Models, Methods and Optimization Tools for Energy Systems

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ECTS: 3

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Max no. of participants: 20

Description: Energy is a resource that needs to be managed and decisions need to be made on production, storage, distribution and consumption of energy. Determining how much to produce, where and when, and assigning resources to needs in the most efficient way is a problem that has been addressed in several fields. There are available tools that can be used to formulate and solve these kinds of problems. Using them in planning, operation and control of energy systems requires starting with the basics of math programming techniques, addressing some standard optimization problems, and adapting the solutions to new particular situations of interest.

A first issue is revisiting the modelling concept. The model is a simplified and limited representation of our reality. Complex multi-level problems may need different models and models valid at the operational level (operation and control) may not be useful at the tactical or strategic levels (scheduling and planning). Thus, when addressing optimization problems, detailed physical models based on differential equations will be replaced by algebraic equations expressing the basic relations between lumped parameters. The second issue is the choice of a problem-solving method. It is well known that all optimization methods have at least some limitations and there is no single method or algorithm that works best on all or even a broad class of problems. In order to choose the best method for a given problem, one must first understand the nature of the problem and the type of design space that is being searched.

Students attending this course will learn how to recognise and formulate different optimization problems in planning, operation and control of energy systems, and how to solve them using existing softwares and solvers such as MATLAB, GAMS, and Excel. Different principal algorithms for linear, network, discrete, nonlinear and dynamic optimization are introduced and related methodologies together with underlying mathematical structures are described accordingly. Several illustrative examples and optimization problems, ranging from the classical optimization problems to the recent MINLP models proposed for the optimization of integrated energy systems (such as residential AC/DC microgrids) will be introduced during supervised hand-on sessions and different tools (such as classic mathematical methods, heuristics and meta-heuristics) will be used for solving the cases. The choice of objective functions, representation of discrete decisions, using formulation tricks and checking the results will be also covered.

The course is intended for those students that, having a general knowledge in mathematics and simulation, have a very limited experience in math optimization and programming, and need to be introduced to these tools for energy systems optimization.

Prerequisites Familiarity with basics of real analysis, linear algebra, and probability and statistics.

Link: http://www.et.aau.dk/phd/phd-courses/