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Power Loss Reduction in Distribution Systems through an Intelligent Method Considering Operational Costs

M. Izadi[1], F. Razavi[2], *Member, IEEE*, M.Gandomkar[1], A. Najafi[3], M. Soleimani[2]

[1]Department of Electrical Engineering, Saveh Branch, Islamic Azad University, Saveh, Iran
[2]Department of Electrical Engineering, Qazvin Branch, Islamic Azad University, Qazvin, Iran
[3]Electrical and Computer Engineering, Shahid Beheshti University, Tehran, Iran

ABSTRACT

A considerable amount of energy produced by a power plant is lost on its way to the customer. This has always been one of the most important problems facing power industry. Given the fact that distribution networks are extended, most of power loss takes place in such networks. Many methods have been used for reducing power loss, but each of the papers previously published on this subject have focused on one or two of such methods. In this work, different ways of reducing power loss were investigated both individually and together using an intelligent method and considering attendant costs. The paper proposes an innovative method for estimating the cost of adjusting imbalance of a three-phase system. The objective function aimed to minimize the costs associated with adjusting load imbalance, determine optimum placement and size of fixed capacitors, and remove inappropriate transformers, dilapidated conductors, and loose connections. Maximizing the financial gain from power loss reduction was another consideration. Five ways of reducing power loss in an actual feeder were compared and prioritized considering operational costs. The findings indicate that, regarding the amenities available in the feeder under study, adding capacitors and adjusting load imbalance are the most efficient and cost-effective ways of reducing loss. What is more, the present work seems to be a forerunner in that it takes account of the cost of adjusting load imbalance.

KEY WORDS: Loss reduction, Load imbalance correction, capacitor placement, dilapidated transformers, dilapidated conductors, loose connections

1) INTRODUCTION

Energy preservation is of utmost importance considering environmental issues, the high cost of fossil fuels, formation of privately-owned power utilities, and the expenses and time required for developing power plants.

Much government-funded investment has been made into reducing energy loss in different areas, including electrical energy. Reducing power loss at the distribution level has attracted the most attention because of the high amount of loss at this level. This, coupled with massive investment, means that even the smallest change in the way a network is developed or optimized could result in substantial changes in the financial status of power distribution utilities.

Like consumption, power loss requires an increase in power plant capacity, especially at peak hours, thus demanding much investment. Obviously, loss implies that a considerable amount of the generated energy is wasted rather than sold to the customers. This imposes many charges on power utilities and ultimately on power industry.

Power loss is a function of various factors and components. The main components of loss in a distribution network are summarized in [1] as follows:

- Ohmic loss in the conductors of primary and secondary network.
- Ohmic loss in the windings of distribution
- Iron loss in the core of distribution transformers.
- Ohmic loss in service cables between secondary feeders and customers.
- Ohmic loss in leakage currents of shunt equipment, such as insulators and arrestors.

A wide variety of methods have been proposed and tested over the past few decades for reducing power loss. Ref. [1] provides a list of such methods applied to the distribution level:

- Reconductoring in primary and secondary feeders.
- Feeder reconfiguration.
- Using high efficiency distribution transformers.
- Reduction of secondary network length with larger number and optimal location of distribution transformers.
- Using distributed generation.
- Subtransmission substations placement near load centers.
- Load balancing between three phases and feeders.
- Load factor improvement with demand side management strategies.
- Voltage upgrading.

***Corresponding Author**: Farzad Razavi, Department of Electrical Engineering, Qazvin Branch, Islamic Azad University, Qazvin, Iran. phone: +98912177 3241; email: farzad.razavi@qiau.ac.ir