RWTH AACHEN UNIVERSITY

E.ON Energy Research Center
ACS | Institute for Automation of Complex Power Systems

Bachelor Thesis / Master Thesis

Enhancement of Distributed Mixed-Integer Programming Algorithms for Energy Management Purposes

Abstract:
With the growing number of volatile renewable energy source installations, a more fluctuating power production can be observed on the supply side of power systems. This results in an increased need for operational flexibility to balance the (local) power demand and supply in distribution grids. Distributed energy resources are able to provide a certain share of the flexibility required, where modern control strategies and detailed mathematical models of the distributed energy resources are necessitated to coordinate and fully exploit the flexibility potential offered by the distributed energy resources. Many distributed energy resources, such as electro-thermal heating units, electric vehicles or storage devices, require discrete control decisions. This leads to the consideration of discrete decision variables in order to model distributed energy resources adequately. As a result, an entity which tries to coordinate distributed energy resources needs to solve a Mixed-Integer Programming (MIP) problem. However, determining solutions for MIP problems is known to be a computationally challenging task. Central optimization algorithms are not highly scalable and hence not applicable to complex MIP optimization problems containing thousands of variables and constraints. Thus, provably convergent distributed solvers are necessitated for such MIP problems. Distributed solvers/algorithms come with the advantage to share the computational load over multiple computing nodes and to keep sensitive data private. For example, one widely-known distributed algorithm is the Alternating Direction Method of Multipliers (ADMM) algorithm.

Task description:
There are already existing implementations of distributed MIP solvers applied to energy management problems available at the institute. The goal is to enhance these algorithms in order to improve their (computational) performance. To this aim, different strategies suggested in recent literature should be tested and assessed. This could comprise (but is not limited to) the following approaches: algorithm cold start vs. warm start capabilities, constraint relaxations, computational load balancing, convergence rate improvements, application of heuristics.
The improvements should be implemented in Python programming language. Basic knowledge of Linux systems and the Message Passing Interface (MPI) standard will be beneficial. The thesis can be written either in German or English.

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