Study on Effect Demand Side Management and Penalty Assessment based on Guaranteed Standard Performance on Reliability Performance of Distribution Network

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Abstract

Abstract— The distribution network is an essential component of strategic planning because it assures that power is delivered to consumers without interruption and with high reliability. In such an operation, the demand is met by adjusting the generated power, and then the power system's safe performance is achieved. Besides that, nowadays, reliability performance of power supply systems is a crucial priority for distribution network operators (DNOs). In a certain period of years, Energy Regulators revises their performance requirement limits for more reliability and continuity of supply service to the customer and correspondingly, penalties applied to each DNO based on the achieved network performance. However, in recent years, a new idea in electric power networks has emerged: demand side management (DSM). DSM is the process of influencing consumer energy demand via a variety of means, including financial incentives and education. The purpose of DSM is usually to persuade consumers to use less energy during peak hours or to shift their energy use to off-peak periods like nights and weekends. Interruptible loads are one of DSM's most important models. Three cases of reliability evaluation of distribution systems using Monte Carlo simulation (MCS) will be explored in this study. In the first case, no DSM and penalty approach was included in the process, and the reliability calculation considered each customer's peak load. In the second case the DSM is considered, and the changes in system load are represented by the load profile throughout the day. For the third case the DSM and penalty will assess and evaluate the efficiency of reliability performance. The simulation results demonstrate that interruptible loads have a significant impact on power system reliability.

1 Introduction

The demand for electricity is constantly increasing due to the rapid technological advancement in the current twenty first century. This is mostly due to population increase, the demand for more electrical equipment in every residence, and the ever-changing industrial environment. Consumers expect and demand efficient and dependable services from the electric utility industry [1]. As a result, today's civilization requires the reliability of power supply. However, new trends and the latest technologies, as well as environmental limitations and rapid growth, have made it difficult to meet these needs [2].

Based on the International Energy Agency, world electricity demand in 2030 will exceed 50% more than now [3]. It is very impossible to understand global energy consumption. For example, global annual energy consumption is equal to the energy produced every four seconds by the Hiroshima nuclear explosion. The Boeing 737, for example, can cross the Atlantic Ocean in one terajoule [4].

After considering line losses along the line, one unit of electricity stored and preserved on the consumer end saves around 10% compared to one unit stored on the generator side. As a result, determining the best management options throughout the planning stage is more beneficial to always ensure customer satisfaction. Due to significant technical, environmental, and economic consequences, utilities throughout the world are considering DSM strategies as an alternative to generation of power [5]. Energy efficiency programmes can lower peak demand and average power system expenses while also deferring the need to expand power system capacity. Given the fluctuating expansion of renewable resources and the diminishing amount of conventional production in the total generation portfolio, several research on DSM have acknowledged the necessity for future networks to provide greater system flexibility through different ways [6].

The feature of DSM is a very important program to maintain the performance of the electric power system so that it can be reliable and improve the economic efficiency of the system [7], [8]. DSM, in fact, adjusts the customer load curve using a range of programmes such as peak clipping, load shifting, valley filling, and energy conservation, among others. Other advantages of the DSM include maintaining voltage stability and decreasing transmission congestion, boosting maintenance flexibility, balancing energy supplies, and lowering the disruptive disadvantages of renewable energy sources [9]–[11]. Apart from the benefits of the DSM the