

## Transmission Line Protection Challenges under High Penetration of Renewable Energy Sources and Proposed Solutions: A Review

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**Abstract :** European power networks involve the use of multiple overhead transmission lines to construct a highly duplicated system that delivers reliable and stable electrical energy to the distribution level. The transmission line protection applied in the existing GB transmission network are normally independent unit differential and time stepped distance protection schemes, referred to as main-1 & main-2 respectively, with overcurrent protection as a backup. The increasing penetration of renewable energy sources, commonly referred as “weak sources,” into the power network resulted in the decline of fault level. Traditionally, the fault level of the GB transmission network has been strong; hence the fault current contribution is more than sufficient to ensure the correct operation of the protection schemes. However, numerous conventional coal and nuclear generators have been or about to shut down due to the societal requirement for CO<sub>2</sub> emission reduction, and this has resulted in a reduction in the fault level on some transmission lines, and therefore an adaptive transmission line protection is required. Generally, greater utilization of renewable energy sources generated from wind or direct solar energy results in a reduction of CO<sub>2</sub> carbon emission and can increase the system security and reliability but reduces the fault level, which has an adverse effect on protection. Consequently, the effectiveness of conventional protection schemes under low fault levels needs to be reviewed, particularly for future GB transmission network operating scenarios. The proposed paper will evaluate the transmission line challenges under high penetration of renewable energy sources and provides alternative viable protection solutions based on the problem observed. The paper will consider the assessment of renewable energy sources (RES) based on a fully rated converter technology. The DIGSILENT Power Factory software tool will be used to model the network.

**Keywords :** fault level, protection schemes, relay settings, relay coordination, renewable energy sources

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