Abstract

An effective method of achieving climate neutrality is to focus on the sectors that have the greatest contribution to Green House Gas (GHG) emissions i.e, electricity generation and transportation sectors. However, an alternative solution for electricity generation, which can be thought of, is the use of renewable energy resources. To further dampen out the effect of GHGs, transportation sector is to be served by zero-emission vehicles.

The rapid growth of Electric Vehicles (EVs) and their capability of providing vehicle to grid (V2G) power support in distribution network needs in-depth studies for the effective operation of the distribution system. The uncoordinated and unpredictable penetration of EV's will generate significant stress on distribution network. If integration of EVs are not investigated properly, they may violate techno-economical constraints of distribution system. Maintaining the techno-economical constraints and phase balance of distribution networks throughout the day is a challenging problem for distribution system operator. Local Distribution Companies (LDC) have to provide quality power on the distribution network. Thus, distribution system peak load, voltage profile, and energy losses must be monitored and should be maintained within acceptable limits by taking care of consumer satisfaction.

In view of these facts, the goals of the work presented in this thesis are to address the challenges associated with effective utilisation of Plug-in Hybrid Electric Vehicles (PHEVs) as a distributed resource in distribution system. The integration of PHEVs in presence of local Distributed Energy Resources (DERs) modules is to be properly coordinated in such a way that it would not be counterproductive for distribution system. The proposed actions in this thesis are sequentially applied in four stages. In first stage, a stochastic simulation of load demand of PHEVs is developed considering the uncertainties related to driving pattern of PHEVs, based on the demand responsiveness and conventional approach using Monte-Carlo simulation. The PHEVs charging load behaviour is

more complex in comparison to the conventional load. Thus, charging method influences the EV load model, which is critical for a realistic system study in context of distribution system planning and operation. To assess the true reflection of EV load model accounting for the effect of grid voltage, three existing EV load models are incorporated in proposed modified current injection load flow algorithms in second stage of this thesis. Further, in third stage of the work, a 24-hour optimal scheduling of PHEVs in conjunction with DERs is performed considering the different objectives simultaneously (i.e. cost minimization, CO_2 emission minimization, real power losses minimization and load flattening). Furthermore, different case studies are also performed to segregate the effects of PHEVs scheduling in presence of local DER modules, so that one may be able to understand their individual and combined effects. In the last stage, a 24-hour day ahead optimal active and reactive power scheduling of DGs and PHEVs is investigated which aims to minimizing utility energy cost as an objective function and mitigation of phase unbalance and peak shaving in terms of PAR as an additional constraints.