

A Mixed-Integer Nonlinear Model to Support the Operation of Distribution Systems With Hidden DERs

Pedro N. Vasconcelos^{1,2}, Fernanda C. L. Trindade³, Bala Venkatesh¹, Walmir Freitas³, Antonio C. Zambroni de Souza², Glauco N. Taranto⁴

¹Toronto Metropolitan University, ²Federal University of Itajubá, ³State University of Campinas, ⁴Federal University of Rio de Janeiro

With impending deep electrification powered by innumerable Distributed Energy Resources (DERs), modeling each DER individually is becoming a critical challenge to the Distribution System Operators (DSOs). Even though the DSOs know the total DER installed capacity at the feeder level, the exact individual type, location, and size of such generators may remain unknown. This paper proposes a mixed-integer nonlinear programming formulation to support the operation of distribution systems under massive DER integration. The proposal accurately estimates distribution system power flows, relying on a limited set of measurements. It aims to establish equivalent DER models representing hidden resources and improve the representation of limited-visibility networks. The only DER information required is the total solar and wind installed capacity at the feeder level. The performance is assessed by comparing estimated and measured values of bus voltage magnitudes and branch power flows. Results demonstrate the efficacy of the proposed formulation in accurately replicating measurements, achieving an accuracy of over 90% when estimating active power flows in unmetered branches.