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OPTIMIZING THE. USE OF BREAKER SWITCHED CAPACITORS IN CEB SYSTEM

A dissertation submitted to the
Department of Electrical Engineering, University of Moratuwa
in partial fulfillment of the requirements for the
Degree of Master of Science

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Abstract

Ceylon Electricity Board (CEB) as many other utilities uses breaker switched capacitor banks for voltage support and reactive power compensation in grid substations. At present it has a 320Mvar installed capacity and 70Mvar more to be come in next few years. The main intentions of the use of capacitor banks is to give voltage support at the substation level, reduction of losses in power transformers and transmission lines, and to release the capacity constraints in transformers and lines.

CEB uses power factor regulation for switching these capacitor banks. The general view of the system control center (SCC) who operates the network is that this concept does not allow economical utilization of capacitor banks and sometimes they need to manually switch on them overriding the auto controller and vise versa. Underutilizing an economical reactive power source is a factor to consider. Therefore, the objective of this research is to study the technical feasibility of connecting maximum available capacitor banks in each sub station and by doing so, to propose a better switching policy than the existing one.

The research was planned as a case study, selecting a typical grid sub station in CEB and then, the results are expected to be extrapolated to a general concept, to suit the whole CEB network. First, actual substation data was collected, logged and analyzed. The possibilities of connecting more capacitor banks, under such real time system characteristics were studied in a computer simulation model. PSCAD is the simulation software used for the network simulations. The impacts due to additional banks on the system conditions, technical constraints, non violation of general standards and economics were studied using the results from the simulations. The results were compared with actual data measurement by forcing the simulated conditions for the maximum utilization, in the real system.

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The analysis revealed that the present switching concept does not fully fit for CEB network. The possibilities of further utilization of already installed capacitor banks, was identified. Instead of present switching criteria, reactive power based control and voltage based control schemes were evaluated. Although the present criterion has a comparatively high utilization factor, it also seems that banks are not utilized at mostly required periods. As per the observations, reactive power controlled capacitor bank switching criteria is more useful compared to loss reduction in the system. When comparing the voltage control based switching, the switching pattern is similar to the pattern with reactive power control based switching in the day time. -During night time it gets closure to the requirement that SCC actually needs. However, complex algorithms are necessary to coordinate the two control loops, AVR and capacitor bank controller when-using such voltage control schemes. When two independent controls try to control same parameter, it leads to an unnecessary switching or simply, hunting the tap changer and capacitor banks.

Finally, as the conclusion of the research, multi functional switching scheme based on voltage and reactive power was proposed for the switching policy of the capacitor banks in the CEB network.

DECLARATION

The work submitted in this dissertation is the result of my own investigation, except where otherwise stated.

It has not already been accepted for any degree, and is also not being concurrently submitted for any other degree.

UOM Verified Signature

D.D.U. Dompege
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We endorse the declaration by the candidate.

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This report is a result of a study carried out in partial fulfillment of the requirements for the Degree of Master of Science. The generous support, guidance, and instructions received from my supervisors, lecturers, technical experts and my colleagues in numerous ways, is the key for the success of this effort.

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