Wind power is one of the most used renewable energy sources; however, effective wind turbine design remains a challenge. This paper proposes a framework to explore the multi-objective design optimization of wind turbines and find the best compromise solution by considering the altitude. The design objectives are minimization of the cost of energy and maximization of the rated power by considering the rotor radius and hub height with respect to the structural design constraints. The Pareto envelope based selection algorithm II (PESA-II) and two versions of the non-dominated sorting genetic algorithm II and III (NSGA-II & NSGA-III) with a mutation strategy and a constraint handling method are implemented to generate Pareto fronts. Five comparing metrics are used to identify the most efficient optimization technique, and two decision methods are adopted to find the best compromise solution. A case study is solved under two altitude scenarios. The overall results show that NSGA-II performs better than the other algorithms, and the obtained best compromise solution is within the design limits. It is also observed that when the altitude increases, the cost of energy increases, and the rated power decreases