

950MW CSP Hybrid Power Plant Phase IV

The 950 MW CSP Hybrid Power Plant, Phase IV of the Mohammed bin Rashid Al Maktoum Solar Park, is the largest single-site concentrated solar power (CSP) project globally, integrating 700 MW from CSP, 250 MW from photovoltaic (PV) panels, and an additional 110 MW auxiliary PV panels for self-consumption. This innovative hybrid design has enabled the project to achieve the lowest Levelized Cost of Electricity (LCOE) for CSP globally at USD 7.3 cents per kilowatt-hour. Phase IV is a remarkable engineering achievement, combining numerous cutting-edge innovations, including large parabolic troughs and economies of scale through shared facilities. This combination enhances efficiency, reliability, and cost-effectiveness, underscoring the project's financial viability and innovation. Developed to meet the critical need for energy storage and ensure renewable energy availability over 24 hours, the plant optimizes grid stability in response to high PV penetration in the Dubai grid. It supplies clean energy to approximately 320,000 residences, reducing annual carbon emissions by around 1.6 million tons. This project represents the largest global investment in a hybrid CSP and PV system, with investments totaling USD 4.29 billion under the Independent Power Producer (IPP) model.

The complexity of this hybrid system is highlighted by its advanced CSP technology, featuring a 100 MW central tower (CT) and 600 MW from parabolic trough (PT) systems. The integration of Thermal Energy Storage (TES) with molten salts provides significant storage capacities: 3,588 MWh,th (15 hours) for the CT and 6,525 MWh,th (12 hours) for each of the PT systems, utilizing 26 TES tanks, resulting in a total storage capacity of 23,163 MWh,th. In comparison, typical TES capacities for commercial CSP plants are around 1,300 MWh,th per unit. The largest CSP unit before this project, located in Morocco, had a storage capacity of 3,125 MWh,th. These TES tanks are crucial for continuous power generation, ensuring energy availability both day and night. The 110 MW PV auxiliary system replaces the need for grid power during the daytime, providing auxiliary power to the CSP units, contributing to green energy generation, and achieving the lowest LCOE globally. This interconnection with an auxiliary PV facility for self-consumption is a new innovation not seen in earlier CSP plants.

A notable innovation in the CT unit is the solar field design, featuring 70,000 wireless heliostats, a significant increase from the typical 40,000 to 50,000 in commercial CSP plants. These heliostats have a lifespan of 35 years, compared to the standard 20 to 25 years, enhance operational continuity under environmental and human factors and optimize solar field efficiency. The advanced wireless technology, including PV+battery systems for power supply and Wi-Fi access points for communication with the Plant DCS, eliminates traditional cabling, simplifying construction, and reducing costs.

Phase IV represents a landmark in engineering excellence, consolidating advanced innovations into a cohesive project. The project's achievement of two Guinness World Records, the largest thermal energy storage capacity of 5,907 MWh for CSP PT technology and the tallest CT tower at 263.1 meters reflects its groundbreaking nature. By consolidating these innovations, the project not only sets a new standard in renewable energy but also achieves the world's lowest LCOE for CSP, making it the largest and most efficient hybrid solar power installation globally.