Analysis of Reserve Capacity for Power Plant

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ABSTRACT: ***The demand of electricity is increasing day by day. For smooth supply of electricity to the consumer the management of power plant is required. There are different factors which should be calculated and reach to a required level for the supply of electricity to the consumer. There are different factors for the measurement in which reserve capacity plays an important role. The factor reserve capacity calculates at the time of construction of power plant. Here in this research paper two systems are considered, system 1 and system 2. The calculation and analysis has been done for both the system by calculating different factors for power plant like load factor, maximum demand, demand factor has been calculated. The system 1 reserve capacity is 103MW while system 2 reserve capacity is 410MW. The analysis of reserve capacity for system 1 and system 2 has been done by collecting data of power plant from different sources then calculated different factors for both the systems.***

KEYWORDS: ***Capacity Factor, Maximum Demand, Power Demand, Power Plant, Power Generation.***

INTRODUCTION

The system is a combination of components which perform some task. Where it has some input and according to input gets output. Figure 1 illustrate the definition of the system.

Figure 1: Define system

1. *What is load?*

The load depends upon the electricity application. It takes power as input. The loads are of different types like municipal load, private load, agricultural load, residential load, commercial load, industrial load etc. where it is connected with the system [1].

2. *What is average load?*

Average load defines in three different period of time. Daily mean loads, each month's mean load as well as annually mean loads. Where the power consumed by load on daily basis for 24hrs is called the daily average load. The power consumption by load for a month is called the monthly average load, similarly power consumed by load for 12 months is called the annual average load [2].

3. *What is single line diagram?*

In power system there is complexity in connection of different large equipments like motor, generator, transformer, etc. Single line diagram is the representation of large equipments with small symbol. Single line diagram decreases the complexity of system.

4. *What is plant capacity?*

Plant capacity is the mean demand's proportion towards thoroughly installed capacity of the power plant. It can also be described like real energies produced towards maximum possible energies that could have been produced. It calculates the reserve capacity of the power plant which helps in balancing the demand and supply [3].

5. *Importance of plant capacity*

Plant capacity acts out a significant role over balancing demand as well as electricity supply. Before the construction of any power plant, the selection of plant capacity is important. 75% plant capacity means such power plant is supplying 75% power of power plant [4].

6. *What is loads factors?*

The loads factors may be defined as the mean power's proportion to maximized demand of consumer. The loads factors should be one or less than one. The value of load factor determines the utilization of electricity. As the value of load factor is nearly one, the utilization of electricity is more, which is beneficial for any industry.

7. *What is maximum demand?*

The peak demand is called the maximum demand. In the load curve shows the power demand to the duration of demand. So the peak value of power demand to the load is called the maximum demand.

8. *What is reserve capacity?*

Reserve capacity is the difference between the plant capacity factor and maximum demand. The power which is reserve in power plant. Reserve capacity helps in balancing the demand and supply of electricity [5][6].

9. *What is Power Demand?*

Power demand totally depends upon the consumer. The demand of power of industries, residential demand, commercial demand, municipal demand, private demand, agricultural demand etc. are called the power demand [7].

Research Question

- Why reserve capacity in important for power plant?
- What is demand factor?

LITERATURE REVIEW

There are different researches related to "analysis of backup capability for powered plant" through which following are some description.

As in "classifications of reserved capability within futuristic powered plants" author Frunt J. et al. analyzed the reserve capacity by dependency of demand and supply and demand[3]. This research paper describes reserved capability relied over the instances as well as the exemplary variations within energy systems for future by discussing frequency domain.

As in "newer approaches for qualifying reserved demands within system holding substantial mounted winds capacities" Author R. Doherty et.al analysis has been done for reserve capacity[5]. The reserve capacity by taking wind power. This paper represents a new method for qualifies the reserve capacity of a systems by captivating indeterminate significance of wind power.

According to author J. Wang et al. in "operating reserve model in power market," an electricity system operation efficiency is versatile, and must be optimized using a cost-benefit analysis focused on the generating system's reliability assessment[6]. To assess the optimal reserve potential and consequently clearance the operating reserve market, a clearance method of its operating reserve market is introduced.

As in "power system characteristics and cost" author S. Kaptan et al. presented the different types of powered plant like hydroelectricity producing power plants, wind energy to electricity producing power plants. The analysis has been done by calculating different factors including cost of power plant.

METHODOLOGY

1. *Design:*

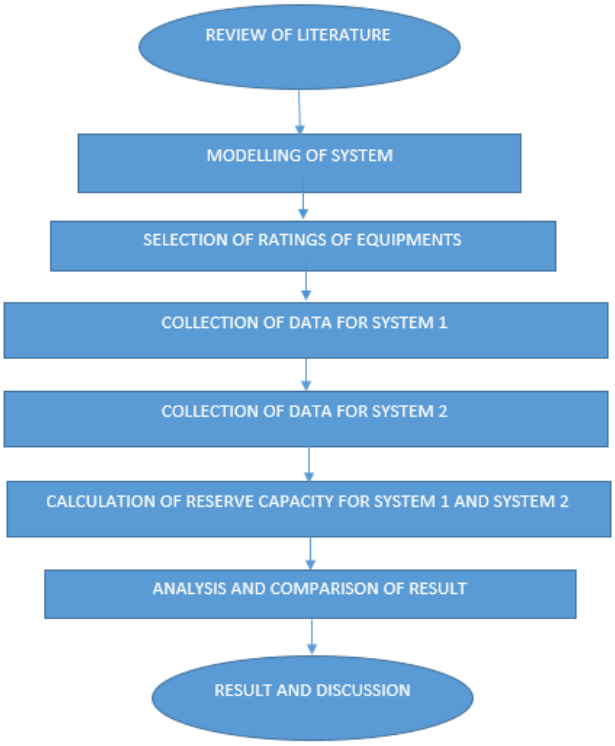

Figure 2: Methodology

The methodology of calculation and analysis of reserve capacity is shown in Figure 2.

2. *Sample:*

The instruments used in this research are at rated calculated value, according to the calculation of total reserve capacity of the system. Above which the equipment may burn. Some measuring instruments are also used for this experiment research. The data of a power plant has been collected to calculate the load factor and maximum demand, according to the demand of energy and capacity of power plant, reserve capacity has been calculated.

3. *Instrument:*

In this Research, data has been collected by survey of a power plant. Analysis has been done by calculation of load factor, demand factor and maximum demand.

4. Data Collection and Analysis:

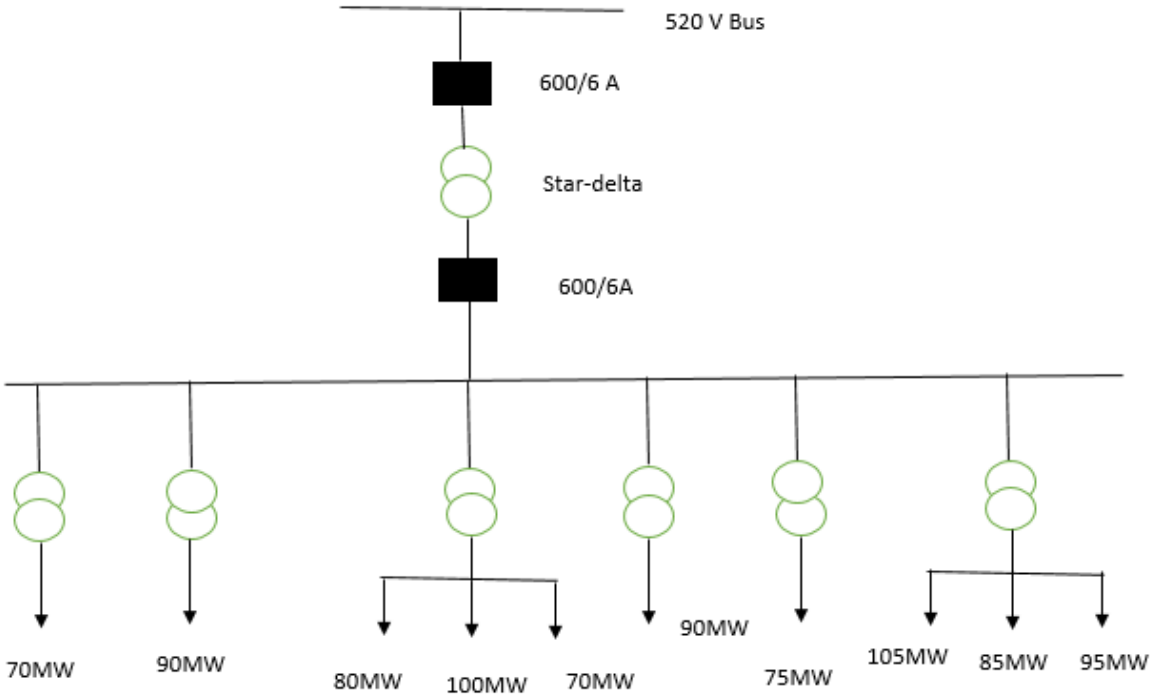

Figure 3: one line drawing of system 1

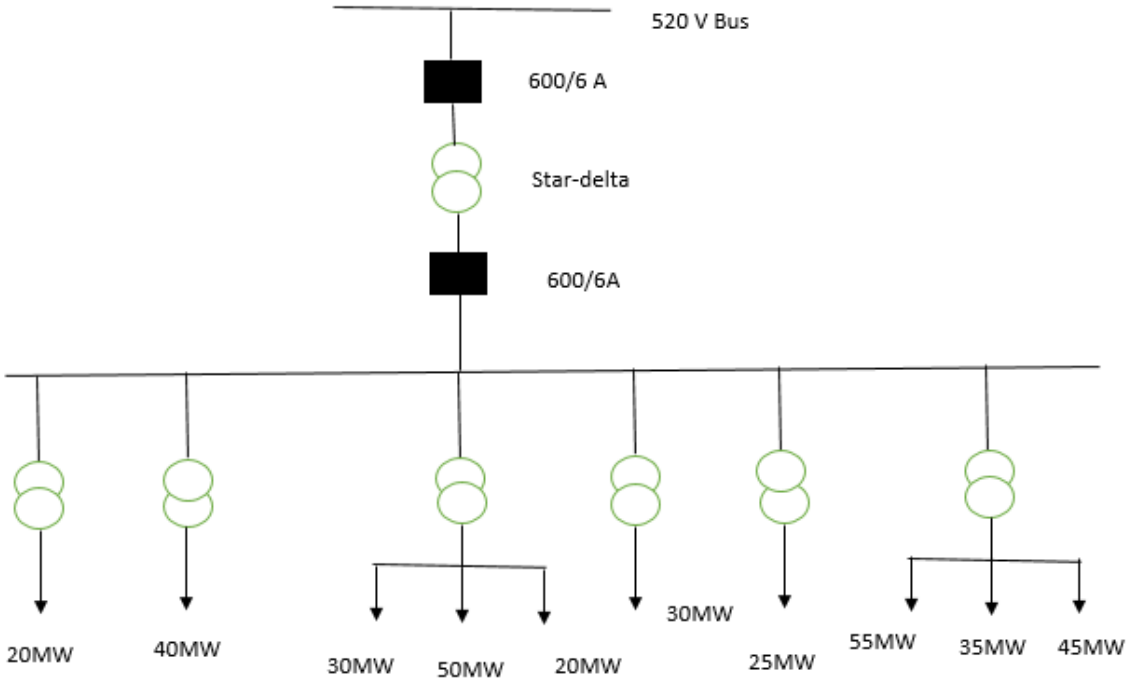

Fig 4: One lined drawing of system 2

Figure 3 and 4 represents the one lined diagrams regarding the systems 1 and 2.

Table 1: Data collection of system 1

Consumers	(Demand) in MW	(Time period) in hour
1	20	6
2	40	4
3	30	2
4	50	4
5	20	3
6	30	4
7	25	4
8	55	2
9	35	4
10	45	6

Table 2: Data collection of system 2

Consumers	(Demand) in MW	(Time period) in hour
1	70	6
2	90	4
3	80	2
4	100	4
5	70	3
6	90	4
7	75	4
8	105	2
9	85	4
10	95	6

Table 1 and Table 2 shows the data collection of power plant from different sources.

Calculation of reserve capacity for system 1

Annual load factor = 0.29

Plant capacity = 0.58

Maximum demand = 500MW

$$\text{Plant capacity factor} = \frac{\text{Unit generated}}{\text{Plant capacity}}$$

$$\text{Plant capacity factor} = \frac{350}{.58} = 603.44\text{MW}$$

Reserve capacity = Plant capacity – Maximum demand of electricity

Reserve capacity = 603.44 – 500 = 103.44MW

Calculation of reserve capacity for system 2

Annual load factor = 0.853

Plant capacity = 0.95

Maximum demand = 500MW

$$\text{Plant capacity factor} = \frac{\text{Unit generated}}{\text{Plant capacity}}$$

Plant capacity factor = $\frac{860}{.95}$ = 905.26MW

Reserve capacity = Plant capacity – Maximum demand of electricity

Reserve capacity = 905.26 – 500 = 409.26MW

RESULTS & DISCUSSIONS

The calculation and analysis of reserve capacity for system 1 and system 2 has been done successfully. Where system 1 data shows the minimum reserve capacity of electricity and system 2 data shows the maximum reserve capacity of electricity. The result for system 1 and system 2, the reserve capacity for system 1 is 103MW which is less reserve capacity, while system 2 reserve capacity is 410MW which is a good reserve capacity.

CONCLUSION

This research analyzed by designing system and calculation approaches. From the above research it is found that the calculation of reserve capacity has been done for two systems, system 1 and system 2. Result of calculation of reserve capacity for both the systems, System 1 reserve capacity is 103MW and system 2 reserve capacity is 410MW. The system 2 reserve capacity is more than the system 1. For future scope the calculation and analysis of reserve capacity can be done for more systems. Different other factors can also be calculated for the system 1 and system 2.

REFERENCES

[1] S. Kaplan, *Power plant characteristics and costs*. 2010.

[2] F. Z. Kadda, S. Zouggar, M. El Hafyani, and A. Rabhi, "Contribution to the optimization of the electrical energy production from a Hybrid Renewable Energy system," 2014, doi: 10.1109/IREC.2014.6826969.

[3] J. Frunt, W. L. Kling, and J. M. A. Myrzik, "Classification of reserve capacity in future power systems," 2009, doi: 10.1109/EEM.2009.5207144.

[4] *Power Plant Engineering*. 1996.

[5] R. Doherty and M. O'Malley, "A new approach to quantify reserve demand in systems with significant installed wind capacity," *IEEE Transactions on Power Systems*, 2005, doi: 10.1109/TPWRS.2005.846206.

[6] J. Wang, X. Wang, and Y. Wu, "Operating reserve model in the power market," *IEEE Transactions on Power Systems*, 2005, doi: 10.1109/TPWRS.2004.841232.

[7] HOLDERNESS AL, "Power plant," *Telecommunication Journal of Australia*, 1971, doi: 10.4324/9781315251127-23.