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A Reliability Methodology for Distribution Systems with DG

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ABSTRACT

With growing of electric energy requirement, it is a significant increase in the penetration of distributed generation (DG) to fulfill this increase in demand. Interconnecting DG to an existing distribution system provides various benefits to several entities as for example the owner, utility and the final user. The integration of DG into existing networks has associated several technical, economical and regulatory questions. Penetration of a DG into an existing distribution system has many impacts on the system, with the power system protection being one of the major issues. DG causes the system to lose its radial power flow, besides the increased fault level of the system caused by the interconnection of the DG. Short circuit power of a distribution system changes when its state changes. Short circuit power also changes when some of the generators in the distribution system are disconnected. This may result in elongation of fault clearing time and hence disconnection of equipment in the distribution system or unnecessary operation of protective devices.

KEYWORD: Distribution System, Distributed Generation, over-current relays, protection.

1. INTRODUCTION

In our world, the progress of the technologic problem and expanding of power market have been changed our life.

1.1 Advantage of DG

Due to increasing of consumers, we have to provide extra load with some smaller size of DG. Some advantage of DG can be viewed from two angles: first of all, from view of consumers and the second is view of power sector. Some profit of DG are upper reliability, lower the losses of systems and upper efficiency and lower pollutions [1, 2].

1.2 Study of DG

Small size renewable energy has been expanded nowadays, because it advances our life in secure supplying of energy. Important goal of this paper is to provide adaptation between protection of power system and a lot of various DG [3].

2. BACKGROUND

In this paper, we use of these below parameters. For understanding of the DG concept, this categorize are showed in Table 1.

Table 1
Several of DG

TYPE	SIZE
Small DG	1 Watt< 4kW
Medium DG	4kW < 4MW
Large DG	4MW < 40MW
Extra Large DG	40MW < 250MW

2.1 Categories of DG

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DG produces two structure of electricity (DC and AC). These two structure from kind of DG systems [4]-[6].

1) Photovoltaic Systems: photovoltaic panels (solar panels) are using greatly nowadays in all countries. Size of the panels is very various and we can get energy from them easily. We can use them without producing any pollutions and maintenance cost. So it is very beneficially to apply them. When the price of electricity market increased, using of these panels has been changed dramatically.

2) Wind Turbines: a large number of factories produce wind turbines in any size from 5 to 2000 kW. Nowadays, the price of this product has been decreased considerably. Because of the energy of this way is depending on amount of wind, so it is not suitable for continuous loads. Some countries use this kind of energy for unreachable region that is not connected to power system grid.

3) Micro-Turbines:

A mechanism of this technology is converting thermal energy to mechanical energy by using flow of a gas. This technology has been emerged some years, so micro-turbines are very expensive. Only some countries have been installed this units [7].

2.2 Coordination between Distributed Generation and other component of power system

Being DG in power systems produces both advantages and disadvantages for us. For example effect on voltage profile and power flow. This paper tries to solve the problem and highlight the benefits of being several of DG.

Increasing the losses is one of the biggest problems in power systems. Locating the DG can decrease this factor in power system that is useful for companies and consumers.

On the other hand, we can manage and control voltage profile in distributed systems [8, 9].

3. OVER CURRENT RELAYS

The over current relays is designed to detect the extra current cause by a fault. One of the biggest considerations in protection is relay setting. We have to choose both over current and over load conditions.

3.1 Over Current Relay Simulation

Many of software have simulated this relay. One of the best models is ‘Digsilent’ that is suitable to decrease problem of connection between Distributed Generation and Distribution System. It is better that the protection scheme evaluated in both directions in distributions systems [10, 11].

3.2 Several of Over Current Relays

Setting of over current relay is three kinds: definite time, invers time and definite current.

- Definite time relay: in these relays the value of current is related to period of performing. The sequence of performing of these relays is based on distance from the source.

- Definite current relay: when the current of system reach to the special amount of current then relay will operate. The operating of these relay are based on current value, so the greatest distance from the source performs first cut off the load [12, 13].

- Time inverse relay: The performance of these is based on inverted proportion of the fault current. The setting of these relay can set by characteristic curve.

4. MODELLING AND SIMULATION RESULTS

Simulation result is based on a 20 KV distribution network in Iran. In this model, we have some abbreviations, for example GTGs are simulated as synchronous generators and WTGs as induction generators. In addition, this paper simulated in ‘Digsilent’ [14].

In this distribution system, we can survey two situations. First, this system evaluates without DG and second, this system evaluates with cooperating DG. Some parameters for relays are shown in table 2.

TABLE 2
Time over-currents characteristics of relays R65, R61, R52 and R41 for Case1

Relay	I(A)	TD(S)	Instantaneous pick up current (A)
R65	100	0.037	2780
R61	175	0.412	3290
R52	205	0.437	3427
R41	295	0.439	3903

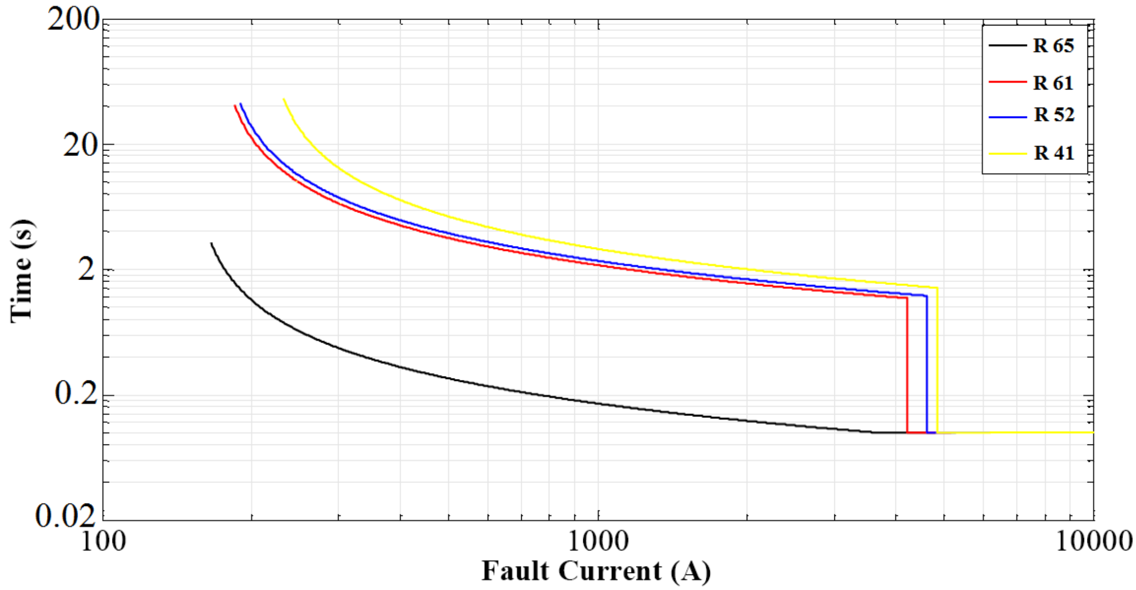
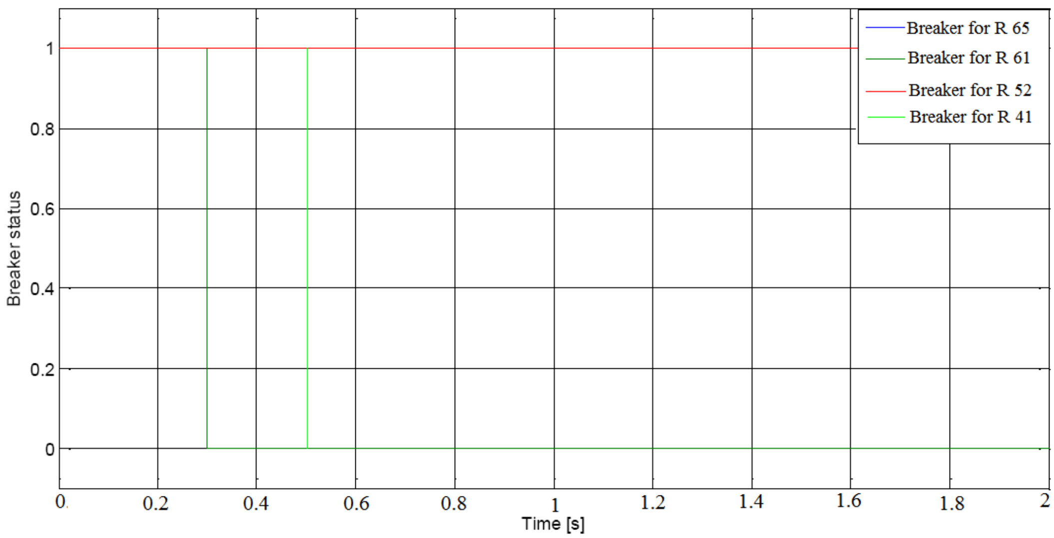


Fig 1: Time over-current characteristic plot of relays R65, R61, R52 and R41 for Case1

Figure1 shows that suitable adaptation between these relays: R65, R61, R52 and R41.
This paper simulated a three phase fault in line 65 with resistant of 0.04Ω. In figure 2, we show the breaker situation that the fault is clarified by the breaker for R65 relay. Figure 3 shows that breaker situation when the DG is installed in distribution systems. In this case, R52 is not performed and the current move from the transmission line.



Fault Current (A)

Fig 2: Status of circuit breaker for a three phase fault in Line65 when relays are setting according to Fig1

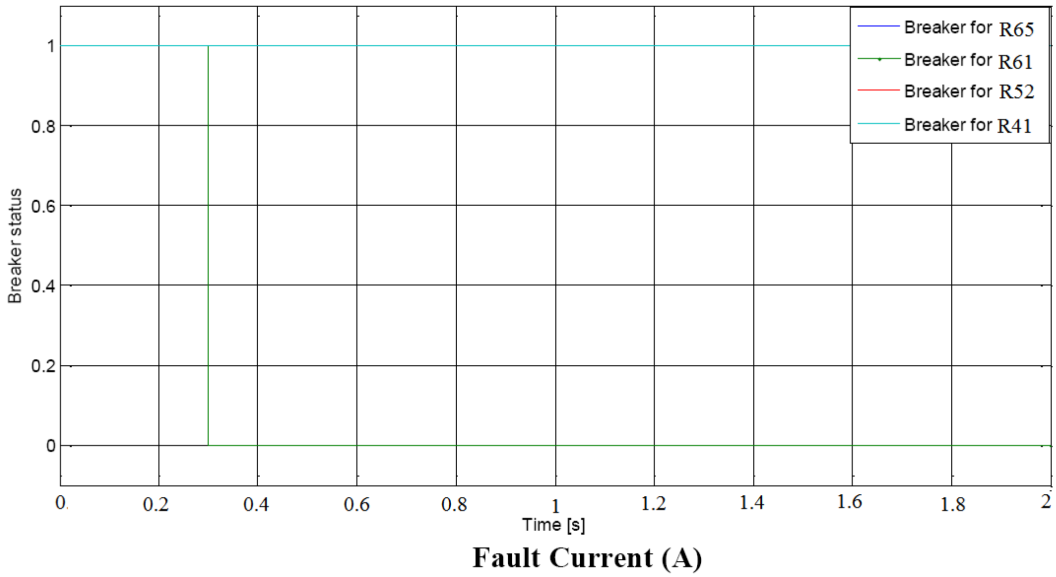


Fig 3: Status of circuit breaker for a three phase fault in Line65 when relays are setting according to Fig1

We presented another simulation that previous distribution systems are change by GTG and two fixed speed wind turbine generators. Figure 4 shows some characteristic of these relays: R31, R28, R19 and R14. We can see the resistance is achieved 0.04 Ω. Figure 5 presents the breaker situation that shows us R31 is opening and we can compromise with other relays.

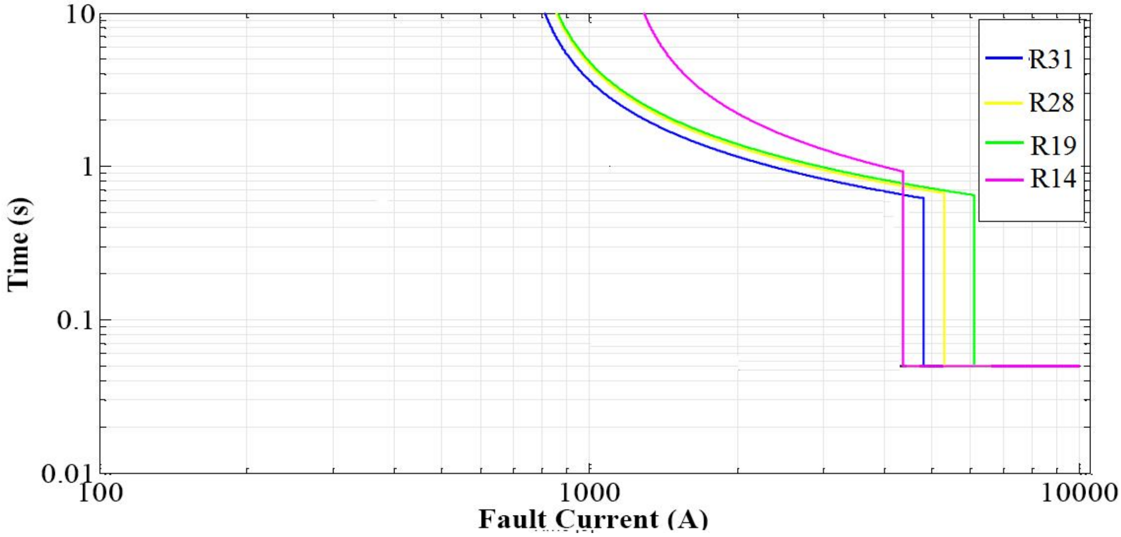


Fig 4: Time over-current characteristics plot of relays R31, R28, R19 and R14

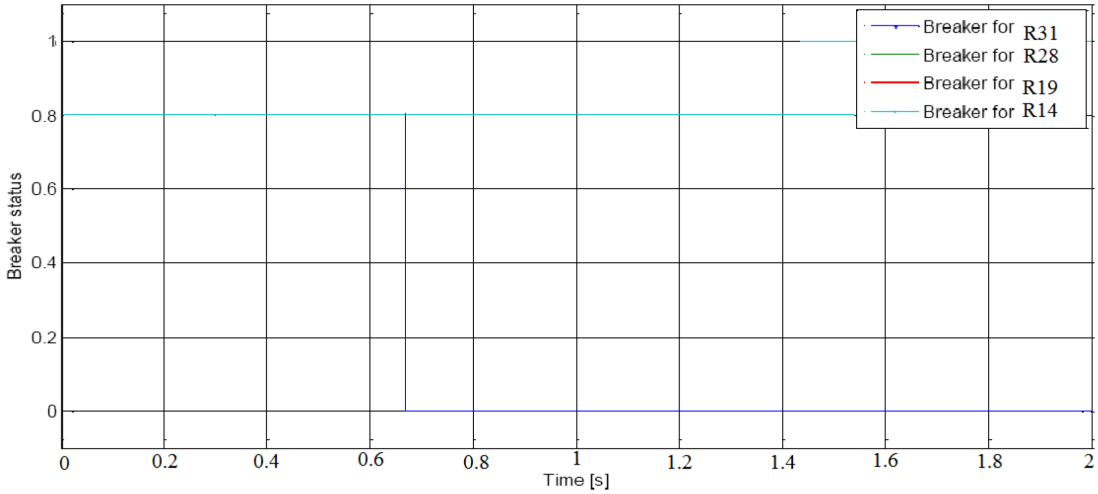


Fig 5: Status of circuit breaker for a three phase fault in Line28

5. Conclusion

DG can have a positive effect on the performance of the distribution system, but a lot of distributed generation leads to lower adaptation in protection system. Some facilities such as synchronous generators have the highest performance to faults, thus the various technology effects on the protection of distribution systems.

In this paper, we got that DG effect on characteristic of radial distribution system.

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