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Highlights

• This paper investigates the coordination between transmission, distribution, and DER aggregators.

• The model is a non-linear bi-level problem, which is transformed into a linear single-level one.

• The model is applied to a 33-bus distribution network connected to the RTS 24-bus power system.

Abstract The coordination between distribution system and transmission system operation in the presence of distributed energy resources (DERs) is a new framework that needs appropriate modeling. Moreover, local energy market models are emerging, and there is the need to describe the decision-making occurring in active distribution systems including the distribution company (Disco) and the DER aggregators. This paper investigates the coordination between transmission, distribution, and DER aggregators that interact in a local market model. The individual objectives of the decision-makers are conflicting with each other. For this purpose, a bi-level optimization approach is proposed, in which the operation problem of the Disco and the day-ahead market clearing managed by the wholesale market operator are considered as the upper- and lower-levels problems, respectively. Moreover, to model the uncertainties of output power of renewable energy sources in the Disco's problem, the information gap decision theory is used. The resulting model is a non-linear bi-level problem, which is transformed into a linear single-level one through the exploitation of the Karush-Kuhn-Tucker conditions and the duality theory. To investigate the effectiveness of the model, two case studies are defined in which the IEEE 33-bus and a real 43-bus distribution systems are connected to the RTS 24-bus power system.

Keywords Bi-level approachDistributed energy resourcesDistribution systemLocal energy marketTransmission system