

# **Regulatory framework and business models for charging plug-in electric vehicles: infrastructure, agents, and commercial relationships**

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## **Abstract-**

Electric vehicles (EVs) present efficiency and environmental advantages over conventional transportation. It is expected that in the next decade this technology will progressively penetrate the market. The integration of plug-in electric vehicles in electric power systems poses new challenges in terms of regulation and business models. This paper proposes a conceptual regulatory framework for charging EVs. Two new electricity market agents, the EV charging manager and the EV aggregator, in charge of developing charging infrastructure and providing charging services are introduced. According to that, several charging modes such as EV home charging, public charging on streets, and dedicated charging stations are formulated. Involved market agents and their commercial relationships are analysed in detail. The paper elaborates the opportunities to formulate more sophisticated business models for vehicle-to-grid applications under which the storage capability of EV batteries is used for providing peak power or frequency regulation to support the power system operation. Finally penetration phase dependent policy and regulatory recommendations are given concerning time-of-use pricing, smart meter deployment, stable and simple regulation for reselling energy on private property, roll-out of public charging infrastructure as well as reviewing of grid codes and operational system procedures for interactions between network operators and vehicle aggregators.

**Index Terms-** Plug-in electric vehicles; Business models; Electric vehicle aggregators

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