Studying the integration of solar energy into the operation of a semi-autogenous grinding mill. Part II: Effect of ore hardness variability, geometallurgical modeling and demand side management

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In the first part of this work, a solar photovoltaic system with battery storage (PV-BESS) and grid backup system to supply a SAG mill was modeled. There, the overall framework, the optimization model, and the model for the solar forecast were presented. Here, in the second part, the impact of ore hardness variability and uncertainty is studied. Demand side management strategies are modeled to improve the solar energy integration. This work starts by analyzing the impact of the mineral hardness variability and uncertainty (in the SAG mill's feed) on the sizing of the PV-BESS system. For this, several feed hardness variabilities are considered in order to understand the effects of the frequency, amplitude, and phase with sun hours. Second, for demand-side management, a feed hardness array is generated by mixing two normal distributions with different standard deviation and mean values, representing a hard and soft ore. And third, realistic SAG mill feeds are generated with geostatistical simulations. Different densities of the sampling grids in the geostatistical simulations generate estimated ore feeds with varying levels of uncertainty. These are used to propose a greenfield sizing methodology. The results show that the PV-BESS system proves to be an attractive solution under all scenarios considered, being able to reduce the total costs by over 30% (when considering a Chilean scenario). It allows decreasing the electricity imports by more than 80% and lowering the power capacity contracts by more than 15%. The frequency and phase of the hardness of the feed show the benefit of mineral management; the more

prominent the amplitude and the standard deviation is, the more cost-effective the integration of renewable energy becomes. Managing the rock hardness assists in complying with the capacity contract during more extended periods of low solar irradiation and reduces the need for batteries. Models estimated from limited data are smooth and under estimate the hardness variability leading to smaller BESS results from the simulations showing its importance as an energy buffer. The sizing methodology using predicted feed showed that the model could be applied to a realistic mineral feed.