GUEST EDITORIAL PREFACE

Special Issue on Mathematical and Heuristic Modeling and Optimization of Energy Systems, Part 1

N. I. Voropai, Energy Systems Institute, Siberian Branch of the Russian Academy of Sciences, Irkutsk, Russia

Challenging problems in the development of operation and control of modern energy systems require thorough detailed studies. Mathematical and heuristic modeling and optimization of energy systems are a powerful means for these studies. In the current issue the optimization is understood in a broad sense, including linear and nonlinear, continuous and discrete, heuristic and stochastic optimization, etc. At the same time the efficiency of optimization methods highly depends on mathematical and simulation models of the considered energy systems. Hence, another powerful means is a more advanced and sophisticated modeling technique, which takes into account specific features of modern energy systems. Finally, effective mathematical and heuristic approaches should be supported by reliable practical results. Therefore, the current issue is also devoted to testing the suggested methods and corresponding models on real data in order to reveal their advantages and disadvantages.

Originally, the main direction in the studies of Energy Systems Institute, Siberian Branch of the Russian Academy of Sciences, in Irkutsk was the search for the best variants of creation, expansion and operation of complex energy facilities and systems for production of power, heat, oil and oil products, and the whole energy sector. The main tool in these studies is the mathematical and computer modeling and simulation. In order to implement the mathematical and computer models of energy system expansion and operation it is necessary to apply special computational mathematical methods and heuristic techniques. This first part of the special issues of the International Journal of Energy Optimization and Engineering presents some new results in the above mentioned area of studies of Energy Systems Institute.

The paper prepared by N.I. Voropai and V.I. Zorkaltsev gives an overview of the main original optimization models and methods developed at Energy Systems Institute. General

ideas of these optimization models and methods deal with the reduced gradient method, interior point algorithms, method of modified Lagrange function, and cutting-plane algorithms.

The paper by A.S. Apartsyn, S.V. Solodusha and V.A. Spiryaev deals with the elements of theory and applications in the modeling of nonlinear dynamic systems with the Volterra polynomials. The first part of the paper presents an original approach to identification of the Volterra kernels. The approach is based on setting special multi-parameter families of piecewise constant test input signals. The second part is devoted to the Volterra equations of the first kind. The special focus in the paper is on the importance of the Lambert function in the theory of these equations.

The next paper prepared by E.V. Markova, I.V. Sidler and V.V. Trufanov is devoted to the integral models of developing electric power systems. The first part of the paper deals with the problem of optimal control in the area of electric power industry which is described on the basis of a one-sector variant of the Glushkov integral model of developing systems. The second part of the paper is devoted to application of the Prony method to the identification of the Volterra equations in the two-sector models of developing systems. The authors suggest a numerical method for identifying the efficiency function parameters.

The paper by V.A. Stennikov, T.B. Oshchepkova and N.V. Stennikov addresses the issue of optimal expansion and reconstruction of heat supply systems which includes a set of general and relatively specific problems. Therefore, a comprehensive approach to solving these problems is required to obtain a technically admissible and economically sound result. The authors present a mathematical statement of the problems, their decomposition into separate subproblems and an integrated technique to solve them. The application of the developed methodological and computational tools is shown.

New results in the development of a method for optimizing the parameters of heat supply systems and software implementation are presented in the paper prepared by E.A. Barakhtenko, T.B. Oshchepkova, D.V. Sokolov and V.F. Stennikov. The problem of choosing optimal parameters involves determining the diameters of new heat pipelines, searching for the methods to reconstruct existing network sections, and choosing the pressure heads of pumping stations and their sites. To solve this problem the authors suggest a dynamic programming method for optimizing branched networks and a multiloop optimization method for calculating loop networks that are both being developed in the theory of hydraulic circuits.

The paper by V.A. Stennikov, O.V. Khamisov and A.V. Penkovsky is aimed at working out mathematical models and methods to solve the problems of operation of developing heat supply systems in the competitive market environment. A reasonable solution to this problem can make it possible to determine optimal conditions for the operation of the developing heat energy market, and their implementation can increase technical, economic and energy efficiency of heat energy. This problem is solved by using the methods of hydraulic circuit theory, nonlinear dynamic programming, and two-level programming.

Finally, the paper prepared by V.A. Stennikov and I.V. Postnikov deals with the problem of comprehensive analysis of heat supply reliability for consumers. The authors suggest a methodological approach, where mathematical models and methods for nodal evaluation of heat supply reliability for consumers are developed and the studies on the impact of different components of fuel and heat supply systems on its level are described. The mathematical models are based on the Markov random processes of heat energy consumption and some other models.

The above mentioned papers present different areas of research activity of Energy Systems Institute, which relate to different energy industries.

N. I. Voropai
Guest Editor
IJEOE

Nikolai I. Voropai (M'1996, SM'1998, F 2008) is Director of the Energy Systems Institute (Siberian Energy Institute until 1997) of the Russian Academy of Sciences, Irkutsk, Russia. He is also Head of Department at Irkutsk Technical University. He was born in Belarus in 1943. He graduated from Leningrad (St. Petersburg) Polytechnic Institute in 1966 and has been with the Siberian Energy Institute since. N.I. Voropai received his degree of Candidate of Technical Sciences at Leningrad Polytechnic Institute in 1974, and Doctor of Technical Sciences at the Siberian Energy Institute in 1990. His research interests include: modeling of power systems; operation and dynamic performance of large interconnections; reliability, security and restoration of power systems; development of national, international and intercontinental electric power grids. N.I. Voropai is a member of CIGRE, IFAC, IAEE, Fellow Member of IEEE. He is the Chair of WG on Asian and Australazian Electricity Infrastructure of IEEE PES.