ENERGY DAYS 2025

Network Modeling: Current Trends in Stability, Reliability, and Optimization

Thursday 6th November 2025
Charles University, Fac. of Mathematics and Physics
Malostranské nám. 2/85, Praha 1; metro A : Malostranská

Friday 7th November 2025
Czech Statistical Office
Na padesátém 81/3268, Praha 10; metro A : Skalka
Czech Cultural Institute, Nekázanka 16, Prague 1
Praha 1; metro A

Saturday 8th November 2025
Czech Technical University, Fac. of Mechanical Engineering
Karlovo nám. 13, Praha 2; metro B : Karlovo náměstí

Akademie věd České republiky

STRATEGY AV21
Top research in the public interest

FENStatS
Federation of European National Statistical Societies

Eustat

ČESKÝ STATISTICKÝ ÚŘAD

Schedule and abstracts as of November 6, 2025

Thursday, November 6, 2025

18:30 – 21:00 Visitation to MFF UK and opening Get-Together
Charles University, Faculty of Mathematics and Physics, Malostranské nám. 2/85, Praha 1
metro A : Malostranská + 1 stop by tram or 5 minutes' walk

Friday, November 7, 2025

Registration at the Czech Statistical Office starts at 8:30
8:45 – 9:00 Opening
9:00 – 13:00 Invited and contributed lectures
13:00 – 14:00 lunch
14:00 – 17:00 Invited and contributed lectures
19:00 – 21:00 Evening discussion at Czech Cultural Institute

Czech Statistical Office, Na padesátém 81/3268, 100 82 Praha 10
metro A - Skalka

Czech Cultural Institute, Nekázanka 16, Prague 1
metro A – Můstek

Saturday, November 8, 2025

Registration starts at Czech Technical University at 8:30
9:00 – 9:05 Opening
9:05 – 13:00 Contributed lectures, discussion

Czech Technical University, Faculty of Mechanical Engineering, Karlovo náměstí 13, Praha 2
metro line B - Karlovo náměstí

Jaromír Antoch

Predikce spotřeby elektřiny (Electricity consumption prediction)

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V přednášce bude uvažován funkcionální lineární regresní model, sloužící k analýze reálné datové sady popisující spotřebu elektřiny na Sardinii, která obsahuje 52 584 hodnot spotřeby elektřiny, která byla zaznamenávána společností ENEL každou hodinu během šesti let. Kompletní datová řada byla rozdělena do 307 týdnů, u kterých byly odděleny dny v týdnu (pondělí až pátek) a víkendy (sobota a neděle). Důvodem pro toto dělení, které vedlo ke dvěma sadám diskretizovaných křivek spotřeby elektřiny, je skutečnost, že lze dle očekávání pozorovat významné rozdíly mezi spotřebou ve všedních dnech a víkendech. Hlavním cílem je predikce křivek spotřeby jak pro nadcházející víkend, tak pro nadcházející pracovní dny, pokud je známa spotřeba v současném týdnu.

A functional linear regression model linking observations of a functional response variable with measurements of an explanatory functional variable will be considered. The model serves to analyze a real data set concerning electricity consumption in Sardinia, consisting of 52 584 values of electricity consumption collected every hour. 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 is because we observe important differences between weekdays and weekend consumptions. The main interest lies in predicting both oncoming weekend and oncoming weekdays consumption curves if present weekdays consumption is known.

Jaromír Antoch is professor of statistics at the Charles University of Prague. He is interested in simulations, robust statistics, change point detection and applied statistics. He served, among others, as President of the International Association for Statistical Computing, member of the Council of the International Statistical Institute, President of the Czech Statistical Society, etc.

Sylwia Bialek-Gregory

Economics of grid regulation: Insights from Germany

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Engineering studies offer valuable insights into the design and operation of optimal power systems, encompassing cost-efficient, risk-minimizing strategies for power grid investment, operation, and maintenance. Yet, in practice, the decisions made by key grid stakeholders often diverge from what would be considered socially optimal. In my presentation, I take an economic perspective, exploring the regulatory frameworks and incentive mechanisms required to align individual decision-making with broader societal objectives, ensuring an efficient and resilient power grid. The presentation is grounded in current German debates concerning electricity market design, policy reforms, and regulatory innovations. I discuss the recent changes in the Energy Industry Act as well as the regulatory reform initiated by Federal Network Agency (Bundesnetzagentur) to understand what framework is needed to prepare the power infrastructure for a low-carbon future.

Sylwia Bialek-Gregory is a PhD economist working on the questions around energy systems as well as environmental regulations. She is currently the Executive Manager Research & Consulting at the Institute of Energy Economics at the University of Cologne (EWI). In this role, she is jointly responsible with the Executive Manager Commercial for the strategic and academic development of the Institute. Before joining EWI, she served as the Head of Unit at the scientific staff of German Council of Economic Experts. She also worked at the Institute for Policy Integrity at New York University, first as a postdoctoral researcher and later as an economist. Her research focuses on the optimal design of electricity markets as well as the economic assessment of policy instruments.

Ivo Bukovský, Moritz Sontheimer, Vladimír Malý

Digitální dvojče a predikce výkonu solárního systému – dílčí výsledky studie

Czech Technical University in Prague, Faculty of Mechanical Engineering, Prague, Czech Republic;
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Prezentace představí dílčí poznatky z aplikace digitálního dvojčete založeného na neuronových modelech pro sledování a predikci výkonu fotovoltaických systémů v porovnání s jednoduššími prediktivními neuronovými modely. Studie ukazuje, že vysvětlitelné neuronové modely mohou spolehlivěji předpovídat solární výkon ve složitém prostředí a tím přispívat k efektivnějšímu a udržitelnému řízení energie.
Digital Twin and Solar System Power Prediction – Preliminary Study Results

The presentation introduces preliminary findings from the application of a digital twin based on neural models for monitoring and predicting the performance of photovoltaic systems, compared with simpler predictive neural approaches. The study shows that explainable neural models may provide more reliable solar power forecasts in complex environments, contributing to more efficient and sustainable energy management.

Ivo Bukovský is an associate professor at the Czech Technical University in Prague. He focuses on adaptive novelty detection via learning entropy, adaptive algorithms and neural networks for complicated dynamic systems and signals, multi-scale analysis approaches to signal processing and

dynamic systems, time series analysis and prediction, nonlinear adaptive control and fuzzy-logic rule-based systems for modeling and evaluation of complex dynamic systems

Eliška Cézová
Optimalizace a snižování spotřeby energií

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V současnosti se optimalizace využívá ve snaze maximálně zefektivnit procesy či výrobu. Důraz je kladen zejména na hospodárnost návrhu projektů, aby došlo k co největší úspoře materiálu a maximálnímu využití pevnostních charakteristik prvků na jedné straně, snížení zatížení životního prostředí díky snížení spotřeby neobnovitelných surovinových a energetických zdrojů. V přednášce se soustředím na vybrané optimalizační postupy, jež současné počítače pro tento účel nabízejí.

Currently, optimization is used to maximize the efficiency of processes or production. Emphasis is placed primarily on the economy of project design to achieve the greatest possible savings in material and maximum use of the strength characteristics of elements on the one hand, and to reduce the burden on the environment by reducing the consumption of non-renewable raw materials and energy resources. In the lecture, I will focus on selected optimization procedures that current computers offer for this purpose.

Eliška Cézová is assistant professor at the Czech Technical University in Prague. She is specialized in statistical process control and metrology.

Gejza Dohnal
Stabilita IPLNA prediktoru založeného na neuronové síti (Stability of IPLNA predictor based on neural network)

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Tato prezentace se zabývá stabilitou adaptivního prediktoru obecně nelineárního stochastického modelu, který je však lineární v parametrech (In Parameter Linear Nonlinear Architecture, IPLNA) založeného na HONU (High Order Neural Unit) a včasnou detekcí změn chování stochastických systémů v průběžném (on-line) řízení. Sledovaný stavový proces je obecně nelineární a nestacionární, což omezuje použitelnost klasických metod a vyžaduje identifikaci deterministické složky. Stabilita prediktoru je klíčovou vlastností. Ukazuje se, že v případě adaptivního prediktoru

využívajícího metodu gradientního sestupu (gradient descent) nejsou splněny podmínky pro klasickou Ljapunovovu stabilitu, ale lze zaručit jiné typy (marginální) stability.

This presentation addresses the stability of an adaptive predictor for a generally nonlinear stochastic model that is linear in the parameters (In-Parameter Linear Nonlinear Architecture, IPLNA) based on the High-Order Neural Unit (HONU), as well as the early detection of changes in the behavior of stochastic systems under continuous (online) control. The monitored state process is in general nonlinear and nonstationary, which limits the applicability of classical methods and necessitates identification of the deterministic component. Predictor stability is a key property. It is shown that for an adaptive predictor employing the gradient descent method, the conditions for classical Lyapunov stability are not met; however, other forms of (marginal) stability can be guaranteed.

Gejza Dohnal is professor at the Czech Technical University in Prague. He specializes in statistical process control, reliability, quality control, and statistical applications. He successfully leads many large projects, let us mention REQUEST among others.

Jakub Dostál

Co brání efektivními využití flexibility z domácích baterií

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Příspěvek se zaměřuje na to, co brání efektivnímu využití flexibility z domácích bateriových úložišť. Popisuje, jak může fungovat moderní dům vybavený solární elektrárnou a bateriovým systémem tak, aby majiteli pomáhal snižovat náklady na energii. Text přibližuje celý technologický řetězec zodpovědný za řízení toků elektrické energie – od střídače, přes řídicí jednotku, tržní mechanismy a komunikaci s členy skupiny sdílení energie, až po výslednou fakturaci elektřiny. Zvláštní pozornost je věnována problematickým částem tohoto řetězce, zejména pestré škále střídačů a rozdílným nárokům na rozhodovací algoritmy.

Jakub Dostál takes care of the development and research of technologies needed for aggregation flexibility. He cooperates with the Department of Applied Mathematics of the Palacký University in Olomouc, where he obtained the necessary skills on several research projects and experience with advanced mathematical and statistical methods. In the long run he deals with Bayesian methods, machine learning and artificial intelligence focusing on energy.

Petr Dušek
Český blackout v řeči čísel (Czech blackout in numbers)

Během přednášky se pokusím podat analytický pohled na největší energetikou způsobený výpadek elektřiny v moderních dějinách Česka. Řekneme si také o vybraných serverech, na nichž lze bezplatně získat kvalitní energetická data, jež lze použít pro studijní účely, studentské kvalifikační práce apod.

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Zdeněk Fabián
Nejistota a informace (Uncertainty and information)

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V přednášce se zaměřím se na klíčový statistický problém, a to na to, jaké množství informace nese náhodný výběr ze spojitého rozdělení, a jak tuto informaci měřit.

I will concentrate on the key statistical problem, namely, what amount of information carries a random sample taken from a continuous distribution, and how to measure its information.

Zdeněk Fabián is scientific worker emeritus at the Institute of Computer Science of the Czech Republic. He specializes in information theory, modelling uncertainty and the use of artificial intelligence in data analysis and modelling.

Christoph Graf
Iberian Peninsula blackout: A Trade-off between operational risk and consumer cost

Stanford University, Energy and Sustainable Development Program, and New York University, Institute for Policy Integrity, USA
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Ensuring sufficient energy availability to meet demand-while operating resources within their own physical constraints and those of the grid-is fundamental to the secure and reliable functioning of any power system. Under the European short-term wholesale market design, system operators must reactively adjust (redispatch) market schedules originating from an assumed unconstrained ("copper plate") network. This sequential market-clearing approach can complicate real-time operations and may increase the operational risk. We perform an event study analysis using hourly market and system data from 2019-2025. We find that after the 2025 Iberian Peninsula Blackout the Spanish system operator responded by prioritizing reliability, procuring greater volumes of gas-fired generation and reducing anticipated real-time output from wind and solar resources. However, this more conservative approach to operational risk, focused on ensuring secure and reliable real-time operations, has also led to higher redispatching costs.

Christoph Graf is an expert in energy economics, navigating the intersection of economics, law, engineering, and operations research. Dr. Graf's research delves into the intricacies of electricity market designs within the context of the ongoing energy transition, while also tackling the complex issue of market power within capacity-constrained transmission networks. He currently serves as a Research Scholar at the Institute for Policy Integrity at New York University and a Research Affiliate in the Program on Energy and Sustainable Development at Stanford University.

Jakub Linda a Veronika Tóth
Trajectories of sustainable energy use and supply of woody biomass in Slovakia for 2025–2050

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The European Union aims to achieve energy security, self-sufficiency, and carbon neutrality, with forest biomass playing a significant role in the Slovak context. Biomass accounts for more than 60% of renewable energy production in Slovakia and is primarily used in households and the pulp and paper industry. Driven by the EU Bioeconomy Strategy, nature conservation targets, and climate neutrality goals, forests and woody biomass in Slovakia are increasingly under pressure. This pressure is further intensified by bark beetle outbreaks and other natural disturbances, making the estimation of available energy biomass a key challenge for sustainable resource management. Forest growth modelling using the SIBYLA software indicates that annual timber harvests will range between 7.5 and 9.2 million m^3 by 2035, corresponding to projected demand. However, a major challenge lies in the changing structure of assortments a decline in coniferous and an increase in low-quality broadleaf species. Biomass consumption is expected to remain around 15 TWh by 2035, with its availability influenced by the application of the cascading principle, which may reduce its energy potential by 30–37%. The key challenge is to align industrial demand with the evolving wood assortment structure and to introduce measures

for monitoring wood flows, investing in efficient technologies, and regulating sustainable use. Under these conditions, biomass can contribute to the energy transition without compromising forest.

Lubomír Lízal
Macroeconomic Costs of the Energy Transition in the Czech Republic

Czech Technical University, Prague, Czech Republic & VŠFS Praha
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In this lecture we estimate the direct macroeconomic costs of the proposed electric energy mix change in the Czech Republic. We augment the physical electric energy balance model with seasonally (monthly adjusted) estimated hourly average electric prices to show the economic difference between the yearly energy balance and import costs due to seasonal price patterns. This simple economic model is then applied on proposed future energy mix stemming from State Energy Policy (SEK). We show that this change in production mix leads to an increase in net imports that are comparable to the value above 0.5% GDP. As imports are the factor reducing GDP and we do not consider the economic multipliers in the direct impact, we can safely conclude the GDP shall fall more due to the neglected multiplication. When considering also the fiscal multiplier the total impact shall be around 1% GDP, annually.

Lubomír Lízal is a Czech economist, a member of the Bank Board of the Czech National Bank from 2011 to 2017. He is a member of several expert committees and scientific councils. He also served on the Supervisory Board of the energy company ČEZ. He lectures at the Faculty of Electrical Engineering of the Czech Technical University in Prague and at the University of Finance and Administration in Prague.

Valerio Piersimoni
Time series forecasting for electrical demand

Cellforce Group GmbH, Porsche Group, Germany and Czech Technical University in Prague, Faculty of Mechanical Engineering

Rising electrification and variable renewable generation place high demands on accurate and reliable load forecasts. This talk presents four case studies of electricity demand prediction on a real 5-minute dataset (CAISO/NREL) with exogenous variables (weather, PV/wind output) and a focus on uncertainty quantification. We combine LSTM architectures with Bayesian learning (SVI with Trace ELBO) to deliver not only point forecasts but also confidence intervals to support system operators and resource planners. We demonstrate one-step and 12-step-ahead forecasts (including a

15-minute aggregation variant) and summarize achieved metrics. We also discuss data requirements and practices that prevent information leakage between training and test sets.

Valerio Piersimoni works in Cellforce Group GmbH, Porsche Group, Germany, as process engineer.

Florian Sobieczky
Learning Physical Laws with AI

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Physical laws are typically formulated in the form of differential equations. To discover new physical effects, it is therefore usually necessary to describe them by incorporating the well-known ambient physical theory and leaving room for modeling additional, often small, but discrepant anomalous observations. Several modern approaches to 'Science Informed AI' have recently been developed to 'learn PDEs', such as SINDY, PINNs, Lagrangian NNets, and PIRL. After giving a short overview of such ideas, we show that even with (by now) conventional Machine Learning Techniques, it is possible to 'extract' physical knowledge from experimental data by using a hybrid model approach for applying AI (only) to the physical perturbation of the known knowledge domain. For physical laws described by a time-dependent linear ordinary differential equation, we present a method to learn the inhomogeneous term correcting the homogenous solution which describes the known physical effects.

F. Sobieczky, E. Dudkin, J. Zenisek, Learning the inhomogeneous term of a linear ODE, Proc. Comp. Science, Vol. 232, 2024, pp. 1548-1553, https://doi.org/10.1016/j.procs.2024.01.15

Florian Sobieczky is a senior researcher in the Data Science Lab at the Software Competence Center Hagenberg focusing on Machine Learning for Fault Detection. His research is in probability theory, particularly discrete stochastic processes. The projects at SCCH to which he is typically contributing are related to the statistics of production processes, fault detection, anomaly diagnosis and predictive maintenance. In the context of Explainable Artificial Intelligence is involved in the project on *Interpretable Artificial Intelligence Corrections*, with the aim of delivering explanations of the predictions of high performing machine learning methods for which AI acts as a "corrector" on top of the predictions of the classical model.

Vladimír Wágner

Současný stav a budoucnost jaderných technologií

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V přednášce rozebereme, v jakém stavu jsou různé jaderné technologie a jaká je může čekat budoucnost. Řekneme si o přechodu k reaktorům III. generace, jaké mám typy malých modulárních reaktorů, a kdy je šance, že se do komerční nabídky dostanou ty klasické a ty pokročilé. Pro uzavření palivového cyklu potřebujeme rychlé reaktory IV. generace, podíváme se jaké je situace v této oblasti, a také o možnostech využití thoria. V České republice se podařilo v jaderné oblasti pokročit, tak si řekneme i o situaci zde.

Vladimír Wágner joint Nuclear Physics Institute of CAS just after ending of his university studies of nuclear physics on Faculty of Mathematics and Physics of Charles University. He was member of group which studied nuclear structure using nuclear spectroscopy methods up to 1990 and now he is member of Relativistic Heavy Ion Group. He made his diploma and Ph.D. thesis dealing with a structure of deformed nuclei at this institute. Presently he is studying mainly hot and dense nuclear matter. Such matter is for example inside neutron stars or is produced during supernovae explosion. Small volume of such matter is possible produce by collision of heavy nuclei accelerated to the very high energy (nucleus velocity near to the velocity of light). He is involved also to the studies of possible application of relativistic proton reaction with thick target for neutron production and using of obtained neutron field for transmutation of radioactive waste.

Local Organizing Committee

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contact email — info@energy-days.cz/
registration, program and other information — https://energy-days.cz/

Strategy AV21

Top research in the public interest is the motto of the strategy of the Czech Academy of Sciences, which presents itself more strongly as an institution whose primary mission is high quality research focused on the problems and challenges faced by contemporary society. Topics such as the **future of energy in the Czech Republic**, public health or the quality of public policies involve complex sets of problems, the solution of which requires broad-based interdisciplinary research. The Czech Academy of Sciences has therefore adopted Strategy AV21 based on a set of coordinated Research Programs utilizing interdisciplinary and inter-institutional synergies to identify the problems and challenges of our time and to harmonize the efforts of research institutes of the Czech Academy of Sciences towards their solutions.