Power flow optimization in the presence of microgrids

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Mots-clés : *Power flow optimization, microgrid, bilevel programming*

1 Introduction

Power flow optimization problems consist in generating electricity from different types of power plants in order to meet the demand of the electrical network. Many different types of such problems exist, depending on the type of electrical network (transmission, distribution, ...) and the types of power plants considered (thermic, nuclear, solar, wind, hydro, ...). Even when the context is well specified (type of network and power plants), the true resulting mathematical optimization problems are often intractable due the presence of discrete decisions variables and non-convexities in the functions describing the technical constraints (e.g., [2]). As a result, one should also decide on the level of simplification used to model the electrical power flows (AC model, DC model, or bus model) and the technical constraints faced by the power plants.

Yet, networks of future generations will turn the picture even more complex by replacing the traditional and centralized power transmission networks with smart-grids:

> *“A smart grid is an electrical grid which includes a variety of operational and energy measures including smart meters, smart appliances, renewable energy resources, and energy efficiency resources”*

We focus in this work on modelling the interaction between the generating companies (GenCos) and micro-grids, which consist in smaller nearly isolated sub-grids that interact only with the global system when a load/offer mismatch occurs.

We propose a bilevel mixed-integer linear program for the problem where the leader represents the GenCos and the followers the microgrids. We provide a conservative approximation for the bilevel program that relaxes the *optimistic assumption* commonly made in bilevel programming (the optimistic assumption assumes that the followers always take the solutions which are most beneficial for the leader). Our approximation considers instead arbitrary optimal solutions for the followers. We obtain a one-level mixed integer linear program whose computational complexity is not much higher than the complexity of solving the underlying power flow optimization problem. We present numerical results based on the instances used in [1], combined with micro-grids simulated from real data. Our results confirm the numerical tractability of our reformulation. They also show that our conservative approximation provides an optimal solution very close to the true optimal solution of the problem (where the optimistic assumption is satisfied).

Références

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