The Real-Time Impact of Vehicle-to-Grid (V2G) Integration on the Electric Power Grid Infrastructure

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Reliable and affordable electricity is a key to sustainable economic development be it in urban or rural environments. In many rural regions, utilities have yet to expand their electrical grids to support relatively remote towns and villages with the possible integration of electric vehicles (EVs). However, millions of new EVs, buses, vans, etc., found hitting the roads will not survive without ample charge for powerful lithium-ion batteries because EVs will certainly require between 525 to 860 TWh of electricity by 2030. These requirements are approximately 80 TWh higher than the last year, according to the International Energy Agency (IEA). In the meantime, many communities in urban regions demand an electricity service that is either more reliable or more cost-effective than that offered to them by local utilities. Because the integration of a large number of EVs at residential premises has imposed serious concerns on power system operation and control such as frequency disturbance due to fast charging, unattractive pricing tariffs due to charging during peak hours, unoptimized charging strategies, customers dissatisfaction due to uncertainty of price, etc.

While considering the traditional distribution system, its radial architecture means that a single fault can cut power to remaining consumers at the periphery of the network. Current distribution systems are typically designed for one-way flow out to consumption and thus have limited ability to accommodate two-way flow from distributed renewable energy resources. For these reasons, many communities in developed as well as developing nations alike are turning to microgrids with active demand response and customer engagement as a technological solution that is equally empowering their development objectives to further support V2G integration with high reliability and uninterruptible operation. These microgrids epitomize "smart grid" principles and allow for distributed renewable energy resources in combination with demand-side resources such as smart homes and buildings. Furthermore, while the potential for microgrids will inevitably grow, they must be designed to allow future interconnection with existing electric infrastructure, other neighbouring microgrids, and V2G and/or G2V infrastructures. Therefore, new intelligent optimization and control systems are needed to design and develop the power grid infrastructure in such a way as to facilitate massive EV integration.

Conclusions

Based on the literature review, it is realized that artificial intelligence (AI) and advanced machine learning (ML) algorithms can play an important role to overcome ongoing problems as a short-term solution. Because, without accurate prediction of the required load, price uncertainty, renewable energy capacity and customer behaviours, it seems difficult to devise an accurate opination and control strategy.

References

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