

OVERVIEW OF ENERGY GRID IN INDIA

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Abstract

Economical growth in India has led to considerable growth in power sector. This paper presents the overview of grid energy in India. Load dispatch centers and their roles in the management of electrical power transmission have been discussed thoroughly. Also this paper glides us through recent HVDC projects in India.

Keywords- Load Dispatch Centers, National Grid, HVDC, Challenges in the grid management, ‘One Nation One Grid One Frequency’

1. INTRODUCTION

Electricity is the most important infrastructural input in the development of economy. For smooth evacuation of power from generating stations to consumers, transmission and grid management are essential functions.

Grid management refers ensured moment to moment power balance in the interconnected system, whereas transmission refers to the maintenance of transmission infrastructure.

Earlier the country was divided geographically into five regions namely northern, western, eastern, northeastern and southern. The first four out of these five regional grids operated in synchronous mode which meant power in these regions can flow seamlessly as per relative load generation balance. The southern grid was connected to the rest of Indian grid through asynchronous links which meant quantum and direction of power flow could be controlled manually [2].

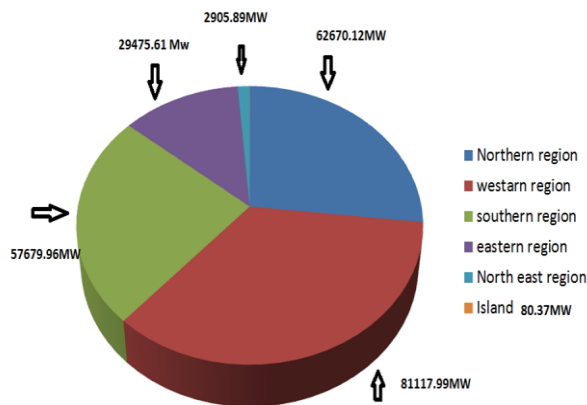


Fig 1: pie chart showing power ppproduction in different regions.

Figure 1 shows power produced in different regions of India.

The western region of India dominates the charts by producing 81,117MW of power [2].

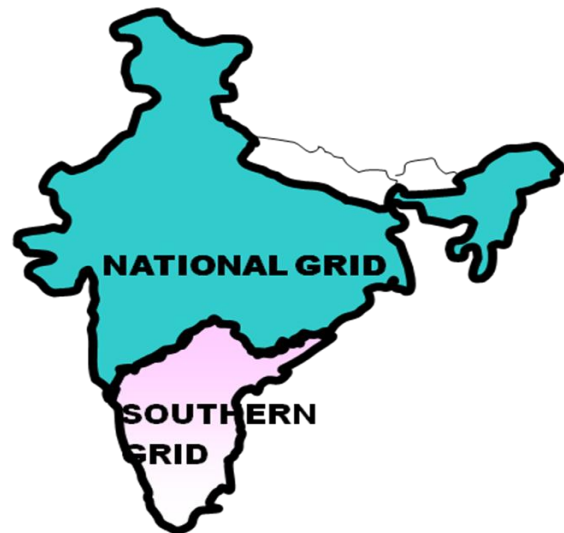


Fig 2: Electrical grids of India

Figure 2 describes that India, is currently divided between two grids namely, national and southern. All the grids in India are being run by state owned POWERGRID Corporation.

- Transmission lines run all over India forming a circuit network of 1, 04,200 km.
- The power transformation capacity is about 1, 85,638MVA.
- The numbers of substations managing the network are 176.

The total inter-regional power transfer capacity is 33,950MW [1].

2. GRID EVOLUTION

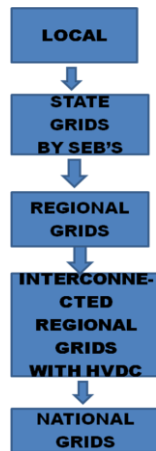


Fig3: Grid Evolution

The above figure shows grid evolution from 1950 onwards.

- Pre-independence-Small Isolated System
- During 60s-limited interconnection between neighboring states.
- Late 80s-Integrated grid operation through 400kV system.
- Late 90s-Asynchronous inter-regional links.

3. LOAD DISPATCH CENTRE (LDC)

The control of grid is planned to be done at three levels of hierarchy namely, National Load Dispatch Centre (NLDC), Regional Load Dispatch Centre (RLDC) and State Load Dispatch Center (SLDC).

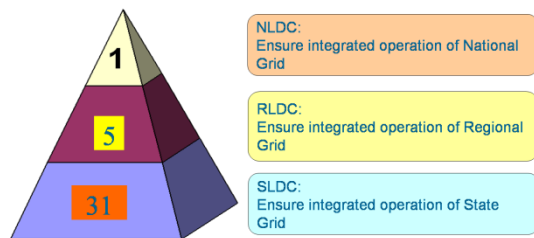


Fig 4: Grid Management Heirarchy

As per Electricity Act (EA) 2003, LDC's monitor grid operations, exercise supervision and control over the interstate transmission system and are responsible for optimum scheduling and dispatch of electricity within the region.

Presently POWERGRID is operating a National Power system Desk (NPSD) for information exchange and facilitating inter-regional transactions'.

- RLDC is responsible for carrying out real time operations of the grid control and dispatch electricity within a region through secure operations of regional grid.

- The functions of SLDC elaborated in EA 2003 are similar to that of RLDC except the area of jurisdiction which in case of SLDC is the state [1].

4. NATIONAL GRID

- National grid was set up in late 90s.The National Grid is basically combination of eastern, western, northern and northeastern regional grids.
- The National Grid was set up with idea that it would help in electrical power transfer from surplus regions to deficit regions.
- Also it focuses on maximum utilization of resources from diversified regions.
- National Grid coordinates with RLDC for energy accounting for inter-regional exchange of power.

5. OPERATING AIDS FOR GRID MANAGEMENT

- In order to enhance the power system visibility and improve the quality of supervision in real time operation. In the country, the grid control rooms at regional and state levels have been equipped with a State-of-the-art communication and data acquisition systems.



Fig5: Data Acquisition System

- The above figure explains a typical data acquisition system for electrical communication.
- Under the system the vital system variables are measured with the help of transducers installed at all the important locations.

6. HVDC

- Introduction to High Voltage Direct Current has revolutionalised the existing power systems.
- In the second era of electricity revolution alternating current (AC) displaced direct current (DC) because its voltage can be stepped up and lower currents that results can be pumped through relatively thinner wires.
- HVDC comes into play when large volumes of electricity need to be transmitted over distances above 800km [3].

Table 1: HVDC projects in India

Sr.No.	Project name	Commissioned on	Power Rating (MW)	AC Voltage (kV)	DC Voltage (kV)	Length Of Line (km)
1	Rihand -Dadri	Dec-1991	1500	400	500	816
2	Talcher-Kolar	Jun-2003	2000	400	500	1369
3	Mundra-Mohindergar	2012	1500	400	500	986
4	Ballia-Bhiwadi	Pole1-Mar2010 Pole2-Mar-2011	2500	400	500	780
5	Biswanath-Agra	2015	6000	400	800	1728

7. BACK TO BACK HVDC PROJECTS

Back to Back stations are those stations where both the converters are housed in the same building and the length of the dc line is kept as short as possible.

It has the advantage of bidirectional power flow.

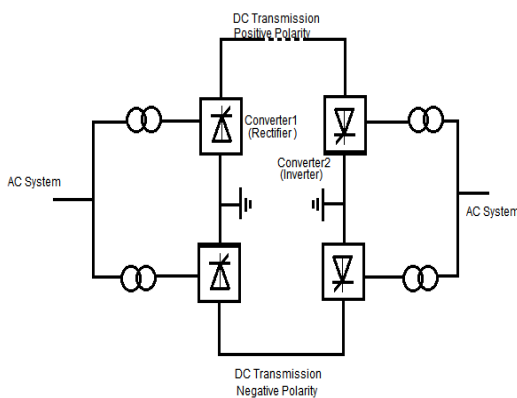


Fig 6: Back to Back HVDC Links

Currently there are 4 Back to Back Projects in India namely:

- Vindhyachal
- Sasaram
- Chandrapur
- Gazuwaka[4].

8. CASE STUDY: ONE NATION, ONE FREQUENCY, ONE GRID

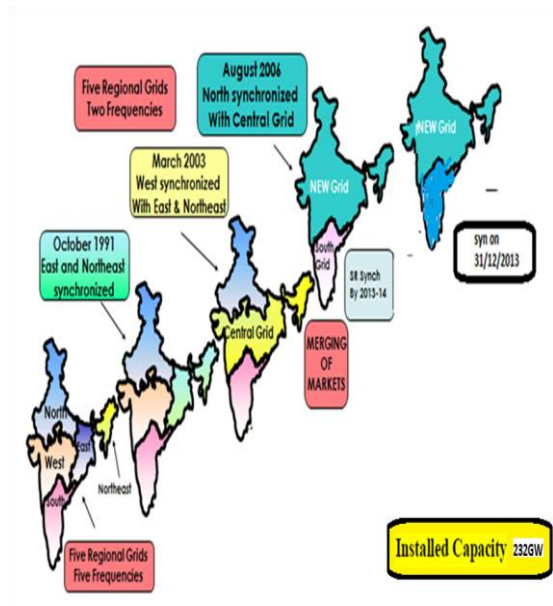


Fig7: Synchronization of Indian grids

- The central transmission utility POWERGRID successfully commissioned the Raichur-Solapur 765kV single circuit transmission line on Jan 2014.
- This transmission line interconnects southern grid, synchronously with rest of the Indian grids.
- It cost the POWERGRID CORPORATION 815crores to set up the system.
- The power generation capacity is 232GW.
- With this India became one of the largest operating synchronous grids in the world.
- With this project power deficit southern states especially Andhrapradesh, Tamilnadu and Kerala are able to utilize the power from surplus regions.

Table 2: All India Power Supply Position

Region	Power			
	Requirement	Availability	Surplus(+) /Deficit(-)	(%)
	(MU)	(MU)	(MU)	
Northern	319885	301418	-18467	-5.8
Western	286752	283396	-3356	-1.2
Southern	309840	250583	-59257	-19.1
Eastern	119632	131880	12248	10.2
Northeastern	12424	11024	-1400	-11.3
All India	1048533	978301	-70232	6.7

- The south witnessed peak power deficit of 6.8% in Nov 2013 according to the latest official data from POWERGRID.
- Peak power deficit refers to the shortage of electricity when the demand is at maximum.
- In last November, while the southern regions electricity demands reached 34,118MW the availability was only 31,786MW.
- With the introduction of One Nation, One Grid, One Frequency the supply demand situation improved.

Table: 3 Frequency Profile of northern, western, eastern, north-eastern and southern regions in the year 2013

Month	Frequency Profile			
	NR/WR/ER/NER		SR	
	Max.Freq.	Min. Freq	Max.Freq.	Min. Freq
Aug'2013	50.77	49.65	50.62	49.01
Sep'2013	50.62	49.21	50.61	49.21
Oct'2013	50.63	49.28	50.53	49.20
Nov'2013	50.51	49.48	50.61	49.24
Dec'2013	50.69	49.33	50.73	49.44

- On December 2013 One Nation One Grid One Frequency mission was incorporated.
- Table: 3 give an idea about frequency matching between southern region and with the rest of the Indian grid [5].

9. CHALLENGES IN GRID MANAGEMENT

- Large interconnected grids are essential for reliability of power supply and for exploitation spatially distributed energy resources centers in the country.
- The manifold growth in the network size has increased the complexity of the grid management.
- The physical nature of power flow on transmission lines, rapidly changing demand patterns, dramatic changes in the system pattern makes grid management extremely challenging.

- Competition has heightened the market pressure, forcing system to be operated closer to its physical limits.
- The conflict of interests, unclear responsibilities, inadequacy of resources and legacy issues among these utilities often impair collective performance of grid management.
- All the above coupled with rapidly diminishing species of power system engineers and general lack of appreciation of this vital function is making grid management a tough job.

10. CONCLUSIONS

- The overview of Indian grid is described giving detailed explanations about the various load dispatch centers.
- The evolution of grid from prior to independence to late 90's was studied.
- The concept of HVDC is explained in this paper and recent projects commissioned regarding HVDC are mentioned.
- Finally, One Nation One Grid One Frequency mission accomplished on 31st December 2013 same is described as case study along with its advantages.
- With the development and resources over time more and more projects have been introduced and efficient power transmission is carried out which earlier was not possible to such an extent.

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