Open access Journal International journal of Emerging Trends in Science and Technology

The Case Study of Optimization of DG System in Jamnagar District

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Abstract:This research work is present in Indian energy sector, however, has constraints of resources, capital, technology and environment raising issues of energy security. The traditional electrical power system model in the Gujarat (India) involves centrally-located power plants and a vast web of transmission and distribution networks, which make up the electrical grid. Although this model has been employed for many decades, the flaws associated with these systems have contributed to environmental degradation, unstable power, poor power quality, higher transmission and distribution losses, and higher tariff threats to public health and economic instability. A series of measured are required to meet the situation, one of which is increased focus on renewable energy sources and is improving the efficiency of highly inefficient Indian distribution and transmission networks. Both these measure are to be complemented with implementation of smart grid technology. Keywords:Smart Grid, Intelligent meter, Balancing of Grid, Renewable sources.

1. Introduction

An optimum DG (**smart grid)** is a modernized electrical grid as shown in fig.1 that uses information and communications technology to gather and act on information, such as information about the behaviors of suppliers and consumers, in an automated fashion to improve the efficiency, reliability, economics, and sustainability of the production and distribution of electricity[1].

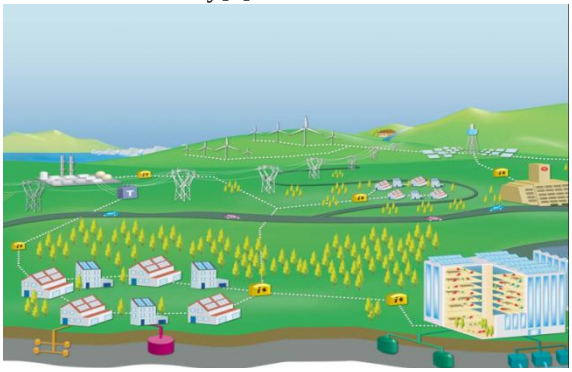

Figure 1: Proposed DG model (Smart Grid)

The proposed DG model shown in fig.1.Where solar, wind and thermal power integrated generating system connected with existing grid is operated with mini control system (IT technology + SCADA) to provide reliable, stable and efficient power to consumers. The variant power of renewable generation is controlled by mini control system with the demand of energy at central generating system[1],[2].

1.1 Objective of project

The objective of this report is to accomplish implementation of system to conduct following minimum function or operations,[3]

- Single window for control and monitoring of Energy / Power flow continuous online,
- Integrated data logging
- Ability to record waveform or faults (as they occur) on continuous basis
- Self-regulated load monitoring and control
- Power Quality Monitoring
- Load flow analysis and demand regulation
- Time Stamped Sequence of Event Recording (Work as a Disturbance Recorder)
- Real time data record and report generation
- Power cost optimization

1.2 Approach of Study:

The power demand of Jamnagar District provide by (1) Sikka TPS,(2) TATA Ultra Mega Power Plant, Mundra,(3) Adani Power Plant, Mundra,(4) Essar power, Jamanagar,(5) Vanakbori Thermal Power Plant,(6) Ukai thermal power Plant through 400 KV and 220 KV transmission line. The power requirement of Jamnagar district as per catered from remote power plants through 3098.95 KM transmission line. Jamnagar District of the state is chosen for implementation of above model. The existing data of installed capacity of Solar and Wind power plant is collected from GEDA as

annual demand of energy. Accordingly the capacity of Solar power plant and Wind power plant and Thermal generating (Gas based) capacity assumed approximately 50% of the total load requirement of the district are selected for proposed DG system[3], [4],[5].

The proposed DG will also be connected with grid and other DG to make micro grid system in the state. Single line diagram of generation and transmission and distribution system of proposed DG model for Jamnagar district is shown in Fig.2. The following measurement is carried out for analysis to develop optimum DG model [5].

1.3 Measurements

Study of Existing Jamnagar 220/132/66 KV Substation.

- Connected load
- Load Profile
- Grid connectivity
- Power sources

The various substations are supplying power to consumers in Jamnagar district. According the electrical transmission and distribution of Jamnagar district the single line diagram prepare by replacing traditional system with proposed DG system as shown in fig 2[5].

1.4 Architecture:

The architecture of DG with integration of control system to optimize the DG model for Jamnagar district is created as shown in fig .3[4].

1.5 Load Profile and Power sources

- Load profile data are collected for entire 96 blocks of 15 min interval per day for entire year 2012 from GETCO and SLDC..
- Solar profile for entire 96 blocks of 15 min interval per day for entire year 2012 and availability of solar generation ascertained are collected from Tata Solar and SLDC.
- Wind profile for entire 96 blocks of 15 min interval per day for entire year 2012 and availability of wind generation ascertained are collected from SLDCs[5].

2. Technology uses in power control system for optimization of DG.

Intelligent metering system having ION® brand web-enabled software and control devices. These can be used stand alone or networked to provide a comprehensive Enterprise Energy Management ("EEM")/Energy Managements system(EMS).ION puts energy intelligence wherever it's needed and delivers information and control to everyone that needs it, wherever they are[6].

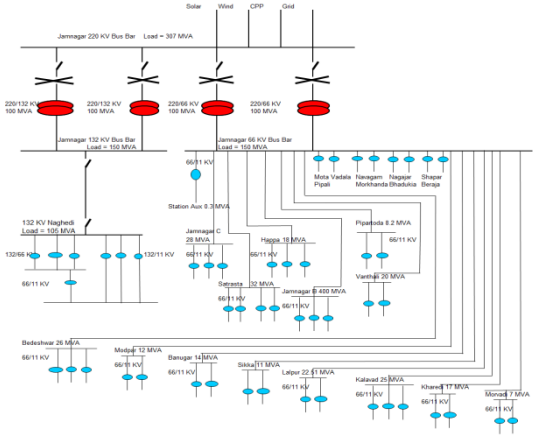

Figure:2 Electrical single line diagram of Jamnagar District with integration DG model

2.1 EEM/EMS systems

EEM/EMS systems can be considered a layer of energy IT that rides on top of an organization's energy assets. It can be defined as follows: A permanently installed system, running 24 hours a day, which provides all the information and control capabilities necessary to enable management, accounting, engineering, and maintenance personnel to make the best decisions, and to take proactive control of energy – and energy assets – throughout an entire enterprise[6], [7].

EEM/EMS systems are made up of several key components:

- Intelligent metering devices
- Software
- Communication Network

1.6 Intelligent Meters

- Purpose – turn analogue signals into digital power data and to act as interface between energy assets and various users: SCADA/Operations, Automation, Energy management, Energy Assets [7].

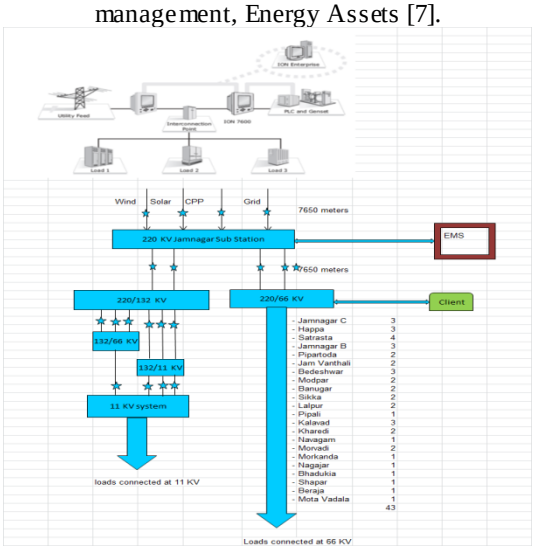

Figure:3 Propose architecture of DG model with transmission and distribution system

3. Enterprise can help maximize electrical system reliability:

Benchmark reliability system performance of key reliability components can be benchmarked against design specifications and industry standards. Test key system functions Critical system functions are tested whenever possible to ensure correct operation, and an EEM system can play a key role in these tests. Automatic transfer switch operations can be monitored to assess the performance of transfer switches. Capture and Analyze system failures power reliability systems are complex and the intelligent devices in ION Enterprise system can capture the data needed to analyze failures. Waveforms can be captured during an equipment failure and can be analyzed and corrective actions taken to prevent repetition of failures[8].

Simulation:

The mathematical model for proposed optimum DG model is shown in Fig. 6.4. The mathematical equation is as shown below. P1 = Solar generating plant capacity in MW, P2 = Wind generating plant capacity in MW, P3 = Gas based generating capacity in MW and P4 = Grid Power in MW, L = Load in MW

$$\frac{dP1}{dt} + \frac{dP2}{dt} + P3 + P4 = \frac{dL}{dt} \quad (1)$$

$$\left(\frac{dP1}{dt} + \frac{dP2}{dt}\right) < \frac{dL}{dt} \quad (2)$$

$$\left(\frac{dP1}{dt} + \frac{dP2}{dt}\right) = P \quad (3)$$

$$\text{Then } \frac{dL}{dt} - P = P3 + P4 \quad (4)$$

$$\left(\frac{dP1}{dt} + \frac{dP2}{dt}\right) \geq \frac{dL}{dt} \text{ then } P3=0,\ P4=0 \quad (5)$$

The above mathematical DG model with optimazation scheme tested on MATLAB tools.The above equations and datasheets of optimum DG as shown in fig.2 for this proposed sceam and modified this project in MATLAB simulations and find the results in form of graph as shown in fig.5 to fig. 9. All results and calculation (mathematical modal) compare to results of optimum DG scheme are same and practically it can be implemented with respect to continuously measured load alongwith good efficiency of power plant to provide cheaper and batter quality of power[7], [8].

3.1 Calculation for the Cost of Power generation:

By considering the existing data of renewable generation (Solar P.P + wind P.P) and controlling the gas based generation with respect to the existing load profile of the same period, the calculation sheet develop per day for fifteen minute duration as under to prove the optimization of DG, actual basic value for calculation of cost of generation are as per table 1. The per unit cost of Solar and Wind generation calculated as under. The weighted average cost calculated as below. (Wind gen x Wind gen cost+ Solar gen x Solar cost + Thermal power cost) (Solar + Wind + Thermal (Gas Based) gen)The weighted average cost shall facilitate the decision of starting of Gas P.P. The software for operation of DG has been created by using the flowchart as shown in Fig. 10 [9].

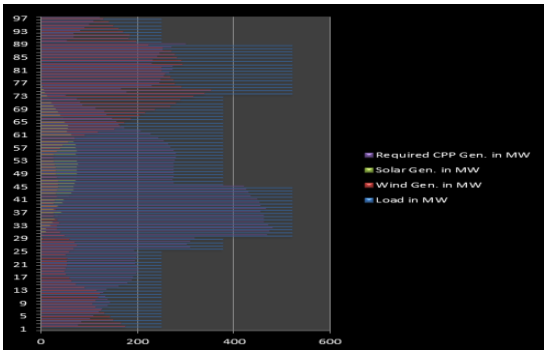

Figure: 4All Over Power generation in MW

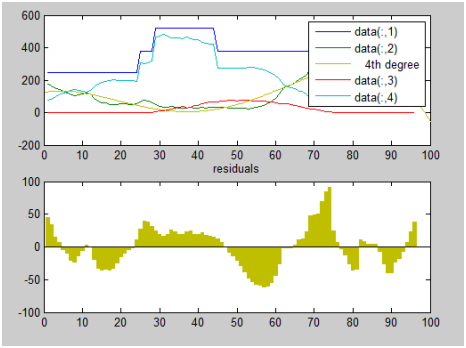

Figure:5 Using equation No. 02 respect to residuals generated power in Wind P.P & Solar P.P

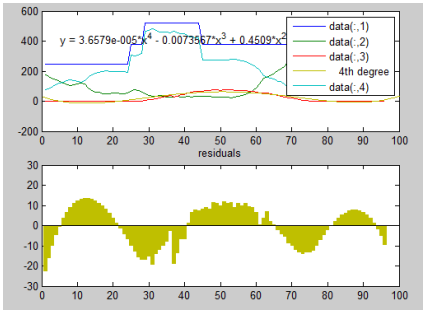

Figure 6:Using equation No. 03 respect to residuals generated power in Gas P.P +wind P.P+ Solar P.P

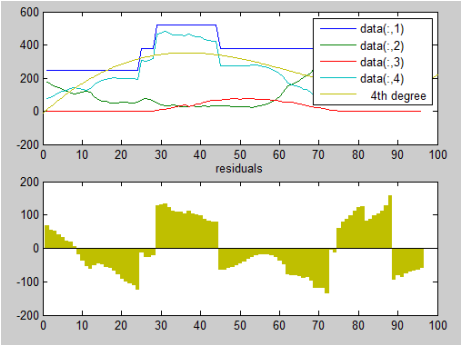

Figure:7 Using equation No. 04 respect to residuals generated power in Gas P.P +wind P.P+ Solar P.P+Grid

Table 1: Basic technical data for propose DG in Jamnagar Dist[10].

Wind installed capacity	1000 MW
Solar installed capacity	250 MW
Solar investment per M	Rs. 8.0Cr./M,Rs. 2000 Cr.
Wind investment per M	Rs. 6.0Cr./MW,Rs. 6000 Cr.
total solar units generation in 20 years	3376817 MWH
Total wind units generated in 20 years	18216278 MWH
Discom per units charges	6 INR/unit
Solar cost per unit considering 2o years generation	0.17 INR/unit
Wind cost per unit considering 20 years generation	0.30 INR/unit
Cost of thermal (Generation on NAPM gas)	5.5 INR/unit

The results of optimum operation of DG scheme in Jamanagar districts are shown as under for 15 minute slot per day in tabular form.The results of DG simulation by software are shown in table 1

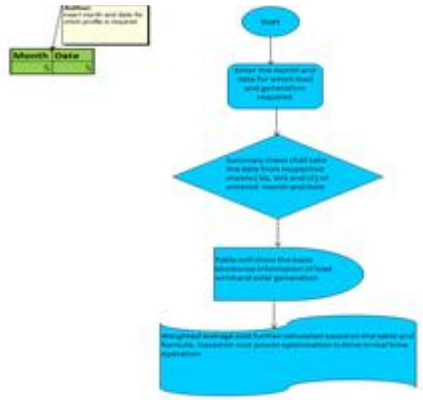

Figure. 8 Flow Chart for operation of DG

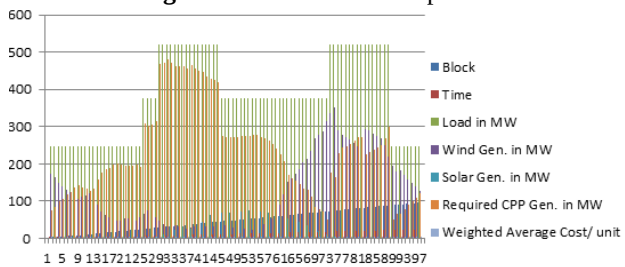

Figure: 9 Fifteen minute generation v/s load graph

which shows the wind generation, solar generation, thermal generation and power cost per unit per day in the fifteen minutes block. Flow chart in fig.8 shows that with enter of date and month in the Excel sheet gives generation, load and per unit cost for fifteen minute blocks during that day. The fig.9 shows the generation requirement with load profile of the district per day[9].

3.2 Comparisons of results

The results of this proposed model compared with existing transmission and distribution systems in Jamnagar District (Traditional Network) as shown in Comparative shows that the 4% to5%transmission losses from remote generating station to Jamnagar district is reduced to zero in proposed DG model. The maximum use of wind and solar generation will reduce the fuel cost of generated power with minimum use of Gas based power plant/grid power in the district. Therefore the average resultant cost of power per unit will be 50% reduced than existing average per unit cost of power in Jamnagar district. The wind and solar power plant of 1250 MW will reduce the 2.4 x 10^6Tone CO_2emissions in atmosphere per year and save 1680 x 10^3Tone coal per year. The cost for strengthening the grid network for evacuation of solar and wind power will be reduced to zero in the district due to local consumption of generation. In view of above results of optimum DG model (Smart Grid),the continuous green power with best quality at low cost will be provided by this proposed DG model in the district than existing Traditional network[1], [9].

Sustainability, Competitiveness and Security of supply

Optimum DG model implementation across the state at load centre will provide the conducive environment to complete the goals of the state[6], [9].

Limitations [9]:

The limitation of the project is as under,

- Huge Capital investment.
- Awareness for implementation of DG in society in short period.
- Renewable generation depend on atmosphere so that fluctuation in maximum use of RE generation.
- Implementation of DG policy.
- Requirement of Huge non useful land
- Fluctuation in prices of Gas effect on cost of power generation.

4. Conclusion:

The model proposed in the Recommendations section shows that a great deal of progress can be made by reconfiguring power generation and transmission systems. One of the overall goals of the smart grid is the development of a more automated and flexible distribution system. The smart grid is very efficient due to the extensive monitoring system whereby each and every aspect of the grid is constantly monitored. With the development of the smart grid resulting in competition in power generation through electricity market operations, the average efficiency in power plants can be improved considerably. The proposed Hybrid Optimum DG model fulfils the all requirement of smart grid. In time, DG will become more prevalent and micro grids will be formed, which are better-suited to meet demand and promote renewable technologies. These efforts will improve public health and the environment, cost of power as well as economies.

References

[1] R.Ramakumar and P.Chiradeja, "Distributed generation and renewable energy systems",in Proc.37th Intersociety Energy Conversion Engineering Conference (IECEC), pp.716-724,2002.

[2] P. Chiradeja and R. Ramakumar, "A review of distributed generation and storage," in Proc. 31st Annual Frontiers of Power Conf., Stillwater, UK,pp. VIII 1–11, 1998.

[3] T. Hoff and D. S. Shugar, "The value of gridsupportphotovoltaics in reducing distribution system losses," IEEE Transactions Energy Conversion, vol. 10, pp. 569–576, Sept.1995.

[4] G. Joos, B.T. Ooi, D. McGillis, F.D. Galiana and R.Marceau, "The Potential of Distributed Generation to Provide Ancillary Services", IEEE Power Engineering Society Summer Meeting, pp 1762-1767, 2000.

[5] P. Chiradeja, "Benefit of Distributed Generation: A Line Loss Reduction Analysis", IEEE/PES Transmission and Distribution Conference &P.Ajay-D-Malraj,S.Senthilkumar,J. Raja, ET AL. / ELEKTRIKA, 10(2), 2008, 41-48 Exhibition: Asia and Pacific, Dalian China, pp.1-5,2005.

[6] Y. G. Hegazy, M. M. A. Salama, and A. Y.Chikhan" Adequacy Assessment of Distributed Generation Systems Using Monte Carlo Simulation", IEEE Transactions on Power Systems,Vol. 18, No. 1, pp.48-52, February 2003.

[7] Koen J. P. Macken, Math H. J. Bollen, and Ronnie J. M. Belmans," Mitigation of Voltage Dips Through Distributed Generation Systems", IEEE Transactions on Industry Applications, Vol. 40,No. 6, pp. 1686- 1693, November/December 2004.

[8] AleksandarPregelj, MiroslavBegovic and AjeetRohatgi, "Quantitative Techniques for Analysis of Large Data Sets in Renewable Distributed Generation", IEEE Transactions on Power Systems,Vol. 19, No. 3, 1277-1285, August 2004.

[9] Caisheng Wang, and M. HashemNehrirV,"Analytical Approaches for Optimal Placement of Distributed Generation Sources in Power Systems",IEEE Transactions on Power Systems, Vol. 19, No.4, pp. 2068 – 2076, November 2004.

[10] Manish Raval, Ph.D. Scholar, Electrical Engg. Department, Pacific University, Udaipur, Rajasthan, India &Dr.VedvyasDwivedi, Supervisor , "Commencing the FACTS in Variable Energy Sources Network to Optimizing Existing Transmission System with Stability, Published in "International Journal of Emerging Trends in Electrical and Electronics (IJETEE),Vol.2,Issue-1,on April 2013".

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