Minimizing Energy Losses: Optimal Accommodation and Smart Operation of Renewable Distributed Generation
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The problem of minimizing losses in distribution networks has traditionally been investigated using a single, deterministic demand level. This has proved to be effective since most approaches are generally able to also result in minimum overall energy losses. However, the increasing penetration of (firm and variable) distributed generation (DG) raises concerns on the actual benefits of loss minimization studies that are limited to a single demand/generation scenario. Here, a multiperiod AC optimal power flow (OPF) is used to determine the optimal accommodation of (renewable) DG in a way that minimizes the system energy losses. In addition, control schemes expected to be part of the future Smart Grid, such as coordinated voltage control and dispatchable DG power factor, are embedded in the OPF formulation to explore the extra loss reduction benefits that can be harnessed with such technologies. The trade-off between energy losses and more generation capacity is also investigated. The methodology is applied to a generic U.K. distribution network and results demonstrate the significant impact that considering time-varying characteristics has on the energy loss minimization problem and highlight the gains that the flexibility provided by innovative control strategies can have on both loss minimization and generation capacity.