

# **Review of positive and negative impacts of electric vehicles charging on electric power systems**

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## **Abstract-**

**There is a continuous and fast increase in electric vehicles (EVs) adoption in many countries due to the reduction of EVs prices, governments’ incentives and subsidies on EVs, the need for energy independence, and environmental issues. It is expected that EVs will dominate the private cars market in the coming years. These EVs charge their batteries from the power grid and may cause severe effects if not managed properly. On the other hand, they can provide many benefits to the power grid and get revenues for EV owners if managed properly. The main contribution of the article is to provide a review of potential negative impacts of EVs charging on electric power systems mainly due to uncontrolled charging and how through controlled charging and discharging those impacts can be reduced and become even positive impacts. The impacts of uncontrolled EVs charging on the increase of peak demand, voltage deviation from the acceptable limits, phase unbalance due to the single-phase chargers, harmonics distortion, overloading of the power system equipment, and increase of power losses are presented. Furthermore, a review of the positive impacts of controlled EVs charging and discharging, and the electrical services that it can provide like frequency regulation, voltage regulation and reactive power compensation, congestion management, and improving power quality are presented. Moreover, a few promising research topics that need more investigation in future research are briefly discussed. Furthermore, the concepts and general background of EVs, EVs market, EV charging technology, the charging methods are presented.**

**Index Terms-** electric vehicles; uncontrolled charging; delayed charging; controlled charging; V2G; V2B; V2H; peak shaving; valley filling; congestion management; renewable energy sources

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