

SAARC TRAINING FOR PROFESSIONALS OF AFGHANISTAN'S POWER REGULATORY SYSTEM

NPCC VISIT



بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

THE POWER SYSTEM OPERATOR OF PAKISTAN

National Power Control Centre



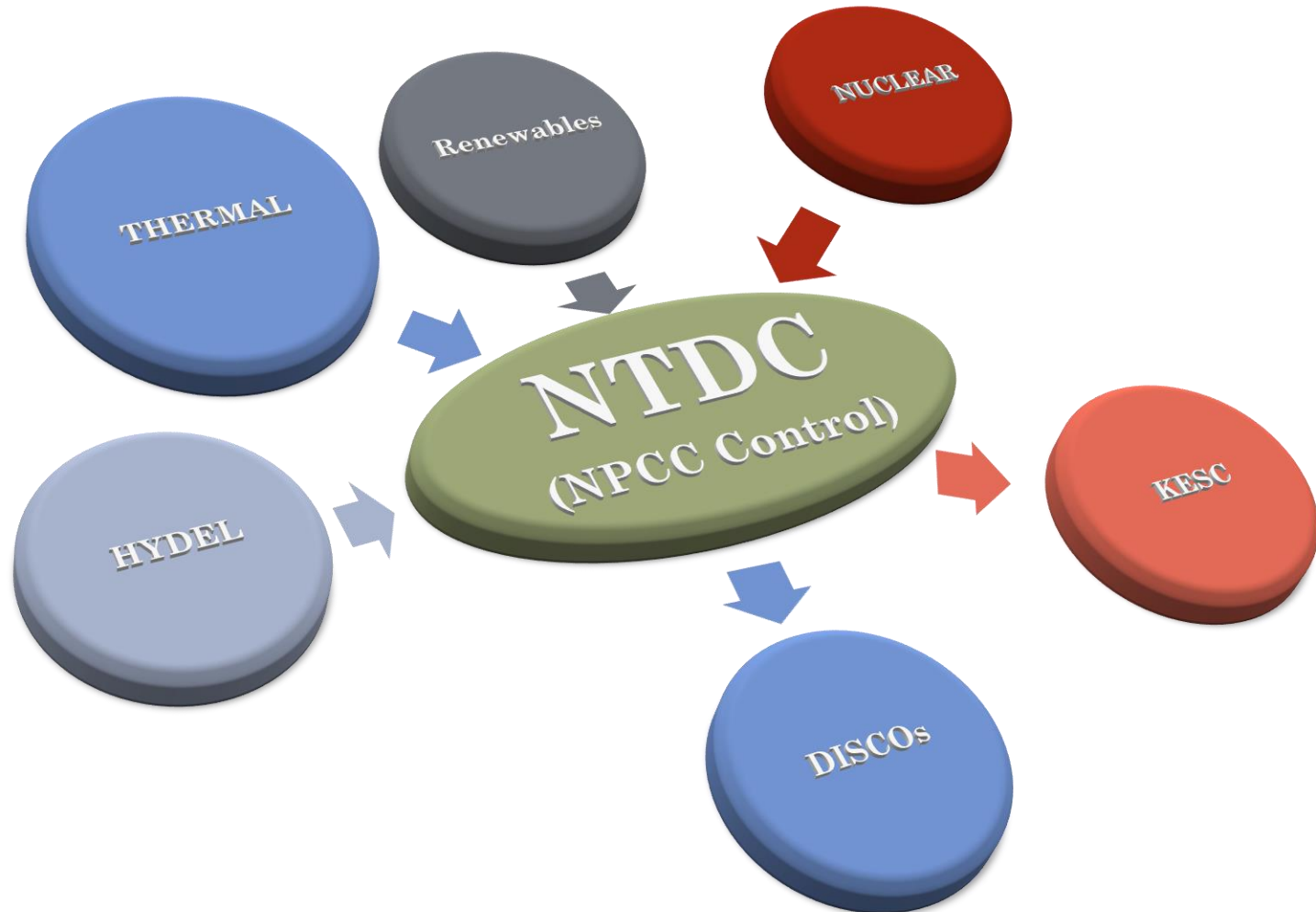
Presented by:
Salman Gul
Deputy Manager NPCC

National Transmission and Despatch Company Ltd.

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 primary transmission network (i-e 500,220 kV transmission lines & 500/220 kV grid stations), provides wheeling facility to CPPA-G for purchase of power from generators and selling to DISCOs
- **DISCOs** construct, maintain secondary transmission network (i-e 132,66 kV transmission lines & 132/11 kV grid stations) and 11/0.4 kV distribution system
- **NPCC** is responsible for operation, monitoring of generation , both primary and secondary transmission system and coordination with all Power sector stake holders (i-e MOE, NTDC head and field offices, DISCOs, GENCOs, CPPA-G & IPPs)

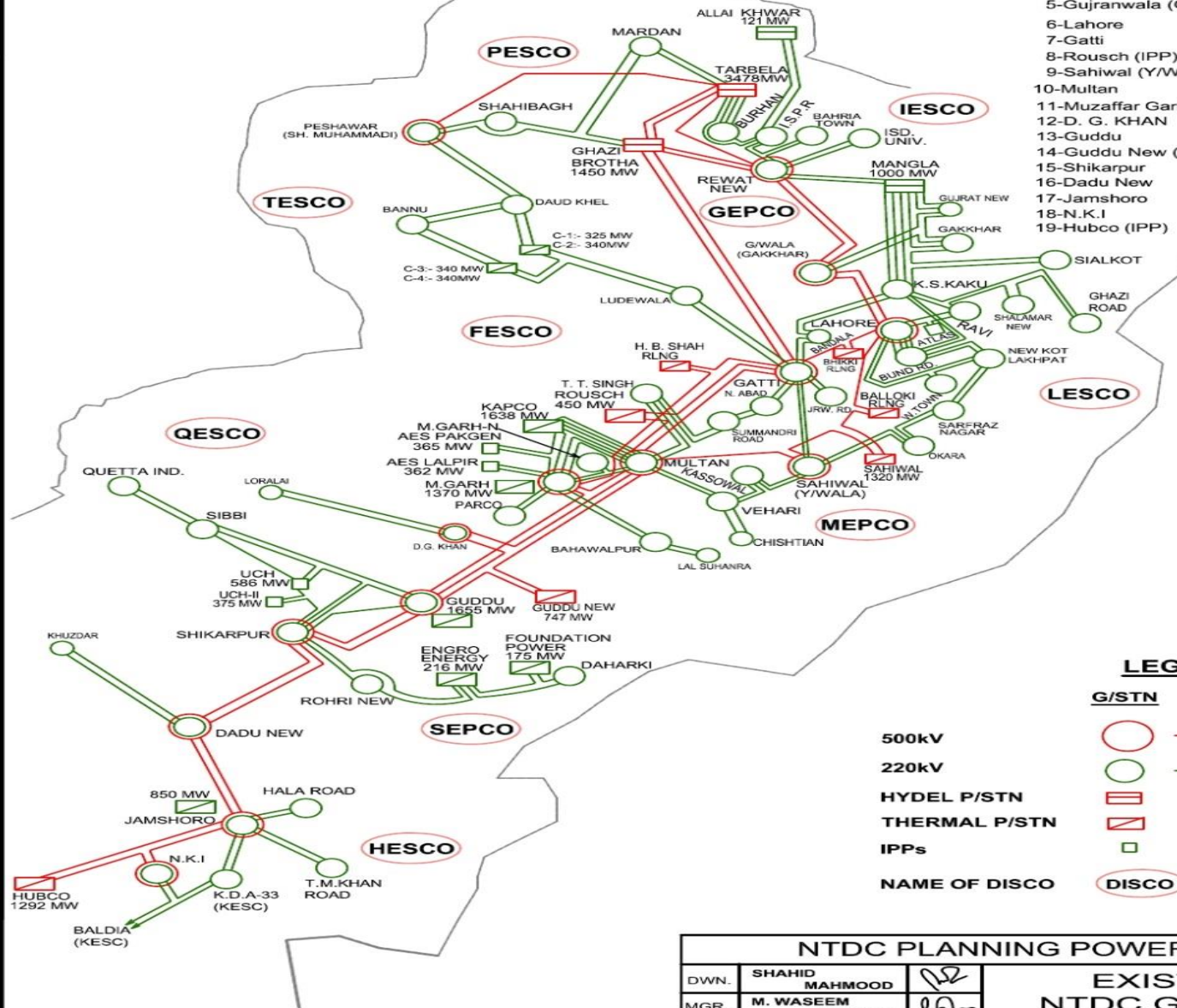
POWER SYSTEM STRUCTURE



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

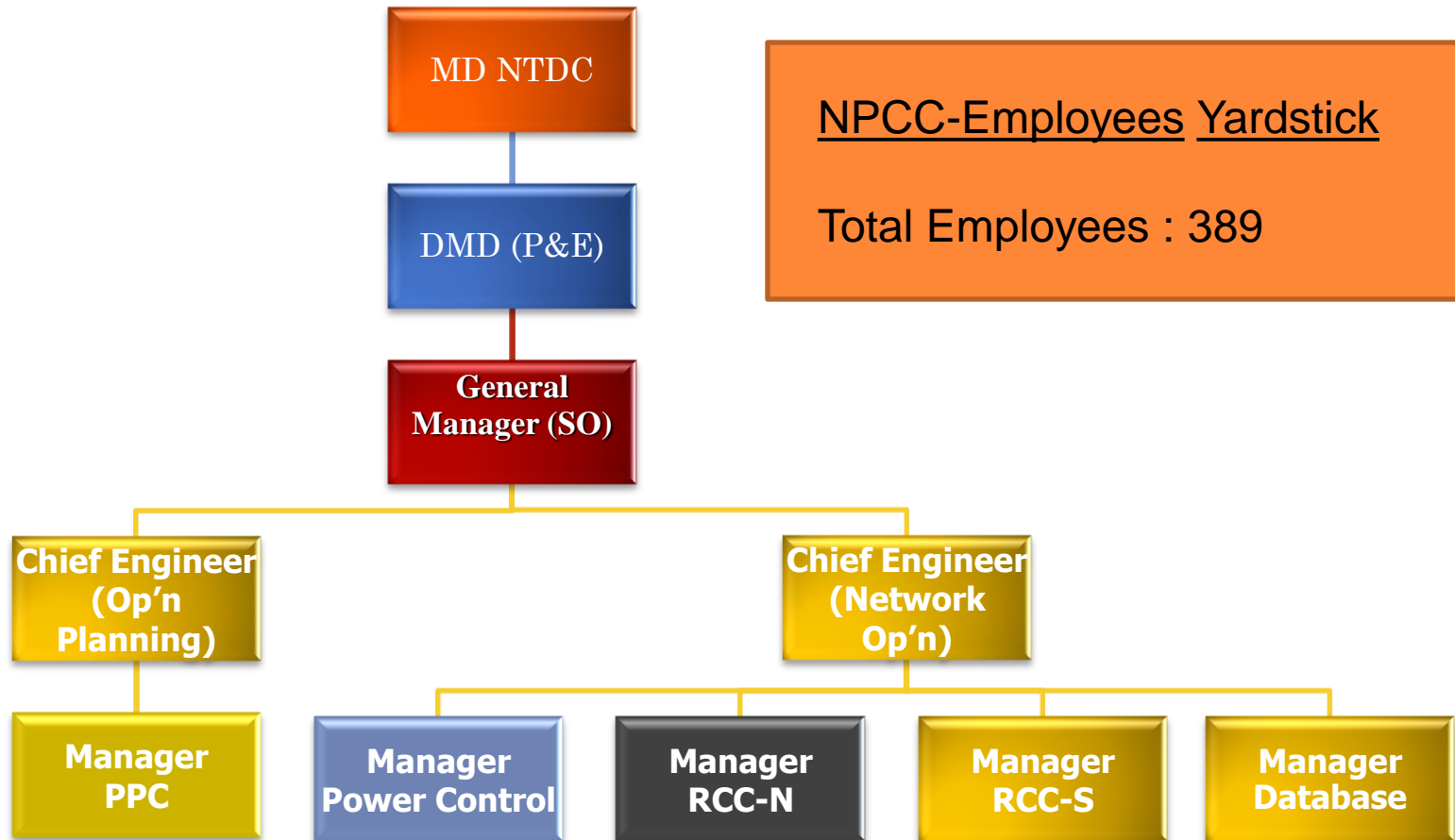
| G/STN | T/L |
|---------------|-----|
| 500kV | |
| 220kV | |
| HYDEL P/STN | |
| THERMAL P/STN | |
| IPPs | |
| NAME OF DISCO | |

NTDC PLANNING POWER

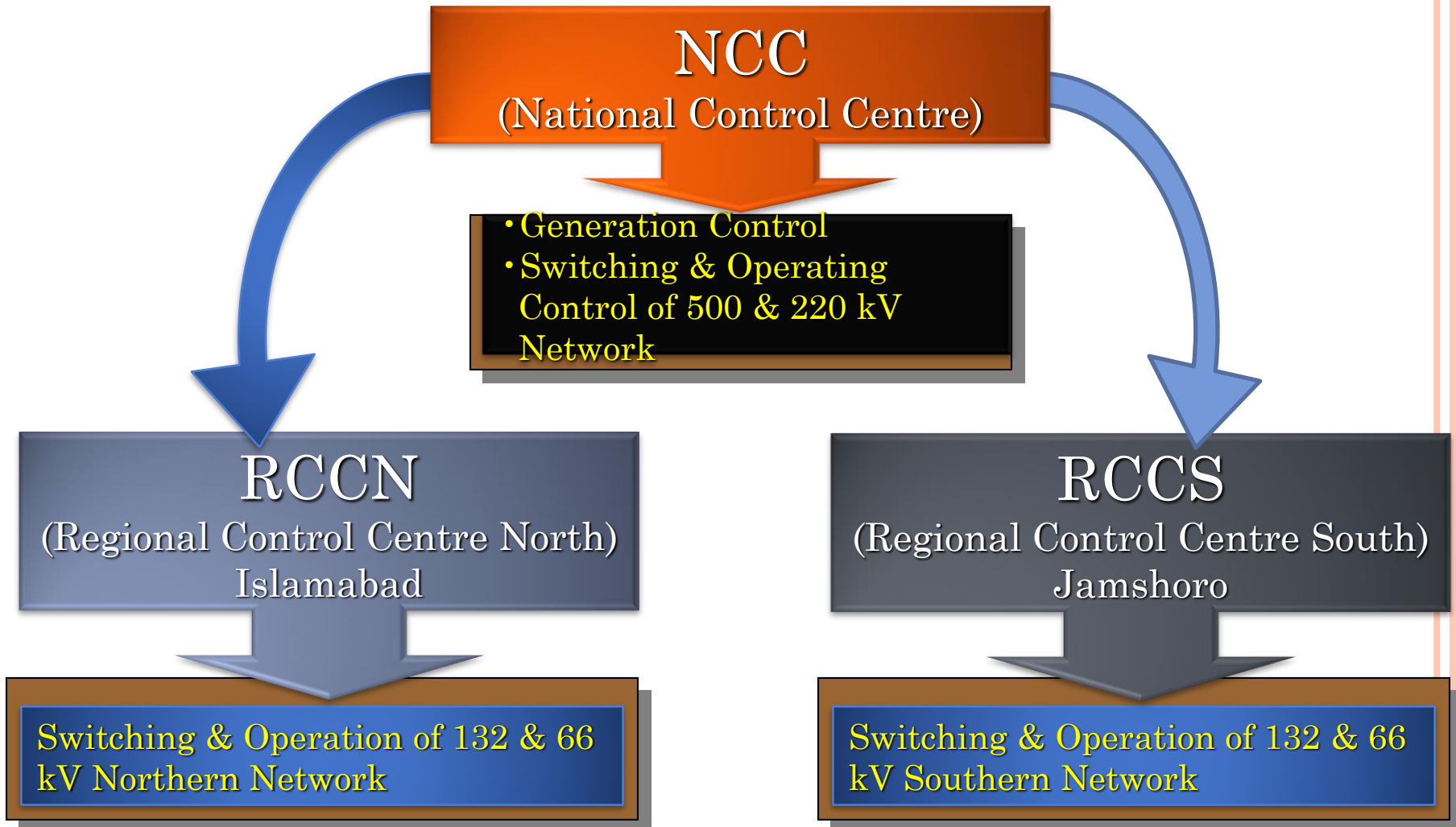
| | | |
|------|-----------------------|--|
| DWN. | SHAHID MAHMOOD | |
| MGR. | M. WASEEM YOUNAS | |
| C.E | | |
| G.M | MAQSOOD AHMAD QURESHI | |

EXISTING
NTDC GRID MAP
500 & 220kV SYSTEM
DRG NO. GM(PP)014-1

ADMINISTRATIVE SETUP OF NPCC



SYSTEM OPERATION HIERARCHY



OBJECTIVES OF NPCC

➤ **Reliability & Security of power system**

- Smooth Supply
- Minimum Interruptions

➤ **Quality of Electric Power Supply**

- Standard Voltage and Frequency

➤ **Safety**

- Personnel.
- Equipment.

➤ **Economy**

- Minimum Generation Cost
- Minimum Losses

MAJOR FUNCTIONS OF NPCC

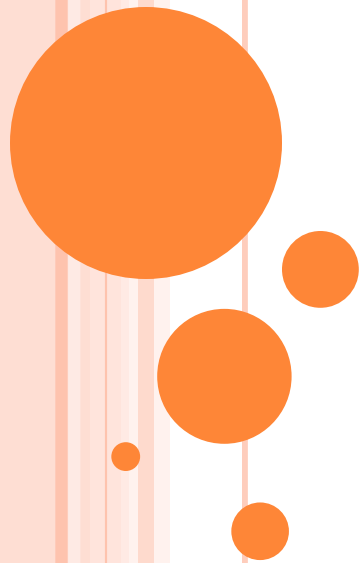
1. National Power Control Centre, commonly known as NPCC, is the nerve centre of Power Sector. Entire power generation and its transmission to the load centres is controlled and coordinated from its National and Regional Control Centres.
2. Maintaining balance between Supply & Demand.
3. Frequency , voltage control and equipment loading within permissible limits.
4. Maintaining security & stability of network.

MAJOR FUNCTIONS OF NPCC

6. Month-wise & Annual Energy Estimation.
7. Economic Dispatch.
8. Switching operations of Power Network.
9. Scheduling of maintenance shut-downs on power-plants & Transmission network elements.
10. Short to medium term operational planning.
11. Advance notifications to thermal plants regarding energy (Year Ahead, Quarter Ahead, Week Ahead and Day Ahead).
12. Collection of system data and preparation of reports

ADMINISTRATIVE FUNCTION

- NPCC is headed by General Manager (System Operation) in main NPCC Building Islamabad.
- GM (SO) is assisted by Chief Engineer (Network Operation) & Chief Engineer (Network Planning).
- GM(SO) reports and coordinates with all Stakeholders regarding Power system.
- NPCC is a control and command body and for smooth operation of system, pass-on instructions to GENCOS, IPPs, DISCOs and Hydro Stations from its Control rooms which function round the clock in 3 shifts with Shift Engineers on duty.



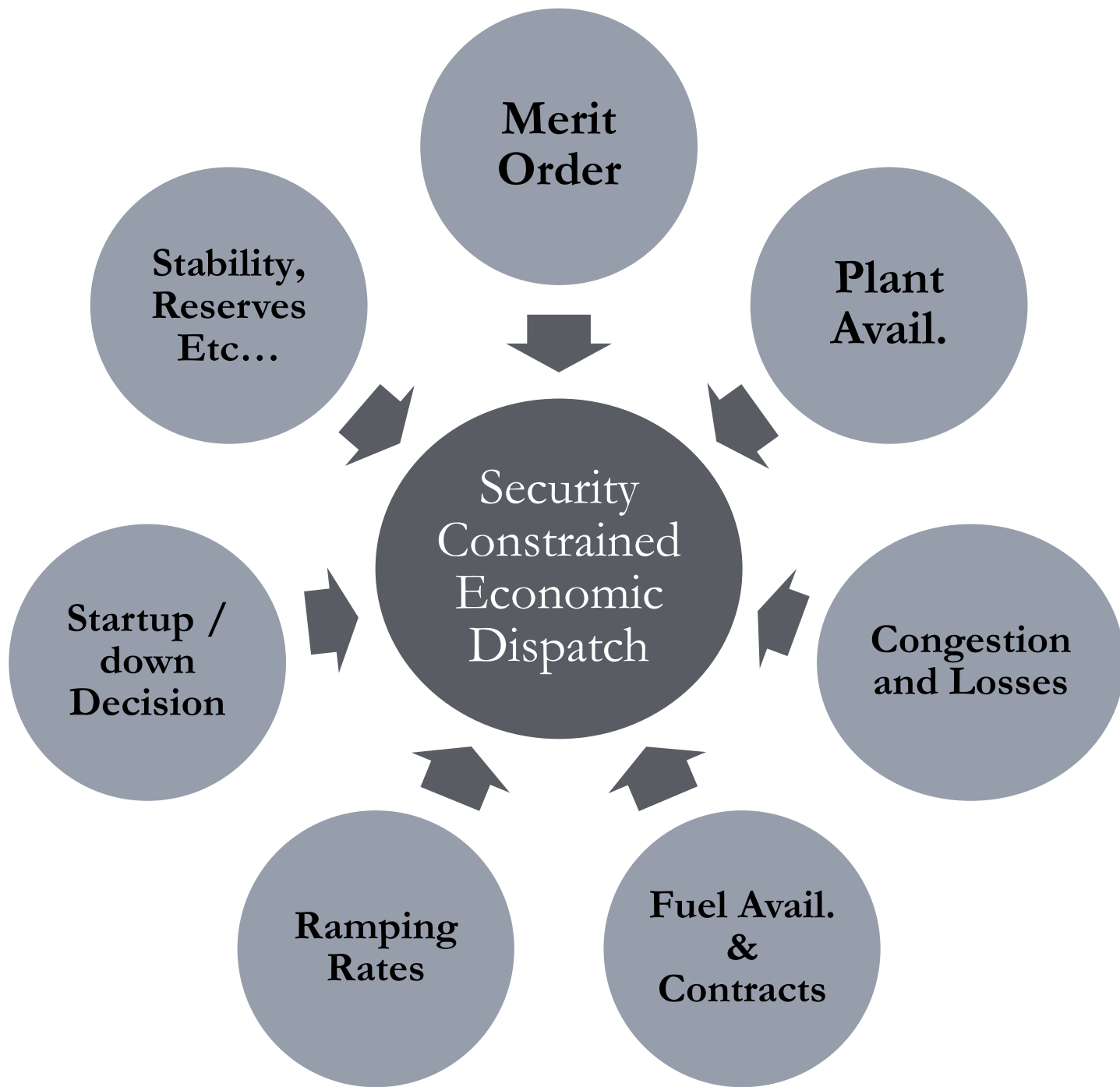
SYSTEM OPERATION & CONTROL

NPCC CONTROL ROOM



PRESENT OPERATIONAL STRATEGY

- System Security and Reliability are issues of top priority nature. This is a technical urgency recognized by utilities all over the world and may demand out of merit operation of some of the generating units in the system.
- The provision of spinning reserve is equal to the $1/3^{\text{rd}}$ of the one biggest generator capacity in system according to grid code.
- 500 and 220 KV transmission lines/ transformers are operated with single contingency compliance.
- Thermal Generators are dispatched in order of economic merit order considering security and stability of system.
- Hydel, Nuclear, REs (Wind, Solar) are operated as must run



GENERATION PLANNING & DESPATCH

Procedure and steps.

- Demand forecasting/estimation on historical trends
- Generation forecasting/estimation keeping in view:
 - Irrigation indents of Hydel stations
 - Schedule outages
 - Forced outages
 - Weather/ Season.
 - Special Events.
 - Constraints if any
- Dispatch of available thermal generation as per merit order.

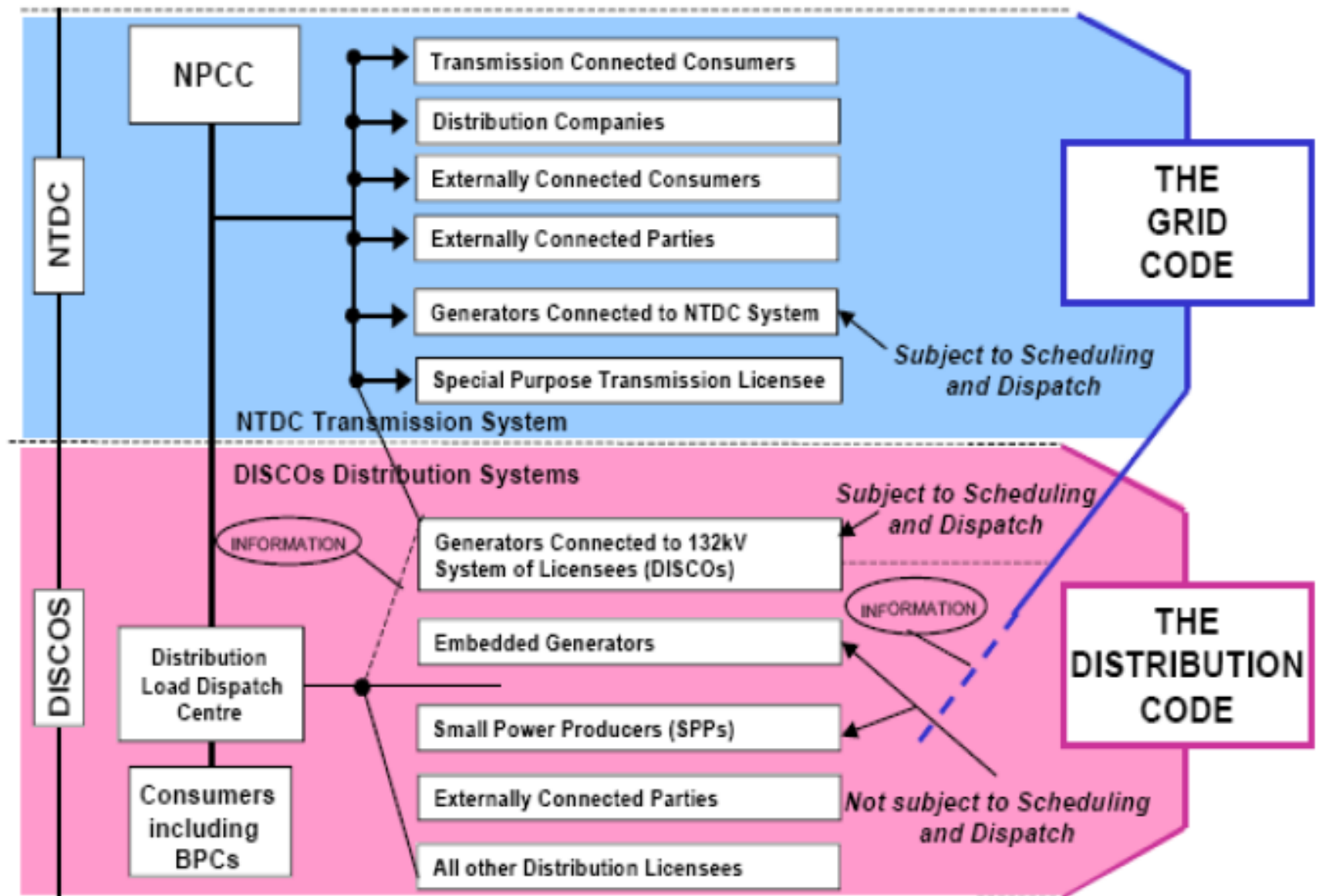
OPERATIONAL CONSIDERATIONS FOR DISPATCH (PLANNED)

- System Stability.
- Transmission/ Transformation constraints.
- Reactive power support for regulating system voltages.
- Planned and scheduled shutdowns on
 - a) Transmission Lines
 - b) Transformers.
 - c) Generating Plants.
- Limitations on No. of starts of steam turbines.
- Testing of generating Plants.

OPERATIONAL CONSIDERATIONS FOR DISPATCH (UN-PLANNED)

- Change in Water indents.
- Change in Gas quota allocations.
- Load restrictions on generating plants.
- Tripping of equipment/ Major Outages.
- Difference in Forecasted and actual load due to abrupt weather change.
- Reactive power support for regulating system voltages.

NEPRA GRID CODE



NEPRA GRID CODE

- Operation of power system regulated under NEPRA's Grid Code
 - OC-1 : General operating principles
 - OC-2 : Demand Forecast
 - Input from all stakeholders for different time horizons consolidated by NPCC
 - OC-3 : Demand Management

NEPRA GRID CODE

- OC-4: Operational Planning
 - Network operation and outage planning/coordination
 - Generation dispatch and outage coordination
 - Insufficient power operating margin
 - Frequency and voltage control and operating margins

NEPRA PERFORMANCE LIMITS

○ Frequency

- Frequency Sensitive Mode (Normal Range)
 - **49.8-50.2 Hz**
- Contingency Frequency Band (Load Shedding Threshold)
 - **49.4-50.5 Hz**

○ Voltage

- | | |
|------------------------|-----------------|
| • N-0 Contingency | N-1 Contingency |
| ○ +8 % and -5 % | ± 10 % |

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.
- 132 kV switching for optimal configuration of radial network



GENERATION MIX

GENERATION SOURCES

ABSTRACT OF POWER PLANTS

| Generation Type | INSTALLED CAP AS PER LICENCE (MW) | DERATED CAPACITY (MW) | NO OF UNITS |
|------------------------|--------------------------------------|--------------------------|-------------|
| TOTAL WAPDA HYDEL (22) | 9,387 | 9,387 | 97 |
| IPP HYDEL (5) | 382 | 379 | 18 |
| TOTAL HYDEL (27) | 9,770 | 9,767 | 115 |
| GENCO-I (3) | 1,174 | 860 | 14 |
| GENCO-II (3) | 2,457 | 1,552 | 17 |
| GENCO-III (4) | 2,051 | 1,765 | 17 |
| TOTAL GENCO (10) | 5,682 | 4,177 | 48 |
| IPP-THERMAL (37) | 17,166 | 15,883 | 210 |
| NUCLEAR (4) | 1,345 | 1,246 | 4 |
| SOLAR (4) | 400 | 400 | 4 |
| WIND (24) | 1,235 | 1,235 | 718 |
| TOTAL VRE'S (28) | 1,635 | 1,635 | 722 |
| BAGASSE (9) | 363 | 353 | 13 |
| TOTAL PLANTS (115) | 35,961 | 33,060 | 1,112 |

GENERATION SOURCES

(Derated Capacity)

| Type | Derated | Percentage Share |
|---------------------------------------|---------------|------------------|
| | MW | %age |
| Total Hydel (Wapda + IPPs) | 9,767 | 29.5% |
| Gencos Fossil Fuel | 4,177 | 12.6% |
| IPPs Fossil Fuel | 15,883 | 48.0% |
| Bagasse | 353 | 1.1% |
| Nuclear | 1,246 | 3.8% |
| Solar | 400 | 1.2% |
| Wind | 1,235 | 3.7% |
| Total | 33,060 | 100.0% |

BREAKUP OF MAX RECORDED GENERATION **DURING PEAK HOURS**

| 22,601 MW on 04 Sept 2019 | |
|---------------------------|--------|
| Wapda-Hydel | 7,937 |
| Gencos | 2,290 |
| IPPs | 12,374 |
| Total | 22,601 |

ABSOLUTE MAX RECORDED GENERATION DURING 24 HOURS

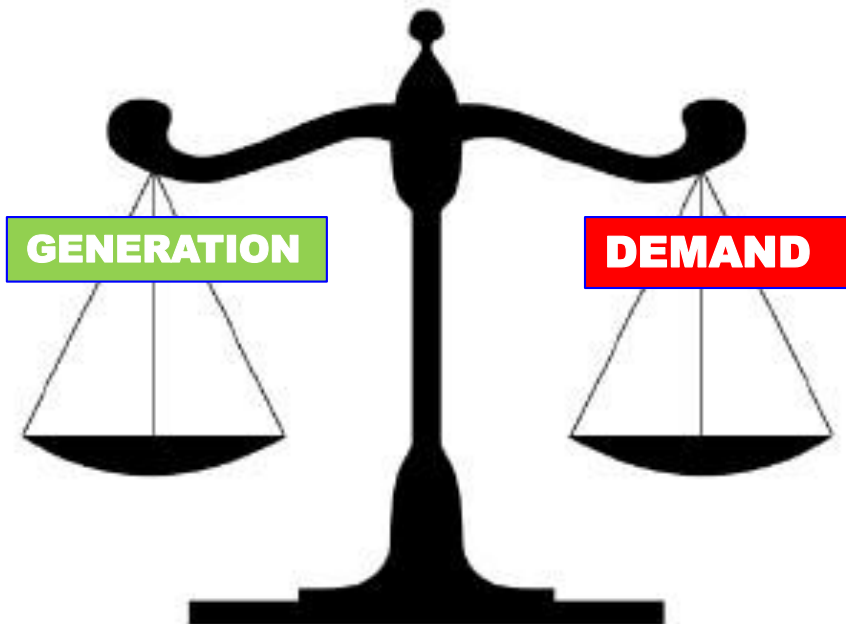
**23,056 MW on 04 July 2019 @
14:18 Hours**



LOAD MANAGEMENT

GENERATION / DEMAND BALANCE

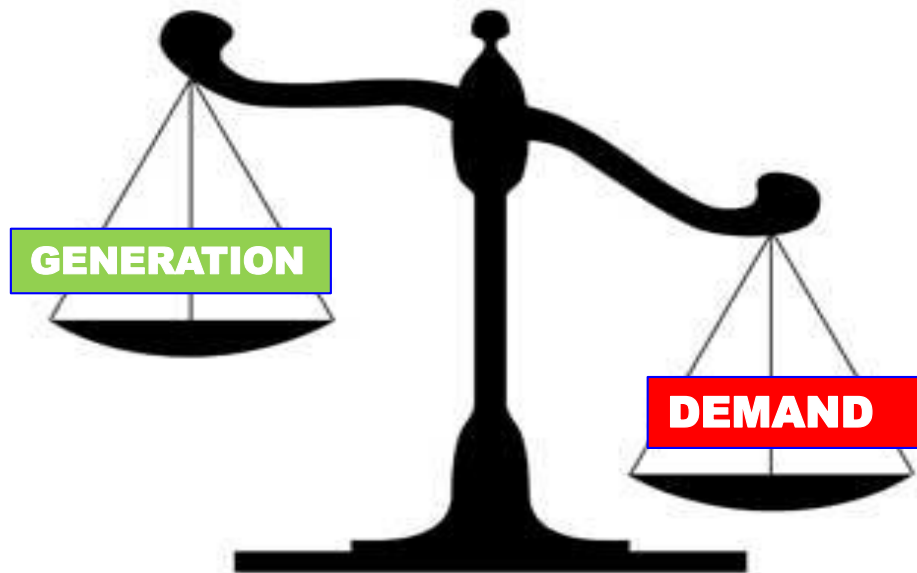
The primary function of NPCC is to keep balance between demand and supply & to ensure system security and reliability. In balanced condition system frequency is 50 Hz.



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

- In case of deficit in generation capacity, balance between demand and generation has to be maintained through load management
- Therefore a multi tier strategy has been adopted for this balance through load management
 - Scheduled load management
 - System security load management
 - Emergency (Forced) 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

- Under Voltage, Under Frequency & Cross Trip Protection schemes have been installed for System Security Load Management

EMERGENCY LOAD MANAGEMENT

Emergency 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



MERIT ORDER

MERIT ORDER APPROVAL COMMITTEE

- Power Plants are operated on the basis of Despatch Merit Order which is approved by a committee of the following members.
 - General Manager (SO) NPCC, Convener.
 - General Manager (PSP) NTDC, Member.
 - Chief Technical Officer CPPA-G, Member.
 - Chief Financial Officer CPPA-G, Member.
 - Chief Technical Officer GENCO, Member.
- Standard Operating Procedure SOP exists for the process of preparing and revision of merit order for operation of power plants.

PROCEDURE OF MERIT ORDER FORMATION

➤ Procedure

1) Chief Technical Officer CPPA-G will intimate the revised applicable **fuel prices** and **variable O&M Cost** fortnightly in respect of Gencos and IPPs Plants comprising of the following components:

i) Fuel Price, ii) Calorific value of fuel, iii) Net Heat Rate, iv) Variable O&M cost, v) Index Premium, vi) Ratio of fuel mix gas and furnace oil, vii) Environment Consideration, viii) Utilization of local gas and RLNG. ix) International contract by GoP for purchase of RLNG.

2) On receipt of information from CTO CPPA-G, office of GM (SO) NPCC shall consolidate/ prepare the revised merit order and put up immediately to all merit order committee members for final approval.

IMPLEMENTATION OF MERIT ORDER

- As per Clause SDC 1.4.3.2 of NEPRA Grid Code, NPCC always operates the plants without any discrimination. Cheaper plants take the lead in despatching. In prevailing situation of shortfall of power in the country, most of the time in the year, all available plants have to be operated and therefore question of any discrimination of despatch does not arise.
- However during short period of lean demand ,Merit order is strictly followed by NPCC keeping in view the technical constraints of Gencos along with voltage transmission issues if any.
- Plants under annual maintenance outages according to planned programs and hydel generation drops during lean period of system demand.



OPERATION PLANNING

OPERATION PLANNING

○ Pre Dispatch Functions

- Annual Production Plan
- Calculation of future fuel requirements
- Year/Quarter/Month/Week Ahead Planning

○ Post Dispatch Functions

- Event/NPMV Verification
- Liquidated Damages
- Operating Committees

POWER TO THE PEOPLE

SAVE ON ELECTRICITY



Save Electricity
Save Money



Switch to
energy efficient
light bulbs



CLOSING REMARKS

BY GM NPCC