

Investigate the effects of distributed generation units in power grid- Case study of power grid Kahnooj –Kerman

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Abstract

Protection systems play a vital role in the safety, stability and reliability of the electricity system and prevent starting or expanding damages caused by various errors. The proper and selective functioning of protection system reduces the level off because it isolates the minimum area for troubleshooting from network and this keeps electrification continuity to other parts of the network. The main components of a security system includes relays, current transformers, voltage transformers and keys that disorder or malfunction of each these components make false operation of protection system. Therefore, survey of the protection system effectiveness in the presence of DG sources and updating protection systems with regard to these resources is essential at the end Kahnooj network has been simulated by DIGSILENT software. The aim is adding an overcurrent relay for every distributed generation to improve network protection and increase network reliability and obtain protection relay settings for acting coordinated. In fact, coordination of network Protection with relay settings and time interval should be exploitable and coordinated.

Key Words: Protective relays, distributed generation, power grid

Introduction

Distributed generation units are electrical energy sources that connect to distribution networks and have less capacity compared with great sources. Distributed generations is always a suitable solution for populated outlying rural areas where the cost of investment in transmission lines for them is much [1-4]. Capacity and location of distributed generation have a great impact on network protection. Network protection is a major issue in the presence of distributed generation. Similar to other generators need for electrical protection against short circuit and abnormal conditions of the system. Some of these unusual circumstances occur through the distribution system such as over voltage, unbalanced current, unusual frequency. Second connections of Circuit Breaker can make ruin generator very quickly in this conditions and be great concern for DG owner. This problem has particular importance especially in the electrical

power distribution system which is considered the most extensive part in a large power system. Because on the one hand, the most errors occur in the distribution network and on the other hand close relationship with the consumers of electrical energy will follow it's accurate and consistent performance. Proper functioning of the distribution network which depends not only on carefully design but also to correct setting to protective equipment is dependent. Faced with the impact of distributed generators on network protection equipment much research have been done to overcome problems [5-6]. In order to protect the distribution network in the presence of distribution networks a lot of work has been done. One way to reduce the impact of distributed generation on distribution network protection is second coordination of protective equipment that needs high costs [7]. Access to a power system with a proper security is an essential goal of power industry. Detection of large and intimidating disturbances is inevitable So how to avoid this problem and achieve suitable operating point after entering disorder to the system for Electrical engineers has been come a serious concern. Because of different philosophies for designing protection system in [8], the article has noted to the problems caused by presence of DG in distribution network, with traditional protection systems. And finally a distribution network with DG Environment has been simulated with DIGSILENT software. To make its problem clear and show traditional protection system inefficiency. This paper presents a new method for coordination of protective equipment.

2: Coordination of protective equipment

In the first place, it seems why effects of DG on the protection coordination is so large, so that the offering a comprehensive protection coordination strategy in initially was not so easy, articles only paid to the effects of DG on the protection coordination. As an initial response, I must say that it is true The DG only on one or more points of distribution network is added. But throughout the whole network there are various implements distribution and the placement of the DG or DGs can be effect on the level of fault currents in all parts of the network and security settings on almost all

protection devices. DG in one place has effect on error fellows of many places and so many protection devices settings. Power system protection and their small and large equipment is one of the most important tasks that needs to be best done to ensure stability and permanent activity of system. This problem has particular importance especially in the energy distribution system that is the most extensive part in a large electric power systems because on the one hand, most errors occur in the distribution network on the other hand its close association with energy consumers makes more necessity of its correct and consistent performance. Properly function of distribution network which depends not only on carefully designed but also on proper tuning of protective equipment is dependent because correct and timely tuning makes the errors arising in distribution network resolve quickly and accurately and improve power quality. Tuning Current and current protective equipment time In order to achieve the desired performance and coordination is called protective equipment [9-10].

3: The impact of distributed generation on the coordination of relays

The impact of distributed generation on the coordination depends on size, type and the installation location of the DG. However, depending on the size and location of distributed generation there are ranges that coordination is maintained. In this article it is assumed that the location of distributed generation are in shin of Islamabad, ZehKelot, Chah haji and Faryab is considered. DG location in Islamabad shin is shown in Figure 1 the relay 2 is backup of relay 1. When distributed generation is connected to the grid for a fault on the feeder L₁ relays of 1, 2, 3, 4, 5 feel more error current compared with when DG is not connected to the network. Figure 2 shows distributed generation to Islamabad and ZehKelot shins that increasing the number of distributed generators make increase the flow of the feeder error. The relay 1 must act faster than the rest of the relay.

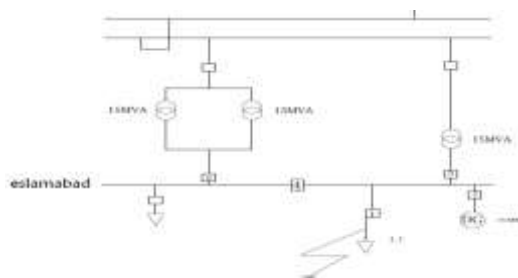


Figure 1: Islamabad bus

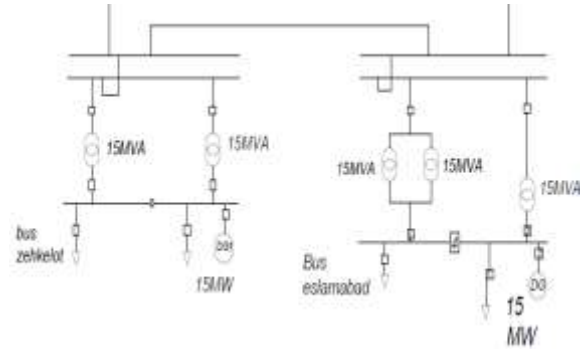


Figure 2: Islamabad and Zehkelot buses

4: suggested method

This paper proposes a new method to solve weaknesses expressed. For example, for the network shown In Figure 5, for three phase fault in front of relay1, relay 1 acts but the error does not go away and to resolve the error, distributed generation should be removed from the grid. Figure 6 shows a modified network which has an over current relay more with name of the relay "a". The purpose of this relay is cutout when error is up and as well as to increase network reliability. In addition to when error is low this relay helps network protection system to solve error faster without loss of relays coordination. In the network shown in the Figure 6 all errors resolve only with using a further relay. For example , for a fault in the relay 1, first relay 1 senses error in downstream and acts faster than relay a. but The error due to the presence of distributed generation does not go in shin B so relay a senses fault current upstream And acts after relay1and error is fixed quickly. In Figure1 Kahnnoj area from Kerman province network has been shown where feeder investigated on busbar 20kv, two station and 3 standard transformers 15 MVA and relays are 1, 2, 3, 4, 5 respectively. It has been simulated with DIGSILENT software. When a fault occur in grid, reverse over current relay is engaged. Its characteristic according to Standard is obtained from following equation.

$$t = \frac{0.14}{\left(\frac{I}{IP}\right)^{0.02} - 1} \quad (1)$$

In this formula, t is cutoff time, TMS is time multiplier setting factor and I is fault current and IP is relay pickup current. In order to relays coordination, first pickup flow should be set. Over current relays must have time reverse unit that their pick up flow must be 1.5 times of maximum load current. In this article it is considered 1.2[9]. The minimum required time difference for performance of each pair of relay for a clear fault current is called coordination time interval (CTI). In this paper, it is considered approximately 3. In this

way, network model can be built based on real information. Some relay has been put in this model and a distributed generation model will be added and a three-phase fault will be considered on feeder L_1 and then the network will be expanded and several distributed generation will be added. As Figure 3 shows the distributed generation on buses Chah Haji is connected. In Figure 2, the two distributed generation is connected to Islamabad and ZehKalot buses, effect of this tree distributed generation is consider (tree distributed generation are connected in Islamabad, Zehkalot and Chah haji). Figure 4 shows the DG at chah haji and Faryab buses. Four distributed generation has been connected at Islam Abad, ZehKalot, well Haji and Faryab buses. And the effect of these four distributed generation is considered. In this paper, a new method has been presented for communication and coordination between protective relays and DG in network by Using mathematical and coordination equations and protection devices performance table.

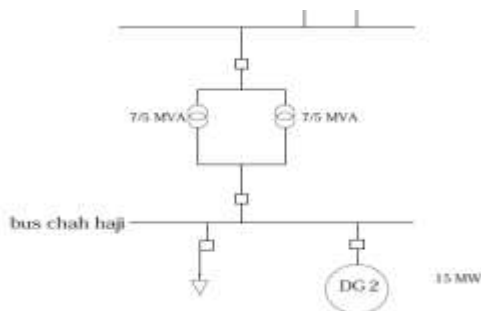


Figure 3: Chah haji bus

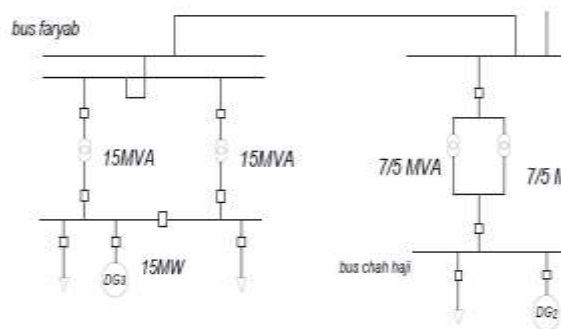


Figure 4: Chah haji and Faryab buses

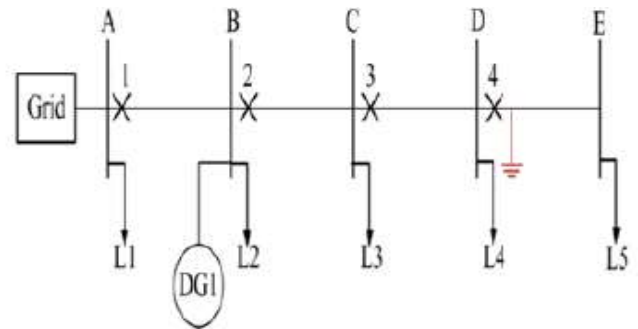


Figure 5: Distribution network with a fault in the relay 4

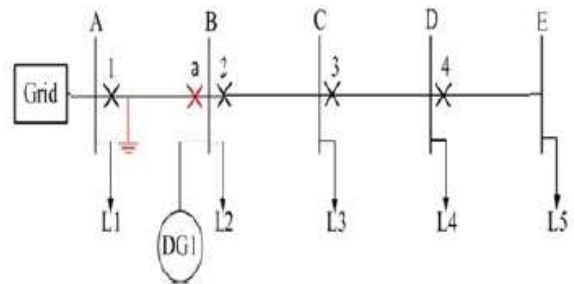


Figure (6): Modified network by relay placed at the end of the line AB

5: Simulation results

Maintaining optimal protection coordination of distribution systems equipment by CTI is appropriate strategy provided that objectives associated with this define and implement them. For this purpose, the results for the four modes has been showed in the below tables. Table 1 shows when the distributed generation is connected to Islamabad shin. Table 2 when DG has been connected to Islamabad and ZehKalot shins. Table 3 when the distributed generation has been connected to Islamabad, Zeh-e Kalut and chah haji shins. Table 4 shows when the distributed generation has been connected to Islamabad, ZehKalot and Chah haji and Faryab shins. As it is clear in the below table, buss relay is feeder relay backup and Distributed Generation relay is buss relay backup. And if the feeder relay fails in less time than CTI relay bus must act. In the following tables relay coordinated Universal time interval and their settings has been obtained. The results indicate relay function are synchronized. For example, difference of feeder and buss relays performance is 0.308 ms. This process continues for the other cases.

Table1: results of relays performance time

	Normal TMS	t(s)= Normal Time	Desirable TMS	$\Delta t(s)$
Feeder	0.11	$t_1=0.192$	0.08	$t_2-t_1=0.308$
DG	0.204	$t_3=0.747$	0.23	$t_3-t_2=0.248$
LV transformer	0.44	$t_4=0.9$	0.44	$t_4-t_3=0.152$
bus	0.182	$t_2=0.5$	0.182	$t_5-t_4=0.15$
LV transformer bank	0.509	$t_5=1.05$	0.509	-

Table2: results of relays performance time

	Normal TMS	t(s)= Normal Time	Desirable TMS	$\Delta t(s)$
Feeder	0.11	$t_1=0.189$	0.08	$t_2-t_1=0.311$
DG	0.2057	$t_3=0.747$	0.23	$t_3-t_2=0.247$
LV transformer	0.448	$t_4=0.9$	0.448	$t_4-t_3=0.153$
bus	0.188	$t_2=0.5$	0.188	$t_5-t_4=0.15$
LV transformer bank	0.5180	$t_5=1.05$	0.518	-

Table 3: Results of relays performance time

	Normal TMS	t(s)= Normal Time	Desirable TMS	$\Delta t(s)$
Feeder	0.11	$t_1=0.189$	0.08	$t_2-t_1=0.311$
DG	0.205	$t_3=0.747$	0.23	$t_3-t_2=0.247$
LV transformer	0.44	$t_4=0.9$	0.44	$t_4-t_3=0.153$

bus	0.187	$t_2=0.5$	0.178	$t_5-t_4=0.15$
LV transformer bank	0.51	$t_5=1.05$	0.51	-

Table4: results of relays performance time

	Normal TMS	t(s)= Normal Time	Desirable TMS	$\Delta t(s)$
Feeder	0.11	$t_1=0.189$	0.08	$t_2-t_1=0.311$
DG	0.20	$t_3=0.747$	0.23	$t_3-t_2=0.247$
LV transformer	0.44	$t_4=0.9$	0.44	$t_4-t_3=0.153$
bus	0.187	$t_2=0.5$	0.178	$t_5-t_4=0.15$
LV transformer bank	0.51	$t_5=1.05$	0.51	-

6: Conclusion and summary:

Connecting distributed generation to distribution networks alters the network performance and loss of relays coordination that it is biggest problem in the way of distributed generation progress. In this article Kahnoot network of Kerman has been simulated by real data. With proposed method, relays settings and network coordinated time interval should be match.

7: Appendix: Profile lines

Table 5: lines basic information

From Bus	To Bus	R(ohm/s/km)	X (ohms/km)	B (nf/km)	L(km)
Chahhaji	Faryab	0.3023	1.4227	5.37	60
Islamabad	zehkalot	0.3019	1.5854	4.18	56
Islamabad	zehkalot	0.3019	1.5854	4.18	1

Table 6: lines Secondary information

From Bus	To Bus	R(ohms/km)	X (ohms/km)	B (nf/km)	L(km)
Chahhaji	Faryab	0.157	0.4115	8.81	60
Islamabad	zehkalo	0.157	0.3939	9.16	56
Islamabad	zehkalo	0.157	0.3939	9.16	1

References

- [1] Hadjsaid, H., et al, "Distributed generation Increases the Complexity of Controlling, Protecting, and Maintaining the Distribution Systems", IEEE Computer Application in Power, PP. 23-28, April 2010.
- [2] J. Radosavijevic, M. Jevtic, Hybrid GSA-SQP algorithm for optimal coordination of directional overcurrent relays, IET Gener. Transm. Distrib. 10 (8) (2016)1928–1937.
- [3] F. Adelnia, Z. Moravej, M. Farzinfar, A new formulation for coordination of directional overcurrent relays in interconnected networks, Int. Trans. Electr. Energy Syst. 25 (January (1)) (2015) 120–137..
- [4] H. Zayandehroodi, A. Mohamed, H. Shareef, and M. Mohammadjafari, "Impact of Distributed Generations on Power System Protection Performance," International Journal of the Physical Sciences, vol. 6, pp. 3873-3881, 18 August 2011.
- [5] H. Zayandehroodi, A. Mohamed, H. Shareef, M. Farhoodnea, and M. Mohammad jafari , "Effect of Renewable Distributed Generators on the Fault Current Level of the Power Distribution Systems " Advanced Materials Research, vol. 622-623, pp. 1882-1886, 2013.
- [6] M.H.J. Bollen, A. Sannio, " Voltage Control with Inverter- Based Distributed Generation" , IEEE Trans Power Engineering Letters, Vol. Zo, No.I, JANUARY 2015.
- [7] M. Thakur, A. Kumar, Optimal coordination of directional over current relays using a modified real coded genetic algorithm: a comparative study, Int. J. Elect.Power Energy Syst. 82 (November) (2016) 484–495
- [8] Khederzadeh M, Javadi H , Ali Mousavi S M (2010). Source type impact of distributed generation (DG) on the distribution protection. 10th IET International Conference on Developments in Power System Protection (DPSP 2010).
- [9] A. El-Fergany, Optimal directional digital overcurrent relays coordination and arc-flash hazard assessments in meshed networks, Int. Trans. Electr. Energy Syst. 26 (January (1)) (2016) 134–154.

[10] M.Y. Shih, A. Conde Enríquez, Implementation of directional over-current relay coordination approaches in electrical networks, Electr. Power Compon. Syst. 43(19) (2015) 2131–2145.

[11] Delghavi MB, Yazdani A. A control strategy for islanded operation of a Distributed Resource (DR) Unit. In: Proceedings of the IEEE Power Energy Soc. Gen. Meeting, Calgary, Ab; July 2009.