The present work addresses two main complementary parts: the first part deals with the modeling and simulation of hybrid solar-gas tower power plant (HSTPP) performances and the second one treats the solar tower power plant (STPP) reliability analysis. An overview of HSTPP technology, current status and a presentation of the major components including the heliostat field, the solar receiver and the power conversion system are first highlighted. Then, modeling and simulation of the HSTPP performances is developed. In this study the HSTPP is divided into two main parts, the first one is the solar part or the solar tower power plant (STPP) and the second is the gas part or gas turbine power plant (GTPP). The STPP performances analysis iswell detailed in this thesis since the STPP is the most important part of HSTPP. To this end, two different methods namelythe artificial neural network (ANN) method and the analytical method using energy analysis are presented and analyzedfor the STPP performance analysis. The simulation of the performances of this STPP using these two methods has led to a very good convergence and accuracy of these results. Besides, GTPP and HSTPP performancesare evaluated and simulated in this thesis. For the STPP reliability analysis, the study focuses on specific methods such as the First Order Reliability Method (FORM). Detailed analysis concerning FORM is developed in this thesis. The same hypothetical STPP example, used for the performance analysis, is proposed also to evaluate this method. The results show that FORM is suitable to assess the reliability of STPP systems and it converges quickly. It can also adjust the first design parameters to a new safe design