.73%	17.30%	16.50%	15.67%	14.19%	12.70%
Coal_Local	0.00%	3.29%	3.54%	7.66%	9.20%	15.19%
RFO	3.09%	1.56%	0.65%	0.57%	0.54%	0.17%
HSD	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Bagasse	0.84%	0.80%	3.20%	3.07%	2.93%	2.80%
Uranium	5.98%	6.22%	10.73%	14.39%	13.77%	13.60%
RLNG(New)	21.18%	20.28%	17.63%	14.65%	15.96%	15.03%
Import	0.34%	0.32%	0.31%	0.29%	0.28%	0.27%
Mix(Captive)	0.33%	0.31%	0.30%	0.29%	0.27%	0.26%

Table 9 Generation Mix

TECHNOLOGY SPECIFIC GENERATION MIX



FUEL REQUIRMENTS PROJECTIONS

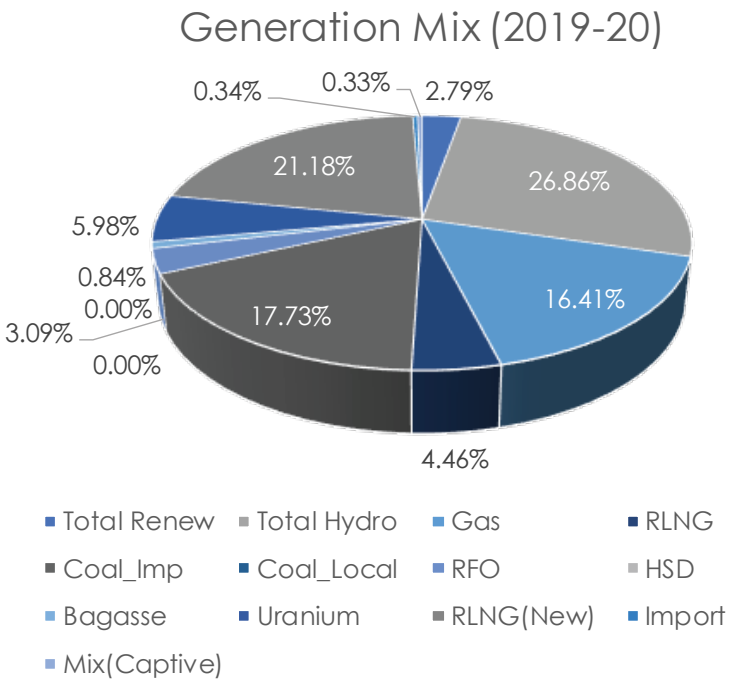
Via using this model, fuel requirements for each fuel category has been predicted thus can be served as assistance tool for taking an informed decision.

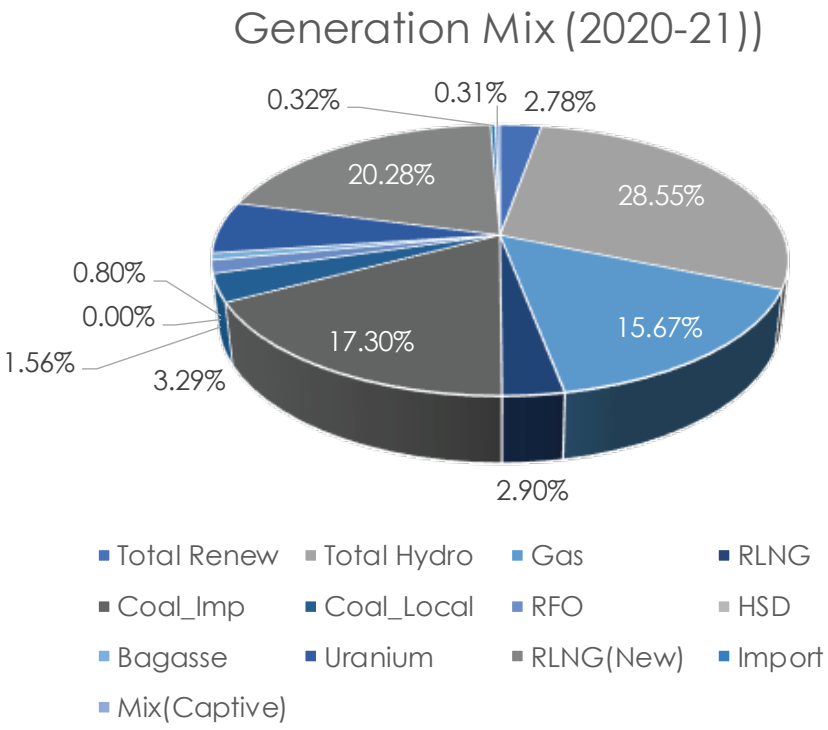
	Fiscal Year					
Fuel (Type & Quantity)	**2019-20**	**2020-21**	**2021-22**	**2022-23**	**2023-24**	**2024-25**
Gas (k. MMBTU)	140,053.41	139,393.11	115,496.13	93,582.16	85,173.71	60,192.21
RLNG (k. MMBTU)	51,744.02	34,393.29	20,977.04	12,960.22	16,205.03	8,036.88
Coal_Imp (k. MTon)	9,378.14	9,555.92	9,521.67	9,446.90	8,940.80	8,350.89
Coal_Local (k. MTon)	-	4,451.89	5,014.93	11,313.02	14,161.42	23,975.17
RFO (k. MTon)	962.69	510.51	220.47	198.37	200.31	66.67
Bagasse (k. MTon)	2,609.27	2,609.27	8,368.13	8,367.93	8,367.35	8,356.35
RLNG(New) (k. MMBTU)	200,290.21	200,320.49	182,104.45	158,072.76	179,876.31	176,965.29

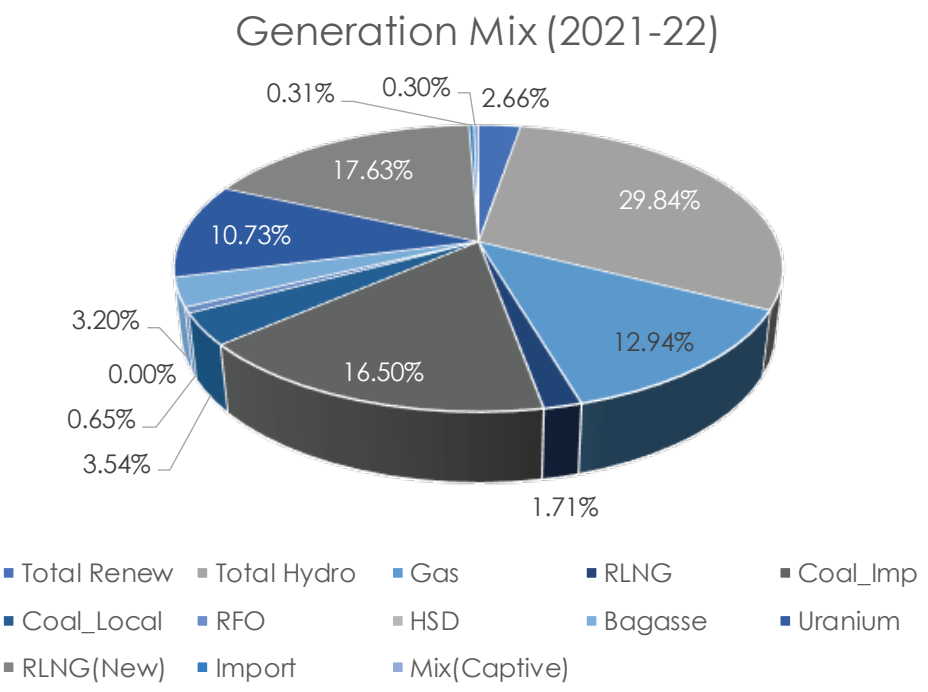
Table 10 Fuel Requirements

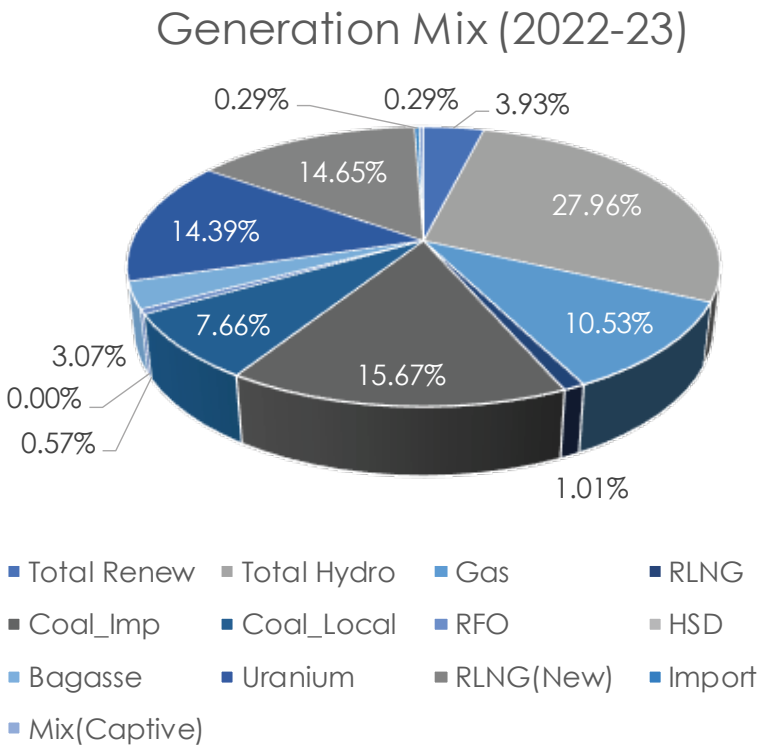
GENERATION MIX

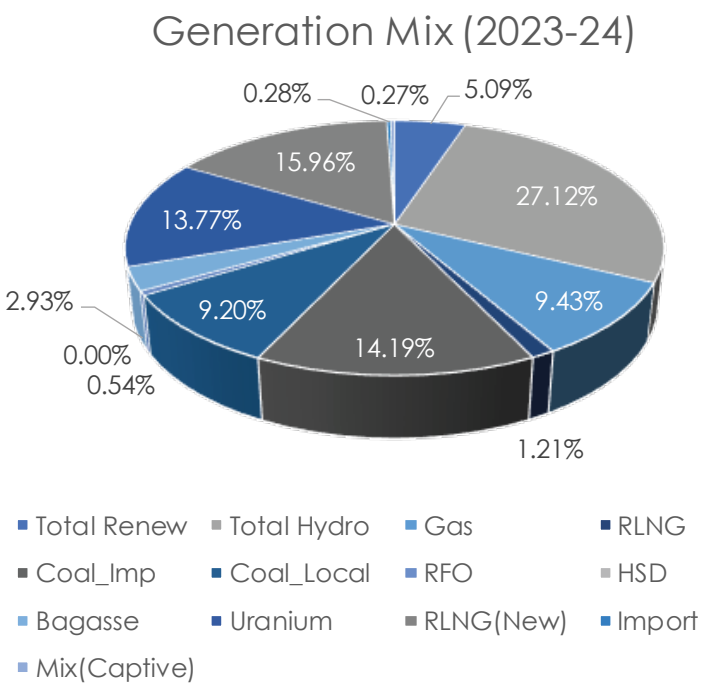
The generation mix projections have been attached under this section:

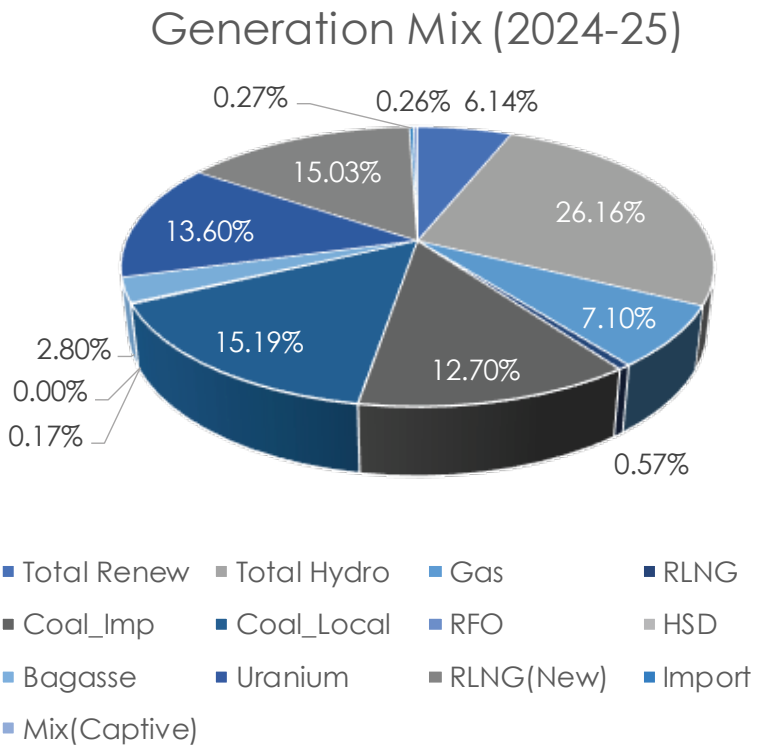





Generation Mix (2021-22)
0.31%
0.30%
2.66%
17.63%
29.84%
10.73%
3.20%
12.94%
0.00%
16.50%
0.65%
3.54%
1.71%
Total Renew
Total Hydro
Gas
RLNG
Coal_Imp
Coal_Local
RFO
HSD
Bagasse
Uranium
RLNG(New)
Import
Mix(Captive)


Generation Mix (2022-23)
0.29%
0.29%
3.93%
14.65%
27.96%
14.39%
7.66%
10.53%
3.07%
15.67%
0.00%
0.57%
1.01%
Total Renew
Total Hydro
Gas
RLNG
Coal_Imp
Coal_Local
RFO
HSD
Bagasse
Uranium
RLNG(New)
Import
Mix(Captive)


Generation Mix (2023-24)
0.28%
0.27%
5.09%
15.96%
27.12%
13.77%
2.93%
9.20%
9.43%
0.00%
14.19%
0.54%
1.21%
Total Renew
Total Hydro
Gas
RLNG
Coal_Imp
Coal_Local
RFO
HSD
Bagasse
Uranium
RLNG(New)
Import
Mix(Captive)


Generation Mix (2024-25)
0.27%
0.26%
6.14%
15.03%
26.16%
13.60%
7.10%
2.80%
15.19%
12.70%
0.00%
0.17%
0.57%
Total Renew
Total Hydro
Gas
RLNG
Coal_Imp
Coal_Local
RFO
HSD
Bagasse
Uranium
RLNG(New)
Import
Mix(Captive)

08

Allocation of Energy & Capacity to DISCOs

8.1 ALLOCATION TO DISCOS FY (2019-20) (WITH TRANSMISSION CONSTRAINTS)

8.2 ALLOCATION TO DISCOS FY (2019-20) (WITHOUT TRANSMISSION CONSTRAINTS)

8 ALLOCATION OF ENERGY & CAPACITY TO DISTRIBUTION COMPANIES

Price Transfer Mechanism envisages allocation of Capacity Purchase Price from pool to DSICOs on the basis of their non-coincidental Demand for the respective month via Capacity Transfer Charge which is calculated using the following expression:

CTC = CTR X MDI

Where,
CTC = Capacity Transfer Charge
CTR = Capacity Transfer Rate
MDI = Maximum Demand Indicator for Respective DISCO

Similarly, Energy Purchase price is allocated to DISCOs on the basis of total energy injected into the DISCO Network via Energy transfer Charge which is calculated as:

ETC = ETR X DEMAND FOR RESPECTIVE DISCO

Where,
ETC = Energy Transfer Charge
ETR = Energy Transfer Rate

SCENARIOS FOR ALLOCATION OF EPP & CPP TO DISTRIBUTION COMPANIES:

The PPP Projections have been developed on the basis of three scenarios as explained in the previous chapter. It is pertinent to mention that each of the below mentioned cases has been mapped onto uniform scenarios of fuel price projections:

Case 1

a. Allocation of EPP &CPP (FY 2019-20) (With Transmission Constraints)

i. PMS based Demand Projections
ii. Actual Demand based projections

Case2

b. Allocation of EPP &CPP (FY 2019-20)(W/O Transmission Constraints)

i. PMS based Demand Projections
ii. Actual Demand based projections

CASE 1

8.1 ALLOCATION TO DISCOS (FY 2019-20) (WITH TRANSMISSION CONSTRAINTS)

This scenario has been developed based on the practical realties, on the note of transmission constraints and the ATC based load shedding. Transmission Network modelled in SDDP includes partial 132 KV voltage level. As explained in precious sections, having transmission network congestions result in dispatch of expensive generators while cheap generation remains idle owing to these constraints, thus increasing the overall energy Purchase Price for the system. This is captured via modelling Transmission Network in SDDP thus resulting in the dispatches to depict the real-world constraints. As described in the previous section, SDDP does DC Flow Analysis therefore its primary focus is the Demand supply Balance, not MVAR compensation, voltage Regulations etc. while in the physical system, there are generators who are dispatched only to regulate the Voltage level. Secondly the Losses below 132 kV level as well as the recovery losses have not been accounted for this scenario. Moreover, the monthly fuel price projections have been assumed as under for this scenario. Further this has also been segregated on the basis of demand numbers i.e.

A. Allocation on PMS based Demand Projections
B. Allocation on Actual based Demand Projections

A. ALLOCATION ON PMS BASED DEMAND PROJECTION:

Under this section, the demand numbers have been inputted from PMS based projections for each distribution company as well keeping the Load Factors uniform on the basis of actual demand for 2018, allocating the Power Purchase Price to respective DISCOs for respective months, as per, mechanism explained above.

POWER PURCHASE PRICE ALLOCATION

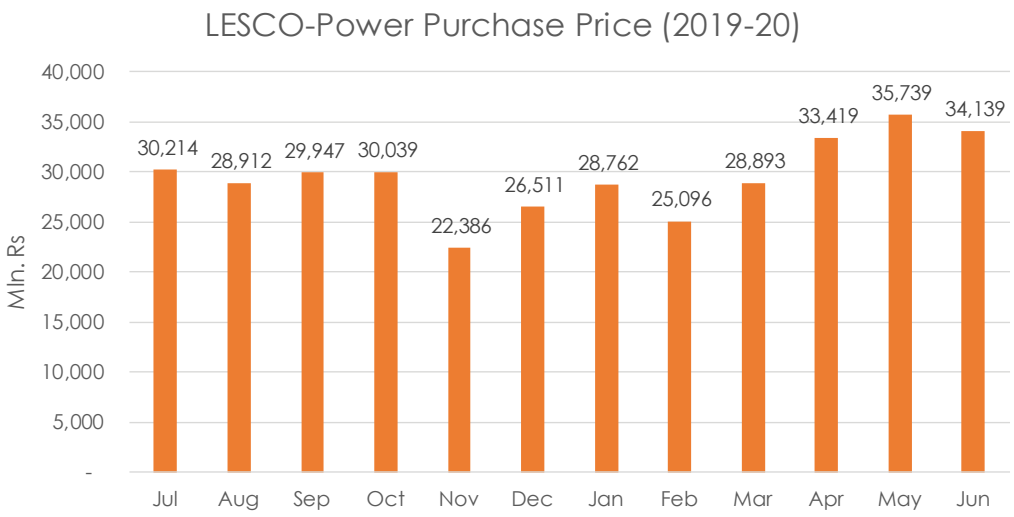
Power Purchase Price
FY 2019-20

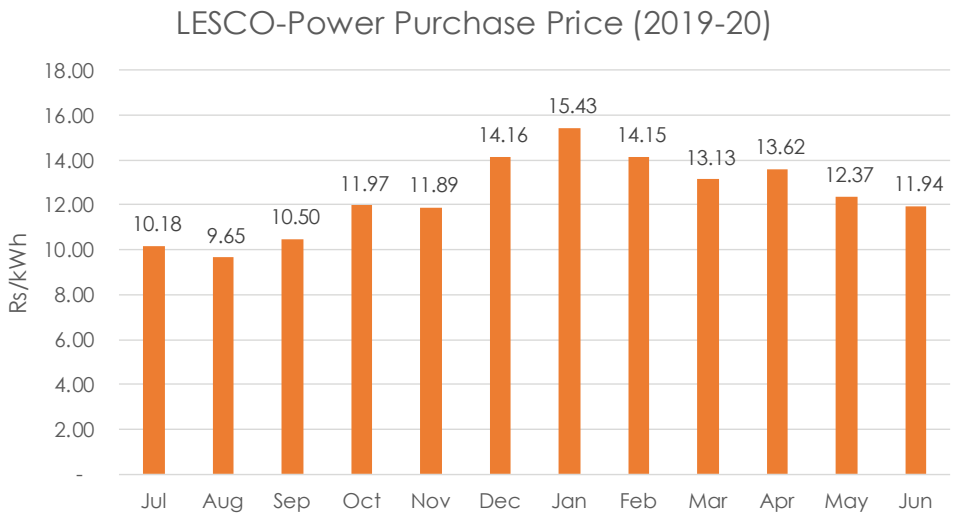
Million Rs.

Name	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Total
IESCO	14,737	13,310	13,729	13,632	11,716	12,022	13,600	12,096	12,675	14,239	16,049	17,209	**165,016**
LESCO	30,214	28,912	29,947	30,039	22,386	26,511	28,762	25,096	28,893	33,419	35,739	34,139	**354,057**
GEPCO	15,232	14,199	14,503	13,782	9,935	10,824	10,919	10,038	12,468	13,941	17,641	16,476	**159,958**
FESCO	18,662	18,805	19,156	19,930	15,352	15,422	16,132	15,437	20,529	21,722	22,409	22,237	**225,795**
MEPCO	26,346	25,275	25,987	26,378	19,514	19,797	20,345	17,674	24,725	27,229	29,674	30,072	**293,016**
PESCO	17,501	16,553	15,727	16,057	15,041	18,532	19,605	17,429	16,300	17,481	19,984	20,464	**210,674**
TESCO	1,345	1,437	1,743	1,966	2,141	2,244	2,140	2,236	1,928	2,161	2,321	1,773	**23,436**
HESCO	7,724	7,286	7,614	8,438	6,530	6,419	5,999	6,746	8,038	9,093	10,824	10,447	**95,159**
QESCO	7,089	6,881	6,443	7,997	7,962	8,716	8,889	8,280	9,159	8,667	9,220	8,398	**97,701**
SEPCO	6,339	5,821	5,940	5,869	4,240	4,015	5,717	3,970	4,975	5,890	7,519	7,076	**67,372**
KESC	4,657	4,412	4,613	5,597	5,329	5,698	5,652	5,250	6,369	6,191	6,367	5,504	**65,638**
Total	**149,845**	**142,890**	**145,402**	**149,685**	**120,147**	**130,200**	**137,761**	**124,253**	**146,060**	**160,034**	**177,749**	**173,795**	**1,757,822**

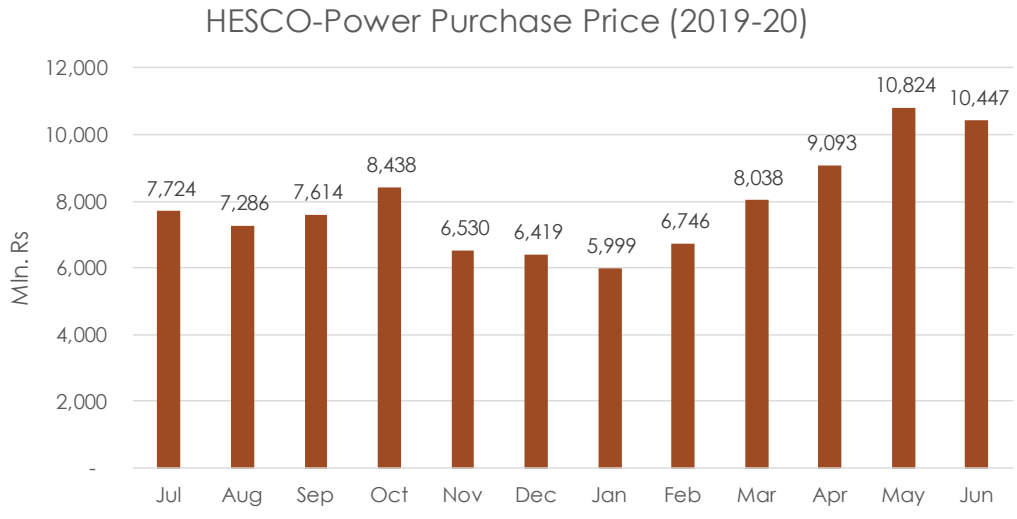
ALLOCATION TO DISCOS (FY 2019-20) (WITH TRANSMISSION CONSTRAINTS)
ALLOCATION ON PMS BASED DEMAND PROJECTION

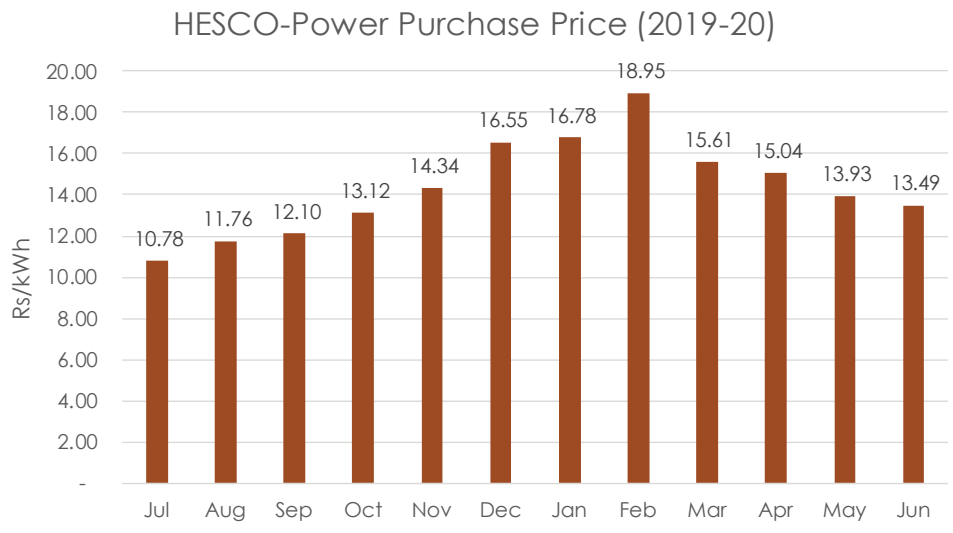
LAHORE ELECTRIC SUPPLY COMPANY





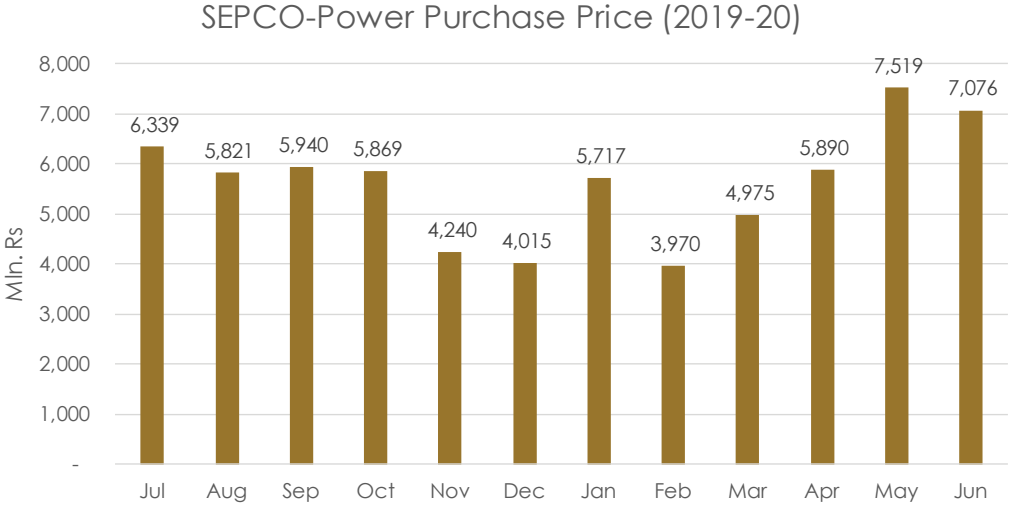
HYDERABAD ELECTRIC SUPPLY COMPANY

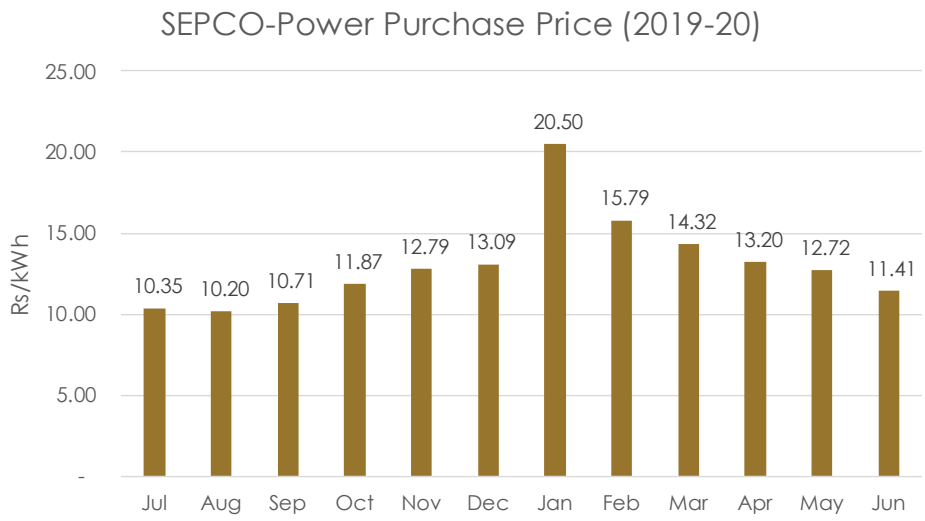




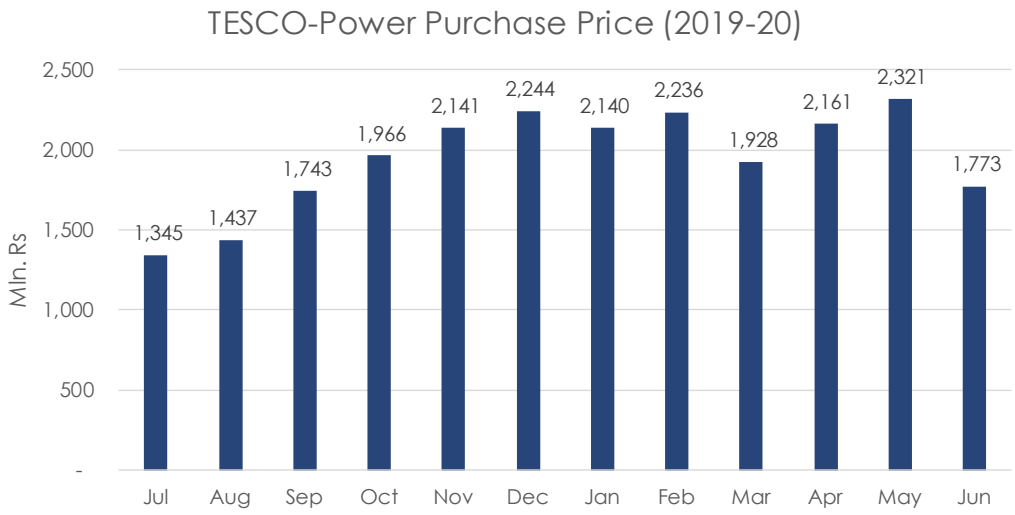
ALLOCATION TO DISCOS (FY 2019-20) (WITH TRANSMISSION CONSTRAINTS)
ALLOCATION ON PMS BASED DEMAND PROJECTION

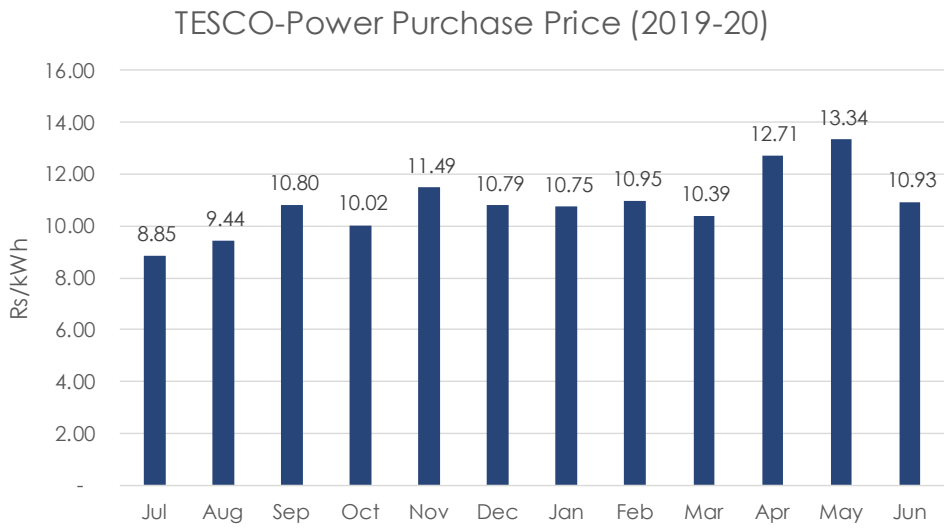
SUKKUR ELECTRIC POWER COMPANY





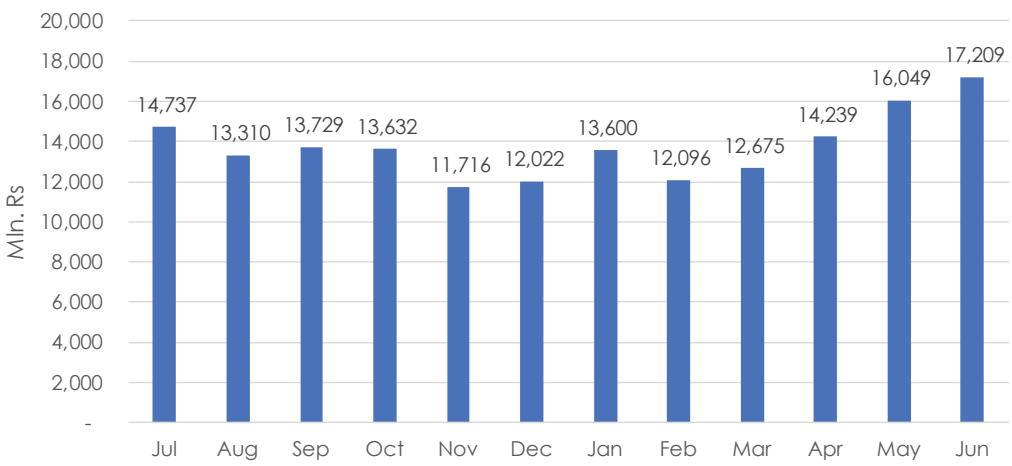
TRIBAL ELECTRIC SUPPLY COMPANY

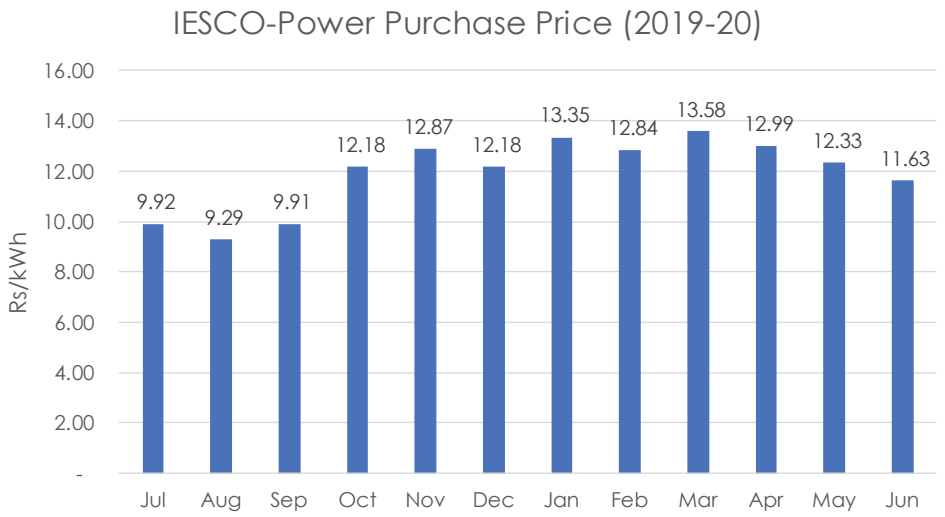




ALLOCATION TO DISCOS (FY 2019-20) (WITH TRANSMISSION CONSTRAINTS)
ALLOCATION ON PMS BASED DEMAND PROJECTION

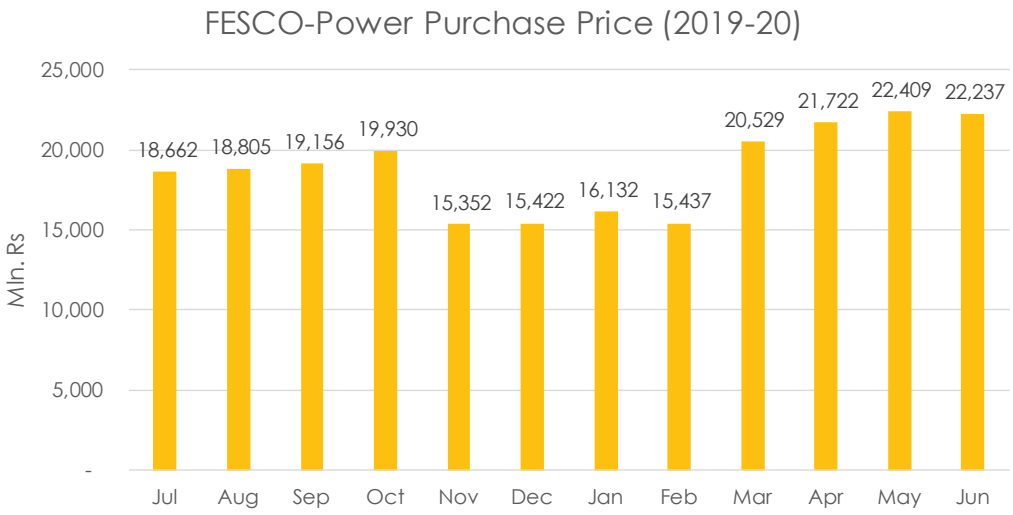
ISLAMABAD ELECTRIC SUPPLY COMPANY

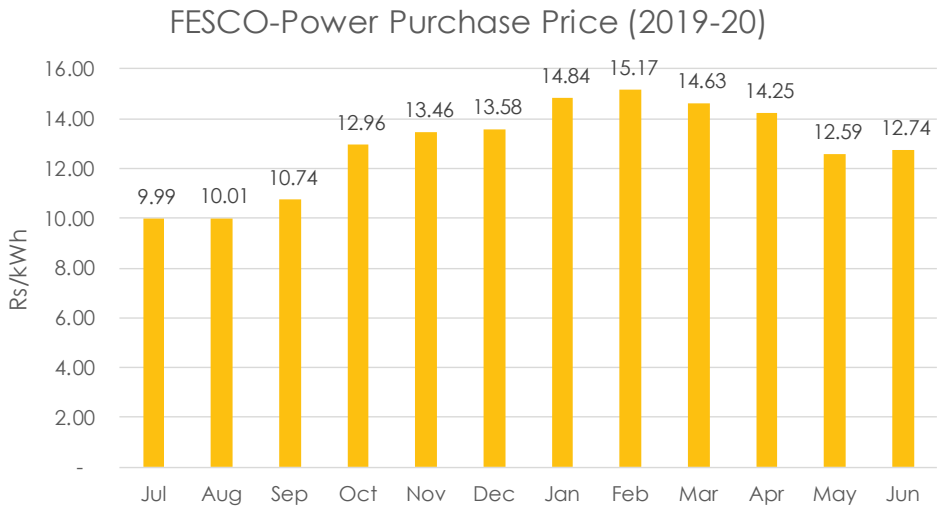




FAISALABAD ELECTRIC SUPPLY COMPANY

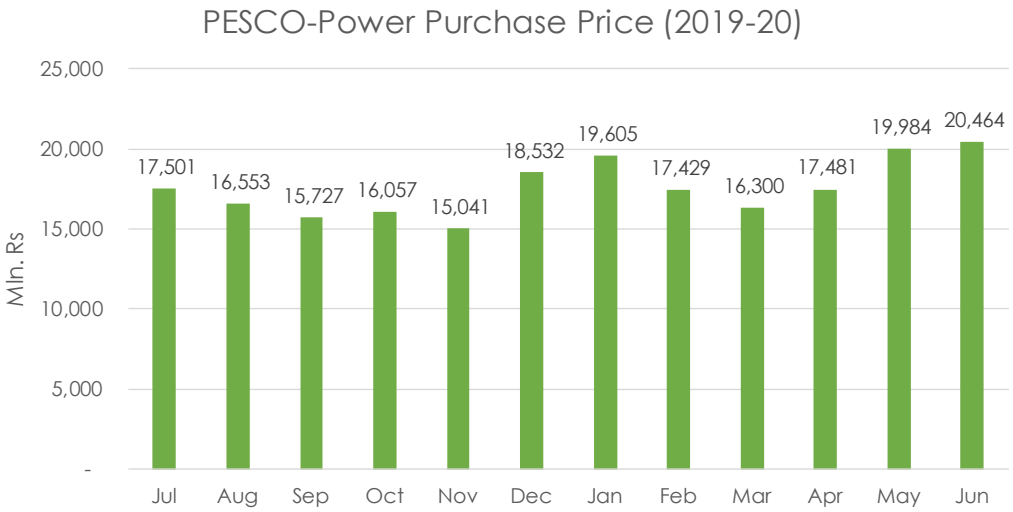
FESCO

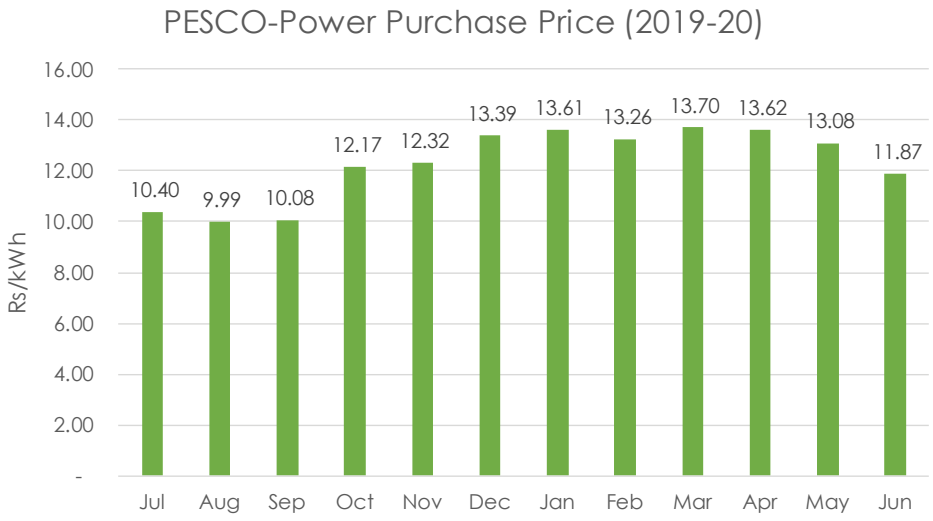




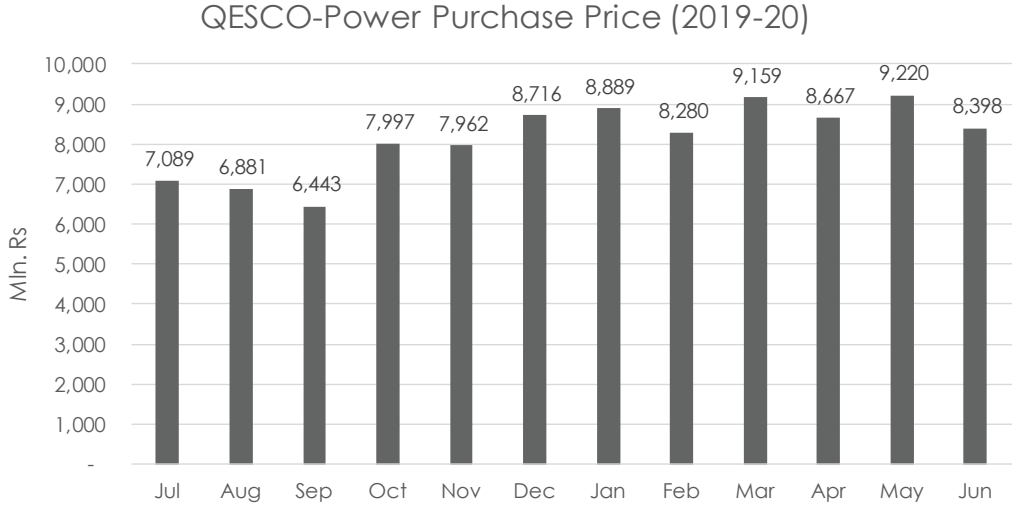
ALLOCATION TO DISCOS (FY 2019-20) (WITH TRANSMISSION CONSTRAINTS)
ALLOCATION ON PMS BASED DEMAND PROJECTION

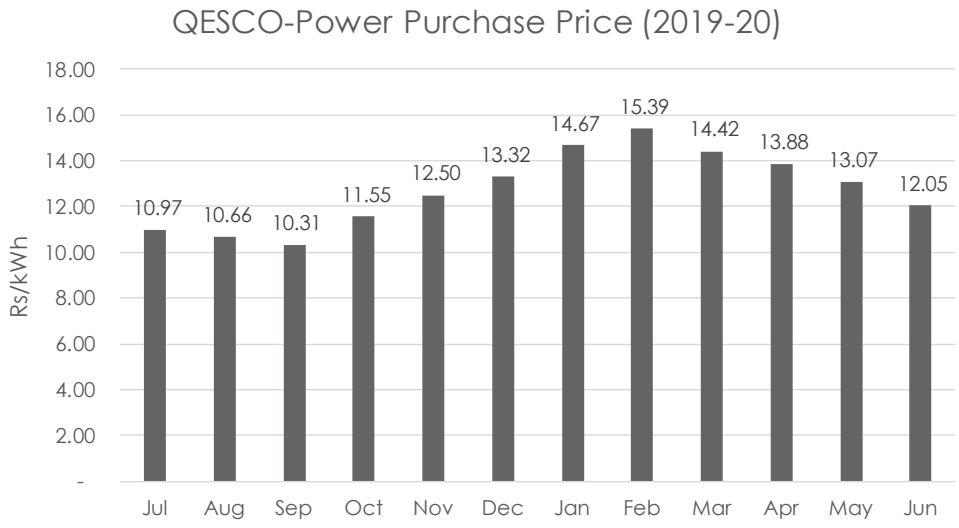
PESHAWAR ELECTRIC SUPPLY COMPANY





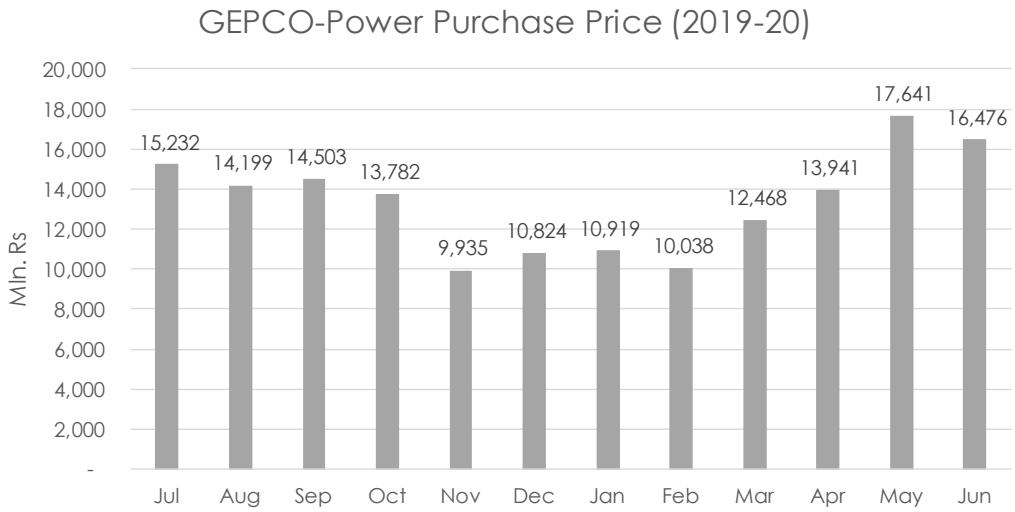
QUETTA ELECTRIC SUPPLY COMPANY

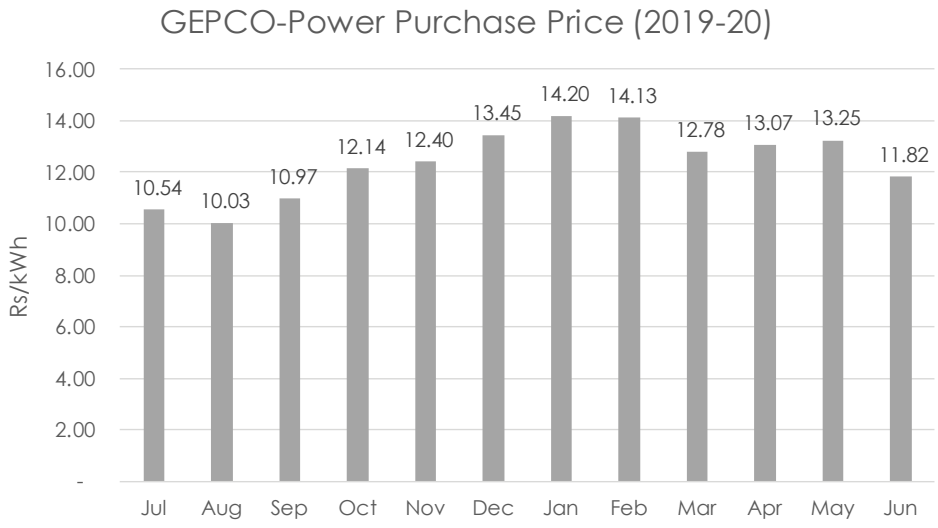




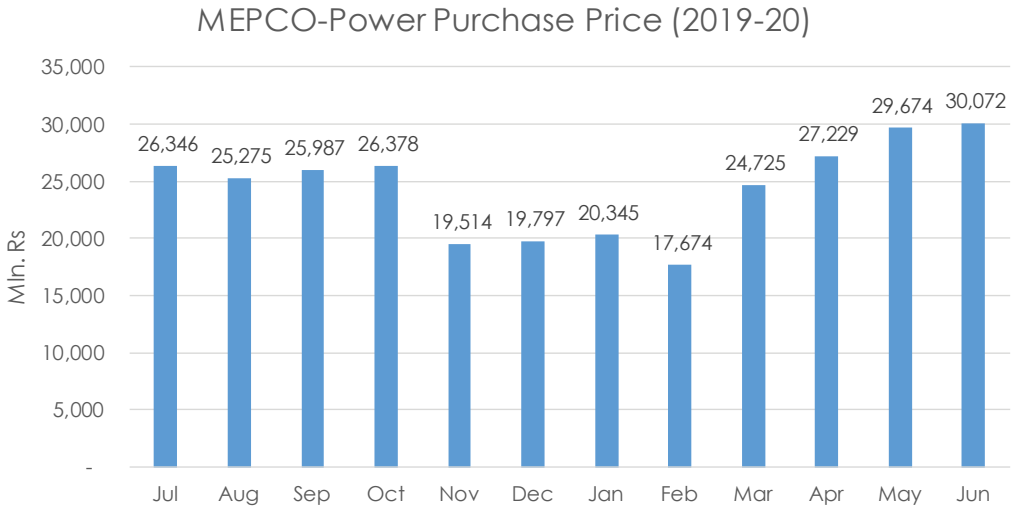
ALLOCATION TO DISCOS (FY 2019-20)(WITH TRANSMISSION CONSTRAINTS)
ALLOCATION ON PMS BASED DEMAND PROJECTION

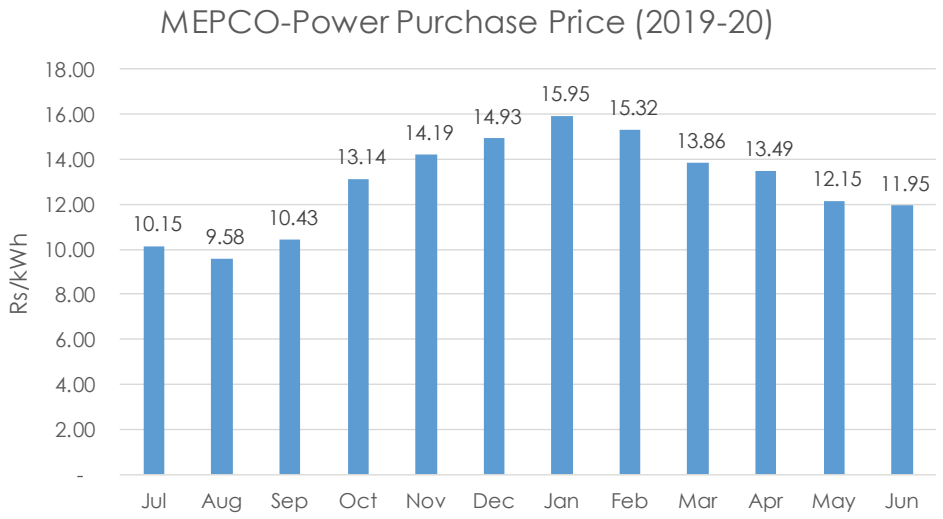
GUJRANWALA ELECTRIC POWER COMPANY



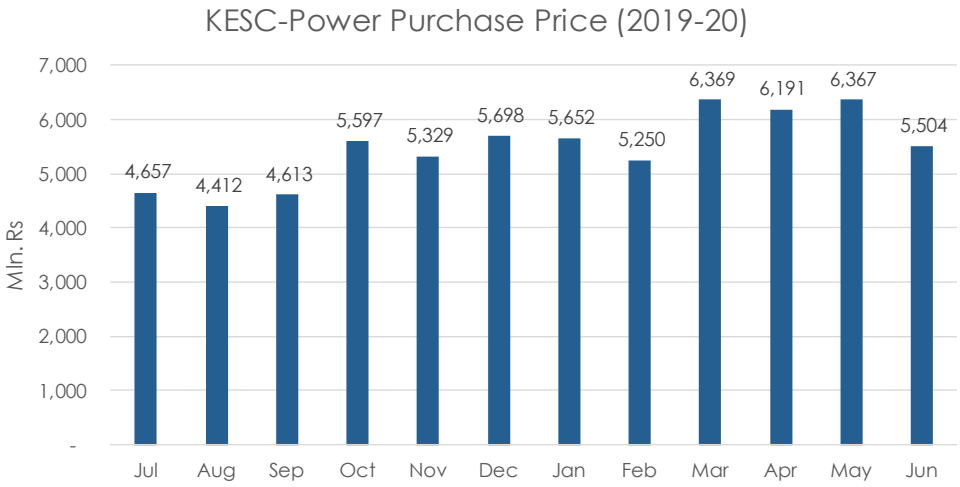


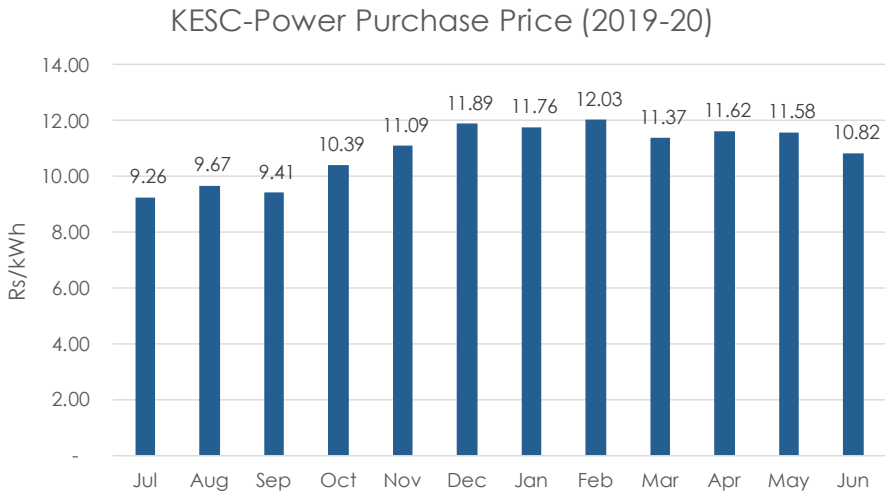
MULTAN ELECTRIC POWER COMPANY





KARACHI ELECTRIC SUPPLY COMPANY





II. ACTUAL DEMAND BASED PROJECTIONS:

Under this section, the demand inputted is on the basis of actual demand numbers keeping the load factors frozen for respective months and the CAGR based on previous five fiscal years is applied for future years projection, allocating PPP to each DISCO as per mechanism established above.

POWER PURCAHSE PRICE ALLOCATION

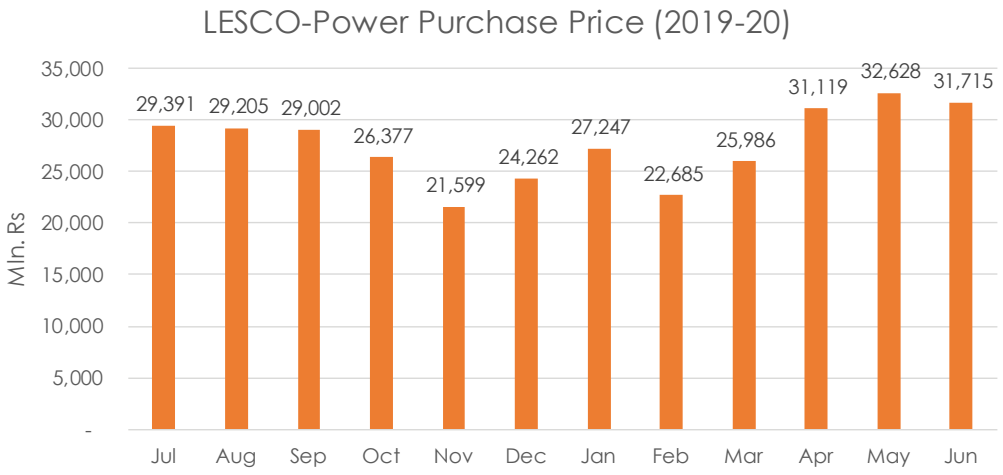
Power Purchase Price
FY 2019-20

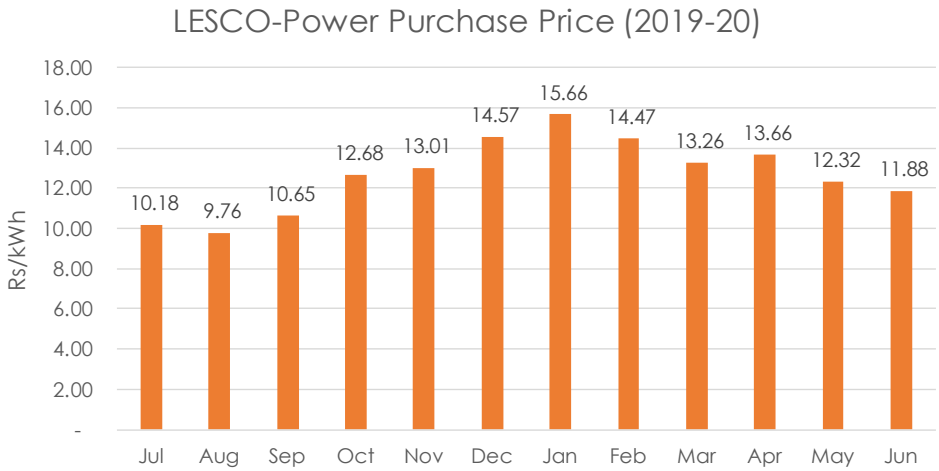
Million Rs.

Name	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Total
IESCO	14,326	13,450	13,272	11,997	11,329	10,847	12,780	10,823	11,439	13,215	14,647	15,957	**154,083**
LESCO	29,391	29,205	29,002	26,377	21,599	24,262	27,247	22,685	25,986	31,119	32,628	31,715	**331,216**
GEPCO	14,830	14,337	14,063	12,122	9,597	9,860	10,298	9,072	11,181	12,944	16,202	15,295	**149,802**
FESCO	18,144	18,989	18,565	17,670	14,864	14,062	15,251	14,047	18,664	20,290	20,491	20,752	**211,789**
MEPCO	25,626	25,533	25,162	23,425	18,920	18,198	19,307	16,097	22,361	25,338	27,048	27,938	**274,953**
PESCO	17,034	16,715	15,211	14,129	14,527	16,876	18,444	15,649	14,724	16,278	18,334	19,002	**196,924**
TESCO	1,303	1,451	1,689	1,683	2,064	1,998	1,982	1,962	1,686	2,002	2,133	1,636	**21,591**
HESCO	7,524	7,346	7,403	7,492	6,333	5,948	5,707	6,252	7,350	8,523	9,981	9,786	**89,647**
QESCO	6,909	6,944	6,236	6,989	7,694	7,933	8,398	7,545	8,315	8,081	8,459	7,807	**91,310**
SEPCO	6,169	5,877	5,756	5,148	4,100	3,649	5,485	3,626	4,514	5,473	6,882	6,551	**63,229**
KESC	4,518	4,457	4,452	4,819	5,130	5,129	5,268	4,662	5,635	5,696	5,777	5,075	**60,617**
Total	145,776	144,305	140,812	131,851	116,157	118,761	130,167	112,421	131,856	148,958	162,583	161,513	1,645,160

ALLOCATION TO DISCOS (FY 2019-20) (WITH TRANSMISSION CONSTRAINTS)
ALLOCATION ON ACTUAL -DEMAND PROJECTION

LAHORE ELECTRIC SUPPLY COMPANY

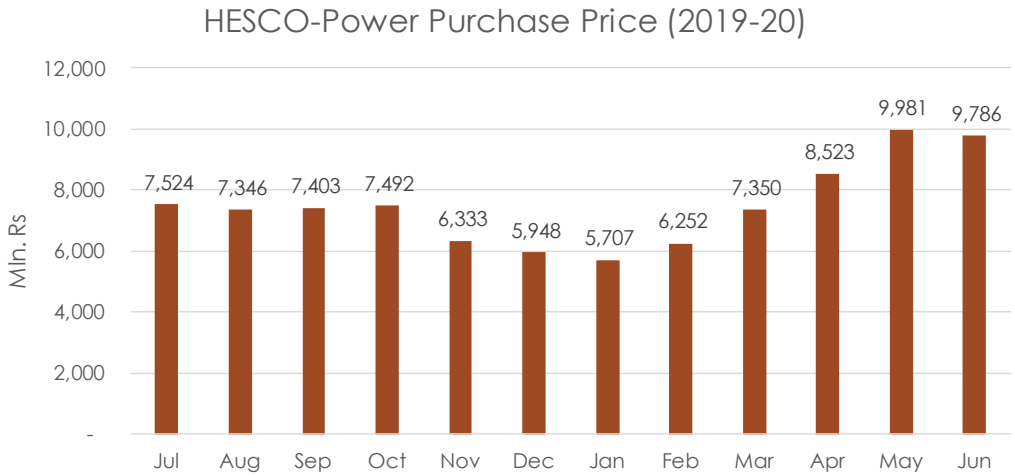


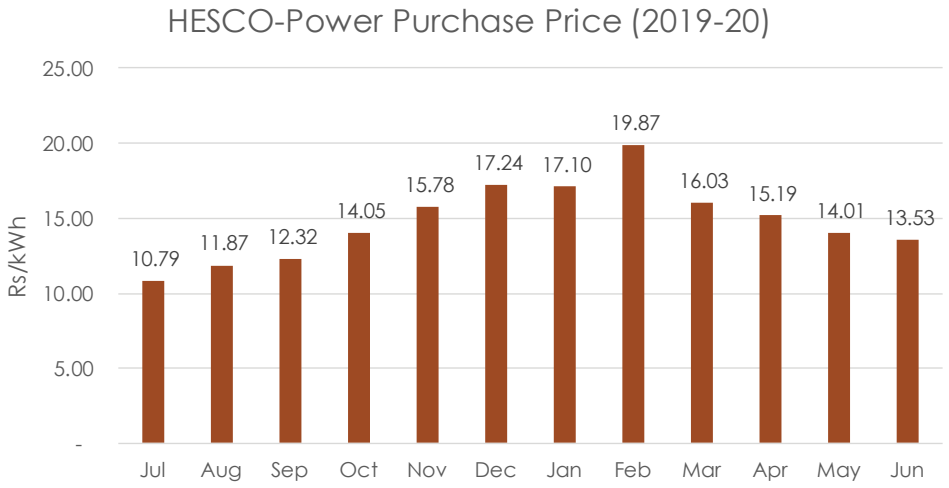


ALLOCATION TO DISCOS (FY 2019-20) (WITH TRANSMISSION CONSTRAINTS)
ALLOCATION ON ACTUAL -DEMAND PROJECTION

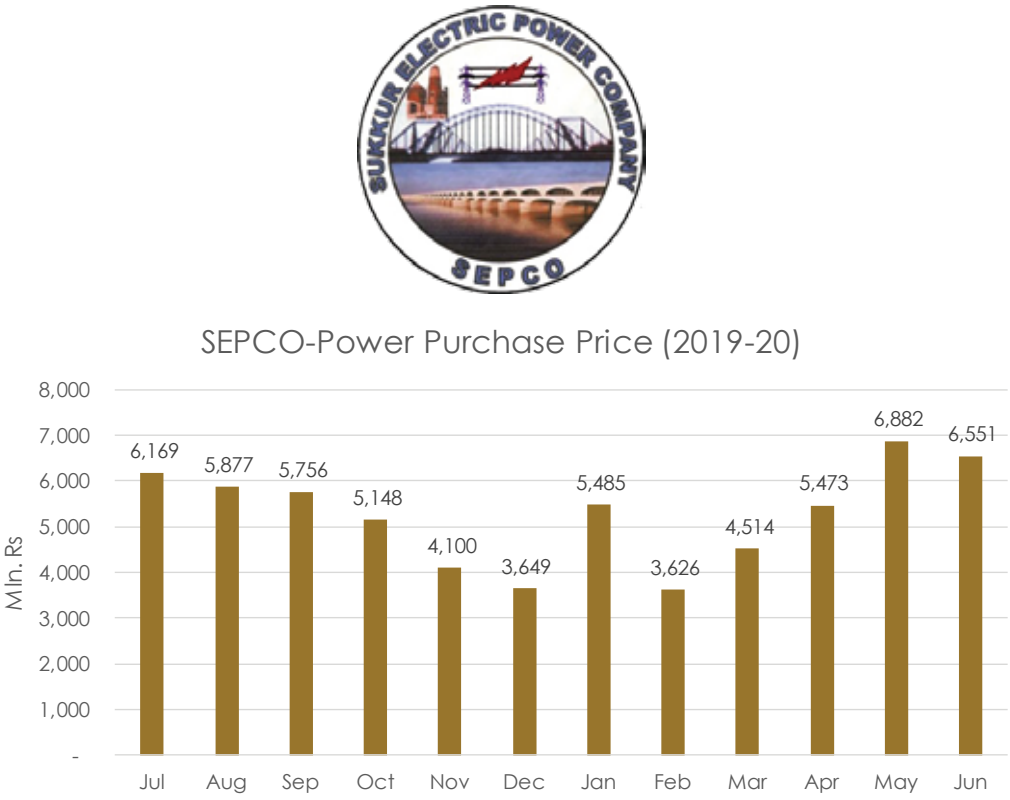
HYDERABAD ELECTRIC SUPPLY COMPANY

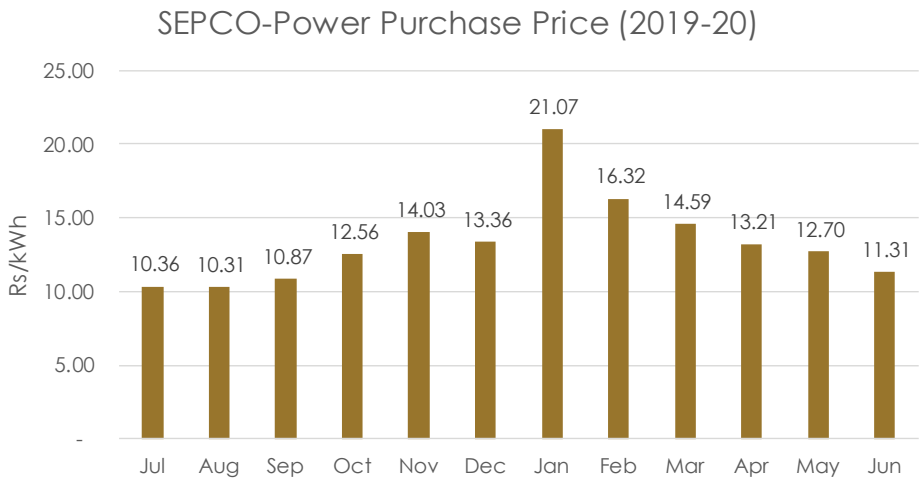
HESCO





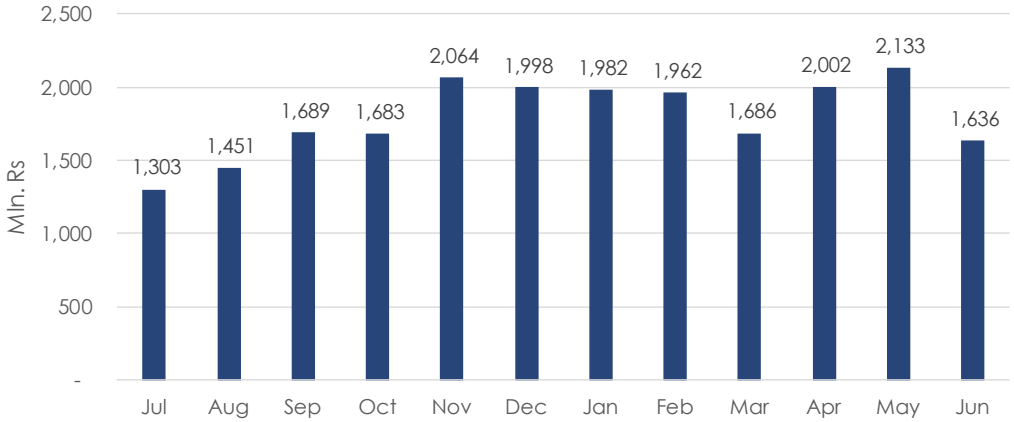
SUKKUR ELECTRIC POWER COMPANY

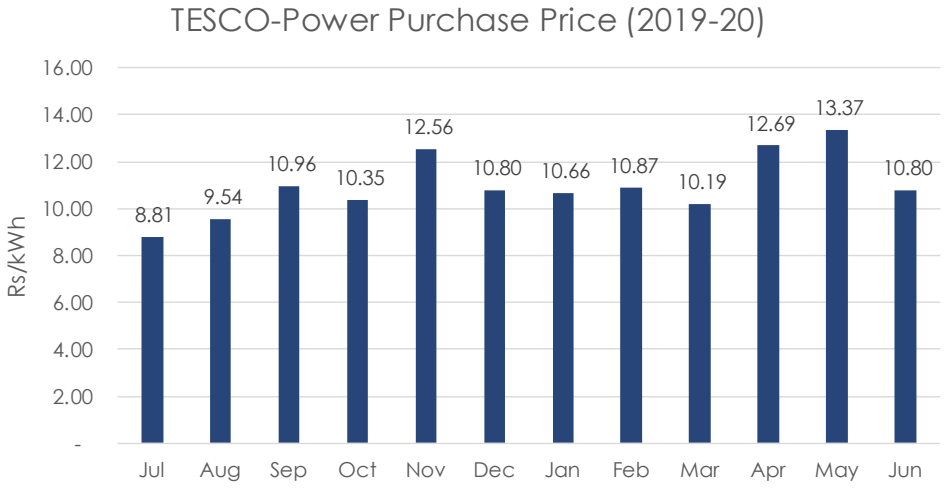




ALLOCATION TO DISCOS (FY 2019-20) (WITH TRANSMISSION CONSTRAINTS)
ALLOCATION ON ACTUAL -DEMAND PROJECTION

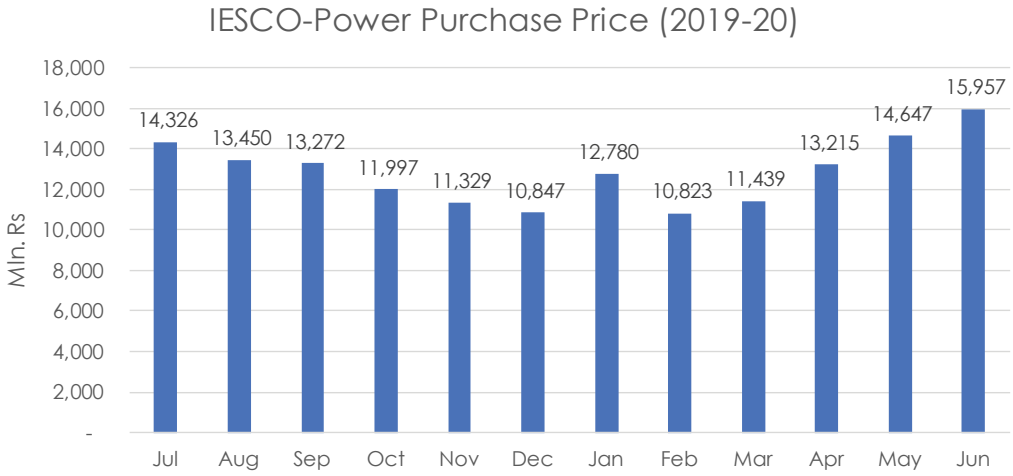
TRIBAL ELECTRIC SUPPLY COMPANY

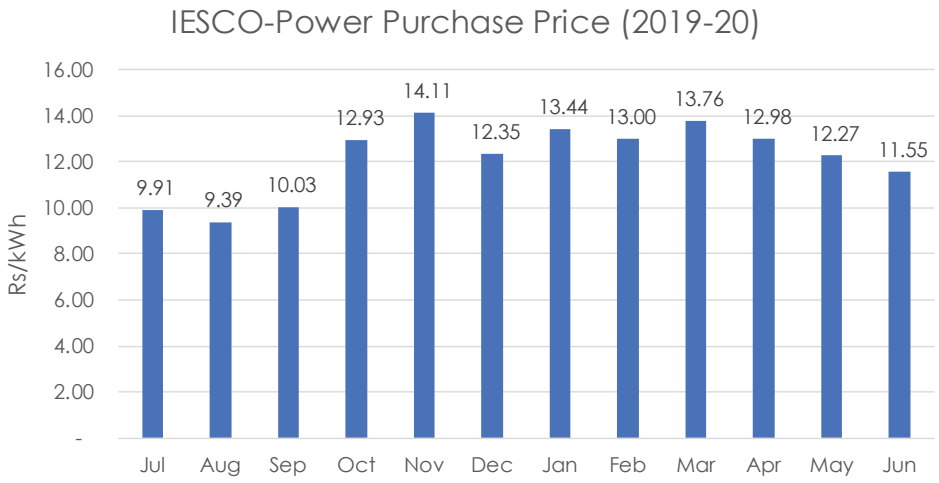




ALLOCATION TO DISCOS (FY 2019-20)(WITH TRANSMISSION CONSTRAINTS)
ALLOCATION ON ACTUAL -DEMAND PROJECTION

ISLAMABAD ELECTRIC SUPPLY COMPANY

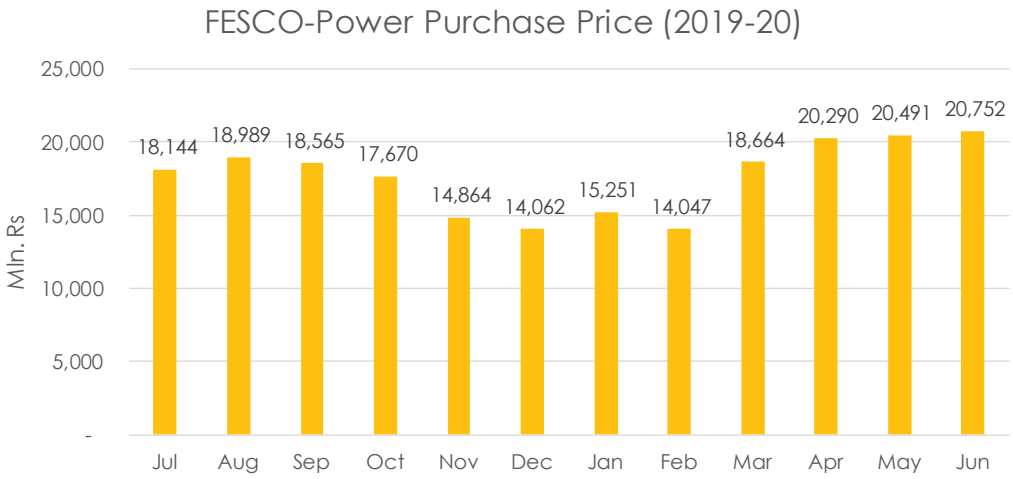


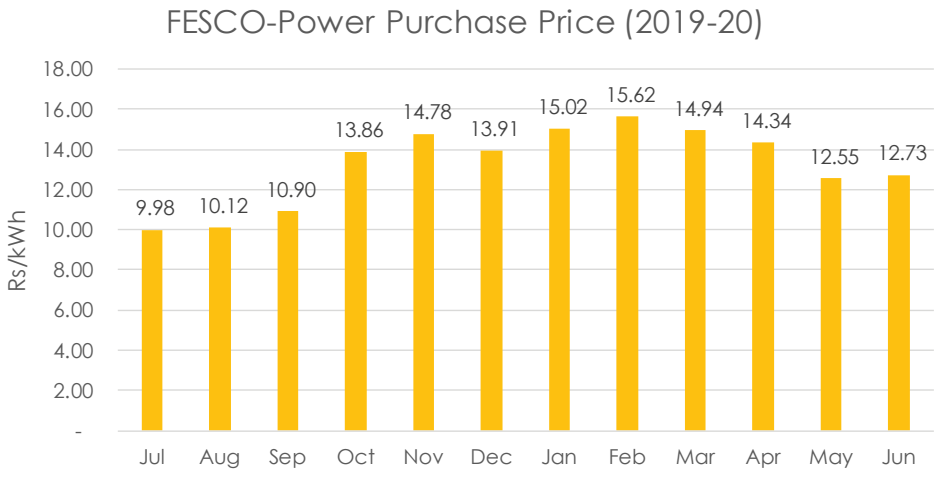


ALLOCATION TO DISCOS (FY 2019-20) (WITH TRANSMISSION CONSTRAINTS)
ALLOCATION ON ACTUAL -DEMAND PROJECTION

FAISALABAD ELECTRIC SUPPLY COMPANY

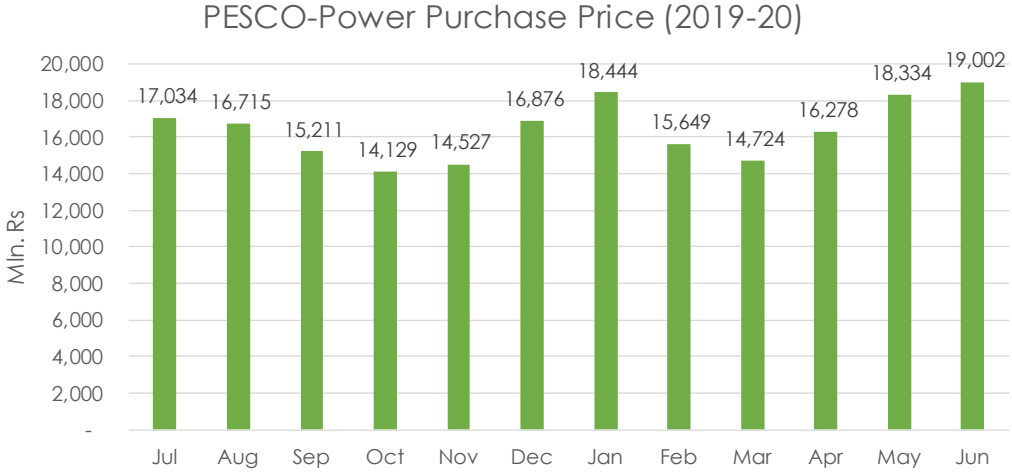
FESCO

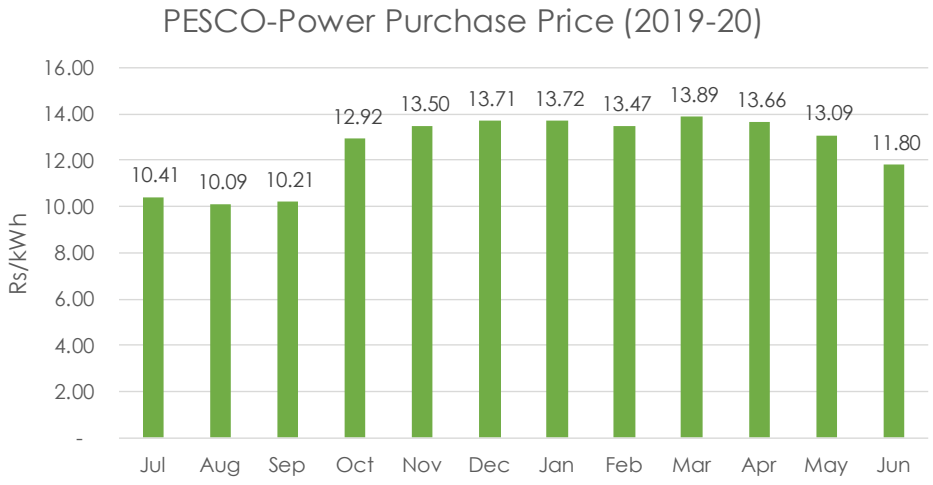




ALLOCATION TO DISCOS (FY 2019-20) (WITH TRANSMISSION CONSTRAINTS)
ALLOCATION ON ACTUAL -DEMAND PROJECTION

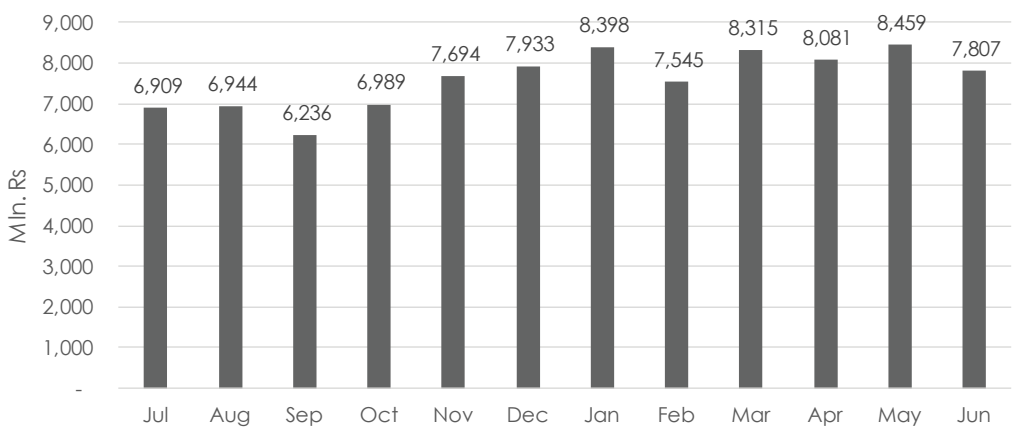
PESHAWAR ELECTRIC SUPPLY COMPANY

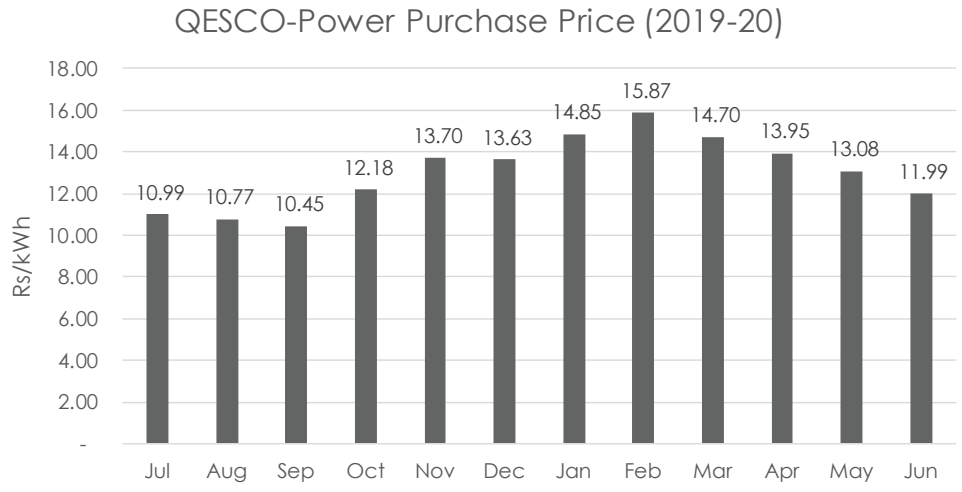




ALLOCATION TO DISCOS (FY 2019-20) (WITH TRANSMISSION CONSTRAINTS)
ALLOCATION ON ACTUAL -DEMAND PROJECTION

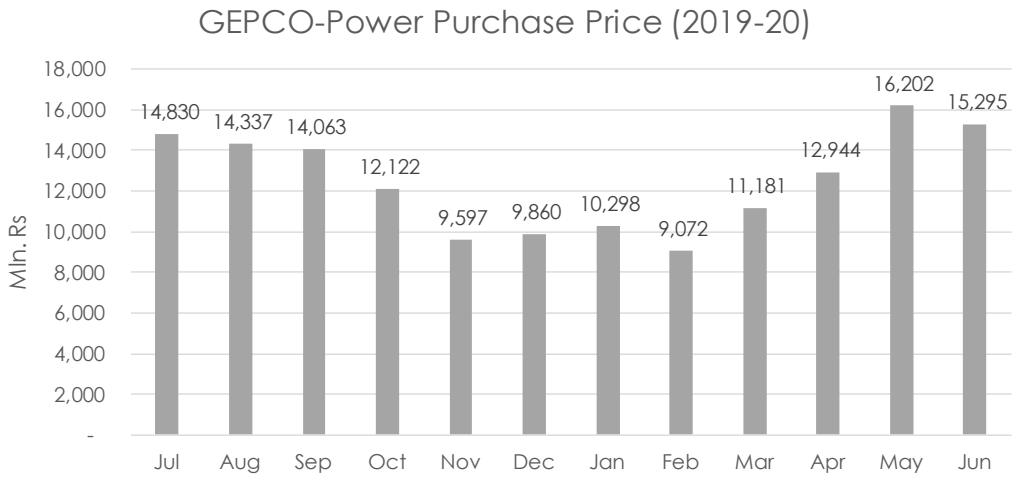
QUETTA ELECTRIC SUPPLY COMPANY

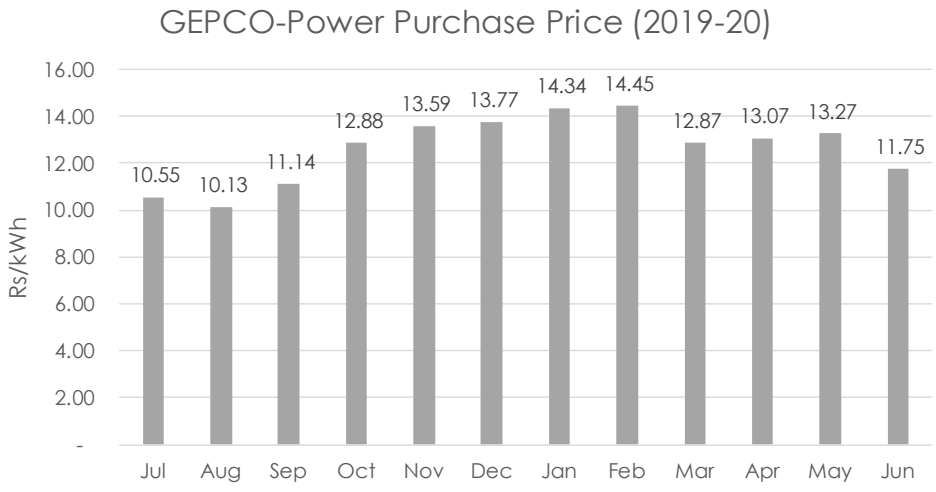




ALLOCATION TO DISCOS (FY 2019-20)(WITH TRANSMISSION CONSTRAINTS)
ALLOCATION ON ACTUAL -DEMAND PROJECTION

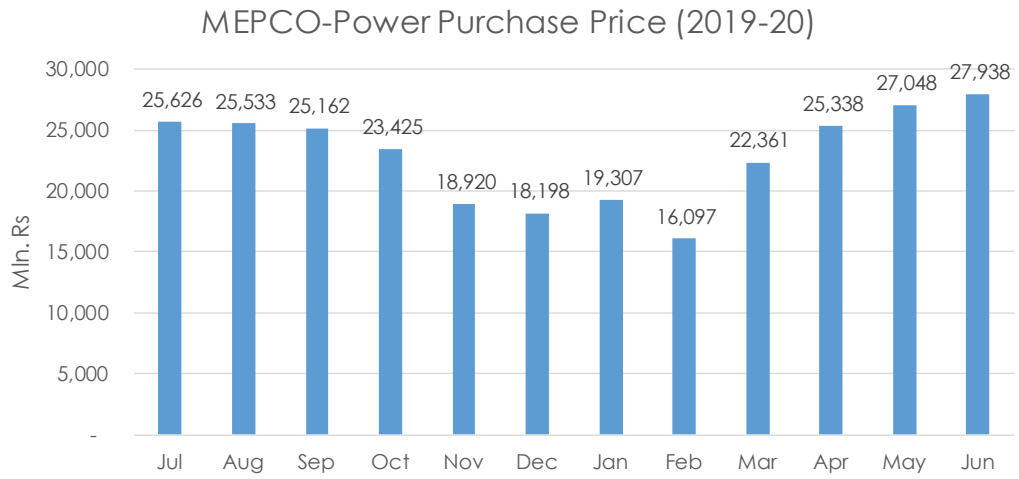
GUJRANWALA ELECTRIC POWER COMPANY

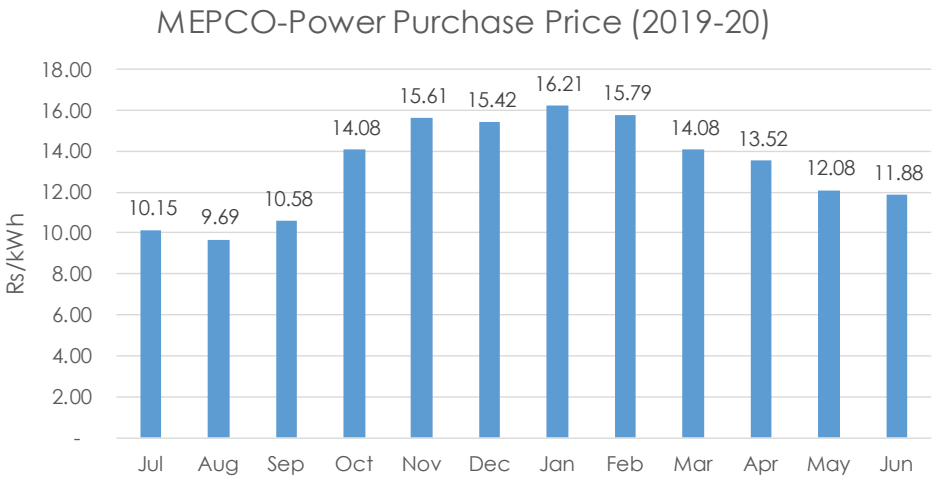




ALLOCATION TO DISCOS (FY 2019-20) (WITH TRANSMISSION CONSTRAINTS)
ALLOCATION ON ACTUAL -DEMAND PROJECTION

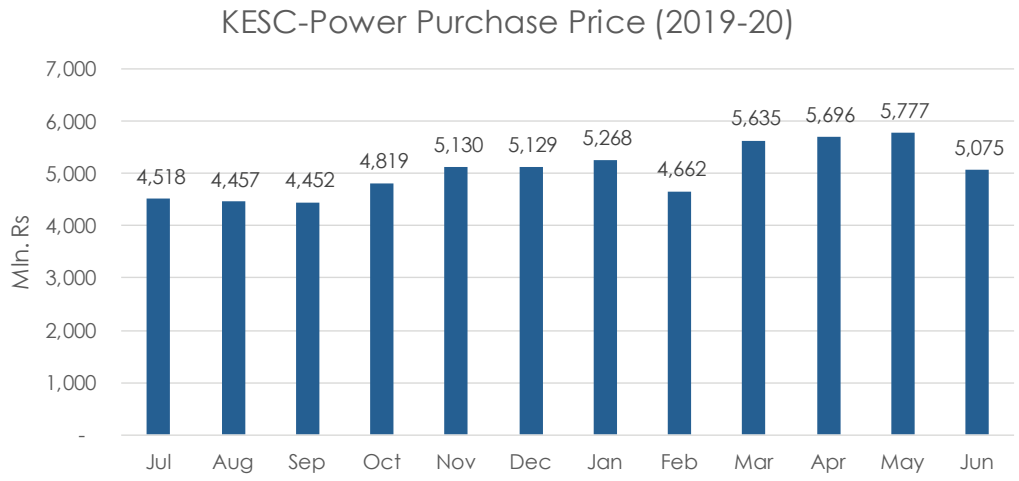
MULTAN ELECTRIC POWER COMPANY

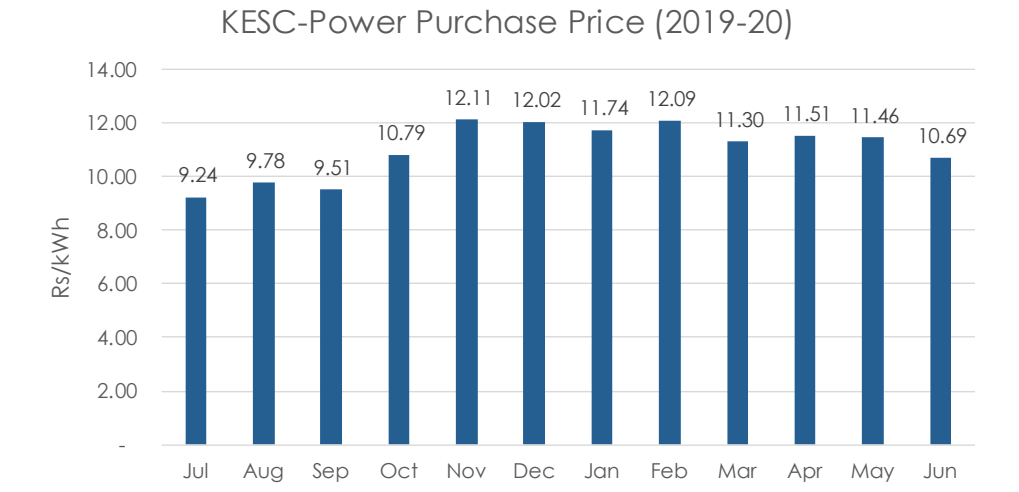




ALLOCATION TO DISCOS (FY 2019-20) (WITH TRANSMISSION CONSTRAINTS)
ALLOCATION ON ACTUAL DEMAND PROJECTION

KARACHI ELECTRIC SUPPLY COMPANY





CASE 2

8.2 ALLOCATION TO DISCOS FY (2019-20) (WITHOUT TRANSMISSION CONSTRAINTS)

This scenario has been developed to estimate the impact of transmission constraints as well as load shedding on the Power Purchase Price (PPP) allocation via considering the same assumption set as that of previous scenario apart from demand and transmission network. Apart from this, the present scenario is simulated without linear power flow analysis i.e. single bus analysis thus pointing out the status of KPIs (Key performance Indicators) associated with the performance of power sector at masses ultimately enabling the policy makers for taking the informed and well-versed decision to make this sector sustainable. This segment has been segregated on the basis of demand numbers as well under following two categories.

A. ALLOCATION ON PMS BASED DEMAND PROJECTIONS
B. ALLOCATION ON ACTUAL DEMAND BASED PROJECTIONS

A. ALLOCATION ON PMS BASED DEMAND PROJECTION

Under this section, the demand numbers have been inputted from PMS based projections for each distribution company as well keeping the Load Factors uniform on the basis of actual demand for 2018, allocating the Power Purchase Price to respective DISCOs for respective months, as per ,mechanism explained above.
as per, mechanism explained above.

POWER PURCAHSE PRICE ALLOCATION

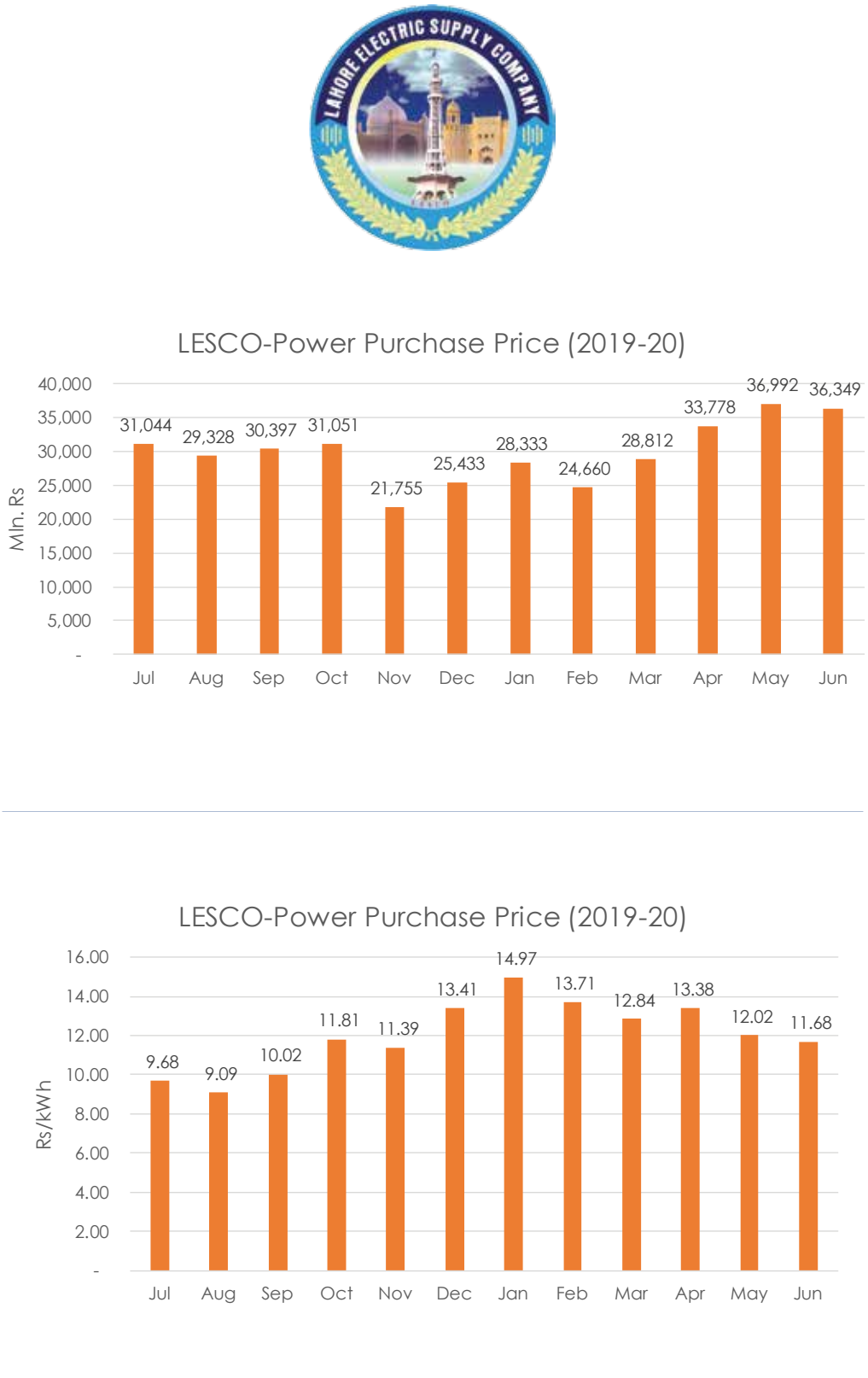
Power Purchase Price
FY 2019-20

Million Rs.

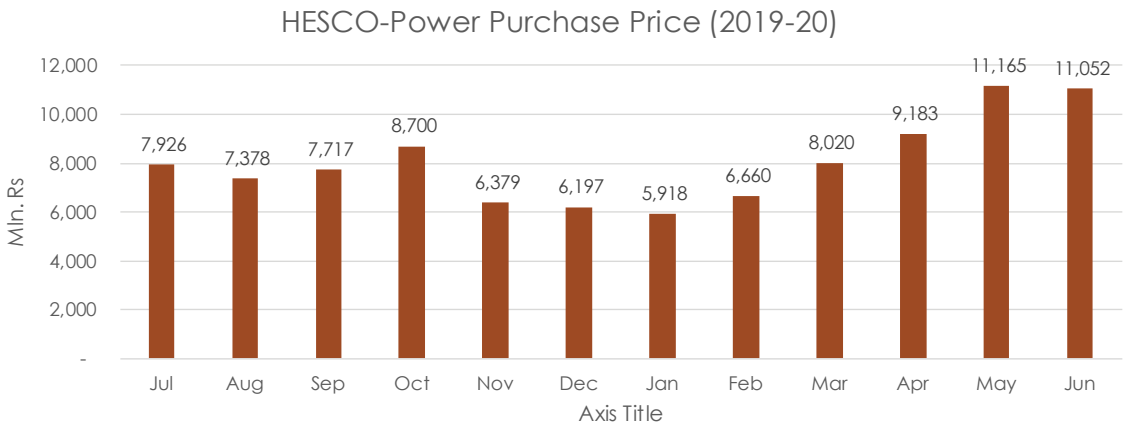
Name	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Total
IESCO	15,151	13,507	13,945	14,084	11,411	11,452	13,364	11,864	12,641	14,399	16,613	18,351	**166,783**
LESCO	31,044	29,328	30,397	31,051	21,755	25,433	28,333	24,660	28,812	33,778	36,992	36,349	**357,934**
GEPCO	15,638	14,398	14,713	14,240	9,667	10,360	10,742	9,863	12,432	14,097	18,223	17,553	**161,926**
FESCO	19,182	19,070	19,439	20,554	14,971	14,768	15,882	15,188	20,480	21,947	23,182	23,595	**228,257**
MEPCO	27,071	25,641	26,379	27,194	19,056	19,034	20,053	17,391	24,661	27,524	30,730	32,019	**296,752**
PESCO	17,973	16,786	15,970	16,590	14,632	17,735	19,272	17,105	16,257	17,669	20,650	21,797	**212,437**
TESCO	1,387	1,458	1,769	2,044	2,079	2,124	2,094	2,186	1,921	2,186	2,397	1,898	**23,540**
HESCO	7,926	7,378	7,717	8,700	6,379	6,197	5,918	6,660	8,020	9,183	11,165	11,052	**96,294**
QESCO	7,273	6,973	6,541	8,275	7,749	8,339	8,749	8,149	9,136	8,759	9,528	8,938	**98,408**
SEPCO	6,511	5,902	6,028	6,068	4,130	3,839	5,654	3,909	4,963	5,955	7,776	7,554	**68,287**
KESC	4,795	4,476	4,688	5,812	5,167	5,422	5,540	5,142	6,348	6,267	6,603	5,894	**66,154**
Total	153,950	144,918	147,586	154,612	116,995	124,701	135,601	122,116	145,672	161,763	183,861	184,999	1,776,773

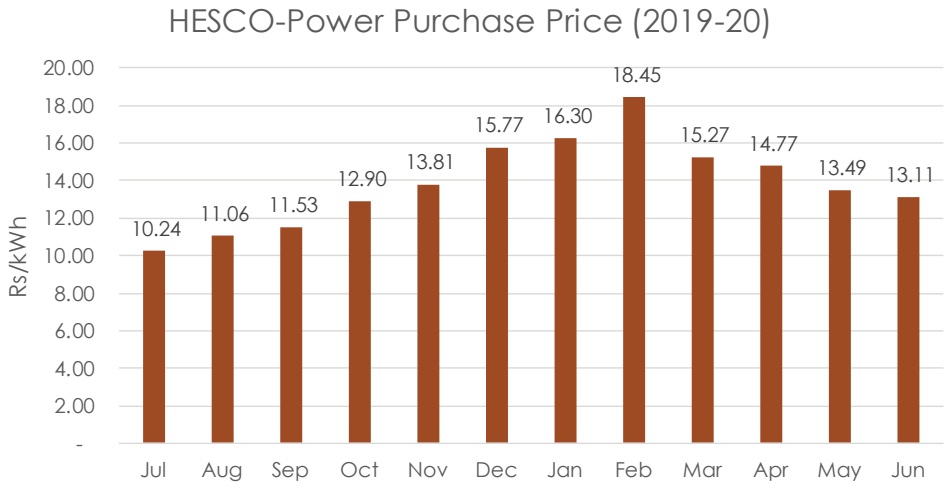
ALLOCATION TO DISCOS (FY 2019-20) (WITHOUT TRANSMISSION CONSTRAINTS)
ALLOCATION ON PMS BASED DEMAND PROJECTION

LAHORE ELECTRIC SUPPLY COMPANY



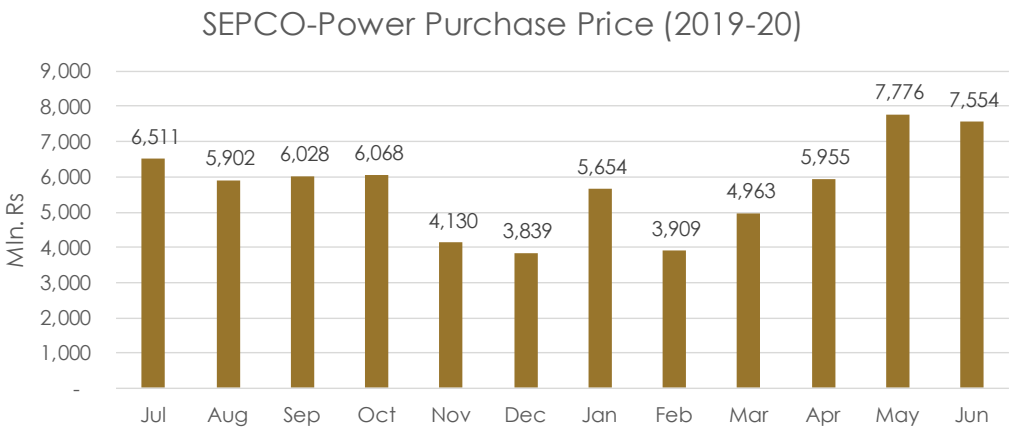
HYDERABAD ELECTRIC SUPPLY COMPANY

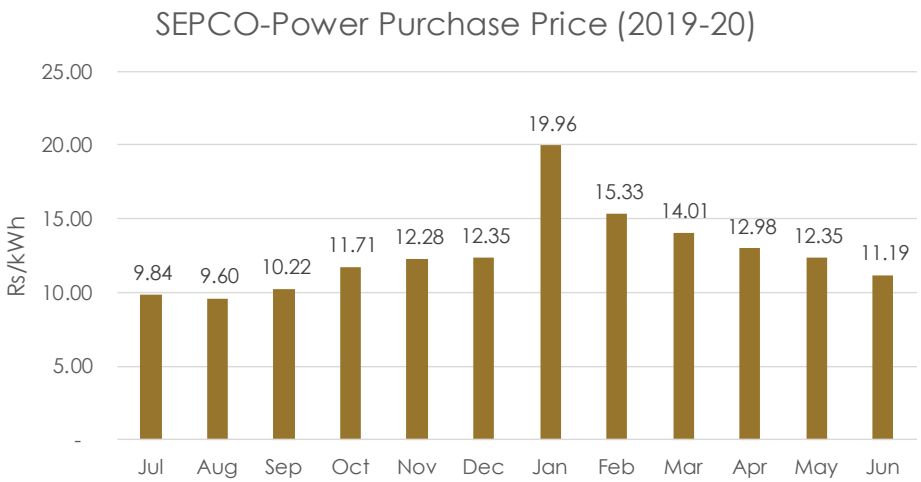




ALLOCATION TO DISCOS (FY 2019-20) (WITHOUT TRANSMISSION CONSTRAINTS)
ALLOCATION ON PMS BASED DEMAND PROJECTION

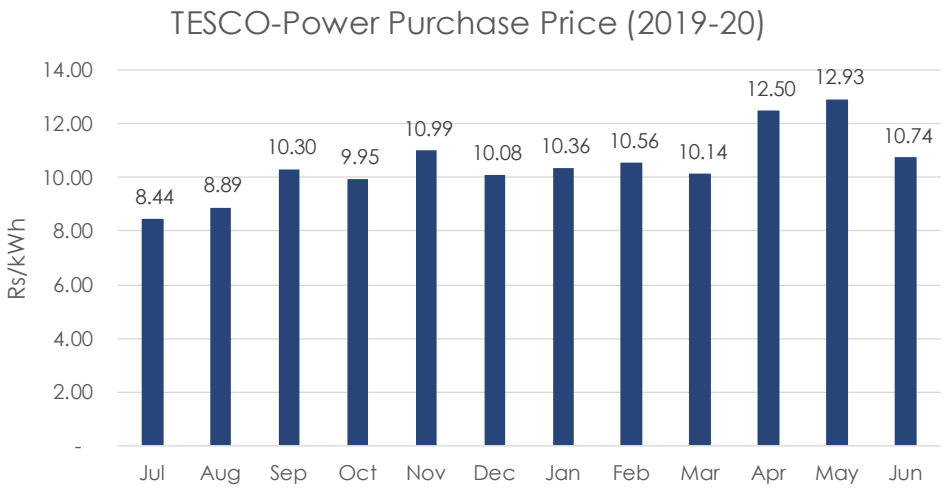
SUKKUR ELECTRIC POWER COMPANY

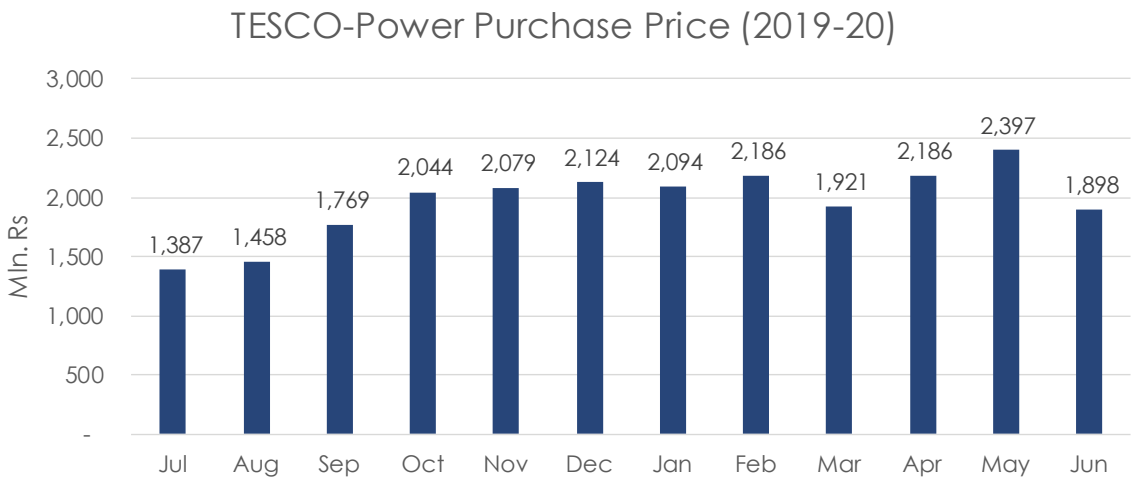




ALLOCATION TO DISCOS (FY 2019-20) (WITHOUT TRANSMISSION CONSTRAINTS)
ALLOCATION ON PMS BASED DEMAND PROJECTION

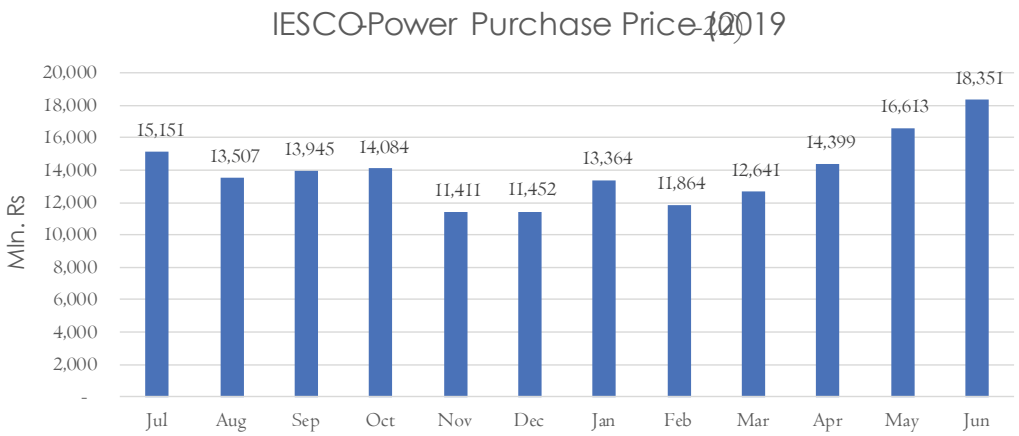
TRIBAL ELECTRIC SUPPLY COMPANY

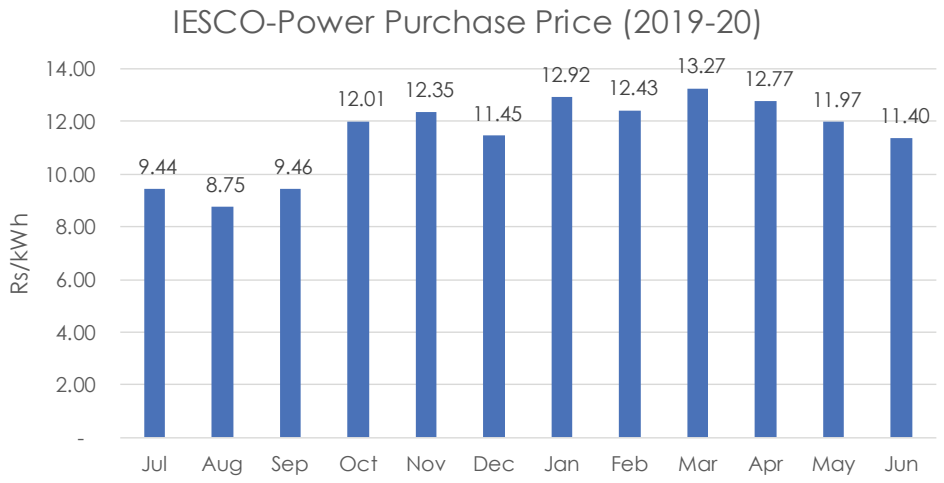




ALLOCATION TO DISCOS (FY 2019-20) (WITHOUT TRANSMISSION CONSTRAINTS)
ALLOCATION ON PMS BASED DEMAND PROJECTION

ISLAMABAD ELECTRIC SUPPLY COMPANY

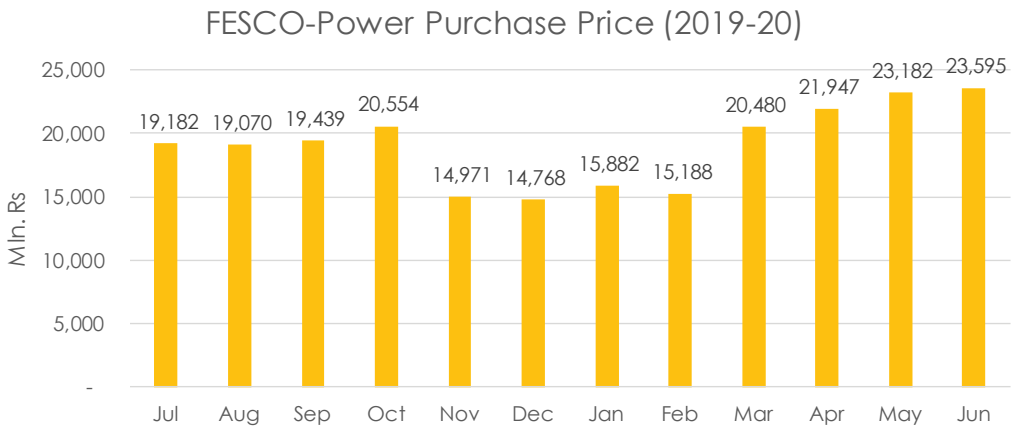


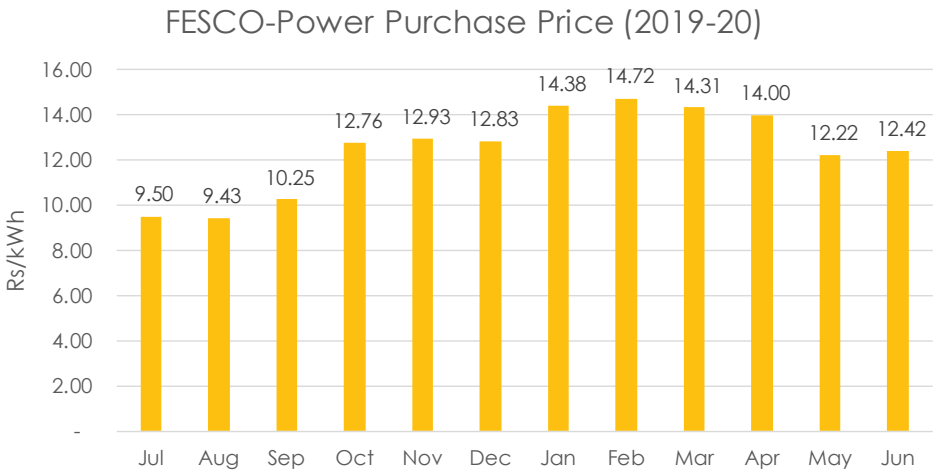


ALLOCATION TO DISCOS (FY 2019-20) (WITHOUT TRANSMISSION CONSTRAINTS)
ALLOCATION ON PMS BASED DEMAND PROJECTION

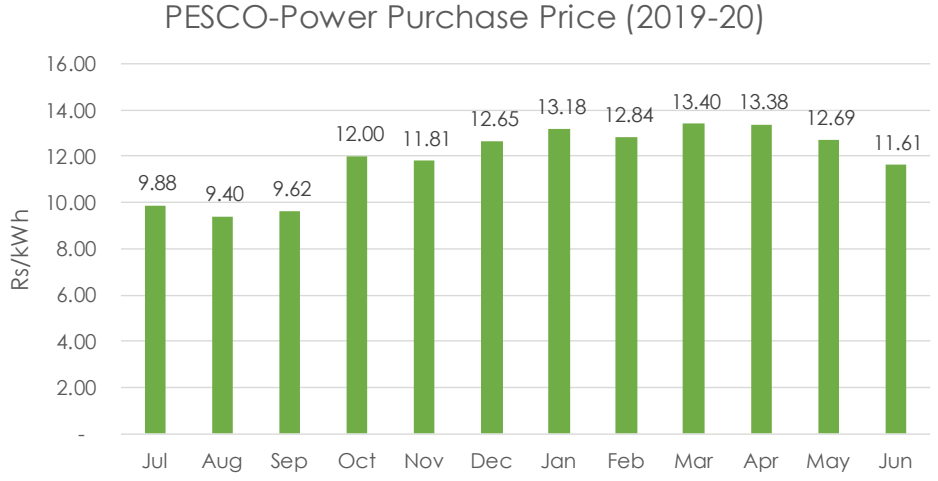
FAISALABAD ELECTRIC SUPPLY COMPANY

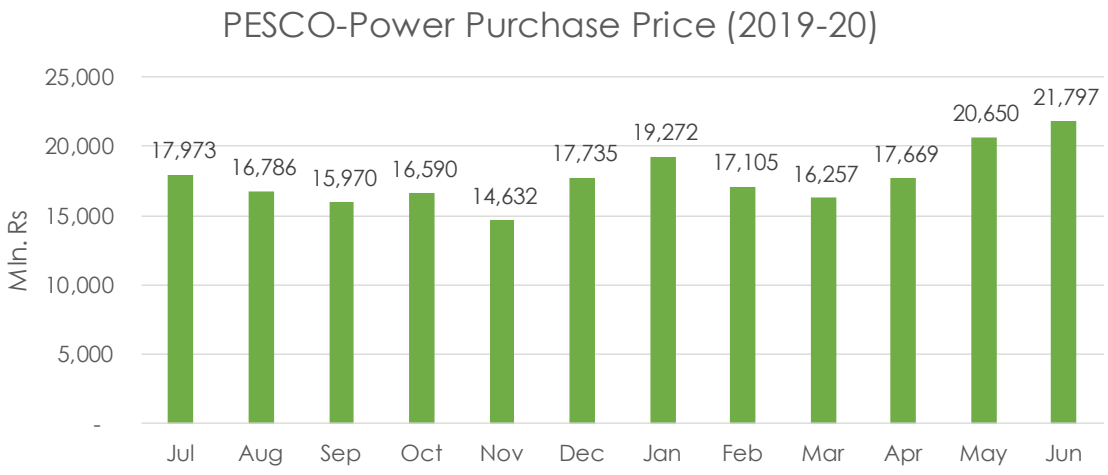
FESCO



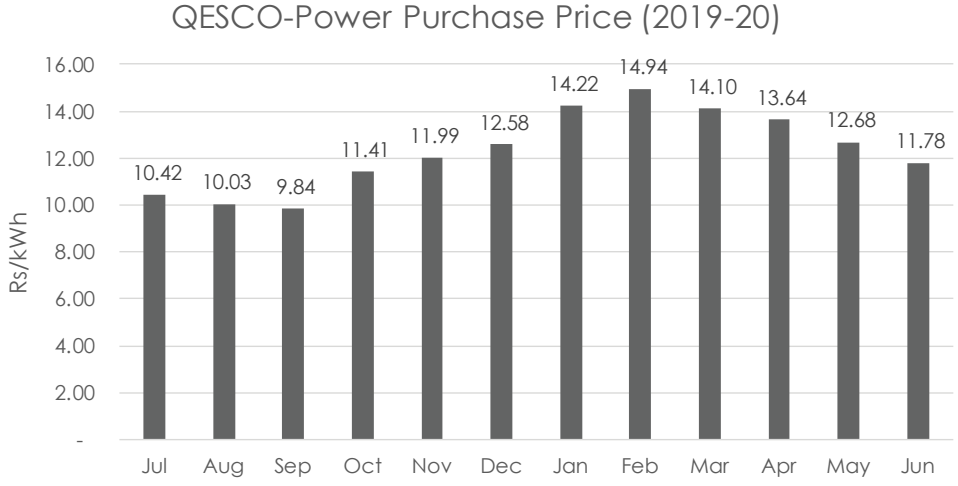


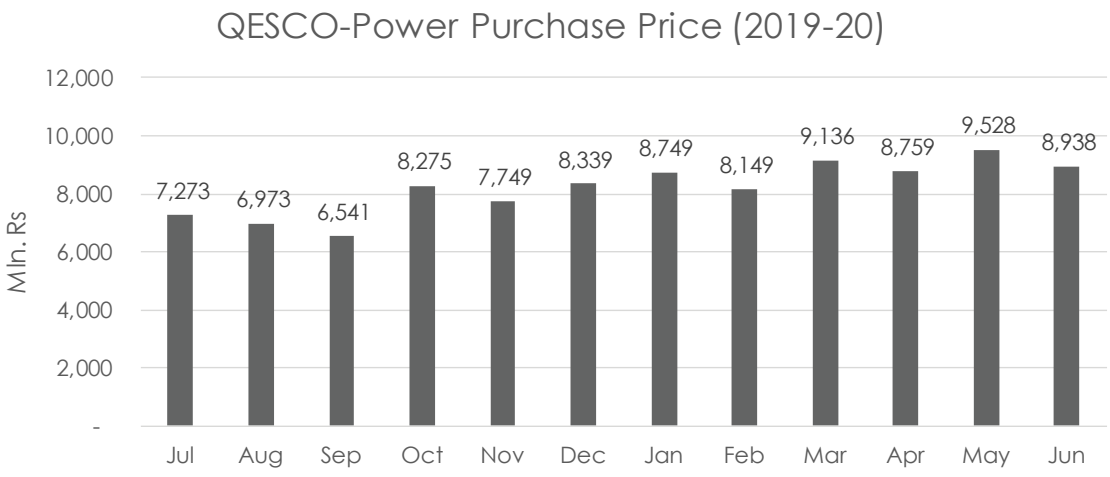
PESHAWAR ELECTRIC SUPPLY COMPANY





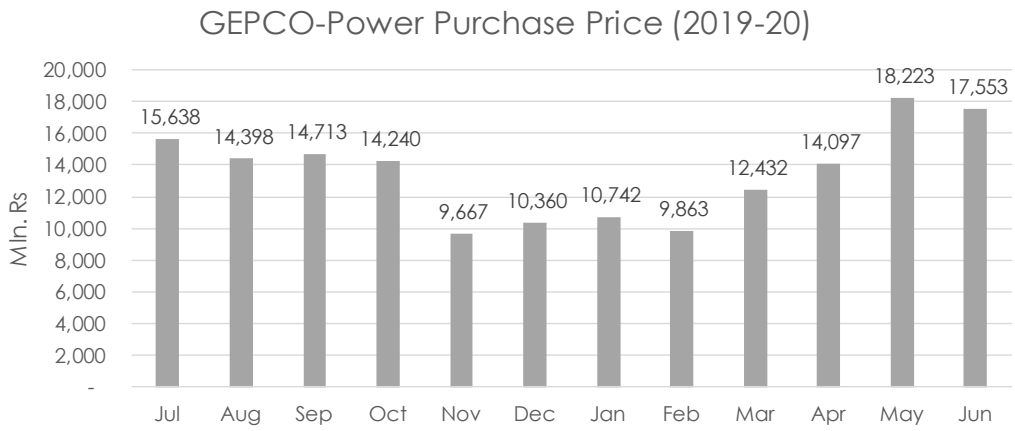
QUETTA ELECTRIC SUPPLY COMPANY

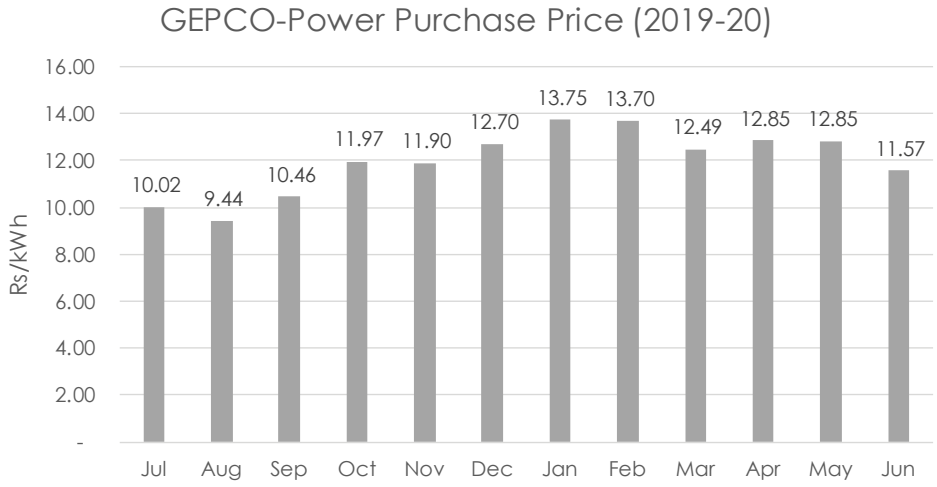




ALLOCATION TO DISCOS (FY 2019-20) (WITHOUT TRANSMISSION CONSTRAINTS)
ALLOCATION ON PMS BASED DEMAND PROJECTION

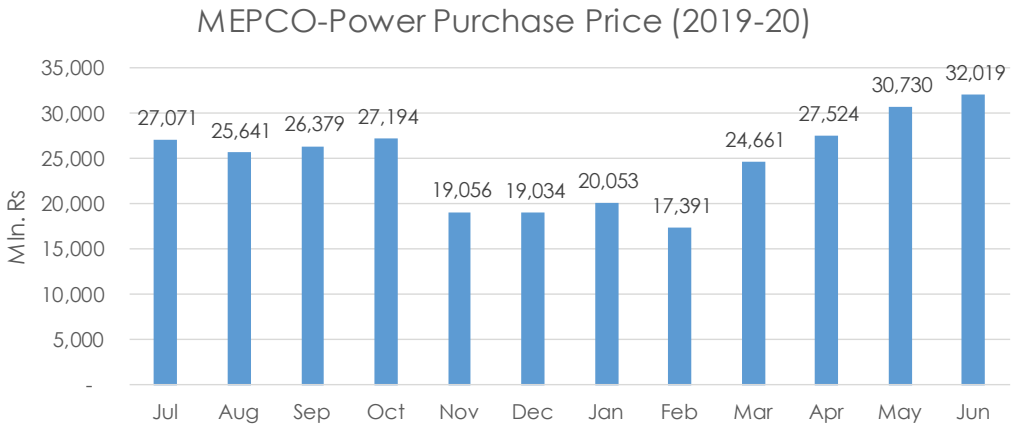
GUJRANWALA ELECTRIC POWER COMPANY

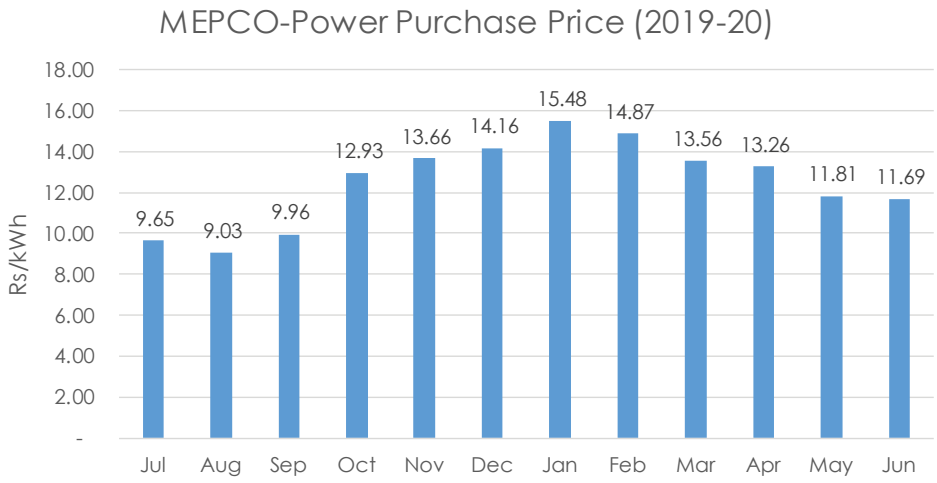




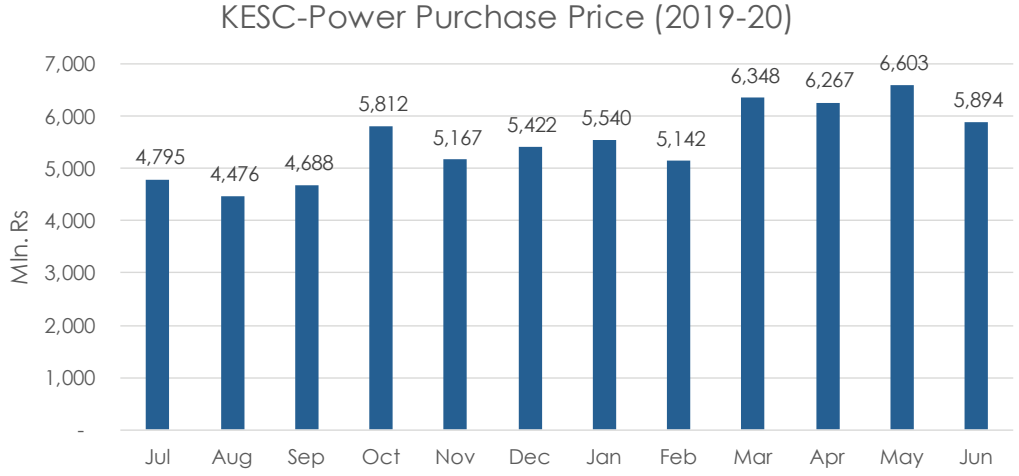
ALLOCATION TO DISCOS (FY 2019-20) (WITHOUT TRANSMISSION CONSTRAINTS)
ALLOCATION ON PMS BASED DEMAND PROJECTION

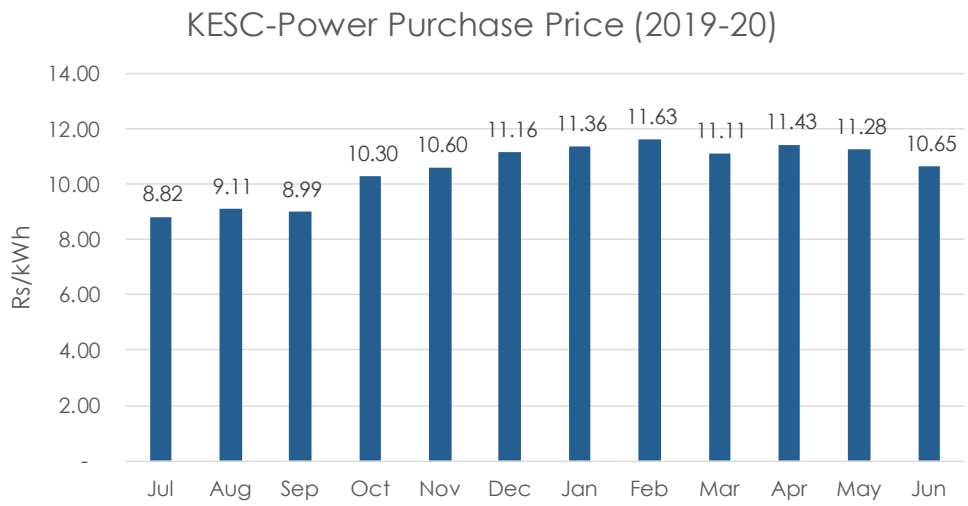
MULTAN ELECTRIC POWER COMPANY





KARACHI ELECTRIC SUPPLY COMPANY





II. ACTUAL DEMAND BASED PROJECTIONS:

Under this section, the demand inputted is based on actual demand numbers keeping the load factors frozen for respective months and the CAGR based on previous five fiscal years is applied for future years projection, allocating PPP to each DISCO as per mechanism established above.

POWER PURCAHSE PRICE ALLOCATION

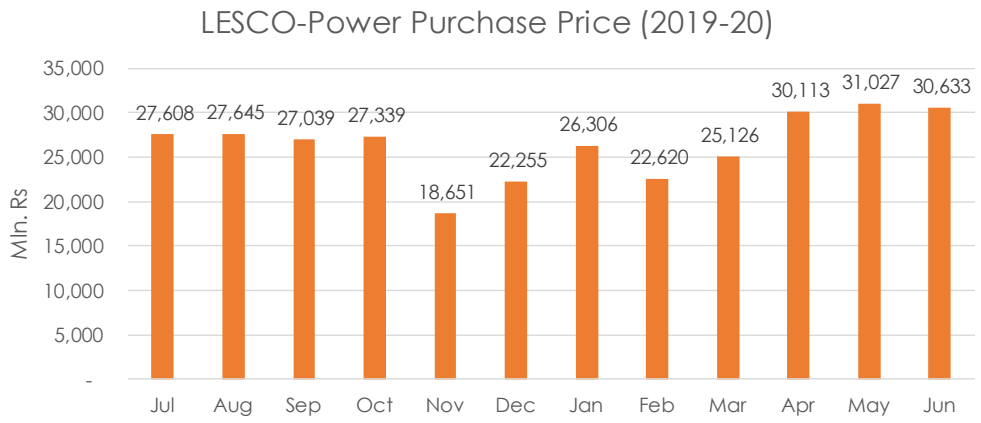
Power Purchase Price
FY 2019-20

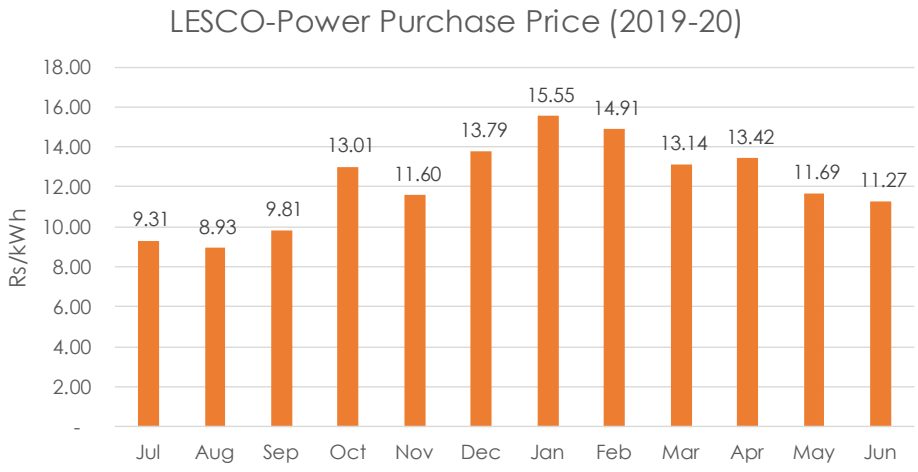
Million Rs.

Name	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Total
IESCO	13,433	12,703	12,318	12,424	9,902	9,792	12,268	10,790	11,074	12,766	13,925	15,397	**146,793**
LESCO	27,608	27,645	27,039	27,339	18,651	22,255	26,306	22,620	25,126	30,113	31,027	30,633	**316,361**
GEPCO	13,963	13,601	13,153	12,557	8,342	8,998	9,911	9,046	10,800	12,507	15,464	14,768	**143,110**
FESCO	17,021	18,012	17,338	18,251	13,074	12,845	14,703	14,008	18,113	19,665	19,504	20,093	**202,628**
MEPCO	24,066	24,159	23,448	24,182	16,762	16,774	18,662	16,053	21,663	24,510	25,694	26,986	**262,959**
PESCO	16,024	15,853	14,137	14,633	12,614	15,394	17,721	15,602	14,259	15,752	17,487	18,350	**187,826**
TESCO	1,212	1,372	1,578	1,761	1,772	1,776	1,882	1,956	1,614	1,933	2,037	1,575	**20,467**
HESCO	7,094	7,027	6,970	7,735	5,618	5,531	5,526	6,237	7,148	8,275	9,551	9,494	**86,206**
QESCO	6,522	6,609	5,806	7,256	6,696	7,232	8,093	7,524	8,066	7,825	8,068	7,543	**87,240**
SEPCO	5,802	5,580	5,374	5,337	3,580	3,320	5,342	3,616	4,378	5,290	6,554	6,317	**60,491**
KESC	4,215	4,219	4,114	5,030	4,378	4,616	5,028	4,647	5,417	5,478	5,472	4,882	**57,497**
Total	**136,959**	**136,780**	**131,276**	**136,505**	**101,390**	**108,534**	**125,442**	**112,101**	**127,657**	**144,112**	**154,783**	**156,037**	**1,571,576**

ALLOCATION TO DISCOS (FY 2019-20)(WITHOUT TRANSMISSION CONSTRAINTS)
ALLOCATION ON ACTUAL -DEMAND PROJECTION

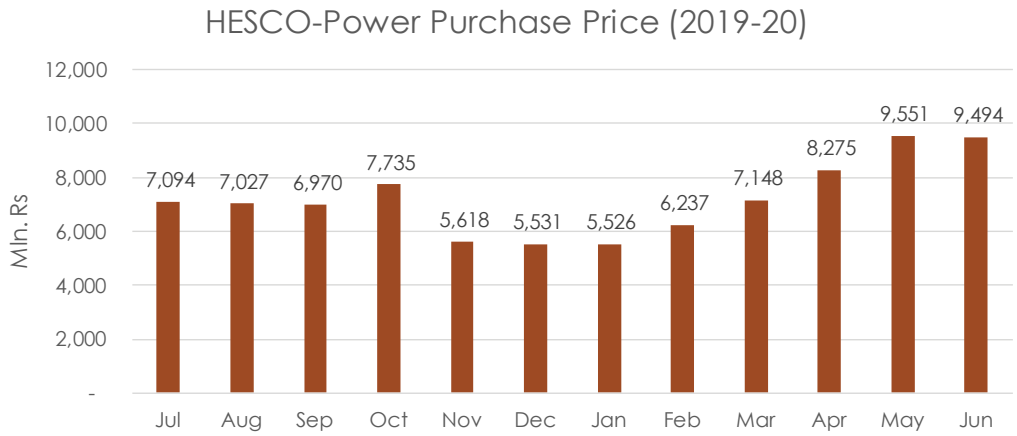
LAHORE ELECTRIC SUPPLY COMPANY

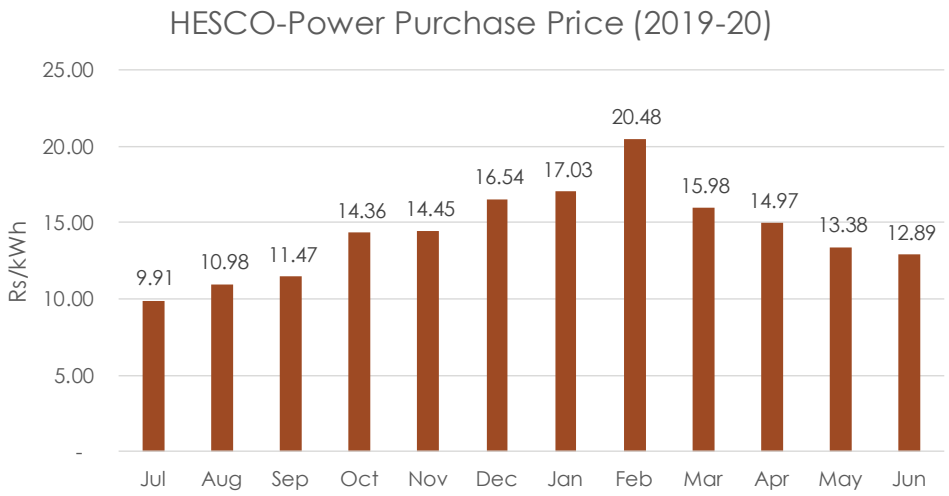




ALLOCATION TO DISCOS (FY 2019-20) (WITHOUT TRANSMISSION CONSTRAINTS)
ALLOCATION ON ACTUAL -DEMAND PROJECTION

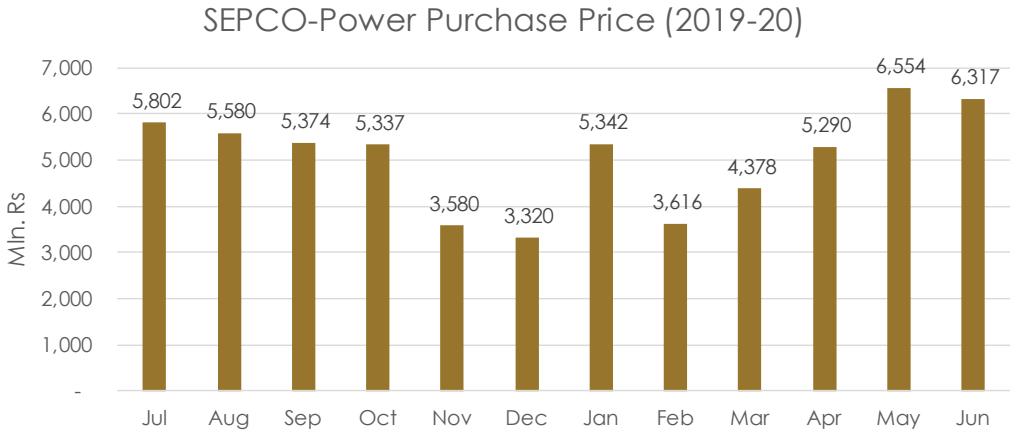
HYDERABAD ELECTRIC SUPPLY COMPANY

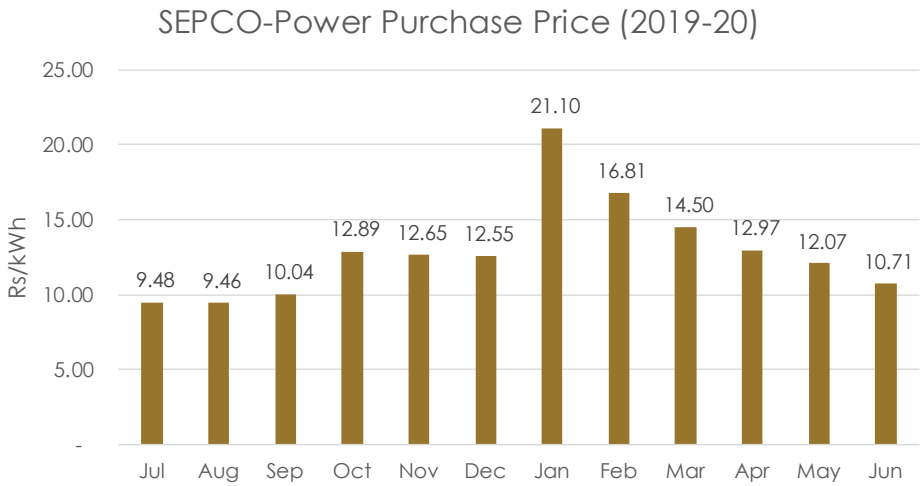




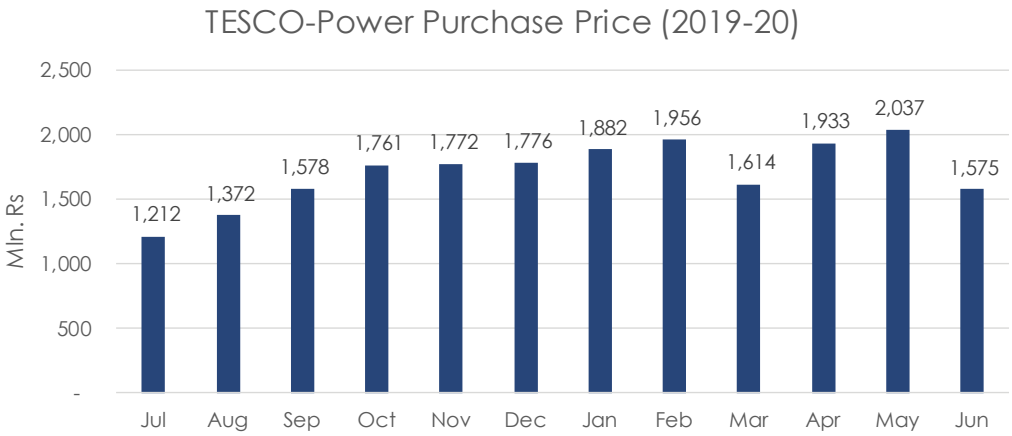
ALLOCATION TO DISCOS (FY 2019-20) (WITHOUT TRANSMISSION CONSTRAINTS)
ALLOCATION ON ACTUAL -DEMAND PROJECTION

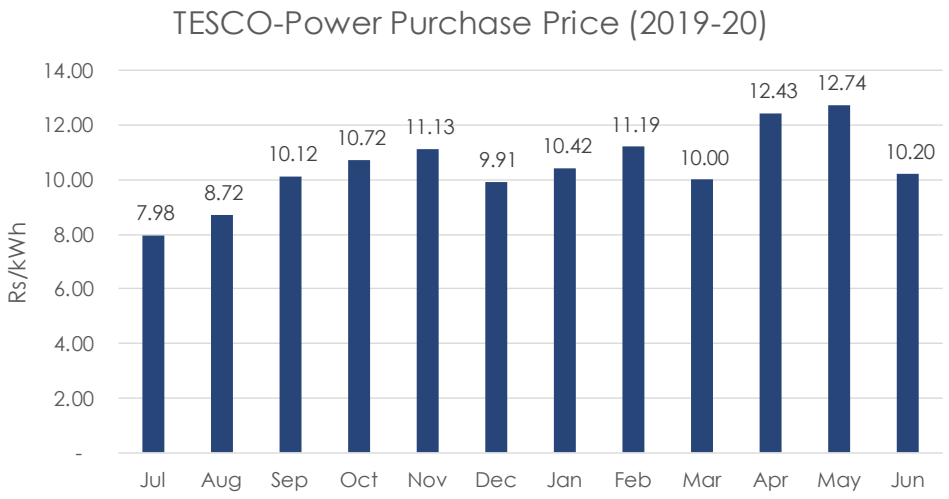
SUKKUR ELECTRIC POWER COMPANY



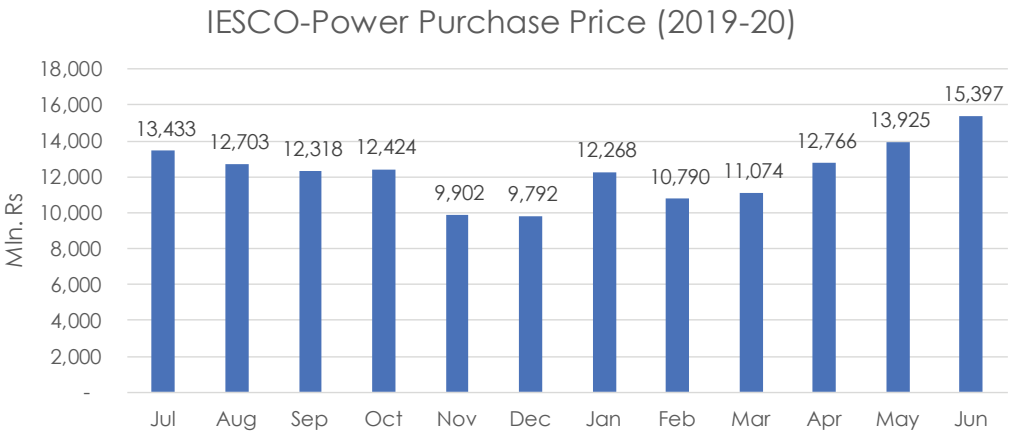


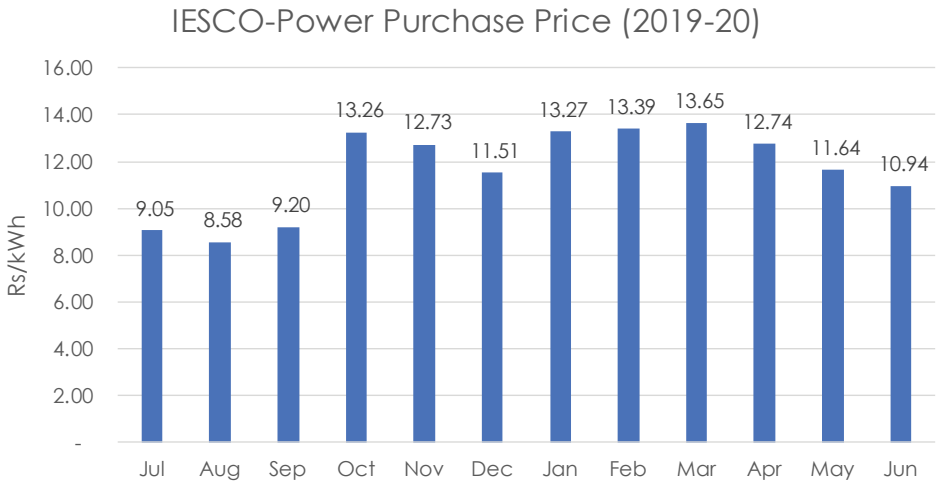
TRIBAL ELECTRIC SUPPLY COMPANY





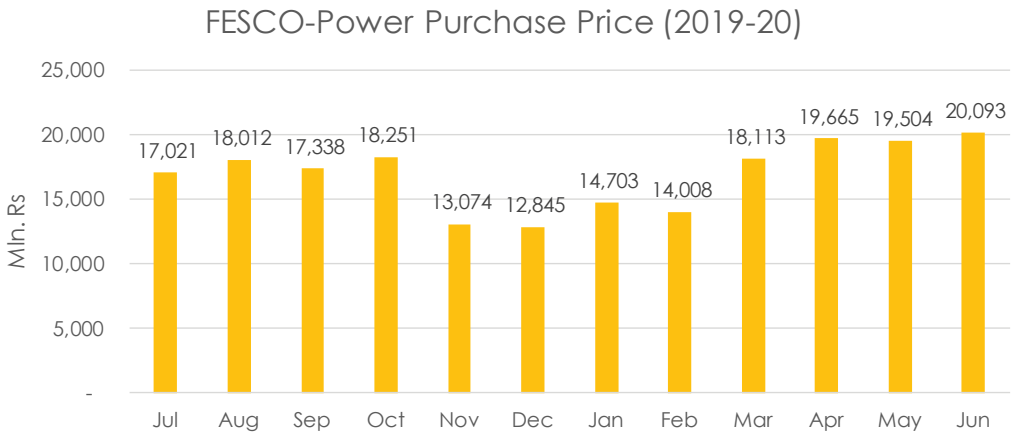
ISLAMABAD ELECTRIC SUPPLY COMPANY

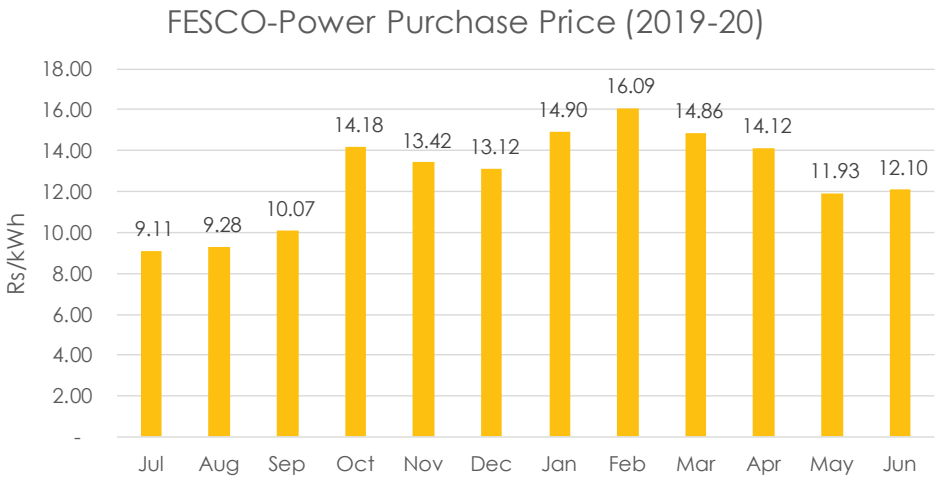




FAISALABAD ELECTRIC SUPPLY COMPANY

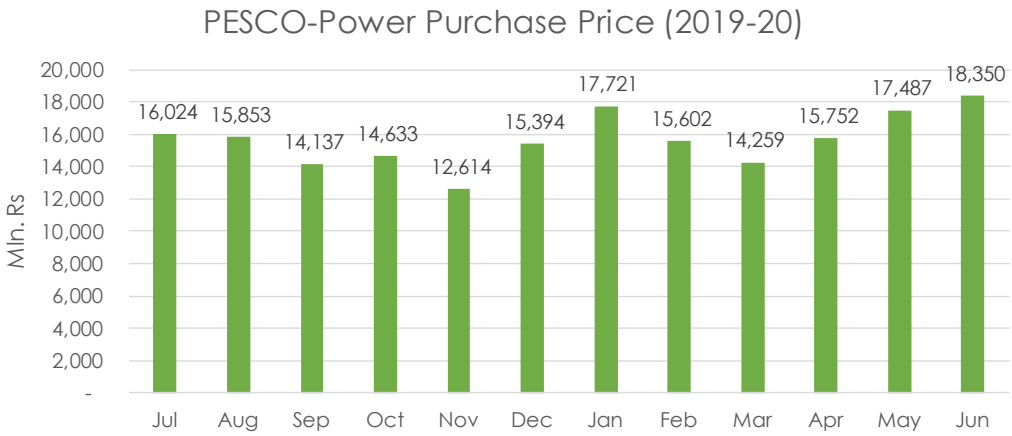
FESCO

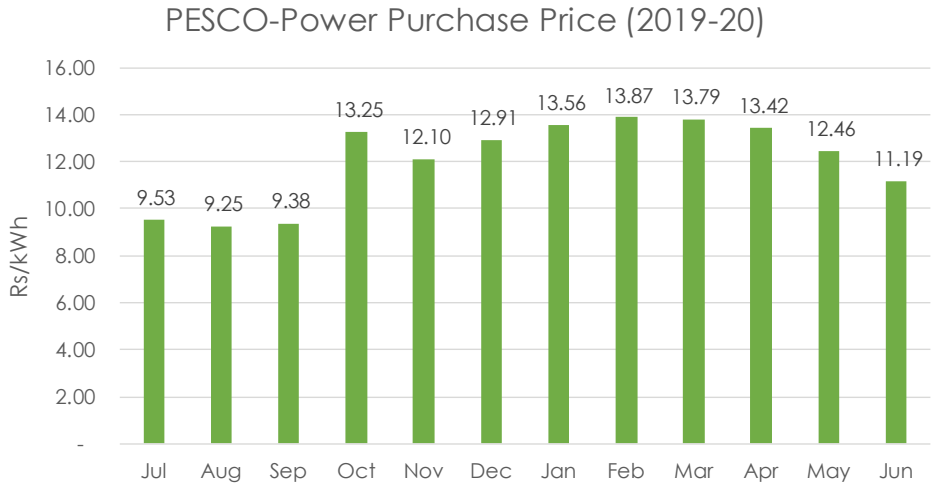




ALLOCATION TO DISCOS (FY 2019-20) (WITHOUT TRANSMISSION CONSTRAINTS)
ALLOCATION ON ACTUAL -DEMAND PROJECTION

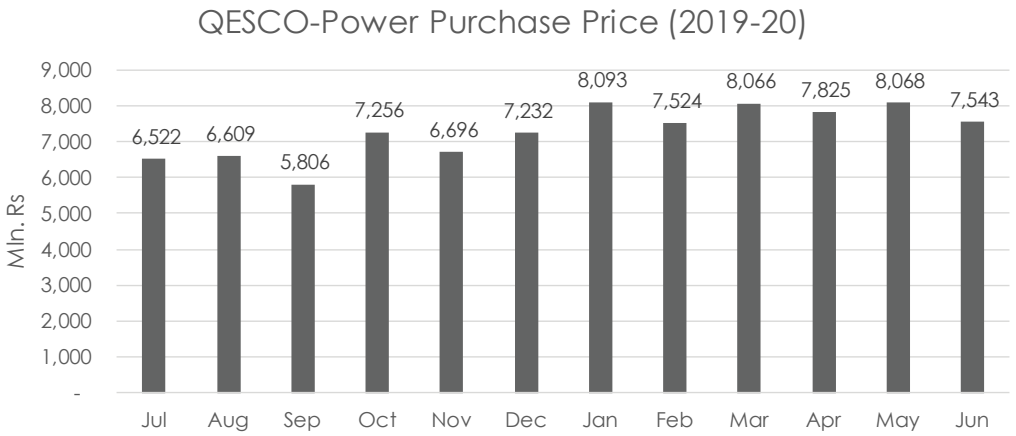
PESHAWAR ELECTRIC SUPPLY COMPANY

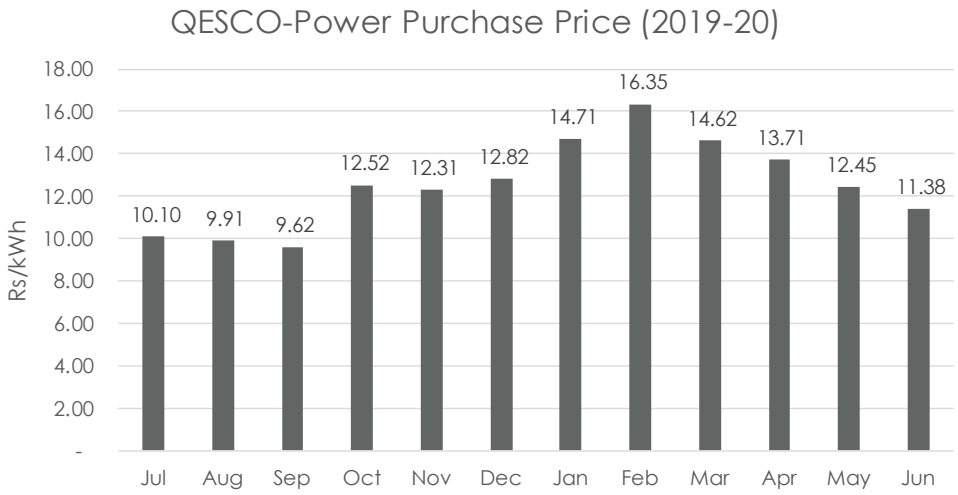




ALLOCATION TO DISCOS (FY 2019-20) (WITH OUT TRANSMISSION CONSTRAINTS)
ALLOCATION ON ACTUAL -DEMAND PROJECTION

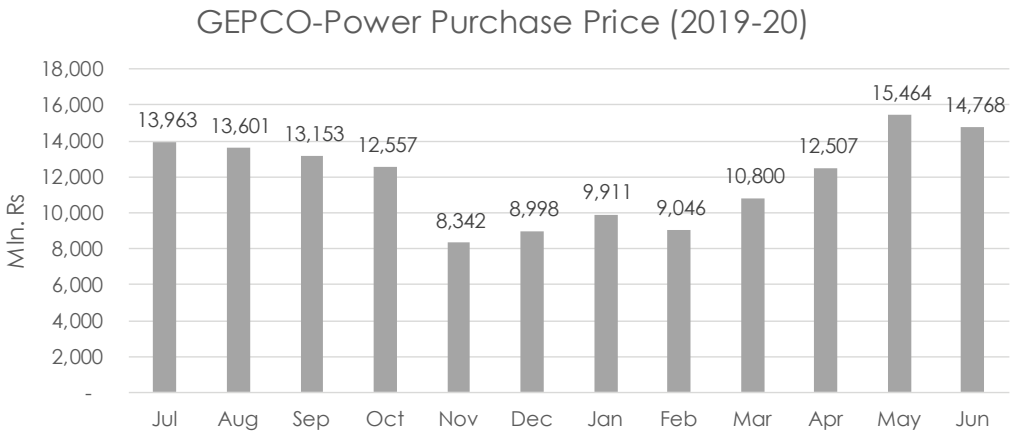
QUETTA ELECTRIC SUPPLY COMPANY

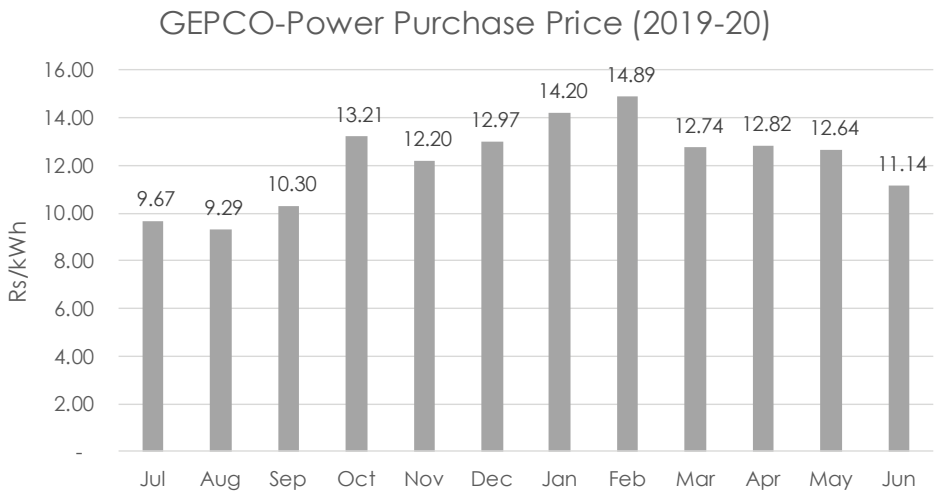




ALLOCATION TO DISCOS (FY 2019-20) (WITHOUT TRANSMISSION CONSTRAINTS)
ALLOCATION ON ACTUAL -DEMAND PROJECTION

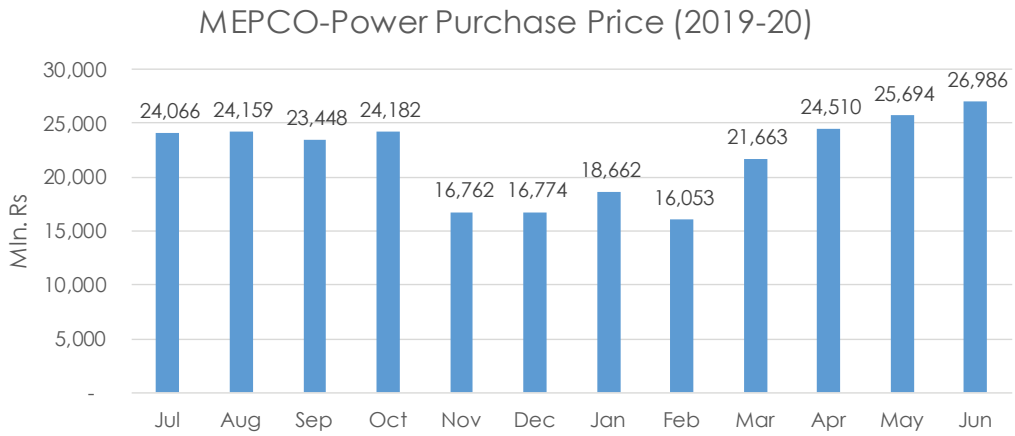
GUJRANWALA ELECTRIC POWER COMPANY

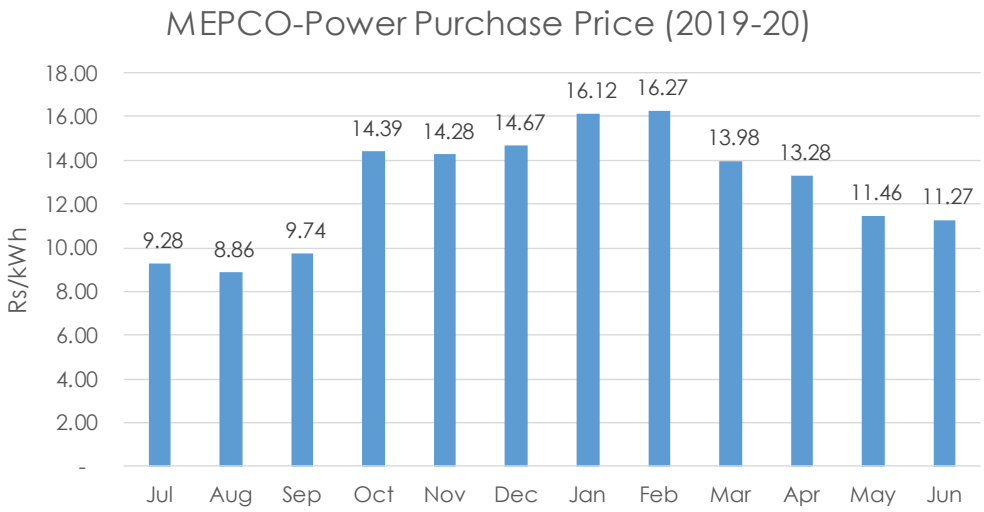




ALLOCATION TO DISCOS (FY 2019-20) (WITHOUT TRANSMISSION CONSTRAINTS)
ALLOCATION ON ACTUAL -DEMAND PROJECTION

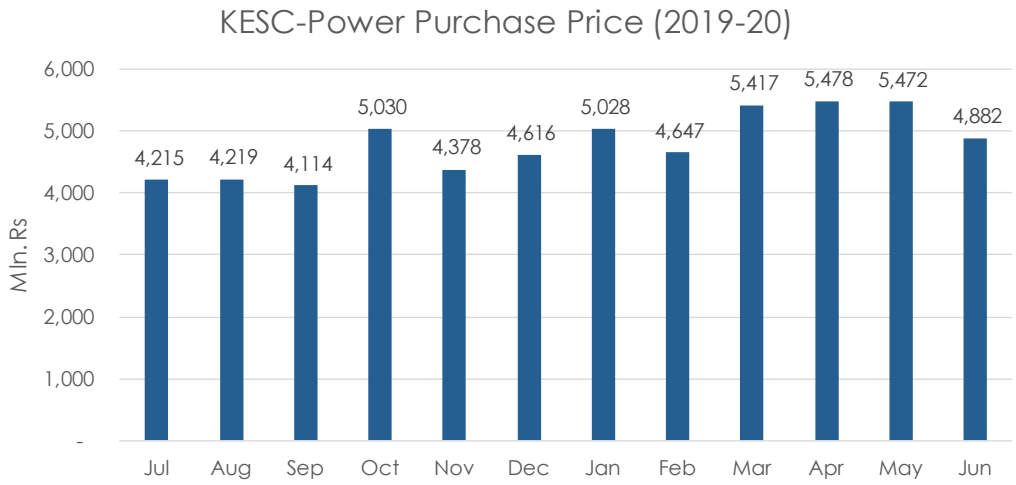
MULTAN ELECTRIC POWER COMPANY

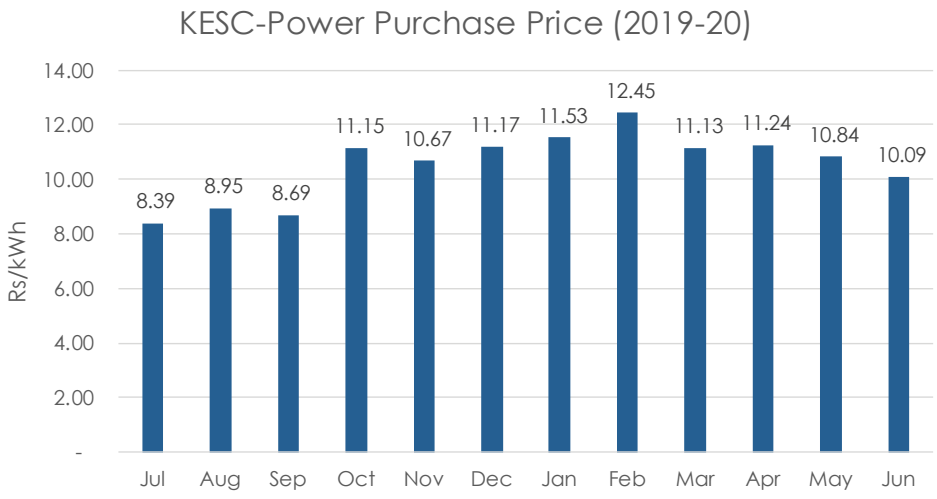




ALLOCATION TO DISCOS (FY 2019-20) (WITHOUT TRANSMISSION CONSTRAINTS)
ALLOCATION ON ACTUAL - DEMAND PROJECTION

KARACHI ELECTRIC SUPPLY COMPANY





09
Submissions

9 SUBMISSION

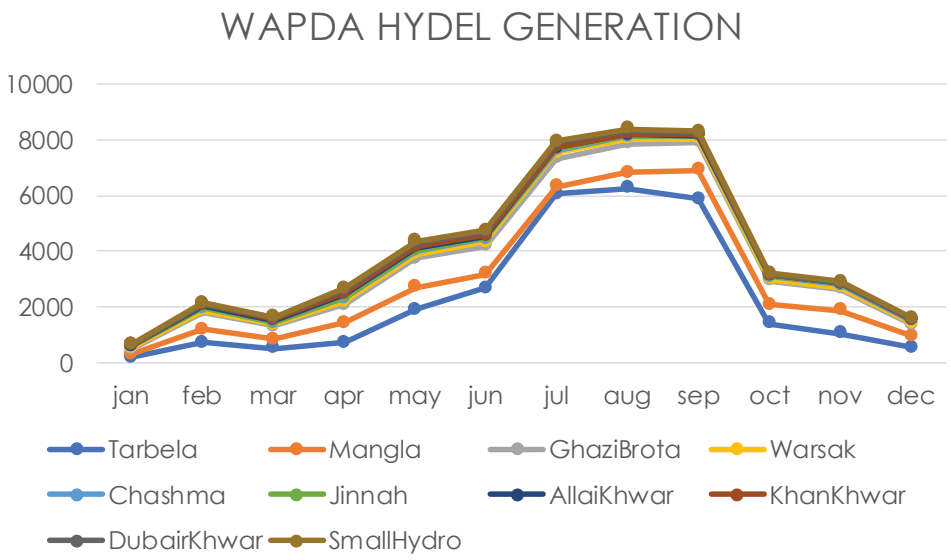
This PPP report is submitted for due consideration by the Authority for setting monthly references of PPP for Year 2019-20, after a through consultative session captured under regulatory framework.

Multiple Scenarios have been projected based upon demand and transmission constraints. As per our analysis, Case referred at Section 7.1 (ii)(Actual Demand Based Projections) more closely depicts the physical realities of Power sector and hence is there by recommended for approval.

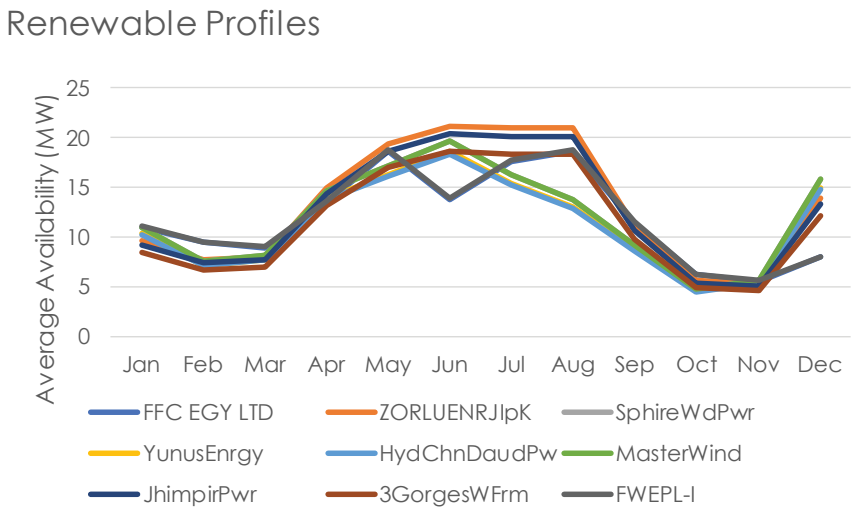
It is worth mentioning here that this model has been developed with several assumptions and references on account of generation, Transmission, Distribution, Fuel Prices, demands etc. and is capable to execute multiple scenarios on the basis of assumption sets. Accordingly, any further analysis, as required by the Authority may be provided to arrive at the informed decision.

10 Annexures

ANNEX A: WAPDA HYDEL GENERATION



ANNEX B: RENEWABLE PROFILES



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