

Time domain load flow analysis in ETAP for modern power distribution systems

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Abstract

The study investigates the capabilities of the Time-Domain Load Flow (TDLF) analysis in the Electrical Transient Analyser Program (ETAP) to assess the hybrid microgrids' performance under dynamic conditions. The hybrid microgrid includes photovoltaic (PV) arrays, battery energy storage, and AC-DC converters. TDLF analysis outperforms the traditional steady-state counterparts by providing time-variant analysis, which comprehensively enhances understanding of the power system's performance under dynamic conditions. The study incorporates a 24-hour PV solar irradiance profile and seven events (four load variations, utility voltage impact and two circuit breaker operations). The TDLF results show that the PV system's output power depends on the solar irradiance profile. They also reveal that the DC bus voltage has a maximum deviation of 4%, and the AC bus voltage deviation reaches 17%, raising concern for the system's reliability and stability. Cable voltage drop profiles show that the DC cable has a maximum voltage drop of 0.3%. The AC cable has a maximum of 13%, indicating considerable cable losses. The results indicate that the DC side is stable while the AC side needs attention. The findings highlight ETAP TDLF's effectiveness in assessing hybrid microgrid dynamics and provide valuable insights into improved reliability and renewable energy integration for sustainability.