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EDITORIAL

Editorial for the special issue: "Optimization in energy"

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The idea for this special issue of Energy Systems entitled "Optimization in Energy" was born following the Fourth Conference on Optimization and Practices in Industry (COPI) organized by the OSIRIS department of EDF R&D in October, 2014. The tri-annual COPI conference is aimed at bringing together academics and industry to share optimization modeling expertise and build collaboration. The 2014 conference was organized jointly with the Gaspard Monge Program for Optimization and Operations Research (PGMO).[1]

The academic research on electricity optimization carried out through the PGMO, along with the applications of optimization in EDF R&D show the great importance that optimization has in the electricity industry. Modeling and computational improvements for traditional operational problems such as unit commitment are still being discovered for very large-scale systems. Other traditional problems involve the annual planning of hydroelectric energy, or the scheduling of maintenance for generating

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1 http://www.fondation-hadamard.fr/pgmo.

units. The increasing share of renewable generation has significantly increased overall uncertainty in traditional problems and opens many questions and research perspectives in stochastic optimization. The use of optimization models in this context not only provides economic value, but enhances the environment by enabling the increased use of renewable resources.

Besides the practical importance of optimization models in energy, through their use as decision-support tools, there is also much academic interest in this area. Optimization models in energy management can involve some combination of large-scale, non-linear, non-convex/mixed integer, and stochastic features that make them challenging to solve. Such formulations and their simpler variants attract the attention of researchers who seek to make theoretical advances in methodology. As a consequence there continues to be a fruitful communication between theoretical and algorithmic improvements and their practical applications.

Since its creation in 1946, EDF has always been at the forefront of developments in optimization and their application in electricity generation and planning. Each decade since 1946 has its own milestones that we catalogue here to emphasize the ongoing contributions of EDF's researchers/engineers.

1 In the 1940s, Pierre Massé laid the foundations of many principles of optimization, in particular to hydroelectric reservoir management [9]. Contemporaneously with Dantzig and Kantorovitch, Massé realized the importance of dual variables, and their economic interpretation, and he also laid the foundations of dynamic programming through the recognition of an optimal value function. Massé was chairman of the board of directors of EDF from 1965 to 1969.[2]
2 In the 1950s Marcel Boiteux introduced Ramsey-Boiteux pricing of electricity [1] as a pricing mechanism designed to maximize social welfare while recovering the fixed costs of natural monopolies like EDF. Boiteux was Directeur Général of EDF from 1967 to 1987.
3 In the 1960s, Pierre Huard developed:
   (a) The reduced gradient method (with Wolfe) and its generalized variant (with Carpentier, also an EDF engineer).
   (b) The method of centers (see e.g. [8]), revived 30 years later with the rise of interior point methods for linear programing.
4 In the 1970s, Jean-Francois Maurras established a fundamental link between graph theory and linear programming to effectively solve the optimization problem of managing large hydraulic valleys.[3]
5 In the 1970s, Michel Gondran worked on the early development of mixed-integer programming applications with a view of applying them in hydroelectric reservoir management [6]. Together with Michel Minoux, he also published an important book on graph theory in 1979 (reprinted in English as [7]). The book is still available today in the 4th edition.
6 In the 1980s, Jean-Claude Dodu developed stochastic methods for large networks [4]. Furthermore, André Merlin and Patrick Sandrin [10] worked on the develop-

[2] http://www.persee.fr/doc/xxs_0294-1759_1987_num_15_1_1884.

[3] https://www.researchgate.net/profile/Jean-Francois_Maurras/info.

ment of Lagrangian decomposition for unit-commitment problems, and were the first to apply subgradient methods to the Lagrangian dual.

7 In the 1990s, Arnaud Renaud together with several colleagues worked on integrating uncertainty in unit-commitment [3].

8 In the 2000s, Louis Dubost, Robert Gonzalez and Claude Lemaréchal worked on primal recovery in unit-commitment after the succesful integration of Lemaréchal's bundle method code in EDF's unit-commitment software [5].

9 In the 2010s, EDF has supported significant research work in mathematical finance through the joint lab FIME which has lead to several academic contributions (see e.g. [2]). As mentioned above, EDF is also an active supporter of the PGMO program.

This special issue covers various aspects of energy management, ranging from theoretical contributions to practical applications. The guest editors are grateful to the many referees who helped in the reviewing process of the papers. The resulting contributions are as follows.

1 In "Multi-usage hydropower dam management: chance-constrained optimization and stochastic viability", Carpentier, Alais and de Lara consider multistage cascaded reservoir management with a specific joint probability constraint. They look at dynamic programming based methods applied in the Lagrangian dual with respect to this constraint.

2 In "Frequency Constrained Unit Commitment", Cardozo, Capely and Dessante consider various indirect constraints to deal with the potential loss of a unit and its subsequent effect on the frequency on an electrical network.

3 In "An Overview on Mathematical Programming Approaches for the Deterministic Unit Commitment Problem in Hydro Valleys", Taktak and d'Ambrosio provide a review of methods dealing with deterministic short-term cascaded reservoir management.

4 In "Optimization techniques for the Brazilian natural gas network planning problem", Bruno, Moraes and de Oliveira propose two stage stochastic programming methods for scheduling production, imports, shipping and delivery in the Brazilian gas networks.

5 In "Assessment of Risk-Averse Policies for the Long-term Hydrothermal Scheduling Problem", Larroyd, de Matos and Finardi compare two different approaches for integrating risk measures in long-term hydro scheduling. More specifically they consider a convex combination of CVaR and expectation and compare it with a reservoir risk curve methodology. In their computational experiments, the former approach turns out to give better results.

6 In "Investment and generation optimization in electricity systems with intermittent supply", Zakeri, Wu and Philpott present a Markov decision problem that can be used to model thermal plant operation with intermittent demand, and show how this can be incorporated into a mixed integer programming model for optimally choosing investments.

7 In "On probabilistic constraints with multivariate truncated Gaussian and lognormal distributions", Henrion and Diniz consider certain probability constraints arising when truncating distributions to specific convex sets. They discuss how

truncation impacts differentiability and convexity of feasible sets. The work provides support for integrating such distributions in practical applications.

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