





**SAARC Workshop “System Operation and Settlement Mechanism,
Cross Border Trade / Regional Power Market in South Asia”**

Dhaka, Bangladesh

10 – 11 December 2017

System Operation, Control & Planning: Pakistan Case Study



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Pakistan National Power Control Center

National Transmission and Dispatch Company Limited

PRESENTATION SEQUENCE

- Introduction
- System Operation, Control and Planning
- Generation Mix
 - Generation Capacity Since 2013
 - New Generation Projects (Up-to June 2018)
 - Power Position (Up-to June 2018)
- Maximum Dispatch
- Load Management

INTRODUCTION TO NPCC

- National Power Control Center (NPCC) is part of National Transmission and Despatch Company (NTDC) which is a corporate entity unbundled from WAPDA power wing
- NTDC constructs, operates, maintains 500/220 kV lines/grid stations, provides wheeling facility to CPPA-G for purchase of power from generators and selling to DISCOs
- DISCOs construct, operate, maintain 132/66 kV lines & grid stations and 11/0.4 kV distribution system
- NPCC is control center of NTDC and is responsible for operation of generation and transmission system

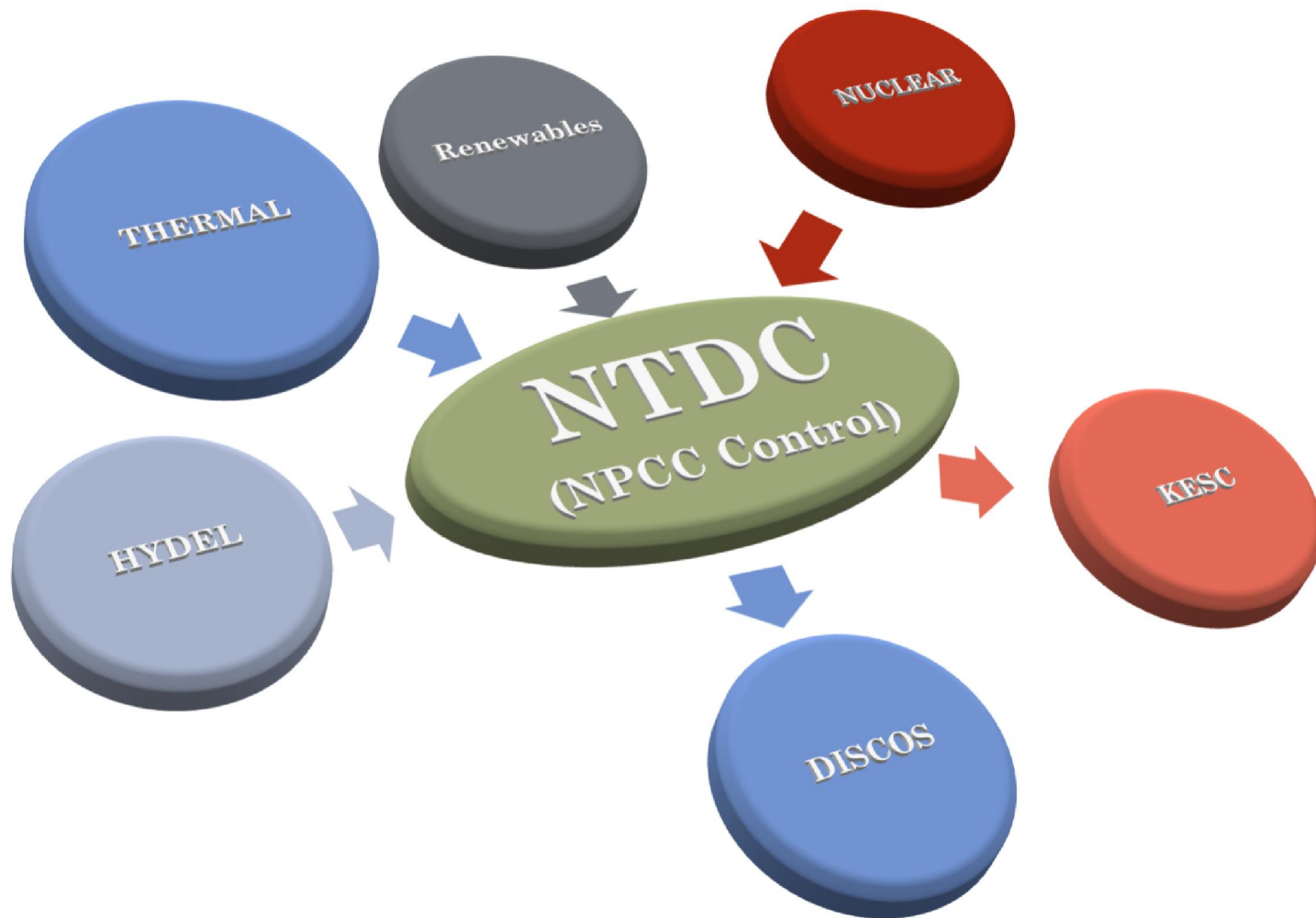
MAJOR FUNCTIONS OF NPCC

1. Maintaining balance between Supply & Demand
2. Frequency and voltage control
3. Operational Control of Power Network
4. Maintaining security & stability of network
5. Month-wise Annual Energy Estimation
6. Economic Dispatch

MAJOR FUNCTIONS OF NPCC

7. Control of Power Network.
8. Scheduling of maintenance shut-downs on power plants & Transmission network elements.
9. Short to medium term operational planning.
10. Advance notifications to thermal plants for fuel arrangement.
11. Collection of system data and preparation of reports

POWER SYSTEM STRUCTURE

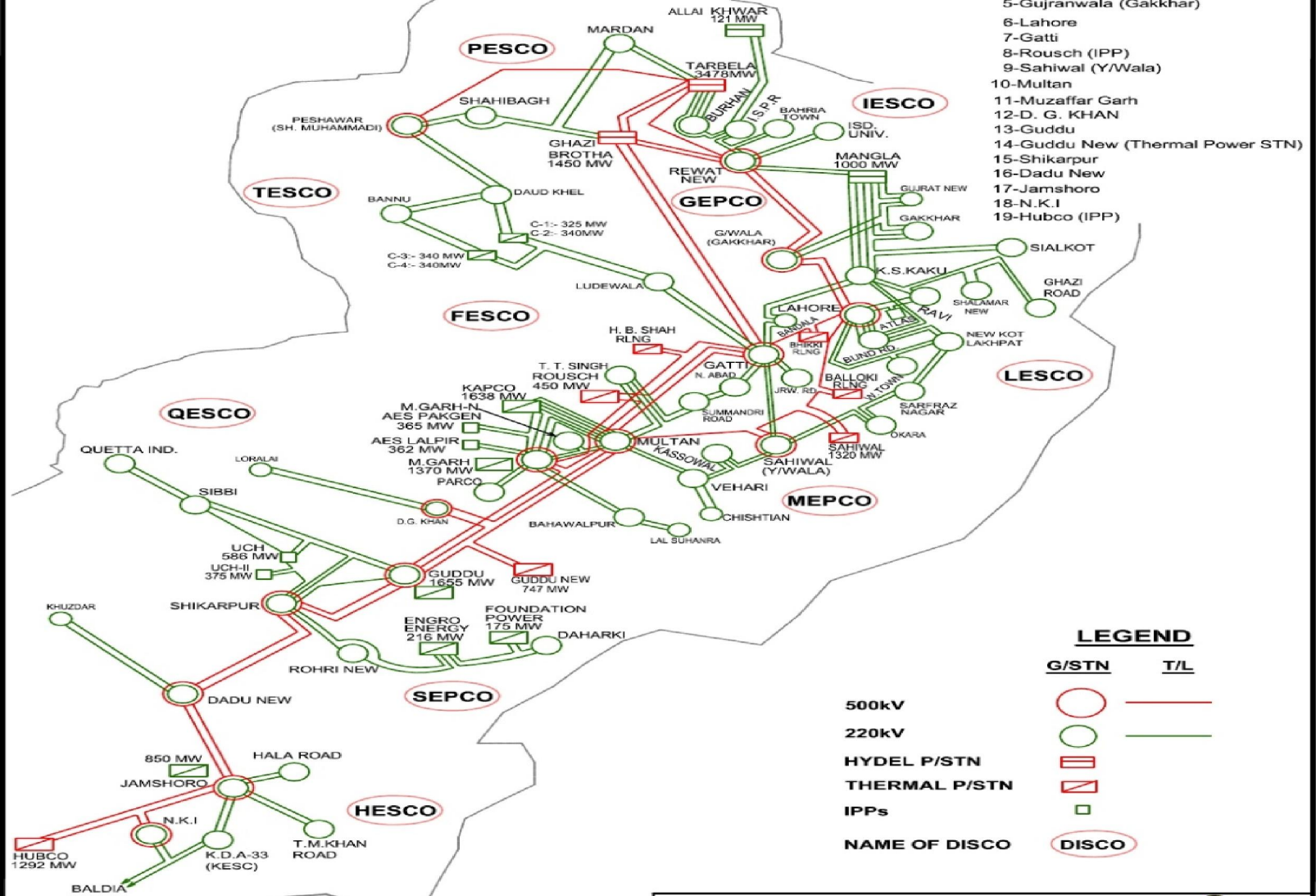


NATIONAL POWER CONTROL CENTRE

- NPCC is responsible for Control and Monitoring of power plants and 500/220 kV Power Network of the country excluding Karachi.

■ Power Plants:	84
■ 500 kV Grid Stations:	14
■ 220 kV Grid Stations:	38
■ 500 kV Transmission Lines:	5,110 KM
■ 220 kV Transmission Lines:	9,686 KM

EXISTING NTDC NETWORK



500kV SUBSTATIONS

- 1-Peshawar
- 2-Tarbela (Hydel Power STN)
- 3-Ghazi Brotha (Hydel Power STN)
- 4-Rewat New
- 5-Gujranwala (Gakkhar)
- 6-Lahore
- 7-Gatti
- 8-Rousch (IPP)
- 9-Sahiwal (Y/Wala)
- 10-Multan
- 11-Muzaffar Garh
- 12-D. G. KHAN
- 13-Guddu
- 14-Guddu New (Thermal Power STN)
- 15-Shikarpur
- 16-Dadu New
- 17-Jamshoro
- 18-N.K.I
- 19-Hubco (IPP)

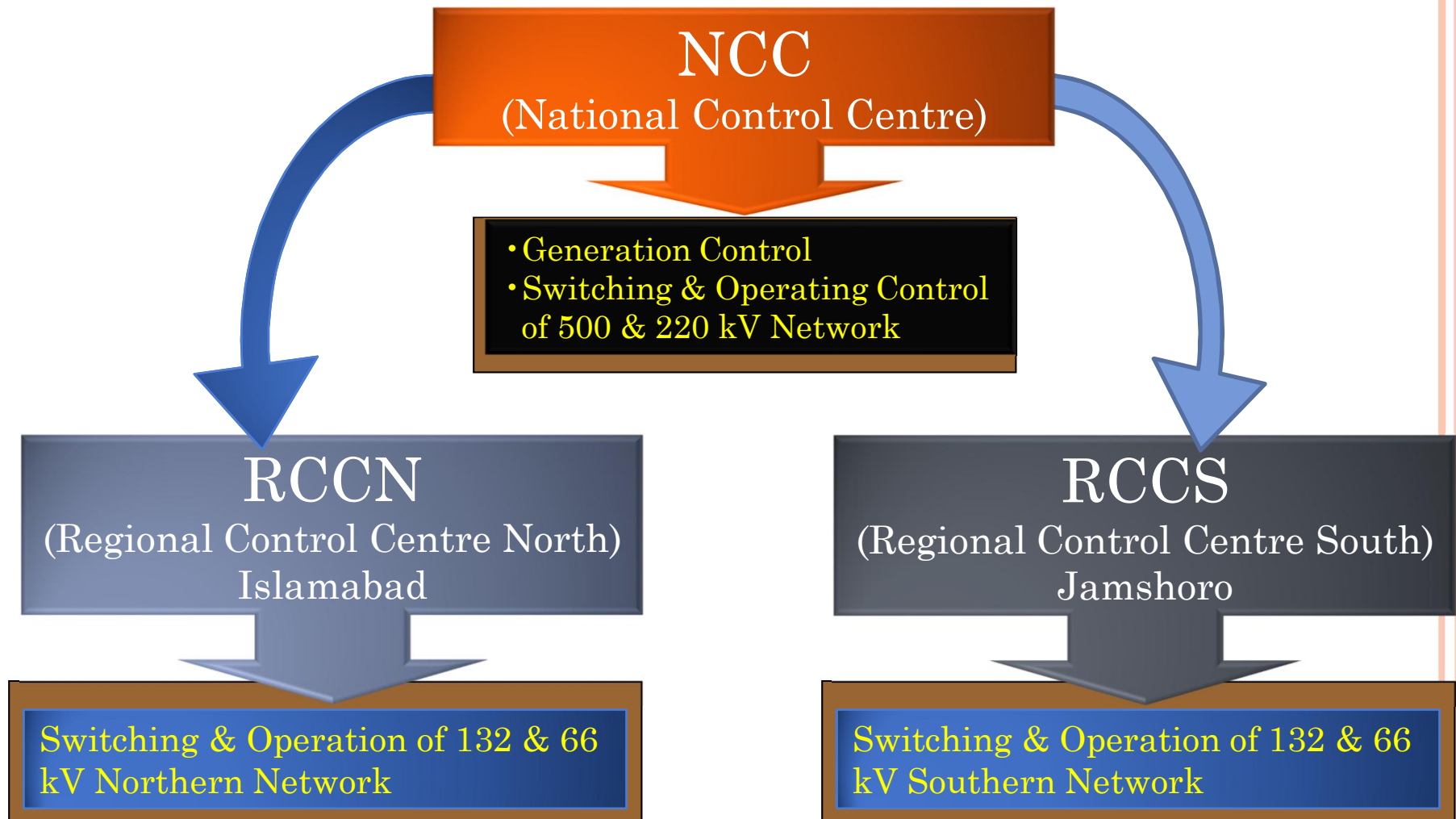
LEGEND

- | | | |
|----------------------|--|--|
| 500kV | | |
| 220kV | | |
| HYDEL P/STN | | |
| THERMAL P/STN | | |
| IPPs | | |
| NAME OF DISCO | | |

NTDC PLANNING POWER

DWN.	SHAHID MAHMOOD		EXISTING NTDC GRID MAP 500 & 220kV SYSTEM
MGR.	M. WASEEM YOUNAS		
C.E			
G.M	MAQSOOD AHMAD QURESHI		DRG NO. GM(PP)014-1 DATE 13-07-2017

SYSTEM OPERATION HIERARCHY





SYSTEM OPERATION, CONTROL AND PLANNING

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GENERATION PLANNING & DESPATCH

Procedure and Steps

- Generation forecasting/estimation on daily, weekly, monthly, quarterly, yearly basis keeping in view:
 - Irrigation indents of Hydel stations
 - Schedule outages
 - Forced outages
 - Constraints if any
- Demand forecasting/estimation on historical trends
- Despatch of available generation in merit order.

ECONOMIC MERIT ORDER

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TRANSMISSION OPERATION & CONTROL

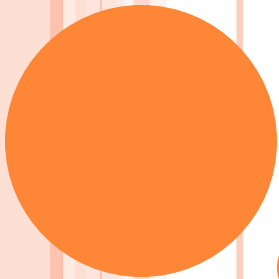
Operational objectives of NPCC are:

- Keeping balance between demand and supply all the time
- Maintaining stable frequency
- Maintaining system security and reliability
- Keeping stable voltages over primary network
- Monitoring of transmission & transformer parameters

SWITCHING OPERATIONS

NPCC performs switching operation on transmission network in following scenarios:

- Planned shutdowns for maintenance, cleaning and washing activities
- Emergent shutdowns in case of abnormal situations.
- Transmission lines and transformers tripping.

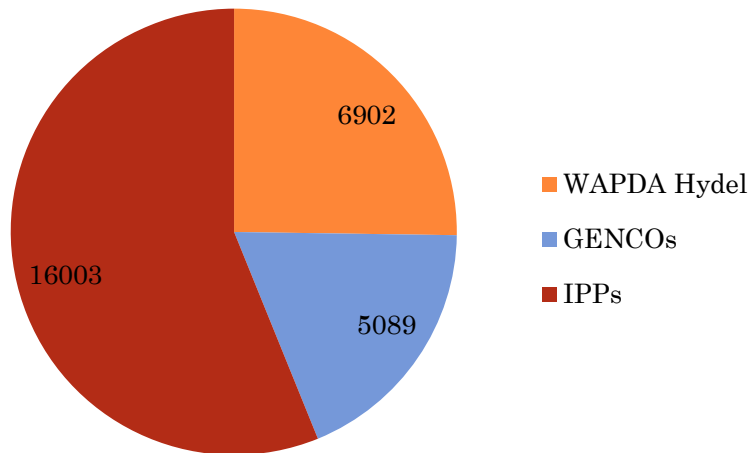


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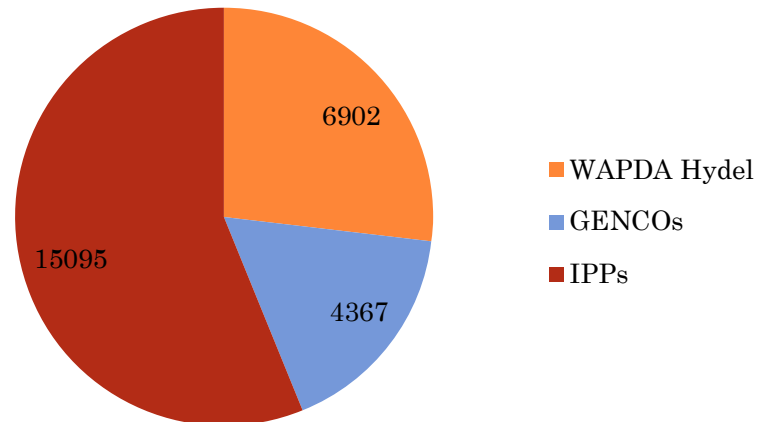
GENERATION MIX

GENERATION SOURCES

Installed Capacity (27,995 MW)



Derated Capacity (26,365 MW)



Generation Capacity / Breakup

GENERATION BREAKUP	INSTALLED	DERATED
(A) TOTAL HYDEL (WAPDA + IPP's)	7,244	7,244
(B) TOTAL THERMAL (FO+GAS+HSD+NUCLEAR+BAGASSE)	19,567	17,937
(C) Total Wind	783	783
(D) Total Solar	400	400
TOTAL WAPDA HYDEL	6,902	6,902
TOTAL GENCO's	5,089	4,367
Total IPPs (Hydel, FO+Gas+HSD+ Wind+Solar+Bagasse+Nuclear)	16,003	15,095
TOTAL SYSTEM (A+B+C+D)	27,995	26,365

GENERATION CAPACITY

As ON 06-12-2017

GENERATION BREAKUP	INSTALLED	DERATED	AVERAGE	PEAK	% SHARE AVG	%SHARE PEAK
(A) TOTAL HYDEL (WAPDA + IPP's)	7,244	7,244	2,416	4,046	20.24%	29.85%
(B) TOTAL THERMAL (FO+GAS+HSD+NUCLEAR+BAGASSE)	19,567	17,937	8,937	8,955	74.90%	66.06%
(C) Total Wind	783	783	527	555	4.42%	4.09%
(D) Total Solar	400	400	53	0	0.44%	0.00%
TOTAL WAPDA HYDEL	6,902	6,902	2,318	3,899	19.43%	28.76%
TOTAL GENCO's	5,089	4,367	1,090	1,090	9.13%	8.04%
Total IPPs (Hydel, FO+Gas+HSD+ Wind+Solar+Bagasse+Nuclear)	16,003	15,095	8,525	8,567	71.44%	63.20%
TOTAL SYSTEM (A+B+C+D)	28,655	26,990	11,933	13,556	100%	100%

FUEL-WISE GENERATION CAPACITY

As on 06-12-2017

Fuel Type	Avg. Share	% Share Average
Hydel	2,416	20.24%
FO+Coal	4,161	34.87%
GAS	3,747	31.40%
HSD	0	0.00%
BAGASSE	107	0.90%
NUCLEAR	922	7.73%
Wind+ SOLAR	580	4.86%
TOTAL	11,933	100.00%

GENERATION OUTAGE

As on 06-12-2017

Outage Type	Capacity	% age of Total System De-rated Capability
Schedule outage	478	1.77
Forced outage	3,040	11.26
Forced outage (Shortage of Gas)	1,270	4.71
Forced outage (Shortage of Oil)	0	0
Unavailable due to Low Hydrology, Solar and Wind	5,382	19.94
Total	10,170	37.68
Standby	3,741	13.86

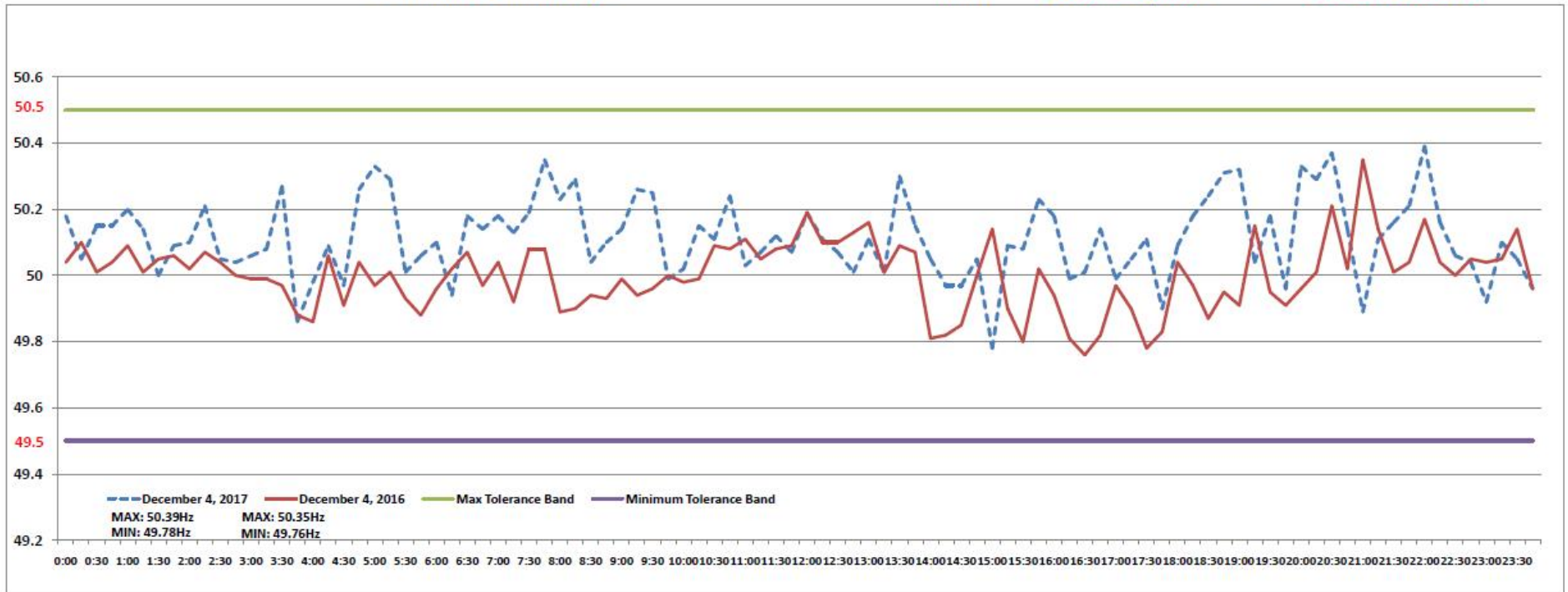
BREAKUP OF MAX RECORDED GENERATION

19,070 MW on 20 Aug 2017	
Hydel	6,772
GENCOs	2,627
IPPs	9,671
Total	19,070

FREQUENCY TREND DATED 04-12-2017

15 Min Average Frequency

Dated **December 4, 2017** & **December 4, 2016**



AVERAGE POWER GENERATION SINCE 2013

Year	Generation	
	Energy (kWh)	Average Power (MW) / Day
2012-13	87,847,005,146	10,028
2013-14	95,264,794,073	10,875
2014-15	97,470,627,929	11,126
2015-16	101,970,322,082	11,608
2016-17	107,932,234,503	12,321

INSTALLED GENERATION CAPACITY Since 2013

	Hydel	GENCOs	IPPs	Total
2013	6,750	4,829	9,644	21,223
2014	6,902	4,727	9,849	21,478
2015	6,902	4,727	9,697	21,326
2016	6,902	4,837	10,741	22,480
2017	6,902	5,089	16,003	27,995

UP-COMING POWER PROJECTS

(Up-to June 2018)

Sr. #	Name of Project	Agency	Fuel	Installed Capacity (MW)	Comissioning Date
2017-18					
1	M/s Layyah Sugar Mills Ltd.	AEDB	Baggase	41	Nov. 2017
2	Almoiz Industries Limited	AEDB	Baggase	36	Nov. 2017
3	Harrapa Solar Pvt. Ltd.	AEDB	Solar	18	Nov. 2017
4	Ranolia HPP	PEDO	Hydro	17	Dec. 2017
5	Machai Canal HPP	PEDO	Hydro	3	Dec. 2017
6	Golen Gol HPP Unit-I	WAPDA	Hydro	35	Dec. 2017
7	LNG Based Plants at Bhikki (1*ST)	PPIB	Imp. LNG	400	Dec. 2017
8	AJ Power Pvt. Lt.d	AEDB	Solar	12	Dec. 2017
9	LNG Based Plants at Balloki (1*ST)	PPDB	Imp. LNG	423	Jan. 2018
10	LNG Based Plants at Haveli Bahadur Shah (1*ST)	PPDB	Imp. LNG	430	Jan. 2018
11	Tarbela 4th Ext. Unit-I	WAPDA	Hydro	470	Feb. 2018
12	M/s Jhmapir Wind Power Ltd.	AEDB	Wind	49.6	Feb. 2018
13	M/s Hawa Energy Pvt. Ltd.	AEDB	Wind	50	Feb. 2018

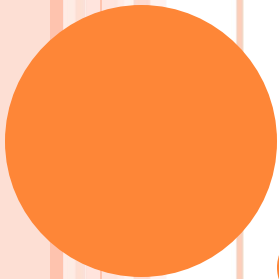
UP-COMING POWER PROJECTS

(Up-to June 2018)

Sr. #	Name of Project	Agency	Fuel	Installed Capacity (MW)	Comissioning Date
2017-18					
14	Neelum Jhelum Hydro Unit-I	WAPDA	Hydro	242	Feb. 2018
15	Neelum Jhelum Hydro Unit-II	WAPDA	Hydro	242	Mar. 2018
16	Karora HPP	PEDO	Hydro	12	Apr. 2018
17	Golen Gol HPP Unit-II	WAPDA	Hydro	35	Apr. 2018
18	Tarbela 4th Ext. Unit-II	WAPDA	Hydro	470	Apr. 2018
19	Neelum Jhelum Hydro Unit-III	WAPDA	Hydro	242	Apr. 2018
20	Neelum Jhelum Hydro Unit-IV	WAPDA	Hydro	242	Apr. 2018
21	Tarbela 4th Ext. Unit-III	WAPDA	Hydro	470	May. 2018
22	Golen Gol HPP Unit-III	WAPDA	Hydro	35	May. 2018
23	Port Qasim Power Project (Unit-II)	PPIB	Imp. Coal	660	Jun. 2018
24	Daral Khwar HPP	PEDO	Hydro	37	Jun. 2018
25	Jabori HPP	PEDO	Hydro	10	Jun. 2018
26	M/s Hartford Alternative Energy (Pvt.) Limited	AEDB	Wind	49.3	Jun. 2018
TOTAL ADDITION ENDING 2017-18				4730.3	

EXPECTED POWER POSITION (UP-TO JUNE 2018)

* Average Basis	Jan	Feb	Mar	Apr	May	June
Expected Demand (MW)	14,575	14,405	15,523	19,193	21,638	23,233
Exp. Firm Generation (MW)	17,403	18,372	17,567	18,589	21,154	21,569
Surplus / (Shortfall) (MW)	2,828	3,967	2,044	(605)	(484)	(1,664)

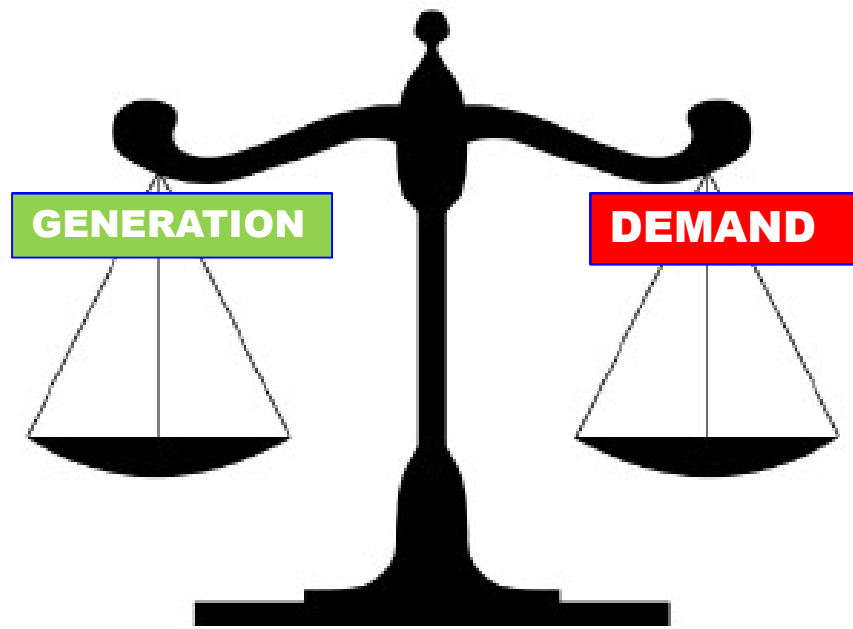


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LOAD MANAGEMENT

GENERATION / DEMAND BALANCE

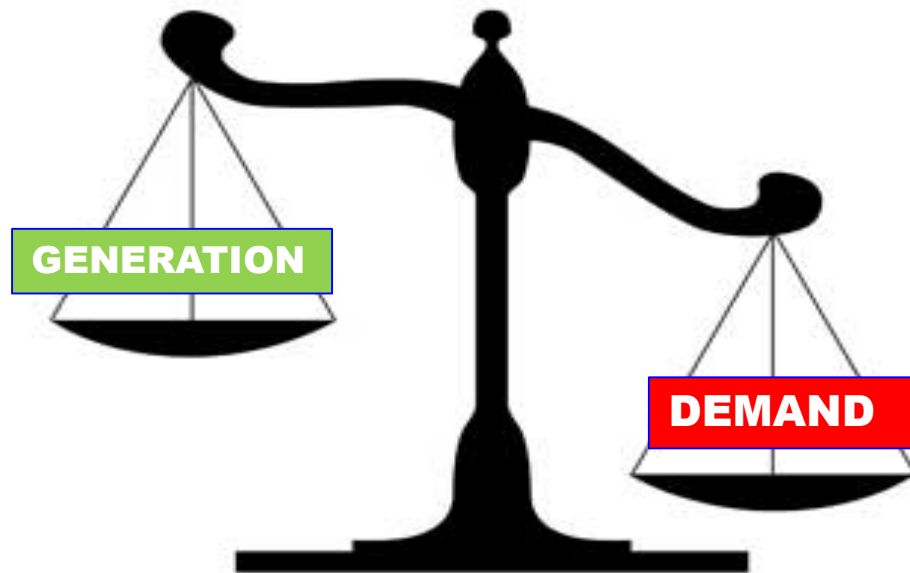
Primary function of NPCCC is to keep balance between demand and supply & to ensure system security and reliability. In balanced condition system frequency is 50 Hz.



SYSTEM FREQUENCY
=
50 HZ

GENERATION / DEMAND BALANCE

When demand exceeds generation, frequency depreciates below 50 Hz and in order to maintain balance between demand and generation, load management has to be carried out.



SYSTEM FREQUENCY
<
50 HZ

GENERATION DEMAND BALANCE

- Load is continuously varying in time and so the generation has to be varied in order to keep frequency in permissible limits
- Variation in generation
 - Hydel (Fastest ramping rates)
 - Thermal
 - Steam Turbines
 - Gas Turbines
 - DG Sets

GENERATION DEMAND BALANCE

- Due to deficit in generation capacity, balance between demand and generation has to be maintained through load management
- Therefore a two tier strategy has been adopted for this balance through load management
 - Scheduled load management
 - System security load management

SCHEDULED LOAD MANAGEMENT

Scheduled load management is carried out by DISCO's, keeping in view the following factors.

- Load demand of respective DISCO.
- Generation share allocated to DISCO by NPCC.
- Constraints like voltage drop, transmission and transformer loading including 11 kV & below system.

SYSTEM SECURITY LOAD MANAGEMENT

System security load management (Forced LS) is carried out by NPCC by opening 132kV transmission lines in case of extreme system emergencies.

Examples are:

1. Un-foreseen generating unit outages
2. Non implementation of schedule load management by DISCOs
3. Rupturing of gas lines
4. Non availability of fuel
5. Sabotage activities on transmission lines
6. Transmission and transformation problems

DEMAND / ALLOCATION / DRAWL BY DISCOs

05.12.2017

		MAX	MIN	AVG
PESCO	Demand	2225	1711	1985
	Allocation	1655	1275	1491
	Drawl	1590	1202	1412
TESCO	Demand	115	77	94
	Allocation	108	64	84
	Drawl	57	19	40
IESCO	Demand	1263	756	1034
	Allocation	1230	800	1050
	Drawl	1170	702	965
GEPSCO	Demand	1075	586	859
	Allocation	1070	700	909
	Drawl	1055	583	844
LESCO	Demand	2259	1409	1907
	Allocation	2300	1453	1884
	Drawl	2162	1392	1802
FESCO	Demand	1347	794	1071
	Allocation	1378	850	1107
	Drawl	1334	788	1052
MEPCO	Demand	1598	860	1241
	Allocation	1595	900	1259
	Drawl	1468	809	1172
SEPCO	Demand	607	426	510
	Allocation	573	354	439
	Drawl	526	265	382
HESCO	Demand	597	411	486
	Allocation	558	399	455
	Drawl	526	336	390
QESCO	Demand	1213	986	1099
	Allocation	887	609	740
	Drawl	776	554	668

DEMAND / ALLOCATION / DRAWL BY DISCOs

AS ON 20.08.2017

		MAX	MIN	AVG
PESCO	Demand	2885	2356	2624
	Allocation	2173	1873	1987
	Drawl	1890	1458	1645
TESCO	Demand	153	94	118
	Allocation	148	118	146
	Drawl	64	30	43
IESCO	Demand	1892	1525	1702
	Allocation	1860	1655	1737
	Drawl	1876	1442	1653
GEPSCO	Demand	1979	1606	1800
	Allocation	1775	1645	1732
	Drawl	1929	1582	1755
LESCO	Demand	3736	3301	3455
	Allocation	3500	3200	3366
	Drawl	3509	3192	3328
FESCO	Demand	2315	1804	2098
	Allocation	2198	2000	2120
	Drawl	2186	1790	2037
MEPCO	Demand	3228	2513	2930
	Allocation	2919	2631	2762
	Drawl	2896	2430	2695
SEPCO	Demand	1280	1010	1139
	Allocation	787	680	782
	Drawl	737	450	621
HESCO	Demand	1122	889	993
	Allocation	804	732	761
	Drawl	836	515	709
QESCO	Demand	1330	1013	1160
	Allocation	850	833	837
	Drawl	798	548	686

COMPARISON OF LOAD SHEDDING HOURS URBAN

YEARS – 2013 - 2017													MAX.	MIN.	AVG
Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec			
2013	6	6	12	13	13	12	12	6	6	6	3	3	13	3	8
2014	8	4	5	6	6	7	5	5	5	6	6	6	8	4	6
2015	6	6	6	6	6	6	6	6	6	5	4	5	6	4	6
2016	5	5	4	6	6	5	6	6	6	6	2	0	6	0	5
2017	3	2	2	4	3	1	1	2	1	1	1		4	1	2

COMPARISON OF LOAD SHEDDING HOURS RURAL

YEARS – 2013 - 2017													MAX.	MIN.	AVG
Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec			
2013	8	8	12	14	14	13	13	8	8	6	4	3	14	3	9
2014	8	5	6	7	8	9	8	8	8	8	8	8	9	5	8
2015	8	8	8	8	8	8	8	8	8	8	7	7	8	7	8
2016	7	7	7	8	8	8	8	8	8	8	3	0	8	0	7
2017	4	3	3	6	5	3	4	4	1	2	1		6	1	4

COMPARISON OF LOAD SHEDDING HOURS

MIXED INDUSTRY

YEARS – 2013 - 2017													MAX.	MIN.	AVG
Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec			
2013	10	7	8	12	12	11	10	8	8	8	3	3	12	3	8
2014	7	4	5	4	6	8	8	7	6	7	3	2	8	2	6
2015	6	5	4	3	4	4	4	4	0	0	0	0	6	0	3
2016	0	0	0	0	0	4	3	0	0	4	0	0	4	0	1
2017	0	0	0	0	2	2	1	2	1	1	0		9	0	1

COMPARISON OF LOAD SHEDDING HOURS INDUSTRIAL

YEARS – 2013 - 2017													MAX.	MIN.	AVG
Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec			
2013	7	2	2	5	6	10	10	8	8	6	3	5	10	2	6
2014	5	4	3	4	6	8	10	10	6	6	2	2	10	2	6
2015	6	1	2	2	0	0	0	4	2	0	0	0	6	0	1
2016	0	0	0	0	0	9	4	0	0	0	0	0	9	0	1
2017	0	0	0	0	2	2	0	0	0	0	0		2	0	1

Thank You!

