STUDY OF DYNAMIC VOLTAGE RESTORER FOR DISTRIBUTION WITH DIFFERENT ENERGY STORAGE OPTIONS

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Abstract

Present Power quality problems in distribution systems have been increased due to the increased utilization of sensitive and critical equipment in the system. Power quality issues may contain transient over voltages, voltage sags, voltage swells, under voltage, overvoltage, harmonics distortion, flicker and voltage imbalance, etc. One of the most severe power quality problems is voltage sag. Among the various solutions to overcome power quality problems, Dynamic Voltage Restorer (DVR) is one of the most effective solutions. The DVRs can be used to mitigate voltage sags/swells by injecting an appropriate voltage in series with the grid voltage, in order to avoid loss of power as it can maintain the load voltage at its nominal magnitude and phase by compensating the particular voltage sag/swell. The DVR consists of a series connected injection transformer, a Voltage Source Inverter (VSI), inverter output filter and a DC energy storage.

DC storage mainly decides the capability of DVR. This dissertation is based on study of the technical and economic aspects of various DC energy storage options on the performance of DVR in the Voltage restoration.

The most common DC energy storage such as Batteries, Conventional Capacitors and the recently developed storage technology "Super capacitors" have been discussed here. MATLAB Simulink platform was used for modeling and simulating the DVR and the energy storage options. Other than the standard DC energy storage models, a new model was built up for Super capacitor and validated through experiential results. Further economics of the above energy storage options in achieving the required energy storage levels have been investigated.

Based on the responses of DVR in different types of sags and swells for the above energy storage options, it can be concluded that for deeper and short duration sag mitigations, super capacitor performs better. But in mitigating longer duration sags, battery performs better. Conventional capacitor storages manufactured in the same scale of super capacitors can perform better than batteries, but in the economic point of view it is not appropriate.

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LIST OF ABBREVIATIONS

Abbreviation	Description
rms	root mean square
SCR	Silicon Controlled Rectifiers
DSTATCOM	Distribution Static Synchronous Compensators
SETC	Static Electronic Tap Changers
UPS	Static Electronic Tap Changers
DVR	Dynamic Voltage Restorers
MV	Medium Voltage
LV	Low Voltage
DC	Direct Current
PWM	Pulse Width Modulation
VSC	Voltage Source Converter
SLG	Single Line to Ground Fault
DLG	Double Line to Ground Fault
SPWM	Sinusoidal Pulse Width Modulation
HEV	Hybrid Electric vehicles
SoC	Status of Charge
ESR	Equivalent Series Resistance
EPR	Equivalent Parallel Resistance
IGBT	Insulated Gate Bipolar Junction Transistors
VSI	Voltage Source Inverter
Ni-MH	Nickel Metal Hydride
THD	Total Harmonic Distortion
FFT	Fast Fourier Transform