Widespread use of electric vehicles (EVs) requires investigating impacts of vehicles’ charging on power systems. This paper focuses on the design of a new DC fast charging station (DCFCS) for EVs combined with local battery energy storages (BESs). Due to the BESs the DCFCS is able to decouple the peak load demand caused by multiple EVs and decrease the installation costs as well as the connection fees. The charging system is equipped with a bidirectional AC/DC converter, two lithium-ion batteries and a DC/DC converter. The introduction of BES within the DCFCSs is investigated with regards to operational costs of the charging stations as well as the ability of a BES to mitigating negative impacts on the power grid during congestion hours. The proposed solution is shown to reduce not only the installation costs but also the charging time and it facilitates the integration of fast chargers in existing low voltage (LV) grids. A cost-benefit analysis (CBA) is performed to evaluate the financial feasibility of BES within the DCFCSs by considering the installation costs, grid connection costs and battery life cycle costs.