
Preface

ΚΑΙ ΟΤΙ ΟΥΤΕ ΕΛΑΧΙΣΤΟΝ ΕΣΤΙΝ ΕΝ ΤΑΙΣ ΑΡΧΑΙΣ ΟΥΤΕ ΤΟ
ΜΕΓΙΣΤΟΝ. ΕΙ ΓΑΡ ΠΑΝ ΕΝ ΠΑΝΤΙ ΚΑΙ ΠΑΝ ΕΚ ΠΑΝΤΟΣ
ΕΚΚΡΙΝΕΤΑΙ, ΚΑΙ ΑΠΟ ΤΟΥ ΕΛΑΧΙΣΤΟΥ ΔΟΚΟΥΝΤΟΣ
ΕΚΠΡΙΘΗΣΣΕΤΑΙ ΤΙ ΕΛΛΑΣΣΟΝ ΕΚΕΙΝΟΥ ΚΑΙ ΤΟ ΜΕΓΙΣΤΟΝ
ΔΟΚΟΥΝ ΑΠΟ ΤΙΝΟΣ ΕΞΕΚΠΡΙΘΗ ΕΑΥΤΟΥ ΜΕΙΖΟΝΟΣ.

ANAXAGORAS OF CLAZOMENAE (499BC - 428BC)

*There is no smallest among the small
and no largest among the large.
But always something still smaller
and something still larger.*

Today, the optimization of production planning processes by means of IT and quantitative methods is a de-facto standard in the energy industry. Franch et al. in Chapter 1 and Ikenouye in Chapter 2 give an introduction, overview, and reasons for this. Furthermore, the energy problem now is not only a challenging one but also one of the most important issues in the world from the political and economical points of view. In every country, the government is faced with the problem of how to adopt the system of ‘Cap and Trade.’ Especially energy consuming industries, such as steel, power, oil and chemicals, are seriously confronted with this problem.

This is also the reason why the German Operations Research Society (GOR) and one of its working groups, held a symposium with the title “Stochastic Optimization in the Energy Industry.” During the 78th meeting of the GOR working group “Praxis der Mathematischen Optimierung/Real World Optimization” in Aachen at Procom GmbH on April 21/22, 2007, the speakers with an application background explained their requirements for stochastic optimization solutions based on practical experiences. The speakers from the research side and the software system suppliers examined different aspects of the whole subject – from the integration of wind energy, the chain of errors in nuclear power plants and the scheduling of hydroelectric power stations, and the risk assessment in trading activities to the various software systems which support stochastic optimization methods.

The symposium offered an interesting overview which reflected the requirements, possibilities and restrictions of “Stochastic Optimization in the Energy Industry.” As the speakers came from all over the world (Brazil, USA, The Netherlands, Norway, Switzerland and Germany) it was also an ideal platform to exchange ideas across countries in the energy sector and beyond.

This book is partly based on the contributions the speakers made to the workshop, but also contains chapters provided by other colleagues. The chapters of the first part of the book give a general introduction to the field. The second part contains deterministic models, while the third part provides methods and applications involving uncertain data. The fourth part includes contributions which focus on pricing.

After opening the European markets for electricity, the energy supply companies expect both new risks and new chances. The ex-ante uncertain market price increasingly determines the amount of their self-generated energy. While the classic unit scheduling objective is the cost-optimal production plan, in liberalized energy markets a holistic examination of the power-station and trading portfolio results in multiple chances to improve the profit situation.

Borisovksy et al. in Chapter 3 consider the problem of constructing trading hubs in the structure of electricity wholesale markets. The nodes of a trading hub are used to calculate a reference price that can be employed by the market participants for different types of hedging. The need for such a reference price is the considerable variability of energy prices at different nodes of the electricity grid at different periods of time. Hub construction is viewed as a mathematical programming problem.

These changes in electric network infrastructure and government policies have created opportunities for the employment of distributed generation to achieve a variety of benefits. Fidalgo et al. in Chapter 4 propose a decisions support system to assess some of the technical benefits, namely, voltage profile improvement, power loss reduction, and network capacity investment deferral, brought through branch congestion reduction.

Bulatov discusses in Chapter 5 three special energy problems which can be solved in polynomial time, exploiting their convexity. These problems are:

Minimal shutdown during power shortages in a power supply system, search for optimal states in thermodynamic systems and optimal allocation of water resources.

The book covers several optimization issues for power plants. Kusiak & Song discuss in Chapter 6 the improvement of combustion processes with application in boiler performance. The modeling of nonlinear processes in nuclear power plant cores is discussed by Yatsenko et al. in Chapter 7. Design optimization of polygeneration energy systems are modeled via mixed-integer nonlinear programs by Liu et al. in Chapter 8 and also by Jüdes et al. in Chapter 9. Mathematical modeling of biomass-based power plants are discussed by Bruglieri & Liberti in Chapter 10 and by Lai et al. in Chapter 11. Electric power systems are considered by Woolley et al. in Chapter 12 and by Chiang et al. in Chapter 13.

Software systems geared to today's market requirements are able to represent the whole portfolio consisting of both generating and trading components. This increases the transparency of the whole planning process. At the same time, risks become apparent and have to be supervised and validated.

Due to increased cost pressure on power generation and trading companies, caused by operating under market conditions, a cost efficient management of the risks becomes more important. As a result of the liberalization of the markets for electrical energy, companies are exposed to higher uncertainties in power generation and trading planning, e.g., the volatility of the prices for electrical energy and for primary energies, especially natural gas. Risks and uncertainties are normally not yet explicitly considered by today's commercial optimization systems. In a deterministic approach, all information is considered to be certain. Actually, there are relative uncertainties in different exogenous factors, e.g., the prices in spot and futures trading, in load forecast, the expected input of wind energy, the water supply and the power stations' availability. However, in the academic world there are a lot of activities on that topic. The contributions of Eichhorn et al. in Chapter 14, Epe et al. in Chapter 15, Heitmann & Hamacher in Chapter 16, Bläsing & Haubrich in Chapter 17, Radziukynas & Radziukyniene in Chapter 18, and Weber et al. in Chapter 19 are all related to risk minimization and stochastic programming.

To derive robust decisions, stochastic optimization operations are suitable for mid- and long-term calculations although they generally take a long time for the computing work. In the electricity industry the observed increases of electricity price dynamics combined with the characteristic periodicity of related decision processes have motivated the use of multistage stochastic programming in recent years to provide flexible models for practical applications in the sector. Especially in power generation and trading, the planning process must obey highly complex interrelations between manifold influences. They range from short term price fluctuations as observed in spot markets to long term changes of fundamental influences. Not only changes in the electric supply system itself must be considered, but also the related availability and costs of required fuels. This is outlined by Frauendorfer & Güssow in Chapter 20.

Another example is the valuation of electricity swing option by Steinbach & Vollbrecht in Chapter 21. The optimization and subsequent hedging of reservoir discharges for a hydropower producer is discussed by Fleten & Wallace in Chapter 22.

This book can be read linearly, from beginning to end. This will give a good overview of how rich the world of energy is for mathematical optimization and especially optimization under uncertainty. The book covers a wide range of techniques and algorithms. Those readers already familiar with the topic are encouraged to visit directly the topics of their interest but we are sure they will also detect many facets of a field which will have a large impact on the future of mankind.

We would like to take this opportunity to thank the authors for their contributions, the referees, and the publisher for helping to produce this book.

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