

Effect of the PV/FC Hybrid Power Generation System on Total Line Loss in Distribution Network

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Abstract— In this paper, the effect of PV/FC hybrid power generation system on total line loss of distribution network has been studied. Studies have been conducted on a real life 20 kV distribution network. A DPL (DIgSILENT Programming Language) code is developed to analyze the effect of the PV/FC hybrid system on total line loss in distribution network. Simulations, in three loading conditions and by considering worst environmental conditions (cloudy weather, at nights, etc) that output power of PV system is zero have been done. Sample distribution network has been considered in two structures: 1-sample distribution network by PV system as DG and 2-same distribution network but by PV/FC hybrid power system as DG. The Simulation results illustrate the effectiveness of PV/FC hybrid system in order to decrease the total line loss.

Keywords—PV/FC hybrid system; Distributed Generation; Renewable energy; Fuel cell; Photovoltaic; Total Line Loss; Distribution Network

I. INTRODUCTION

With development of distribution network and increasing the power consumption, the power losses across the lines resistances are increasing. This problem is more serious in distribution network. A solution, which in recent years has been considered, is supplying some of the consumers by means of distributed generation (DG). DG is a small scale electric power source connected directly to the utility's distribution network or on the customer site of the meter, and it provides electric power at a site closer to customers than the central station generation. DG can generate electricity with high efficiency and low pollution. DG ratings range from 5 kW up to 100 MW. [1-4]

Because of environmental constraint and increasing demand for conventional energy sources like coal, natural gas and crude oil, between different DG technologies, the renewable DG is preferred. Renewable energy sources like wind, sun, and hydro are seen as a reliable alternative to the traditional energy sources such as oil, natural gas, or coal. A renewable energy technology that gains acceptance as a way of maintaining and improving living standards without harming the environment is the photovoltaic (PV) technology. Physically, the power supplied by the PV panels depends on many extrinsic

factors, such as insulation (incident solar radiation) levels, temperature, and loading conditions. Its electrical power output usually increases linearly with the insulation and decreases with the cell/ambient temperature [5]. Thus the electrical output power of PV panels is variable. In the other hands power injection by DG, change power flow in distribution system and cause total line loss changes in distribution network. Thus if DG had been installed in order to reduce the total line loss, the variable output power of PV system changes the bus voltages and total line loss of distribution network. Therefore it is possible that the total line loss increases. For solution this problem, can use PV unit hybrid by another renewable source [6].

Another renewable energy technology that have advantages such as high efficiency, zero or low emission (of pollutant gases), and flexible modular structure, is fuel cell. Fuel cells (FCs) are static electric power sources that convert the chemical energy of fuel directly into electrical energy [7]. In this paper, the PV/FC hybrid system is considered as DG source.

By using DG the power flow in network's lines change, hence by proper placement and appropriate capacity specifying of DG, can reduce the total loss of network. One of the most important factors which affect the total loss of electrical network is the load. By change of load, the total loss also changes. Therefore in different loading conditions, by considering the electrical and network limits such as bus voltage limit or line loading limit, the output power of DG must be properly controlled to optimize the total loss reduction.

In this paper, the effect of PV/FC hybrid power generation system on line loss in distribution network is studied. It is illustrated, when the PV system is under the worst conditions, the PV/FC hybrid system can decrease the total line loss effectively. In this paper, the expression "the worst conditions" refers to the environmental conditions (cloudy weather, at night, etc) that output power of the PV system is zero.

The effect of the PV/FC hybrid system on the total line loss is studied on a real life 20 kV distribution network of city Sirjan (Iran). A PV/FC hybrid power generation as DG is installed to a proper location to minimize the total line loss of distribution network. By considering three comprehensive case for loading conditions (general