Optimal sizing and placement of distributed generation under N-1 contingency using hybrid crow search–particle swarm algorithm	
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Abstract: Line outage contingencies in power distribution systems pose critical challenges, leading to disruptions, reduced reliability, and potential cascading failures. These problems include increased vulnerability, limited resilience, and the need for efficient mitigation strategies to enhance the overall system reliability and quality. This study aims to investigate, analyze, and evaluate the renewable distributed generator (RDG) allocation and sizing under N-1 line outage conditions in terms of the reliability and quality for the IEEE 30-bus benchmark power system as a case study. Under all possible N-1 line outage conditions, there were four critical N-1 line outage conditions, 19–20, 10–20, 27–29, and 27–30, which caused overloading on at least one line. The Severity Performance Index (SPI) recorded the highest value of 0.715 during the line 10–20 outage, followed by 0.683, 0.606, and 0.476 during the line F27–30 outage, line F19–20 outage, and line F27–29 outage, respectively. This indicates that the line 10–20 outage is the most critical among the line outages followed by the line 27–30 outage. During the line 10–20 outage, the crow search integrated with the particle swarm optimizer recommends allocating renewable distributed generators (RDGs) at optimal or feasible buses 14, 15, 17, 20, and 30, with suggested sizes of 26.8127 MW, 38.8986 MW, 27.9600 MW, 21.6300 MW, and 27.0184 MW, respectively. The obtained finding revealed that allocating five RDGs at optimal busbars helped keep the line loading below maximum limits and improved the voltage profiles during the N-1 line outages in the IEEE 30-bus benchmark power system. This approach enhanced the power system reliability and quality across all four N-1 scenarios.