

Practical Aspects of Reactive Power Control in Smartgrid

J. Priya

Abstract - Smartgrid has the advantage that if the generation capacity exceeds the maximum demand, the excess power can be fed back to the utility grid or it can be stored. Thus power flow becomes bidirectional in smartgrid. Basics of grid operations, Load-frequency control, Reactive power-voltage control, Sources of reactive power, Power system stability (Angle, Frequency, Voltage), Excerpts from technical standards and grid codes, Generator capability chart, Generator excitation system, Power system stabilizer (PSS) are the factors to be considered which influences the cost of electricity in India power market.

Key Words: Power system stabilizer (PSS), Load-frequency control, Reactive power-voltage control, Gas turbine power projects (GTPP), Integrated gasification combined cycle (IGCC)

1. INTRODUCTION

Due to rapid increase in population, economic growth and rise in industrial sector the generation capacity needs to be increased. There are several limitations and environmental constraints in the path of power generation by conventional methods. These limitations can be overcome by using renewable energy sources and hence the application of distributed generation is becoming popular. [1]. Power the executives in smartgrid is a vital territory which needs examination. The effect of Distributed Generators on the conveyance framework, where the investigation of burden sharing among different Distributed Generators and utility lattice is a territory which needs examination. PV and power module based Distributed Generators does not carry on as consistent current or voltage source either because of parametric vulnerabilities or because of outside aggravations like climate conditions and burden changes [2].

1.1 Global trends

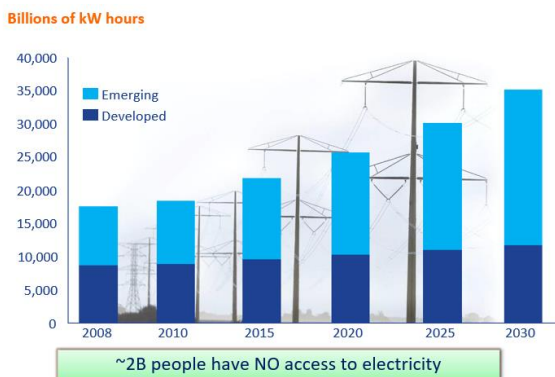


Figure 1.1: Global trends

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(i) Global dynamics

- Major additions in Asia, Africa, the Middle East and Latin America
- Europe, Japan, Korea and North America would stay nearly flat

(ii) Around 40% of the existing power plants due to retire

(iii) Growth in energy efficiency programs ... Generation & distribution systems

- 4x Cost of generating a KWh versus the cost of saving a KWh

(iv) Electricity accounts for 40% Greenhouse gases Stricter emission norms

(v) Renewables power generation to increase

1.2 A grid:

Grid can be defined in many ways as per our requirements. Here it is considered as the interconnection of many elements including distributed energy resources [3].

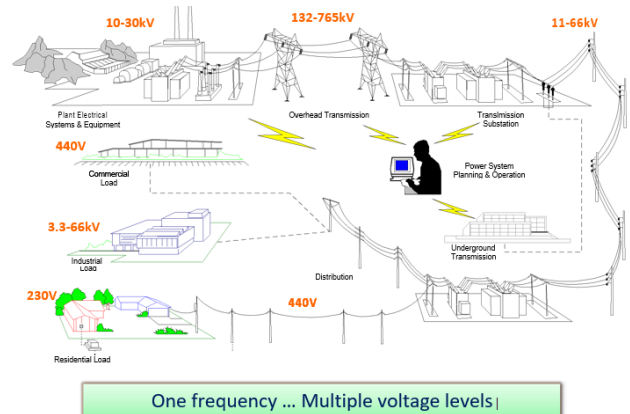


Figure 1.2 Smart Grid

2. POWER PROJECTS

2.1 Gas turbine power projects (GTPP)

GTPP has two cycles. Simple cycle and combined cycle. In combined cycle, heat recovery system is incorporated.

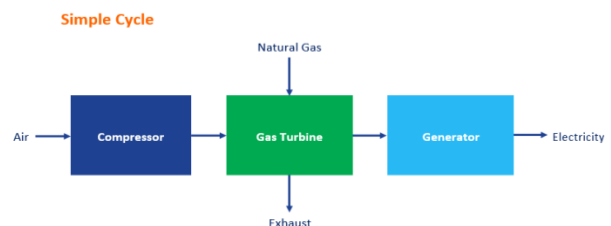


Figure 2.1 a. GTPP Simple cycle



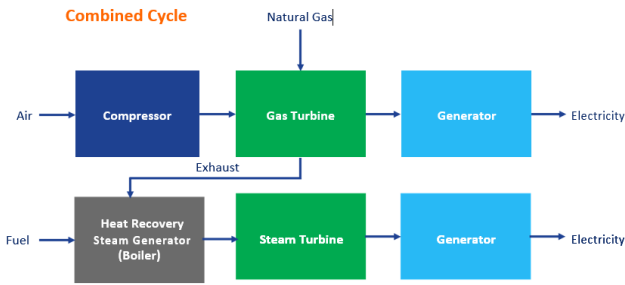


Figure 2.1 b GTPP Combined cycle

2.2 Integrated gasification combined cycle (IGCC)

IGCC has five basic systems namely Gasification, Cooling Stage, Clean up stage, Air separation System and Combined Cycle System.

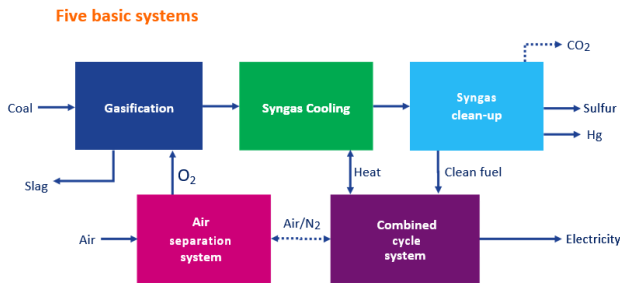


Figure 2.2 Integrated gasification combined cycle

2.3 Technology efficiency (%)

Power scenario[4] shows that demand is increasing and smarter technology is needed to meet the future demand. The technology efficiency in percentage for different processes is shown.

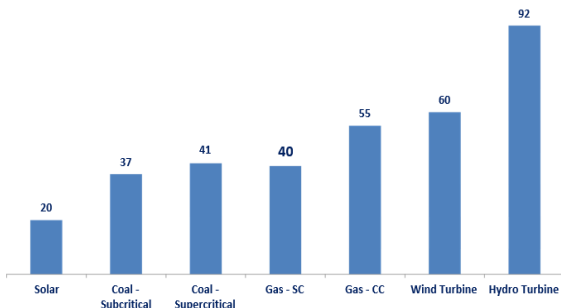


Figure 2.3 Technology efficiency

2.4 Typical load duration curve

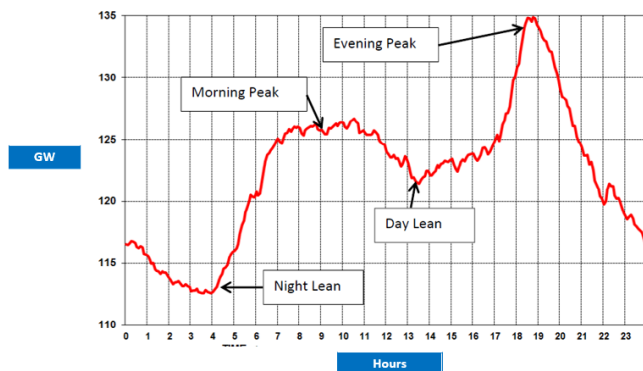


Figure 2.4. Load duration Curve

3. RESULT FOR POWER DEMAND

To meet the power demand, energy storage plays a vital role [5], in which energy can be stored during off peak hours and can be used during peak hours. Knowledge of peak demand at each region is necessary to plan the system accordingly.

3.1 Peak demand Northern Region

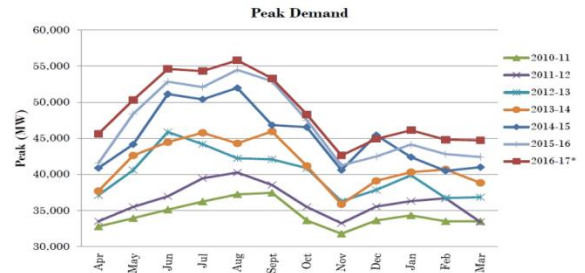


Figure 3.1 Peak demand Northern Region

3.2 Peak demand Western Region

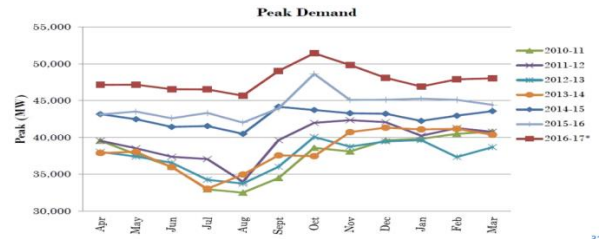


Figure 3.2 Peak demand Western Region

3.3 Peak demand Southern Region

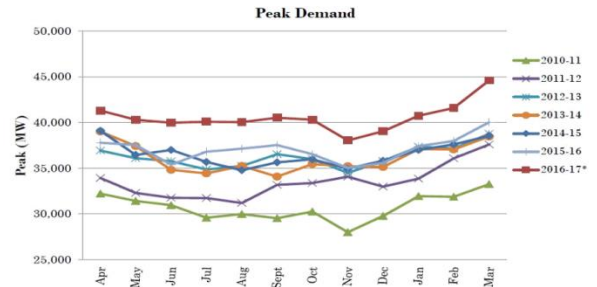


Figure 3.3 Peak demand Southern Region

3.4 Peak demand Eastern Region

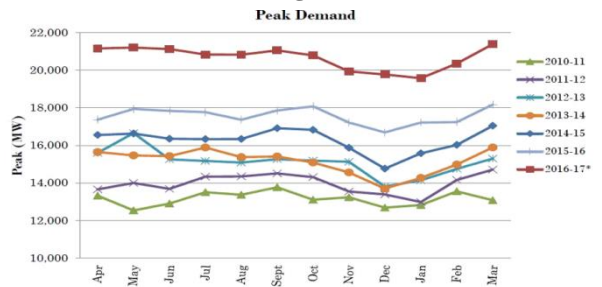


Figure 3.4 Peak demand Eastern Region



4. RESULT FOR LOAD DURATION

4.1 Typical load duration curve

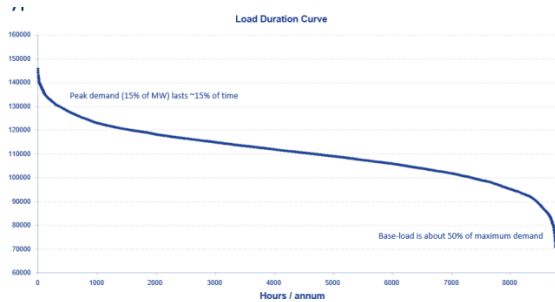


Figure 4.1 Typical load duration curve

4.2 India load curve

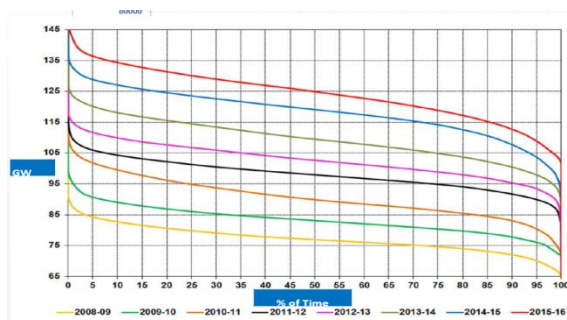


Figure 4.2 India load curve

4.3 Plant load factor (PLF)

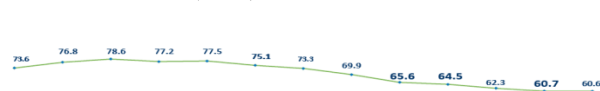


Figure 4.3 Plant load factor

4.4 Peak deficit (Energy / MW%)

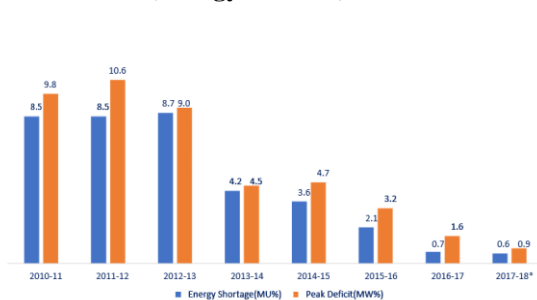


Figure 4.4 Peak deficit

4.5 AT&C losses (%)

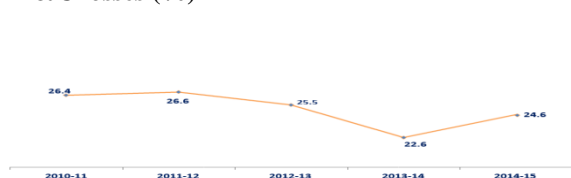
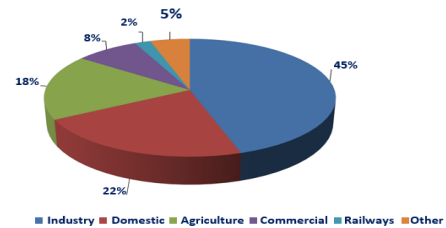


Figure 4.5 Losses

5. ITS TIME TO BUILD SMART GRIDS

Smart grids with reactive power control is a solution to many challenges faced in the power market [6-9]. Percentage load distribution and per capita energy consumption is a dynamic factor.

5.1 Load distribution (%)



Per capita consumption ~1075* kwh (2015-16)

Figure 5.1 Load Distribution

5.2 Structure of India power market

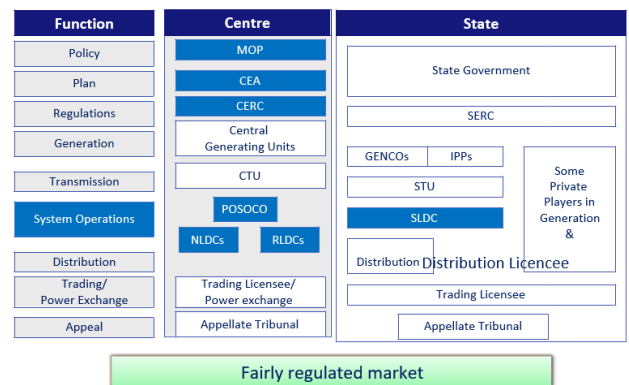


Figure 5.2 Structure of India power market

5.3 Structure of India power market- Central

5.3.1 Ministry of Power (MoP)

(i) Responsible for administration and enforcement of legislation

5.3.2 Focal Electricity Authority

(i) Advises the legislature on issues identifying with the National Electricity Policy

(ii) Formulates momentary and point of view plans for advancement of power frameworks

(iii) Prescribes the guidelines on issues, for example, development of electrical plants, electric lines, network to the framework, establishment & operation of meters and wellbeing and specialized models

(iv) Promotes incorporated tasks of the provincial/SAARC control matrices

(v) Advises focal government, state governments and administrative commissions on every single specialized issue identifying with age, transmission and dissemination of power

5.3.3 Central Electricity Regulatory Commission (CERC)

- (i) Tariff for Central Generators/producing organizations selling in different states
- (ii) Interstate transmission of power
- (iii) Tariff for interstate transmission of power
- (iv) Issue licenses: Interstate transmission/exchanging, fixing exchanging edge
- (v) Specify Indian Electricity Grid Code
- (vi) Advise on definition of Tariff Policy and National Policy

5.4 Structure of India control showcase State

5.4.1 State Regulator (SERCs)

- (I) Tariff for age, supply, transmission, wheeling of power inside the state
- (ii) Electricity buy and obtainment procedure of the appropriation licensees, including the cost of acquisition of power
- (iii) Intra-state transmission and wheeling of power
- (iv) Specify state network code
- (v) Advise the State Government on arrangement matters

5.4.2 India grid vision

One Nation, One Grid, One Frequency

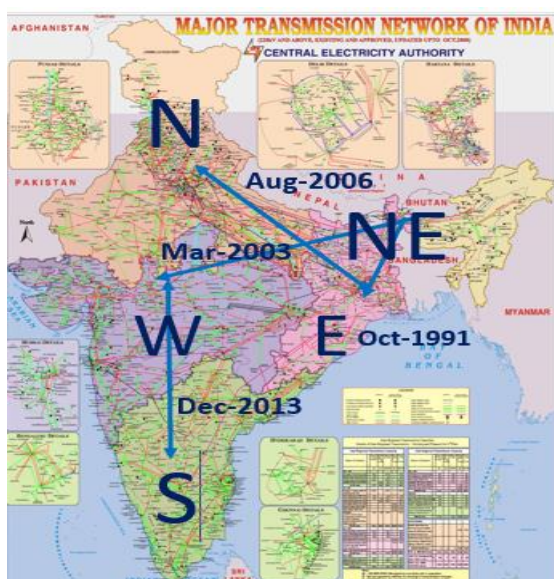


Figure 5.4 Vision of Indian Grid

- (i) ONE grid
- (ii) National level Load Dispatch Centre (NLDC)
- (iii) Five Regional Load Dispatch Centre (RLDC)
- (iv) “High capacity power transmission corridor” (HCPTC) 400kV/765kV AC, +/- 800kV HVDC

6. CONCLUSION

By analyzing the reactive power control strategies in Indian Power Market, it is seen that the vision of One Nation, One Grid, One Frequency is fairly possible and this helps in delivering quality power to the people and makes power control flexible.

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