

Abstract

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POWER QUALITY ENHANCEMENT BY ELECTRIC SPRING

With many countries worldwide determined to de-carbonize electric power generation within the next few decades, concerns about voltage level variation have arisen from the increasing use of intermittent renewable energy sources. These distributed renewable energy sources has undetermined state to the utility companies and a significant portion of them are to be connected to the distribution network close to loads. Due to the increasing use of distributed and intermittent nature of renewable energy sources, it is expected to introduce variations in voltage level of the AC supply, potentially resulting in highly fluctuating ac mains voltage. Recently, various solutions have been proposed for voltage level variation control of future smart grid with substantial penetration of distributed and intermittent renewable energy generation that is based on Power electronics technology. To solve the voltage dip and swell problems caused by renewable energy injected power variations, some classical voltage mitigation techniques are introduced. Different measures have been developed to alleviate the negative effects of the voltage disturbance and to mitigate the power quality problems. A novel topology introduced as Electric Spring (ES) has huge potential in regulating future power systems and is found effective in regulating the point of common coupling voltage despite the fluctuation caused by the intermittent nature of wind power. The ES possesses a mechanism of regulating the power flow of the noncritical loads to provide the required voltage support across the distribution grid. Conventional ES provides only reactive power compensation for mains voltage regulation and simultaneously varies the noncritical load power so as to achieve automatic power balancing within the power capability of the ES and its associated noncritical load. The present thesis provides new control strategy that offers dual functionality of Electric Spring. In addition to the conventional bus voltage regulation function, the presented decoupled control strategy enables the ES to inject local available PV power to grid without violating the bus voltage regulations. Multiple simulation cases are performed in order to prove the ES capability of regulating the bus voltage and RES integration. Simulation cases includes system performance when subjected to variations in multiple voltage levels when the solar irradiance is fixed in comparison with system performance when subjected to irradiance variations under the same voltage level fluctuations. Practical implementation of the system has validated the theory behind the proposed dual functionality ES and has been validated during various bus voltage fluctuations and under solar irradiance variation conditions.