Modelling, Optimization and Detection

Akademie věd České republiky

MOD workshop

October 26th, 2017

CIIRC, Jugoslávských partyzánů 3,

Praha 6, Dejvice

Energy Day 2017

October 27th, 2017

Czech Statistical Office, Na padesátém 81,

Praha 10, metro A Skalka

Energy Systems Modelling

October 28th, 2017

Czech Technical University, Karlovo nám. 13,

Praha 2, Nové Město

CAAT

contact e-mail

info@energy-workshop.cz

registration, program and other information

www.energy-workshop.cz

EUROPEAN UNION
European Structural and Investing Funds
Operational Programme Research,
Development and Education

General programme

Thursday, October 26th 2017

9:30 – 10:00	Registration
10:00 – 10:10	Opening
10:10 – 13:00	Modelling, Optimization and Detection
13:00 – 14:00	lunch
14:00 – 18:00	Modern trends in mathematical optimization and high performance computing

Czech Technical University, Czech Institute of Informatics, Robotics and Cybernetics, Jugoslávských partyzánů 1580/3, 166 36 Praha 6, Dejvice; GPS N 50°6.23817', E 14°23.67588', metro A Dejvická

Friday, October 27th 2017

8:30 – 9:00	Registration
9:00 – 9:10	Opening
9:10 – 13:00	Energy day 2017: Keynote lectures
13:00 – 13:45	lunch
13:45 – 15:45	Energy day 2017: Round table discussion
15:45 – 16:00	coffee break
16:00 – 16:45	Conclusions of the Round table discussions of Energy day 2015, 2016 and 2017

Czech Statistical Office, Na padesátém 3268/81, 100 82 Praha 10, N50°4.20417', E14°30.47880', metro A Skalka

21:00 – 24:00	Chicago blues (music club Upgrade, Vocílkova 9, Prague 2, optional)

Saturday, October 28th 2017

9:30 – 10:00 Registration

10:00 – 10:10 Opening

10:10 – 14:00 Energy systems modeling II.

14:00 lunch

Czech Technical University, Faculty of Mechanical Engineering, Karlovo náměstí 13, Praha 2, building A, room 312
GPS N 50°4.57418', E 14°25.14200', metro line B station Karlovo náměstí

Modeling, Optimization and Detection

Thursday October 26th, 2016

9:30 Registration

9:50 Opening

RoomA: Stochastic modelling and novelty detection

10:00 Gejza Dohnal and Ivo Bukovský
Change point detection versus novelty detection

10:30 Marek Brabec
Structured statistical modeling for industrial applications

Room A: Market design and security of supply

11:15 Christian Winzer and Frieder Borggrefe
Power to the people: Creating markets for security of supply

11:45 Aaron Praktiknjo
Optimal level of security of supply with growing shares of fluctuating renewable electricity

11:45 coffee break

12.00 Christian Linnemann
TODO

12:30 Thure Traber
Capacity remuneration mechanisms in the integrated european electricity market: Effects on welfare and distribution through 2023

13:00-14:00 lunch

ROOM A: Modern trends in mathematical optimization and high performance computing

14:00 Andreas Grothey
Structured conveying algebraic modelling languages for large scale parallel optimization

14:50 Frieder Borggrefe
Next generation energy modelling - benefits of applying parallel optimization and high performance computing

15:15 coffee break

15:30 Milan Hladík
Interval linear programming

16:15 Michal Černý
The partial identification approach to interval data in statistics

16:45 Miloš Kopa
Stochastic optimization problems with decision dependent randomness - contamination and stress testing

17:15 Hynek Beran
New challenges for applied mathematics in the smart grid control (from the viewpoint of the new needs of Energy 4.0 and system transformation)

17:45 General discussion

Czech Technical University,
Czech Institute of Informatics, Robotics and Cybernetics
Jugoslávských partyzánů 1580/3
166 36 Praha 6 – Dejvice

GPS N 50°6.23817', E 14°23.67588'
metro A station Dejvická

Energy days 2017 – Keynote lectures and round table discussion

Friday October 27th, 2017

9:00 – 9:10 Opening

9:10 – 10:00 Zbyněk Štech, Consumption of fuels and energy in households

10:10 – 11:00 Frieder Borgreffe, Challenges after the EC's winter package: Improving security of supply and efficiency of the European energy system

11:10 – 12:00 Hynek Beran, Transformation of the Czech energy system

12:10 – 13:00 Ron S. Kenett, Data analytics, smart grids and information quality

13:00-13:45 lunch

13:40 – 15:45 Round table discussion

15:45-16:00 coffee break

16:00-16:45 Conclusions of Round table discussions 2015, 2016, 2017

20:00-24:00 underground music

Czech Statistical Office
Na padesátém 3268/81, 100 82 Praha 10

N 50°4.20417', E 14°30.47880'
metro A station Skalka

Energy systems modeling
Saturday October 28th, 2016

9:30 Registration

9:50 Opening

10:00 Florian Noll
Challenges faced by municipalities when pursuing national goals in energy policy

10:30 Irina Rau
Public acceptance in the context of the energy transition - challenge or chance?

11:00 Panos Evangelos, Paul Scherrer and Stavroula Margelou
Modelling the long-term solar PV penetration in single and two-family houses in Switzerland

11:30 coffee break

11:45 Zdeněk Fabián
Information and uncertainty

12:15 Jaromír Antoch
Prediction of electricity consumption

12:45 Eliška Cézová
Modelling pollution over and around open-cut coal mines

13:15 Herr Hildebrand?

13:45 Final discussion, lunch

Czech Technical University
Faculty of Mechanical Engineering
Karlovo náměstí 13, Praha 2
GPS N 50°4.57418', E 14°25.14200'
metro line B station Karlovo náměstí

Book of Abstracts:

Keynote Lectures

Hynek Beran
Transformation of the Czech energy system

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Abstract

Energy system story

The energy system of the Czech Republic, similarly as the energy system of the majority of European countries, has been developed in the period between 50´s and 80´s of the last century, i.e. between the end of WW II and the political changes in 1989. Energy production on both sides of "iron curtain" was a strategic industry providing energy to produce steel, weapons etc. After the political changes the heavy industry has been significantly reduced, however, the surplus in installed capacity of power plans remained. This surplus has been the "physical" origin of market design. Cheap energy enabled rapid development of alternative consumption, e.g. hypermarkets, air conditioning etc. No special measurements for system control in the infrastructure have been taken, the prevailing system up to now is only surplus – market. On the other hand huge market deformation suppressed all natural investment activities. Subsidized renewable and debited fossil resources together on the market compete for variable costs.

Absence of automatization in low voltage power grids

Taking into account the industrial revolution, the power grids downto 22kV did not pass the third industrial revolution (automatization) yet. On the other hand new prosumers (both industrial and buildings) are able to communicate actively with the power system. The system does not accept these new partners because of the "surplus of regulative capacity" of lignite power plants exporting fossil energy produced with very low efficiency (sometimes less than 30%) for low prices (30 downto 20 EUR).

Risks and Challenges of the 20´s

After 2022 significant changes and risk factors are expected:

a) About 40% of fossil power plants will not meet the new European emission limits and will be closed
b) In neighboring Germany all the nuclear power plants will be closed. The power lines from the North from offshore and deep offshore wind power plant will not be ready
c) CZ has two nuclear power plants. The elderly one, Dukovany, needs prolongation of safety certificates after 2025. Both the technological and political situation is not 100% clear.
d) Main renewable energy in CZ is solar. The installed capacity grows up. This energy I unstable and dependent on weather – i.e. requires additional system regulation or storage.

The expected results from the above mentioned situation are:

- ✓ After 2022 or 2025, Czech Republic can have problems with balancing the system on the hourly base. Surplus at noon caused by photovoltaic + nuclear, deficit at morning and afternoon peak.
- ✓ When closing lignite power plants, CZ stops to be and energy exporting country and remains a country with a neutral power export / import balance. The surplus of regulatory capacity / ancillary services on exporting lignite power plants will be significantly reduced.
- ✓ When closing also nuclear power plant, the balance is about minus 20%. No export from neighboring countries can be expected, however, gas turbines can be used.

Need of new system design

This situation is a great challenge to develop new strategy of energy system control based on Energy 3.0 (i.e. automatization in the infrastructure) and Energy 4.0 principles. The main features are:

a) Significant part of the system control must be in the embedded structure cooperating with the central system.
b) In the time of deficit, the system must not provide “rolling blackout”. It should be designed to distribute the energy to intelligent infrastructures, which can regulate themselves, and it has to communicate with their requests, not only to switch them off.
c) The origin of the above mentioned tasks is primarily technological. They are sophisticated control tasks. New methods are to be used for such system (predictive control, multiagent etc.).
d) On the other hand both the legislative rules (unbundling) and the possibility of both market and distribution tariff motivation must be taken into account.

Hynek Beran is specialist in power system control and energy policy. Secretary of the Energy Commission of the Czech Academy of Sciences, head of Workgroup "Knowledge power systems" at Czech Institute of Informatics, Robotics and Cybernetics of the Czech Technical University, founder of the Czech Energy Society. Former secretary of the Independent Energy Commission of the Czech Government. Professional experience in power system control, normative of power system reliability and market design- Participant of the grant „Implementation of the Renewable Energy – security of supply". Business experience in development of EMS, international consulting in Slovakia, Russian central dispatch company and other countries. Today oriented to system stability and transformation using decentral and renewable energy. Professionally interested also in social impact of energy transformation, tariffs, impact on environment and social adequacy.

Frieder Borgreffe
Challenges after the EC's winter package: Improving security of supply and efficiency of the European energy system

German Aerospace Center (DLR)
Frieder.Borggrefe@dlr.de

Abstract
The European winter package was published in November 2016 and laid out the path for future market design of the European Energy system. The impressive piece of proposals written by the European Commission wants to implement a consumer centered electricity market. However the winter package does not propose the endall or final version of the European energy system. In this talk I want to critically discuss the requirements defined by the winter package and the proposed market design.

The presentation outlines the current state of the market design in Europe and evaluates based on scenario based modelling, how the market design could be further improved to become more efficient. The talk outlines model results from the European Energy system model REMix developed at DLR and discusses possible implications of changes in the market design. The presentation will discuss the introduction of market zones and proposals for more efficient markets for security of supply. The presentation also critically discusses the limitations of current energy system models and outlines challenges for energy policy makers.

Frieder Borggrefe works since February 2014 as a researcher in the department of systems analysis and technology assessment in the institute of engineering thermodynamics at the German Aerospace Center (DLR) in Stuttgart/Germany with focus on energy systems analysis. DLR (Deutsches Zentrum für Luft- und Raumfahrt - German Aerospace Centre) is the national

aeronautics and space research centre of the Federal Republic of Germany. Its extensive research and development work in aeronautics, space, energy, transport and security is integrated into national and international cooperative ventures. The Institute of Engineering Thermodynamics (DLR-TT) in Stuttgart, does research in the field of efficient energy storage systems that conserve natural resources, and next generation energy conversion technologies. Within the institute the department for Systems Analysis and Technology Assessment (DLR-TT STB) provides methods and tools which support problem solving in the field of energy related systems analysis and technology assessment. The systems analysis work of the department combines top-down analysis of the overall energy supply system at regional, national and European level with technology oriented bottom-up studies.

Andreas Grothey
Structured conveying algebraic modelling languages for large scale parallel optimization

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Abstract
Algebraic modelling languages (ALM) are an important tool for the formulation of mathematical programming problems resulting in much increased efficiency, error-resistance and ease of use compared with alternatives such as coding evaluating routines for objective and constraint function (and their derivatives) in a high level programming language.

Most ALM only have limited ability to pass the problem structure on to the solver. Typically only sparsity information will be provided, any further block structure will be lost (or has to be recreated after the modelling process). On the other hand modern solvers for large scale problems (such as are common in energy application) invariably only show their true potential when they can exploit the structure of the problem (through decomposition, specialized linear algebra, aggregation techniques in scenario space, etc). It would therefore be beneficial to extends ALM by structure conveying features. In addition large scale problems can only be solved on parallel hardware; in such circumstances the model generation itself may become a bottleneck if performed in parallel. Structure information could enable the parallelization of the model generation phase.

In this talk we will discuss the challenges in designing structure conveying modelling languages and review a few of the implementations that have been proposed.

Andreas Grothey is a Senior Lecturer at the School of Mathematics, University of Edinburgh, Great Britain. His scientific interests are maily in the field of optimization, more precisely:

- Stochastic and mixed integer problems in optimal power flow
- OOPS: Object oriented parallel solver.
- Efficient solution techniques for stochastic programming.
- Parallelisable structure exploiting modelling language.
- Parallelisation of interior point methods on various platforms.

Ron S. Kenett
Data analytics, smart grids and information quality

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ron@kpa-group.com

Abstract
The fourth industrial revolution (Industry 4.0) is raising the bar of data analytics. Smart grids are an essential element of the factory of the future and combining data from sensors with flexible manufacturing technologies is an essential capability required for achieving sustainability and efficient energy management. A paper dealing with analytic challenges in the context of Industry 4.0 can be found in https://ssrn.com/abstract=3003830. The talk will review the role of smart grids in smart manufacturing, will review a smart grid maturity ladder and present the role of analytics in going up this maturity ladder. Throughout, the framework on information quality will used to structure the discussion. For more in information quality see Information Quality (InfoQ): The Potential of Data and Analytics to Generate Knowledge.

Ron Kenett is Chairman of the KPA Group, Israel, Senior Research Fellow at the Neaman Institute, Technion, Haifa and Visiting Professor at the School of Medicine of the Hebrew University of Jerusalem, Israel. He is an applied statistician combining expertise in academic, consulting and business domains. Ron is Past President of the Israel Statistical Association (ISA) and of the European Network for Business and Industrial Statistics (ENBIS). He authored and co-authored over 250 papers and 12 books on topics such as biostatistics, healthcare, industrial statistics, data mining, customer surveys, multivariate quality control, risk management and integrated management models. The KPA Group, he founded in 1994, is a leading Israeli firm focused on generating insights through analytics with a wide range if customers including hp, Unilever, the Israel aeronautics Industry, Elbit, Stratasys and Applied Materials. He is editor in chief of Wiley's StatsRef, serves on the editorial board of several international journals and was awarded the 2013 Greenfield Medal by the Royal Statistical Society in recognition for excellence in contributions to the applications of Statistics. He is member of the National Public Advisory Council for Statistics Israel and member of the Executive Academic Council, Wingate Academic College.

Zbyněk Štech
Consumption of fuels and energy in households

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Abstract
Households sector is a major contributor to GDP. Fuel and energy consumption is an essential part of household consumption. Taking available data sources into account the Czech Statistical Office carried out a household survey. To this end, the Czech Statistical Office had, in the past, carried out two surveys focused on the consumption of fuels and energy in households. "Energo 2015" is now the third and most recent survey focusing on this topic. The surveys aimed at fuel consumption and energy consumption in households are by their very nature unique, as there had been no specific surveys of the households' fuel and energy consumption until the 1990s. The main goal the household survey Energo 2015 was to obtain information on the current distribution of consumption of individual types of fuels and energy in households for specific end-uses. It was necessary to create completely new questionnaires, survey methodology and method to divide specific fuels into individual uses. The Energo 2015 survey serves as an important source of information and the results have been used for many other national and international statistics.

Zbyněk Štech has been with the Czech Statistical Office since 2014 in the Industrial, Construction and Energy Statistics Department, where his work focuses on statistics of consumption of fuels and energy in households.

Contributed presentations

Jaromír Antoch

Electricity consumption prediction

Charles University, Faculty of mathematics and Physics, Prague, Czech Republic
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A functional linear regression model linking observations of a functional response variable with measurements of an explanatory functional variable is considered. The model serves to analyze a real data set concerning electricity consumption in Sardinia. Data set consists of 52 584 values of electricity consumption collected every hour within the period from January~1, 2000, till December 31, 2005. The complete data series has been cut into 307 weeks for which the weekdays (Monday to Friday) and the weekends (Saturday and Sunday) have been separated. The reason for such a separation leading to two sets of discretized electricity consumption curves rests in the fact that we observe important differences between weekdays and weekend consumptions. The main interest lies in predicting either oncoming weekend or oncoming weekdays consumption curves if present weekdays consumption is known. In both cases, the (functional) predictor is the (discretized) curve of present weekdays consumption.

Frieder Borggrefe

Next generation energy modelling - benefits of applying parallel optimization and high performance computing

German Aerospace Center, DLR, Germany
Frieder.Borggrefe@dlr.de

Quantitative energy system modelling based on primarily linear mathematical optimization provide a basis to answer political, technical, and economic questions regarding the future development of electricity systems. In order to capture the complexity of future decentralized electricity system, models are required to become increasingly complex. This presentation outlines how high performance computing (HPC) can be applied to energy system modelling and describes challenges and benefit that arise when complex energy models based on linear and non-linear algorithms are applied to parallel computing.

The presentation draws on results from the project BEAM-ME funded by the German Federal Ministry for Economic Affairs and Energy. The research project aims at improving computational performance of energy system models. Within this project the

consortium of researchers from different research fields (system analysis, mathematics, operations research and informatics) develop new strategies to increase computational performance of energy system models and to apply energy system models to high performance computing.

This presentation presents intermediate results from a benchmark analysis when applying the energy system model REMix to HPC. The presentation concludes with a discussion on future challenges for energy system modelling and how HPC can enable energy modelers to improve scenarios, market design and policy advice.

Marek Brabec
Structured statistical modeling for energy applications

Czech Academy of Sciences, Institute of Computer Science, Prague
mbrabec@cs.cas.cz

We will discuss several statistical models of regression type, useful in modern energy applications. In particular, we will consider a problem of statistical calibration of numerical weather prediction (NWP) models to remove complicated spatio-temporal sructure of raw NWP biases. As we will show, additional motivation for a structured semiparametric approach comes from the fact that physically interpretable components of the statistical model can help understanding errors in NWP inputs and dynamics.

Eliška Cézová and Jaromír Antoch
Modelling pollution over and around open-cut coal mines

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Important part of the Czech electricity is produced since almost 70 years in coal power plants, most of them located in NW of the Czech Republic typically very close to the open-cut coal mines. In this lecture we will concentrate on the analysis of the pollution due to the PM10 particles caused by the extraction. Based on the analysis of the data covering basic meteorological characteristics as well as pollution measured during 2012-2014, we can conclude that an impact of the complex terrain on passive pollutant dispersion with respect to the prevailing wind direction is important. The results also reveal that not only cavity shape and deepness, but also the surroundings orography has in uence on the ow patterns, hence on ventilation, within the area of interest.

Michal Černý

The "partial identification" approach to interval data in statistics

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In our lecture we will concentrate on the partial identification' approach to interval data in statistics. First we summarize some results on elementary statistics in the univariate case, such as variance or t-ratio. We will show that while some tasks are solvable efficiently by interior point methods, another form an NP-hard problem. Nevertheless, we will show that under suitable assumptions some special cases can still be computed efficiently, and that the assumptions are not excessively restrictive.

Then we turn our attention to the multivariate setup. As an example we consider regression with interval-valued dependent variable y and real-valued regressors. We define a class of set-estimators of regression parameters, called zonotope estimators, as a generalization of the class of linear estimators in linear regression models. We derive asymptotic bounds for their limit identification regions. We will also discuss the role of further assumptions on the distribution of dependent variable with additional identification power. For example, imposing a lower bound on the conditional variance of y given the lower and upper bounds can result in tighter limit bounds, and thus more precise estimates.

Gejza Dohnal, Ivo Bukovský

Change point detection versus novelty detection

Czech Technical University, Prague, Czech Republic
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Abstract:
In statistical process monitoring, procedures are applied that require relatively strict conditions for their use. If such assumptions are violated, these methods become inefficient, leading to increased incidence of false signals. The most often, we try to use a classical approach based on maximum likelihood ratio. The most limiting assumptions are both independence of observations and knowledge of probability distributions of monitored variable. Both are limiting in most real situations. There are several type of problems: first, the classical one, when we are looking for time of change of some process characteristics, knowing probability distributions both before and after the change. Second, we have known classification of process states and based on observations, we decide which of them is actual and when the change happened. Third, we try to detect a time when some new, still not-known behavior of the process occurs. While the first and second case we known as "change-point problem", the third type of problems are addressed as "anomaly" or "novelty" detection.

Panos Evangelos and Stavroula Margelou

Modelling the long-term solar PV penetration in single- and two-family houses in Switzerland

Paul Scherrer Institute, Villigen, Switzerland and Swissgrid AG, Laufenburg, Switzerland
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Abstract
Roof-top solar photovoltaics (PV) display a significant potential in electricity generation in Switzerland (up to 20 TWh/yr. or one-third of the current Swiss electricity consumption), but their market penetration is still low. In view of the Swiss Energy Strategy that foresees a significant increase in solar PV power by 2050, we investigate the decision to adopt solar PV at residential buildings. We develop an agent-based model, with each agent being a single- or two- family house located in a Swiss canton, to simulate how different policy support levels, technology learning rates, electricity price levels and private investor's discount rates affect the decision to invest in solar PV. We consider as agents single and two-family households, for which the choice to adopt a solar PV system depends on the economic profitability of the investment, on agent's income, on anticipated by the agent environmental benefits and on impact from social networks. A synthetic population of agents is created, statistically equivalent to the actual population, by applying Monte Carlo sampling on probability distributions fitted to data from Swiss administrative registers. Our analysis shows that the economic profitability stimulates the diffusion of solar PV investments till the year 2030. At the later periods, social (peer) effects become essential in unfolding the diffusion process.

Zdeněk Fabián

Information and uncertainty

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ABSTRACT

What amount of information carries one item taken from a continuous distribution (relative to other possible values)? What is the mean information of a continuous distribution? The statistical notion, Fisher information, carries information about a parameter involved only. As mean uncertainty is usually considered the continuous equivalent of Shannon's entropy, the differential entropy. However, its value can be negative! Does it have any sense? Is it eligible to extrapolate theory developed for discrete models to continuous models with infinite support? In our contribution we provide unexpected solution: Mean information of continuous models is extended Fisher information, mean uncertainty is its reciprocal value.

Milan Hladík

Interval linear programming

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ABSTRACT

We consider a class of linear programming problems with coefficients varying inside given intervals. These intervals represent some kind of uncertainty of obtaining exact values, which can be caused by inexact measurements, missing data, discretization errors or some incomplete information. In contrast to other well-known approaches (stochastic or fuzzy programming), in interval analysis we need to take into account all possible realizations of interval values and determine rigorous answers (in the form of bounds on optimal values and optimal solutions, or in the form for certifying some problem characteristics).

In our presentation, we consider a few of problems arising from data uncertainty. First, we discuss the effect of perturbations on the optimal value. In particular, we focus on the range of possible optimal values. The next important, but also the most challenging, problem of determining the optimal solution set. This set is defined as the union of all optimal solutions under all realizations of the intervals. We present some new results on the topological properties of the optimal solution set and its approximation. Both problems (optimal value range and the optimal solution set) can be solved easily provided there is an optimal basis common to all realizations of interval data. Therefore, we address the problem of basis stability in our presentation, too.

Florian Noll
IZES gGmbH, Saarbruecken, Germany

Challenges faced by municipalities when pursuing national goals in energy policy

Municipalities are key actors of energy transition as they combine several functions, which are important for the implementation of national energy policies. Among other things, they are formally responsible for land usage and development planning processes as well as for approval procedures concerning the construction of renewable power and heat generation systems. In addition, especially their function as mediator between the interests of regional and local actors is decisive for the acceptance of local measures. Although the European and national goals in energy policy need to be implemented locally supported by local government policies, energy transition is so far a voluntary municipal task, which leads to additional burden for the administration and politics. The paper shows the consequences of these circumstances describing the diverse municipal

strategies in dealing with the national goals in energy policy and the challenges local politicians face in this context. Derived from that, the paper also demonstrates the implications for the realization of national energy policies.

Miloš Kopa

Stochastic optimization problems with decision dependent randomness - contamination and stress testing

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ABSTRACT

Stochastic optimization problems typically assume that the random element is exogenous. However, in some recent applications we observe that the random element may be endogenous, that is, it may depend on the decision. These problems are usually difficult to formulate and solve in practice.

In this paper, we deal with several types of stochastic problems with decision dependent randomness. We focus on reformulations and solution techniques of these problems. The obtained optimal solutions are then carefully analyzed as well. We present output analysis, robustness, and stress testing with respect to uncertainty or perturbations of input data for these stochastic optimization problems. Applying the contamination techniques, we present lower and upper bonds for optimal value function for several different decision dependent randomness problems.

Thure Traber

Capacity remuneration mechanisms in the integrated european electricity market: Effects on welfare and distribution through 2023

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Proposals of different Capacity Remuneration Mechanisms (CRMs) to respond to capacity adequacy problems in liberalised electricity systems are frequently considered on national and European level. I present a partial equilibrium model of a CRM that induces hourly scarcity-pricing of capacity (RM) and compare results for the interconnected markets of Germany, France and Poland with those computed for two conventional CRMs that are imposing capacity targets on a yearly basis, i.e. a strategic

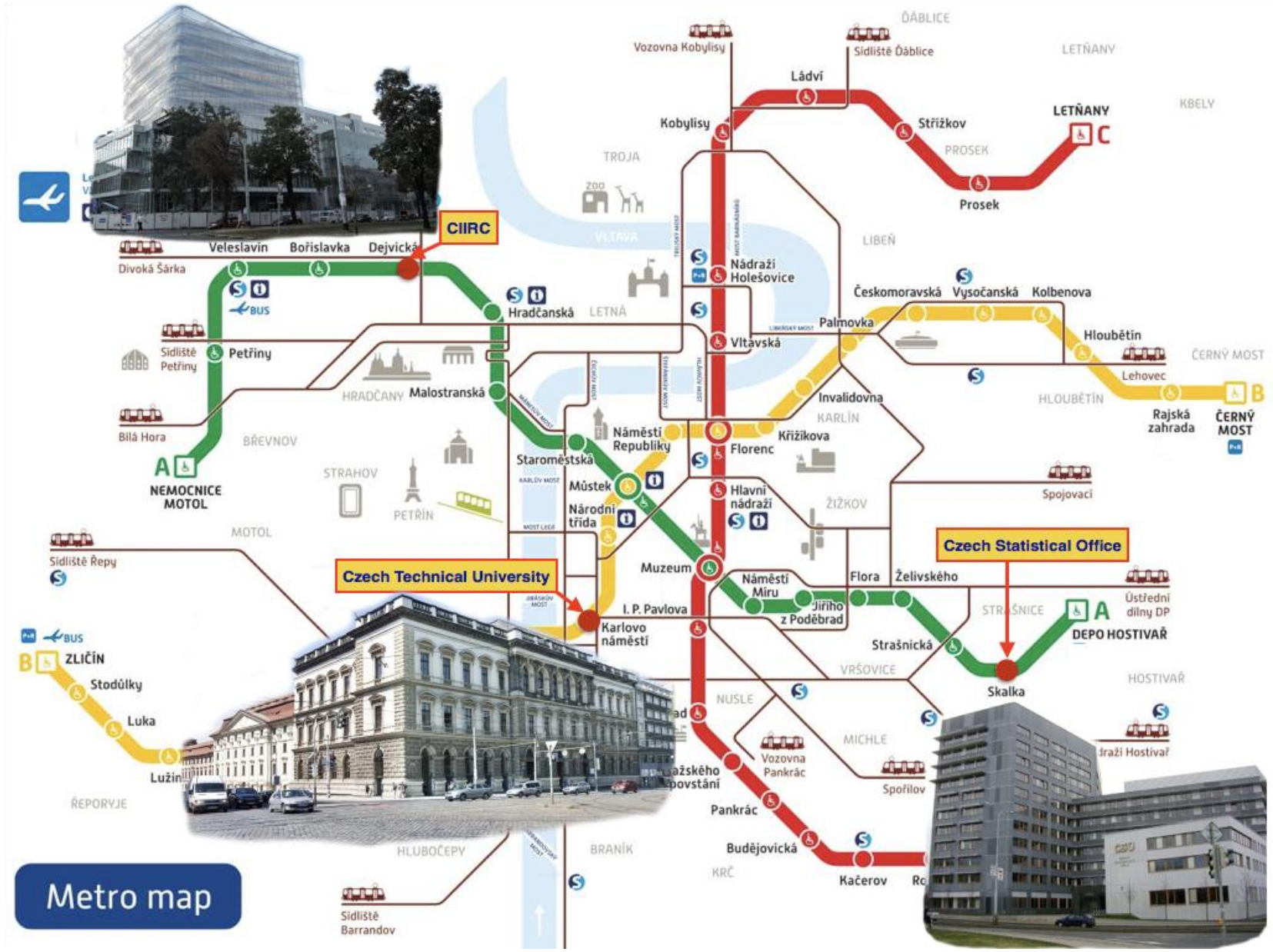
reserve (SR) and a capacity market (CM). I find a saving of costs to the society for the RM-solution in the medium term and favourable results for consumers also on the long run. The results are discussed in view of regulatory options to minimize the potential costs of power interruptions and the possible role of smart metering and decentralised energy contracts.

Christian Winzer and Frieder Borggrefe

Power to the people: Creating markets for security of supply

Switzerland and German Aerospace Center, DLR, Germany
Frieder.Borggrefe@dlr.de

One of the root causes behind many of the distortions in today's electricity markets is that short term security of supply is a good without a market as curtailments are typically not priced based on consumer preferences. Consumer choice of reliability levels is thus replaced with administrative reliability targets and adequate investment needs to be guaranteed through capacity mechanisms and emergency plans, distorting dispatch, investment and innovation incentives instead of relying on market signals. As an alternative approach, this paper proposes to enhance electricity markets by including curtailment bids from all end consumers in the energy market and offer grid tariffs for different reliability levels.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Sponsors

The workshop and round table session are supported by the Czech Academy of Sciences within the framework of the research program *Strategie AV21*, grant GAČR P403/15/09663S, European project COST, Action CA 15109, Czech Technical University in Prague, Charles University, Czech Statistical Office and Czech Statistical Society.

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PENDING ABSTRACTS

Aaron Praktiknjo

Optimal level of security of supply with growing shares of fluctuating renewable electricity

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Public acceptance in the context of the energy transition - challenge or chance?