Electric vehicles (EVs) appear to offer a promising solution to support sustainable transportation and the reduction of CO2 emissions in the metropolitan areas. To satisfy the EV load demand of the new EV models with larger battery capacities, public direct-current fast-charging stations (DCFCs) are essential to recharge EVs rapidly. A stochastic planning method of the DCFCs is presented considering user behaviour and the probabilistic driving patterns in order to predict EVs charging demand. According to the stochastic method, a coordinated charging demand and storage charging demand are proposed with the objective of minimising peak load from EVs and charging-infrastructure costs. The proposed planning method can prevent additional grid reinforcement costs due to EV demand during the peak hours. In the coordinated charging demand, the peak load from EVs is managed by controlling the DCFCs. Instead, in the battery energy storage (BES) charging demand, an optimal BES is proposed as an alternative solution to reduce the peak demand of EVs as well as DCFCs operational costs. Finally, an economic analysis is carried out to evaluate the technical and economic aspects related to DCFCs, the BES lifecycle costs as well as the financial performance of BES costs versus grid reinforcement costs.