University of St.Gallen

Institute for Operations Research
and Computational Finance

Annual Report 2022

Institute for Operations Research and Computational Finance

From insight to impact.

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Organization

The Institute for Operations Research und Computational Finance adjusts its structure to the requirements and opportunities in research, business, and teaching. The interdisciplinary development and application of mathematical optimization unites the team. The diverse backgrounds, on the other hand, enrich the perception of and approach to the tasks.

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I The Institute

Within the University of St. Gallen, the ior/cf-HSG is part of the School of Finance and offers courses from the bachelor level to specialized lectures in various doctoral programs. Our teaching activities emphasize quantitative methods and models with focus on applications. The courses in the HSG trading room, for which the ior/cf-HSG has taken over the lead management, are in high demand by the students.

With its activities, the Institute for Operations Research and Computational Finance (ior/cf-HSG) has supported project partners, clients, and students likewise in achieving their aims or in taking a big step forward in mastering the challenges of their professional daily business. Energy research plays a central role. We support industrial partners in practical problems in numerous application projects, for example with methods for power plant deployment planning under uncertainty or with price forecasts. In liberalized, highly volatile electricity and gas markets, energy derivatives are the focus and characterize the field of energy finance, as they follow different rules than financial derivatives due to physical restrictions and the grid-bound nature of electricity and gas and are therefore more difficult to value. Our expertise is continuously developed in close cooperation with industry and research partners.

The revision of the StromVG is intended to ensure an economically efficient power supply. This goal requires the inclusion of the full revenue potential from power trading. In order to ensure this economic efficieny, we believe it is necessary to rule out the possibility of cross-subsidizing speculative proprietary trading through asset-backed trading. We have contributed with a number of studies to the political discussion in the Swiss power industry demonstrating the quality and relevance of our research activities.

The ior/cf-HSG's technical expertise also attracts the attention of companies, which allows us to share our competences in projects with the industry. The usefulness of our applied software finances the implementation of new ideas. Cooperations with the energy sector adapted the existing packages for power contracts to firm-specific requirements and inspired new applications. Software for algorithmic trading in the intraday market for electricity implement consistent and efficient orders within defined limits for the associated risks. Software tools and consultancy projects are also offered for the banking and finance industry with applications in asset and liability management, risk management and forecasting.

The Institute for Operations Research and Computational Finance continues to concentrate on its core competences, stochastic optimization, and the simulation of market dynamics. Based on accumulated experience and endorsed by our supporters, we are tackling our ongoing and upcoming projects as a team.

For my part, I owe my thanks in turn to the people supporting me. The academic board members paved the way for promising business activities. My team members proved their willingness to perform and demonstrated flexibility whenever needed, and our project partners continued respectively started to trust our institute with their business decisions.

Prof. Dr. Karl Frauendorfer

Inhalt

2 Management Summary

The ior/cf-HSG developes various software tools for market participants in the energy and financial industry. In addition, the institute estimates distributions of future spot prices and price forward curves for electricity and gas that are provided to subscribers. Details of the products and services that are offered, also in cooperation with partners, are described in section 4.

Reallocation of Water Right Concessions

In the course of the imminent *Heimfall* (i.e., with the upcoming reallocation of water rights concessions by the concession municipalities), our focus was on the **economic evaluation of Swiss large-scale hydropower**.

Over the next few decades, the potential for value creation will gradually fall to the concession municipalities as the power plants heimfall, and they now face the challenge of working with financially sound and reliable partners to exploit this potential in the context of a new award of water rights concessions. The goal is to use adequate model approaches to demonstrate the negotiating positions and their value for both the concession municipalities and the electricity industry.

The first step was to evaluate those risks that need to be managed in the course of the *Heimfall*. In a second step, a revisable model is to be developed that supports an efficient distribution of the added value of Swiss large-scale hydropower between concession municipalities, cantons, and the electricity industry by means of parameterizable control variables, depending on the type of power plant and the identified risks. Finally, a user-friendly tool has been implemented to help the contracting parties quantify the opportunities and risks of their different negotiating positions.

The reversion cases, with their structurally profound effects, initially increase the risks in the management of large-scale hydropower in the mountain cantons. With reference to the additional rescue package launched by the Federal Council in May 2022 as a result of geopolitical instabilities, we see any further federal support measures as generally subject to the subsidiarity principle. Thus, with our understanding, the canton first bears the risk of loss and supply. The control parameters introduced support efficient implementation and the setting of effective incentive structures. Auditability is ensured by the fact that the model is based on observable market data (in the sense of the level hierarchy according to IFRS) and on company data that can be verified by internal and external auditors. On the basis of the data quality achieved, an *"efficiency radar"* can be used to compare the performance of the utilities over the fiscal years as well as with the performance of other Swiss utilities. The aim was to identify the inherent potential for efficiency gains in a timely manner and to exploit this potential by means of the control variables. In addition, an integrated hedging strategy based on a selectable hedge index has a stabilizing effect on income while reducing the risk of loss.

Looking to the medium term, in which the storage reserve to bridge the winter gap, sector coupling, and digitalization will be much more strongly integrated into the business models of the utilities, we see great potential for efficiency gains in the anchoring of the *"efficiency radar"*. If these can be used successfully by the concessionaires, not only are the dividends higher, but additional tax substrates are also generated, which accrue directly to the federal government, the cantons, and the municipalities.

Economic Valuation of Flexible Capacities

Flexible capacities of different technologies represent options with complex execution structure. The complexity is characterized by technical restrictions concerning the operation of the flexible capacity as well as by physical restrictions in the power grid. In a perfect market without transaction costs and

unlimited liquidity, the option value is defined by the price distribution and the execution structure. Due to the grid-bound nature of electricity as a commodity, electricity markets are imperfect and exhibit highly volatile transaction costs and liquidity, causing high-cost frictions in electricity trading. For the economic evaluation of a flexible capacity, the restrictions of the technologies, the physical restrictions in the power grid as well as the frictions in the spot markets have to be taken into account.

In the first project year (May 2021-April 2022), we focus on the modelling of frictions in intraday trading (ID trading) of EPEX SPOT as well as on the empirical marketing of Flexible Capacities in balancing markets within the Grid Control Network Germany over the last four years.

For ID trading, a cost-liquidity metric is created that quantifies frictions in basis points (bps) for Limit Order Books (LOB) of an individual trading product. For selected trading periods in 2021 and 2022, LOB empirical analyses are used to summarily estimate trading product frictions.

For selected balancing energy markets, bidding structures and liquidity are evaluated depending on the respectively current regulatory framework. Preliminary analyses show (i) that liquidity in balancing markets is subject to significant seasonal variations independent of active generation capacity and, (ii) that a strong negative nonlinear monotonic relationship between liquidity and the top half of bids is observed. At the time of our evaluations, relevant time series for the auction of balancing energy within the Swiss market area were not available on Entso-e's transparency platform.

Performance Measurement in Energy Trading

Since 2009, Swiss utilities have been confronted with a collapse in electricity prices, which came to an abrupt end with the turmoil on the energy markets in 2021. In addition, the Swiss market area was disconnected from that of neighboring countries due to the lack of a framework agreement with the EU and, as a direct consequence, the lack of an electricity agreement. Value-added potential was lost, which, due to the recent price increase, will cause the margins of the Swiss utilities to be corrected upward again.

On May 18, 2022, in a dispatch to parliament, the Federal Council proposed a rescue package for the electricity industry that would guarantee the supply of electricity in Switzerland even if possible, distortions on the energy markets endanger the existence of systemically important Swiss electricity companies. In the event of a crisis, the rescue package guarantees the subordinated electricity companies the provision of liquidity amounting to CHF 10 billion in the form of loans. The rescue package would initially be limited until 2026 and is then to be replaced in particular by a law on the integrity and transparency of wholesale trading for electricity and gas, as well as specifications on liquidity and capital resources. A legal adjustment of the current framework conditions in electricity trading has already been called for years in the activity reports and market reports of the regulator ElCom.

Our commentary aims to highlight the current misaligned incentives in Swiss electricity trading and is addressed to the shareholders and boards of directors of the large electricity companies, their internal controls, as well as to auditing companies, regulators, supervisors, and politicians.

We use *Axpo's* financial reports 2008/09 - 2020/21 as a basis. Our findings from this led us to point out the need of strictly separating the speculative elements in trading operations from those trading operations that serve hedging, power plant optimization and sales contract management. To this end, we take a critical look at the business model documented in the financial reports, including the application of hedge accounting. In particular, we have used Axpo's 2020/21 financial report to show how the new regulations could be designed to create effective incentives to reduce risk exposure in general and speculative trading in particular.

Currently, our model approaches are being incorporated into the ior/cf-HSG's continuing education program, which is geared toward the Swiss electricity industry. Furthermore, on this sensitive issue, we are in direct exchange with market players who are interested in a comprehensive evaluation.

3 Research Program

Sophisticated solutions to practical problems embody the ior/cf-HSG's maxime. Theoretical achievements lead to new algorithms, the implementation of which in turn may raise research questions. This chapter summarizes the institute's research activity and lists both projects and publications.

According to the ior/cf-HSG's affiliation to the University of St. Gallen, research is a commitment for the institute. Its activities promote applied research aiming at effective contributions for solving challenging and complex problems in the financial and energy industry. In addition, the problems often require preliminary conceptual and theoretical work attributed to basic research.

Many real problems are subject to dynamic decision processes the handling of which depends decisively on uncertainties with respect to the development of relevant factors. The interaction of time and uncertainty in connection with regulatory and corporate requirements leads to complex decision-making problems that generally overstrain human intuition. Stochastic optimization concepts provide a systematic solution to such questions and constitute the methodological link among the ior/cf-HSG's research activities. Theoretical insights allow the development of software solutions; corresponding training courses establish their application and knowledge about the inherent model risks.

The subsequent subsections report on the institute's research projects. They cover topics, which are either part of the ior/cf-HSG's business activities or part of the research focus of the University of St. Gallen. Dissertation projects enhance the knowledge about specific topics, and collaborations with external researchers support the implementation.

3.1 Digital Solutions for Interoperability of Flexibility Platforms (DigiPlat)

The energy transition towards the goal of making Europe carbon neutral by the mid of the century does not only go along with a further extension of electricity generation from renewable sources, also the decentralization of energy resources and sector coupling play a major role in this process. Scalable digital flexibility platforms are needed for the integration of market participants offering flexible capacity for generation, storage, and demand shift. However, standards for such platforms, the interoperability between them as well as specifications of flexibility requirements still need to be defined. These issues are addressed by the research project "Digital Solutions for Interoperability of Flexibility Platforms (DigiPlat)", which is supported by the European Union within the Horizon 2020 research and innovation funding programme and the Swiss Federal Office of Energy.

The DigIPlat project is conducted in collaboration with the following partner institutions from the DACH region (Germany/Austria/Switzerland): Austrian Institute of Technology (AIT), Austrian Power Grid (APG), Fichtner IT Consulting, Karlsruhe Institute of Technology (KIT), Ulm University of Applied Sciences (THU), Transnet BW and the Institute for Operations Research and Computational Finance (ior/cf-HSG) of the University of St. Gallen.

The main goal of the research project DigiPlat is the identification of measures for the implementation, adaption, and knowledge transfer regarding digital solutions for the interoperability of flexibility platforms. Based on this, an international platform will be developed for the integration of transnational flexibility markets to increase security of supply also cross-border. Therefore, within the project a standardized framework is defined and currently existing flexibility platforms with broad stakeholder participation and prototypes are technically evaluated. The economic benefit is assessed with a market model to be developed in the project, which includes intraday and control power markets as well as redispatch and a common network model. A special focus is on the situation of Switzerland, which, as a non-EU member, is excluded from the ongoing integration of electricity markets.

The multinational research cooperation aims at making distributed energy resources (DER), i.e., small and medium sized generation or storage units like domestic battery storages potentially coupled with photovoltaic systems, small hydroelectric power plants, heat pumps or the combined battery capacity

of many electric cars, flexibly accessible to transmission and distribution system operators using scalable digital platforms. The exchange of the offered flexibility potential between the platforms, coordinated activations across multiple voltage levels or market areas will help ensure grid stability and promote an economically efficient and transparent allocation of flexibility, both on a national and international level.

While in the recent past various platforms have been developed by research initiatives or as showcase projects by TSOs/DSOs, international standards for flexibility platforms and standardized flexibility requirements still need to be defined. These are crucial to achieve interoperability between platforms on a national and international level, to allow for a better coordination of vertical and horizontal market integration, and to optimize the allocation of flexibility among platforms.

As a potential major application DER is the provision of ancillary services, in the reporting period prices and liquidity on markets for reserve energy and their potential relation to electricity prices on spot markets have been analyzed. Furthermore, the institute developed a methodology for deriving joint distribution functions of intraday prices and infeed from renewable electricity generation for various time periods before delivery. These approaches will allow a quantification of the economic potential of integrating DERs in existing short-term spot markets and the recently established markets for reserve energy.

Project staff: *Prof. Dr. Karl Frauendorfer, Dr. Gido Haarbrücker, Claus Liebeberger, Dr. Michael Schürle*

3.2 Analysis of Risk and Performance Characteristics of Securities

In times of rising uncertainty, increasing market volatility, changing market environment with shifting correlation structures within equities, as well as across different asset classes, the identification of fundamental risk in growth and return of investments becomes a key challenge to the active management of equity portfolios.

In bullish times, when stock prices are gaining over a long period, diversification through adding a large number of securities or even buying all constituents of a market index might appear to provide sufficient protection against risk. However, this approach to investing is primarily a protection against idiosyn-cratic (unsystematic) risk in equities. Nevertheless, shifts in market sentiment and undiversifiable (systematic) risk might prevail. Today equity prices are increasingly exposed to trades of passive funds, such as ETFs, which might buy and sell all constituents of a market index or industry at once, resulting in market panic and a huge overreaction to otherwise weak indicators of systematic risk. Consequently, prices might deviate strongly from fundamentals.

We acknowledge that idiosyncratic and systematic risk of companies are the risk of fundamentals (e.g., sales and earnings of firms) being affected by both, the firm's strategy (business model of the firm in contrast to business models of other firms) as well as macroeconomic paradigm shifts. This helps the investment decision, even in volatile times, with huge exposure to certain sectors/industries. It supports the timing of investments, as well as the assessment of the risk of paying too much for a stock or selling it too late for too little. Most so-called value funds usually search for underpriced equities by applying simple price-to-fundamental metrics and trends in fundamentals. They screen for underpriced individ-ual components of value, such as sales, ebitda, cash flow, profit margin, earnings, or book value, but not value itself. They might find, for example, that current earnings or book value is mispriced, while ignor-ing that the appropriate combination of all components and their leverage considered together matter, and not just one or more single components. Intrinsically, they might oversee the possibility that equities are "cheap" because they are risky. In this respect this research project investigates alternative ap-proaches with the goal of defining robust investment strategies.

Project staff: *Ass. Prof. Robert Gutsche Ph.D., Dr. Alexandru Rif*

3.3 Publications

This section lists selected basic and applied research works and supervised theses of the past three years.

Research

- Breitenstein, M.; Nguyen, D.; Walther, Th. (2019): *Climate Change and Bank's Risk Management: Can it Affect Investment Decisions?* in: *International Banker,* Summer 2019, pp. 68-69. URL: https://internationalbanker.com/finance/climate-change-and-banks-risk-management-can-it-affect-investment-decisions
- Escobar, D.; Paraschiv, F.; Schürle, M. (2020): *Pricing electricity futures with distortion functions under model ambiguity*. This article is part of D. Escobar's PhD thesis, which received the Best Dissertation Award 2019 of the Austrian Society for Operations Research (ÖGOR).
- Frauendorfer, K. (2021): *Teilliberalisierung Marktgebiet Schweiz – gefangen in der Unvollständigkeit, in: Geiser Thomas/Hilb Martin/Pärli Kurt/Stengel Manuel/Wittmer Andreas (Hrsg.): Ein Kunstflug durch das Recht und die Governance – Festschrift zum 65. Geburtstag von Roland Müller, Zürich/St. Gallen 2021, S. 199 – 216.*
- Halser, C.; Paraschiv, F. (2022): *Pathways to Overcoming Natural Gas Dependency on Russia – The German Case*. Energies, 15 (14), 4939, https://doi.org/10.3390/en15144939
- Kremer, M., Kiesel, R., Paraschiv, F. (2020): *The impact of renewable energies for continuous intraday electricity trading,* Philosophical Transactions of the Royal Society A, **379,** 20190624, https://doi.org/10.1098/rsta.2019.0624
- Kremer, M.; Kiesel, R.; Paraschiv, F. (2020): *Intraday Electricity Pricing of Night Contracts*. Energies, 13 (17), 4501, https://doi.org/10.3390/en13174501
- Li, W.; Paraschiv, F. (2022): *Modelling the evolution of wind and solar power infeed forecasts.* Journal of Commodity markets, 25, 100189, 100189, https://doi.org/10.1016/j.jcomm.2021.100189
- Locarek-Junge, H.; Sumpf, A.; Walther, Th. (2019): *Anwendung der Copula-Formel in der Finanzwirtschaft: Höllenformel oder nützliches Abhängigkeitsmaß?* in: WiSt – Wirtschaftswissenschaftliches Studium, Vol. 48, No. 2-3, pp. 12-19. https://doi.org/10.15358/0340-1650-2019-2-3-12.
- Mas Urquijo, I.; Paraschiv, F. (2022): *Cross-border Effects between the Spanish and French Electricity Markets – Asymmetric Dynamics and Benefits in the Light of European Market Integration.* The Energy Journal, Vol. 44 (forthcoming), https://doi.org/10.5547/01956574.44.4.imas
- Müller L. (2022): *Essays on Dynamics of Order Books*, Dissertation, University of St.Gallen
- Ongena, S., Reite, E.J, Paraschiv, F. (2020): *Harvesting from loyalty in mortgage lending*. Working paper.
- Opitz, Christian (2022): *Urban energy systems: Municipal utilities and the case of Switzerland.* In: Matthias Finger und Numan Yanar (Hg.): The Elgar companion to urban infrastructure governance. Innovation, concepts and cases. Cheltenham, UK, Northampton, MA, S. 129–147
- Paraschiv, F.; Mohamad, D. (2020): *The Nuclear Power Dilemma – Between Perception and Reality*. Energies, 13 (22).
- Paraschiv, F.; Mohamad, D.: *The Nuclear Power Dilemma – Between Perception and Reality.*: Energies, 2020 (13), 6074, https://doi.org/10.3390/en13226074
- Paraschiv, F.; Reese, S.M.; Skjelstad, M.R. (2020): *Portfolio Stress Testing Applied to Commodity Futures.* Computational Management Science, 17 (2), 203-240.

- Paraschiv, F., Wahlstrøm, R.R. (2020): *Review of Crowd Funding Platforms in Scandinavia.* Working paper.
- Wahlstrøm, R.R.; Paraschiv, F.; Schürle, M. (2022): *A Comparative Analysis of Parsimonious Yield Curve Models with Focus on the Nelson-Siegel, Svensson and Bliss Versions*. Computational Economics, 59, 967-1004, https://doi.org/10.1007/s10614-021-10113-w
- Wahlstrøm, R.R., Paraschiv, F.; Schmid, M. (2020): *Bankruptcy prediction of privately held SMEs: a study of input variables using feature selection methods.* Working paper.
- Walther, Th.; Klein, T.; Bouri, E. (2019): *Exogenous Drivers of Cryptocurrency Volatility - A Mixed Data Sampling Approach to Forecasting*, in: Journal of International Financial Markets, Institutions & Money, Vol. 63, pp. 101-113. https://doi.org/10.1016/j.intfin.2019.101133.

Studies for the Swiss Power Industry

- Frauendorfer, K.; Gutsche, R. (2019): *Performance Issues im Schweizer Stromhandel (Der Beginn der Teilliberalisierung in der Schweiz)*. Positionspapier zur Stromwirtschaft CH, ior/cf-HSG.
- Frauendorfer, K.; Gutsche, R. (2019): *Performance Issues im Schweizer Stromhandel (The commencement of limited liberalization in Switzerland)*. A Position Paper on the Swiss Electricity Industry, ior/cf-HSG.
- Frauendorfer, K.; Gutsche, R. (2019): *Die Rolle des Stromhandels in der Schweizer Stromwirtschaft.* Working Paper, ior/cf-HSG.
- Frauendorfer, K.; Schürle, M. (2020): *Einsatzmöglichkeiten flexibler Kapazitäten für Sekundärregelleistung,* Case Study, ior/cf-HSG.
- Frauendorfer, K.; Gutsche, R.; Haarbrücker, G.; Liebenberger, C. (2020): *Spannungsfeld: Stromversorgung vs. Stromhandel: Herausforderungen für das Management*, Management Summary, ior/cf-HSG.
- Frauendorfer, K.; Gutsche, R.; Haarbrücker, G.; Liebenberger, C. (2020): *Field of Tension: Electricity Supply vs. Electricity Trading: Management Challenges*, Management Summary Englisch, ior/cf-HSG
- Frauendorfer, K.; Gutsche, R. (2021): *Empirische Analysen zu Finanzberichten der Alpiq, Axpo, BKW (Geschäftsjahre 2009-2018),* Eine Studie für die Stakeholder der Schweizer Stromwirtschaft zur Prüfung, ior/cf-HSG.
- Frauendorfer, K.; Gutsche, R. (2022): *Alpiq: Quo Vadis?* Ein Kommentar zu den Finanzberichten 2009-2021 der Alpiq
- Frauendorfer, K.; Gutsche, R. (2022): *Geschäftsmodell der Axpo: Cui Bono?* Ein Kommentar zu den Finanzberichten 2008/09-2020/21 der Axpo

Selected Bachelor Theses (2020 – 2022)

- Aerne, P. (2021): *Wertminderungen und Rückstellungen in der Stromwirtschaft von 2009 bis 2014.*
- Avdili, D. (2020): *Handelsplattformen für Öl und Gas und ihre Preisdynamiken.*
- Baumann, A. (2022): *Gründe der Wertberichtigungen und Rückstellungen der BKW (2009-2020) im Zusammenhang mit der Strompreisentwicklung.*
- Bissig, G. (2021): *Immobilienanlagestrategien von schweizerischen Vorsorgeeinrichtungen.*
- Blattner, D. (2021): *Should Investment Companies differentiate between Emerging Markets and Developed Markets in their ESG Policies?*
- Campbell, M. (2021): *Accounts Receivable Securitization as a Financing Option Strategies to Improve Viability for Small- and Medium Sized Enterprises in Switzerland*

- Dlabek, Y. (2020): *Auf dem Weg zu einer Kreislaufwirtschaft? Eine Untersuchung im Bereich Siedlungsabfall für ausgewählte Städte*
- Deuringer, M. (2020): *Hedge Accounting in der Praxis der Energiewirtschaft.*
- Gaist, L. (2022): *Regional Spreads & Calendar Spreads in Energy Commodity Futures - An Explorative Research.*
- Ghielmini, N. (2022): *Stromversorgungssicherheit im Marktgebiet Schweiz.*
- Gisler, R. (2022): *Die Relevanz von synthetischen Kraftstoffen hinsichtlich der Verkehrswende im Strassenverkehr - Eine techno-ökonomische Analyse und Betrachtung von Potenzialen.*
- Greif, N. (2020): *Massnahmen zur Dekarbonisierung auf kommunaler Ebene – Auslegeordnung und Potenzialanalyse für die Stadt St.Gallen*
- Haas, E. (2022): *Die Entwicklung der europäischen Erdgaspreise 2021 und deren Auswirkung auf den Strommarkt.*
- Haser, V. (2020): *Vertical Farming - Realistische Zukunft oder Utopie der Agrikultur?*
- Huber, J. (2021): *Schweizer Pensionskassen in der Corona-Pandemie Eine Analyse aktueller ökonomischer Wirtschaftsentwicklungen und deren Auswirkungen auf Schweizer Pensionskassen zur Bestandsaufnahme potentieller Zukunftsszenarien*
- Inauen, R. (2021): *Die Target-Salden im Eurosystem: Eine kritische Diskussion der Standpunkte aus dem Buch Der perfekte Sturm?*
- Kastrati, A. (2022): *Forensische Datenanalyse zur Auffindung von Unterschlagungen - Ein Überblick der akademischen Literatur.*
- Kiechl, J. (2021): *Accounting Issues im Energiehandel*
- König, R. (2022): *The Impact of Jet Fuel Hedging on Firm Value in the Aviation Industry during an Economic Downturn.*
- Krasniqi, P. (2020): *Implications of Closing Auctions on the Quality of Electronic Equity Markets*
- Krauth, J. (2020): *Die Rolle der Wasserkraft in der Schweizer Energiewende – Eine Analyse der Herausforderungen und Potentiale*
- Lang, M. (2020): *Trendanalyse mit Hilfe von Data-Science*
- Lucas, K. (2022): *Die Auswirkungen der Energiewende in Deutschland auf den Strommix, die Strompreise und die Emissionen von 1990 – 2020.*
- Mazrekaj, R. (2022): *Das bedingungslose Grundeinkommen in Zeiten von COVID-19 - Eine Gegenüberstellung von Kosten im Zuge des Lockdowns und finanziellen Zuwendungen im System des bedingungslosen Grundeinkommens.*
- Meyer, T. (2021): *Das bedingungslose Grundeinkommen in Zeiten von COVID-19: Eine Gegenüberstellung von Kosten im Zuge des Lockdowns und finanziellen Zu-wendungen im System des bedingungslosen Grundeinkommens.*
- Munishi, J. (2020): *Die Rolle der Sektorkopplung für die Energiewende in der Schweiz*
- Muqaj, E. (2020): *Bestandesaufnahme der Sektorkopplung innerhalb der Energiestrategie 2050*
- Nathan, N. (2020): *How the Irrational Investor Gives Rise to Market Inefficiencies.*
- Radovic, M. (2020): *Analyse des Hedge Accountings der Axpo - Betrachtung eines Jahrzehnts.*
- Ramadani, R. (2020): *Der Brexit und seine Auswirkungen auf ausgewählte Wirtschaftszweige*

- Rüegg, N. (2021): *Analyse der Geschäftssegmentierungen und Absicherungsstrategien der Schweizer Energiekonzerne Alpiq, Axpo und BKW über die Jahre 2009 bis 2020*
- Sagur, L. (2020): *COVID-19-Krise und potentielle Auswirkungen auf wirtschaftliche Leistung und Sterblichkeit*
- Sajlovic, D. (2021): *Unterschiede in den Fair Values von Pumpspeicherkraftwerken bei unterschiedlichen HPFCs.*
- Schnidrig, Th. (2020): *Kundenorientierung (B2C) in der Energiewirtschaft – ein Massnahmenkatalog anhand des Praxisbeispiels SWG Grenchen*
- Schuhmacher, E. (2021): *Comparing the Predictive Power of GARCH Models and LSTM Neural Networks Based on Stock Indices*
- Sieber, M. (2021): *Der Effekt von ESG-Ratings als Signal für nachhaltige Entwicklung zwischen Unternehmen und deren Stakeholdern - Eine interdisziplinäre Analyse*
- Stillhart, R. (2022): *Adverse Selection im wirtschaftlichen Kontext.*
- Tsemelis, M. (2020): *On Iran's Influence over the Strait of Hormuz and its Ability to Impact Oil Prices and Global Macroeconomic Variables*
- Voutat, M. (2020): *Green Bond Performance*
- Weiss, T. (2021): *The Impact of Brexit on Selected Economies and Its Implications for Future Economic Cooperation*
- Wildhaber, A. (2020): *Monatliche Saisonalitäten in Spot- und Futures-Renditen - Eine Analyse der Indizes SMI, DAX und S&P 500.*
- Wüst, V. (2020): *Trendbasierte Strategieentwicklung am Beispiel der Städtischen Abfallentsorgung*

Selected Master Theses (2020 – 2022)

- Aklin, G. (2020): *Die Rolle der Kantonswerke – Eine Analyse der strategischen Positionierung von Kantonswerken und Implikationen für künftige Veränderungen*
- Alarcon, A. (2020): *Dynamic Volatility Modelling and Portfolio Optimization*
- Alkan, D. (2020): *Hedging Strategies and Risk Management in Energy Markets: An Analysis for Natural Gas and Electricity*
- Altner, D. (2021): *Analyse Wertminderungen von Schweizer Energiekonzernen zwischen 2009 und 2019 am Beispiel von Alpiq Holding AG*
- Ayari, R. (2021): *Optimal Asset Allocation with Q-Actor-Critic*
- Bedjeti, B. (2022): *M&A-Ankündigungseffekte deutscher Unternehmen.*
- Berney, N. (2022): *How can pension funds manage liquidity in illiquid markets? An analysis of the private equity secondary industry.*
- Borner, Th. (2020): *What target country specific characteristics drive market reactions in M&A deals?*
- Chiodi Cianfarani, F. (2022): *Interregional mergers and acquisitions - Empirical evidence from the EU and US between 1995 and 2021.*
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4 Business Activities

4.1 Energy

The ior/cf-HSG has established the software family BIT@EPI (Business Information Technology at Electric Power Industry) which provides solutions for managerial decision problems and operational tasks situated in the energy sector. BIT@EPI is steadily developed further according to enhanced methodologies as well as due to new or changing practical needs. Its modular concept is suitable to handle the heterogeneous problems arising in the respective application fields and to overcome the challenge of dedicated quantitative analyses.

The set of developed modules covers the modeling of price forward curves and of spot price dynamics (BIT@EPI.Dynamics), portfolio optimization of utilities (BIT@EPI.PFO), and the valuation of virtual power plants (BIT@EPI.VPP). A supplementary module BIT@GAS.PFC allows an automated generation of regime-dependent PFCs with a daily granularity for relevant trading hubs of natural H-gas.

Intraday trading algorithms have been developed further due to changes in market rules and regulations and to extended trading until short before delivery. These algorithms are aligned with the requirements of TSOs trading renewal energy on the electricity intraday market or of asset-backed traders like operators of pumped-storage hydropower assets.

An Order Placer Application allows to feed simulation environments of intraday markets with own orders and order books. This puts developers and users in a position to work with self-designed order books and market situations – a prerequisite to assess the behavior of intraday trading algorithms in the most diverse situations.

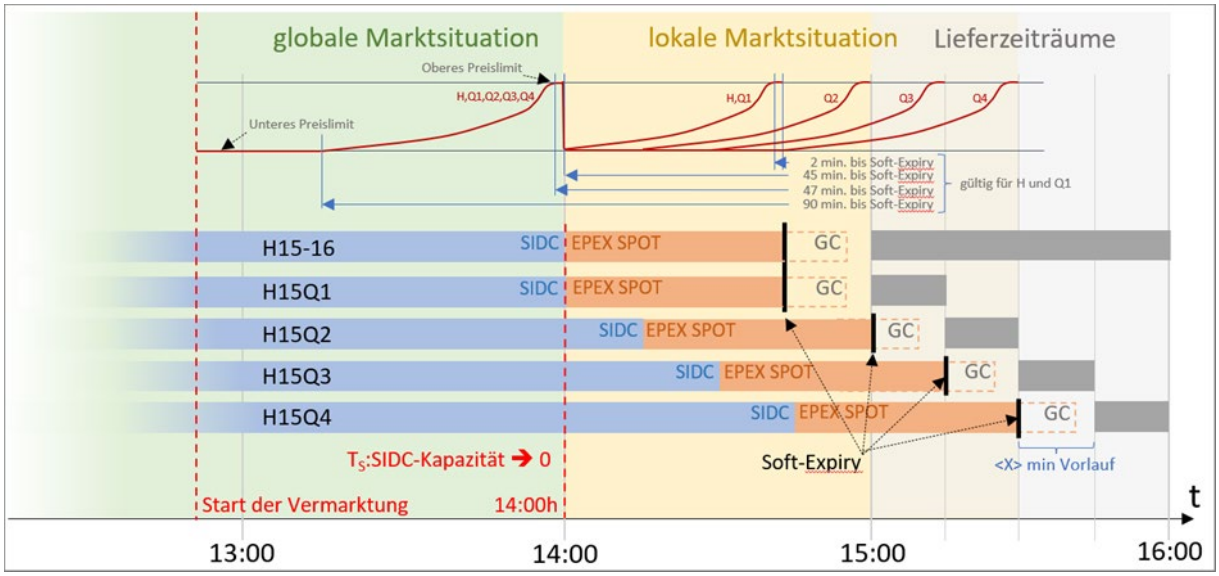
4.1.1 Automated Intraday Trading for TSOs

Due to the uncertain generation of the renewable energy sources wind, photovoltaic, and water, these types of energy production have a strong impact on the volumes and prices on the intraday market for electricity at the EPEX SPOT power exchange. E.g., German transmission system operators (TSOs) are obliged to market a specific portion of this renewable electricity on the day ahead as well as on the continuous intraday market. In cooperation with two TSOs, the ior/cf-HSG developed automated trading algorithms which incorporate the price and volume dynamics and consider the relevant risk management guidelines. The algorithms automatically place orders on the intraday market aiming at an effective management of the TSO's net position which varies due to changing generation prognoses and own intraday market transactions. The order placing itself may be routed through the exchange's API or by embedding the algorithms into a commercial energy trading system.

The portions of the renewable wind, photovoltaic and 'small' hydro power, which are not part of the so-called *direct marketing* variant, are marketed by the German TSOs. The latter ones are obliged to adequately forecast and to market those portions at the EPEX SPOT power exchange: in a first step, the respective predicted renewable energy is traded by the TSO on the day-ahead auction market. However, the prognosis available at closure of the day-ahead market is not perfect, and new prognoses of power production arrive periodically up to the actual time of delivery. The discrepances between the new prognoses and the already traded amounts lead to open positions which must be traded on the intraday market in order to minimize the residual energy for which the cost of balancing energy will finally become effective.

A continuous 7/24 monitoring of all tradable products (hour contracts, 30-minutes contracts, and quarter hour contracts – not even considering configurable block products) cannot be managed effectively by single human traders. The possibility to trade within each of the four German delivery areas up to 5 minutes before delivery allows to react on prognosis updates very shortly before the effective electricity feed-in. In this challenging setting, the utilization of automated trading algorithms may ensure

a continuous, consistent, and cost-effective way of closing the ever-changing **ever**open positions while assuring compliance with imposed risk management directives and trading guidelines.



Exemplary time schedules of SIDC and local market situations

For this purpose, the ior/cf-HSG has developed and implemented automated trading algorithms which either can be embedded into commercial energy trading systems or act directly via the API of the intraday electricity exchange. Likewise, the provision of all relevant historic and current prognosis information and of market data (order books and trades for every single contract), takes place by the encapsuling energy trading system or by own data collection processes. Changes in the order books are immediately received and the algorithm can react instantaneously by placing matching orders on the market. The order placement itself acts in a fully automated way, supervised by external checks with overruling possibilities.

Changed market situations, the own trading course, and the arrival of new prognoses for the relevant renewable energy production trigger the algorithmic calculation of optimal energy amounts which shall be traded on the market according to the currently observable order book for the respective contract. The calculations are based on probability distributions fitted to the observed intraday trade prices, on prognoses of the renewable energy production, and on parameterizable trading rules and preferences. The placement of own aggressive orders on the market is enhanced by a precalculation of own potential trade orders: this allows instantaneous reactions to new visible orders in the contracts's order books. Optionally, arbitrage possibilities for overlapping contracts may be exploited, e.g., for an hour contract and its subordinate quarter hour contracts.

The trading algorithms are complemented by monitoring, signalling, and reporting functionalities. A powerful client GUI supports the user by the provision of graphical representations and tabular listings of the current market situation (tradable contracts, order books, price expectations, etc.), of the own energetic evolution (traded volumes, generation forecasts, open positions, etc.), and of the own trading process (settled trades, placed orders, achieved volume weighted average prices, etc.).

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4.1.2 Automated Intraday Trading for Asset-Backed Traders

Asset-backed trading on the electricity intraday market means acting on the market itself (i.e. buying and selling the currently tradable products) under the condition to have at the same time a flexible asset (turbine and/or pump, power storage etc.) at disposal – or even a whole portfolio of such assets. Referring to the Black-Scholes option price theory, these types of flexible assets may be priced as a classical put or call option. But instead of 'selling' the flexibility of an assset and receiving the monetary option premium, one may use a so-called replication strategy in order to generate the option premium by own efficient intraday trading, e.g., using a delta-hedge approach.

Thinking of a utility with a physical flexible asset in form of pumped-storage hydropower station (PSH), the option premium for the assets' inherent flexibility may be obtained by applying a replication strategy, i.e., replicating the option by efficiently trading at the intraday market and simultaneously taking the respective counterposition of an own matched order by increasing or reducing the assets' schedule accordingly.

Using this flexibility in the assets' schedule, one is physically hedged and is not obliged to close open positions at potentially extremely unfavourable prices – a severe risk which 'prop traders' without physical assets are faced with. Thus, the latter risk is typically encountered by an appropriate margin to be deposited at the market clearing entity.

Ior/cf-HSG has developed conceptual approaches and has implemented algorithmic solutions which aim at efficient asset-backed trading on intraday electricity markets. Particular attention has been laid on the accurate consideration of the technical asset flexibility and of further peculiarities like, e.g., so-called locked hours (a violation of which would entail severe penalty payments) or maintenance plans. The products, one is willing to trade on the electricity intraday market, and the order placement process should be in line with the type of the PSH reservoir (day, week, or seasonal strorage) and with the thereby related information on opportunity costs. The economic success strongly relies on adequate trigger prices, instantaneous reactions on order book changes, and sound price expectations.

An encapsuling software manages and schedules all relevant information processing (imports of natural inflows, short term unit availabilities, maintenance plans etc.) such that further operative necessities, e.g., unit commitment of the PSH or dispatch announcements for the balance responsible party, are periodically fulfilled in a timely manner.

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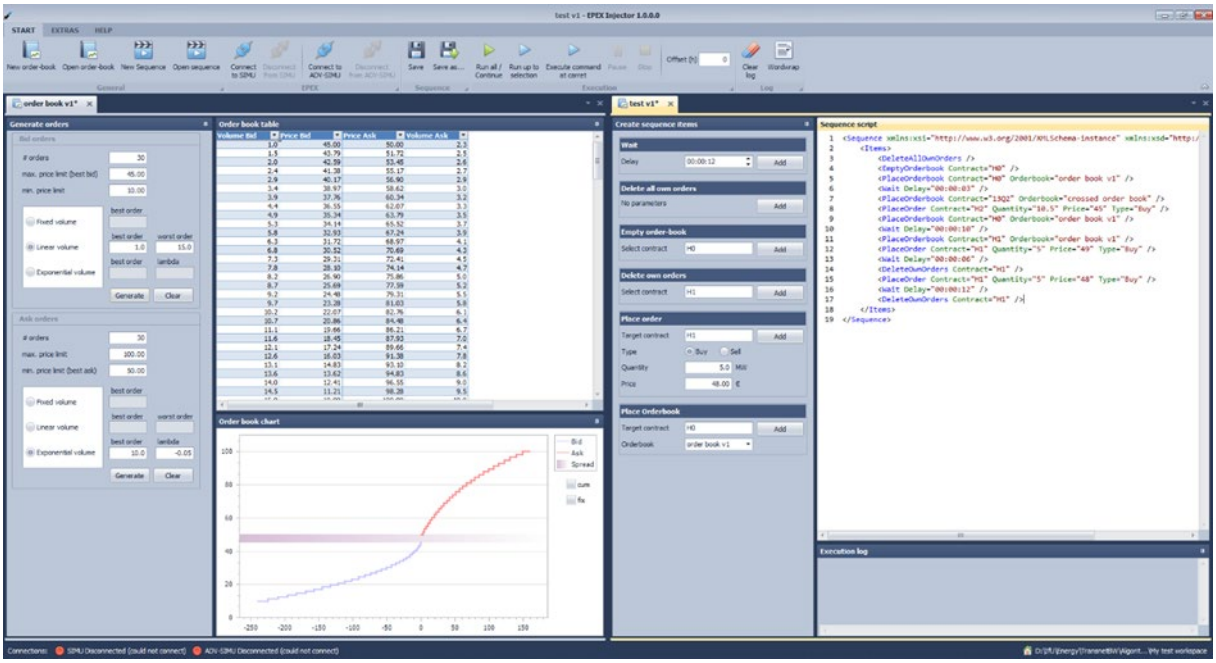
4.1.3 Order Placer application for intraday simulation environments

If the goal is to systematically evaluate an algorithmic trading behavior, one strongly relies on the possibility to test the trading algorithm against 'all' possible events or market situations – i.e. in addition to the usual market behaviour special attention has to be paid to rare and extreme events. However, the simulation environments offered by EPEX SPOT are not sufficient for such intended purposes: due to arbitrary and sparse order books as well as to very infrequent trading activities, these simulation environments serve rather for technical or communication testing than for the performance analysis of the trading algorithm itself.
Ior/cf-HSG developed and implemented an Order Placer application which serves for the creation of the intended market situations and entire sequences of order book developments.
A meaningful benchmarking approach for an individual inflexible market participant – being forced to close positions even at very unfavorable prices – has thus to incorporate an adequate quantification of this flexibility premium.

When implementing an intraday trading algorithm or performing tests of the latter, a sustainable success is inevitaby linked to a rational algorithmic behaviour which transfers the ever-changing information into own actions on the intraday market: and this has to be ensured not only in 'normal' mar-

ket situations and for typical order book structures, but also in unusual market evolvements and even in rare and extreme events.

Admittedly, the electricity exchange EPEX SPOT offers so-called simulated intraday market environments with some arbitrary orderbook situations and trade actions, However, the observable simulation settings hardly meet the necessary requirements for a sound testing of algorithmic trading behaviour: namely providing almost the full spectrum between normal and atypical order book structures, stable or erratic order books, empty or deeply filled bid or ask sides, and so on. Thus, what in fact is needed is the possibility to use the simulation environment as a container for completely self-designed market and order book situations. Utilizing the genuinely provided simulation platform for the conduct of such tests ensures to work with an environment which is technically as close as possible to the exchange's productive intraday market trading system.



Automated intraday trading: GUI of the Order Placer application

The developed application can place a wide order sprectrum, ranging from single orders up to long order sequences for multiple products traded on a simulation environment of an electricity intraday market. All orders, order books and sequences of actions can be created and modified by predefined GUI functionalities or by editing the respective script file. Likewise, complete order books may be generated by using predefined functions, by manual setting, or by copy&paste from external spreadsheet applications, and then be placed automatically on the simulation environment.

This allows to create any desired order book situation and entire equences of order book changes over time, such that the behavior of the own trading algorithm (running in parallel and producing the relevant logging information) against this designed order book evolvement may be observed and systematically evaluated. All created order books, actions and sequences can be stored and re-used to reproduce 1-to-1 the intended situation in the simulation environment.

Currently, the Order Placer can be connected to either of the two simulation environments operaten by EPEX SPOT. In principle, after appropriate changes to the API calls used, the Order Placer may be connected to further simulated intraday markets, too. The Windows .NET application is self-contained and can be installed via copy&paste. Together with the provided documentation, a user-friendly GUI allows to use the application quite quickly to its full extent.

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4.1.4 Price prognoses and data analyses for electricity markets

For more than a decade now, ior/cf-HSG offers an information service which provides clients with long- and short-term prognoses as well as with analyses of related volatilities. For the electricity markets Germany, Austria, and Switzerland, hourly price forward curves (HPFC) are generated for a horizon up to six years. Supplementary spike based HPFCs, short-term spot price prognoses, analyses of volatility structures, and (for Germany) a quarter-hour price forward curve (QHPFC) complete the information package offered. Subscriptions may be received by e-mail, downloaded from a special website, or captured by a webservice.

A successful trading and efficient hedging activities within physical or financial electricity require a sophisticated valuation of various contract types as well as a profound risk analysis and management. All these tasks strongly rely on the quality of the underlying HPFCs which is at the heart of every monetary valuation approach. Furthermore, the stochastic price dynamics have to be taken into account because otherwise the analyses would disregard relevant sources of risk.

As regards the method itself for generating HPFCs, special attention must be paid to the absence of arbitrage, to a suitable modeling of cyclical price components (the seasonality over different time spans of, e.g., one year, one week, one day), and to the consistency of forward price and spot price dynamics. The latter consistency holds when the current expectation of the uncertain prospective spot prices (over the respective maturities) matches the currently observed futures' prices. In this sense, a HPFC does not contain the most likely values of the spot prices in the future but rather represents the expected values of the probability distributions of the hourly spot prices. Furthermore, the adjacent regions Germany, Austria, and Switzerland and cross-border auctions require consistency among the respective market HPFCs.

For the following markets, HPFCs are generated for every trading day of the respective energy exchange: Germany (EEX Phelix DE), Austria (EEX Phelix AT), and Switzerland (Swissix), the futures of which are all traded at the European Energy Exchange EEX. All HPFC cover a time horizon of "5 years +", i.e., the remaining period of the current year plus the 5 subsequent calendar years. The calculation is carried out by an automated overnight run for the next trading day, always based on the most recent market data.

These HPFCs are generated in form of a so-called EE variant ('Erneuerbare Energien'): this variant intends to reflect the marketing potential for power producers of renewable energy, as – with begin of 2010 – the German transmission system operators habe been obliged by the 'Erneuerbare Energien Gesetz' to trade at the respective electricity exchange that amount of renewable energy which is not selected for the so-called 'direct marketing' method by their producers.

The EE variant incorporates these new marketed energy amounts in an implicit manner. Our studies based on historical data revealed that the classical way of assuring the resulting HPFC to be free of arbitrage – going along with a kind of shifting a scaled shape curve over small time windows according to the underlying base and peak futures products – may lead to anomalies within the HPFCs in the following sense: the price relation of neighboring hours within the HPFC does not reflect the respective price relation of the day-ahead spot prices; this behavior can be observed at the transitions from peak to off-peak periods and vice versa. In order to dissolve such inconsistencies, a supplementary constraint set is used within the optimization problem which ensures the arbitrage freeness of the HPFCs: based on historic price differences over a rolling time window of ca. 3 months, specific ranks of the ordered differences are taken as proxies for upper and lower confidence bands; these bands serve as upper and lower limits for the absolute price differences of neighboring hours within the HPFCs to be generated.

The offered set of electricity price forward curves is complemented by spike based HPFCs which shall reflect the incompleteness of the power markets. These so-called 'Spike HPFCs' are available for the markets EEX Phelix DE, EEX Phelix AT, and Swissix at the EEX and allow to set up a consistent setting for stress tests.

For the EEX Phelix DE market, an additional quarter-hour HPFC (QHPFC) is provided which incorporates quarter-hourly price patterns and which is in line with the respective EEX Phelix DE hourly PFC.

Supplementary short-term prognoses are determined for the same markets EEX Phelix DE, EEX Phelix AT, and Swissix at the EEX. These prognoses are delivered in the form of five confidence bands which represent an approximation of the real probability distribution of the hourly spot prices for the next seven days. Their determination relies on the seasonality within the respective HPFC, on the 24-hours term structure of the volatility (on a week-ahead basis), and on the stochastic dynamics of the clearing prices. All confidence bands are given by pairwise quantile information, thus coping with the fact of asymmetric spot price distributions. In particular, the volatility at the 'short end' (i.e., for the very near future) plays a significant role for these 7-day prognoses: because historically, electricity markets exhibit the same behavior of volatility clustering as financial markets do, i.e., a more volatile phase with higher price amplitudes is followed by a phase of lower volatility with minor price amplitudes and vice versa.

Moreover, a point forecast for the next 24 hours is provided together with supplementary information on the term structure over the same time span: this point forecast is given by the mode of the probability distribution of the spot price; the term structure is determined on a day-ahead basis reflecting the magnitude of the short-term price fluctuations.

Further information on this information service provided by ior/cf-HSG is available on the website www.iorcf.eu/dynamics.

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4.1.5 Risk-adjusted contract and portfolio management

BIT@EPI.PFO (Portfolio Optimization) has been developed as a state-of-the-art and multitasking decision support system. It supports participants within the energy sector to cope with today's challenging business processes and the tasks involved. Various types of delivery contracts and the own net position can be assessed, going along with an optimal value-oriented or quantity-oriented procurement strategy. The remaining risk exposure is split into separable categories according to the respective risk sources; corresponding risk premia are quantified which are in line with the market under consideration. Special reports and export functionalities generate specific information for the involved business units like sales department, (risk) controlling, or procurement. Due to the broad application concept, BIT@EPI.PFO addresses likewise utilities, trading companies, and electricity producers.

For a long time, the focus of utilities – and thus as well of the software applications used in the respective field – was predominantly directed at a low-cost and preferably safe coverage of the predicted load. This traditional view was rather limited and faded out other important aspects which are affected by a load forecast and a corresponding procurement: the quantification of residual risks, their implications for pricing one's own delivery services, and influences of a single procurement/hedging strategy for the overall net position. In response to these broader practical requirements, the ior/cf-HSG concentrates on further developing a decision support system which covers the tasks of procurement, sales, and risk management in an integrated way. Modern, liberalized electricity markets with both physical and financial electricity trading define the frame conditions for an effective decision support system.

Typical situations utilities are faced with are industrial customers who want to get an offer for the electricity supply over a specific time period according to their business needs. Formerly, two type of supply contracts existed for this purpose: a schedule delivery, where the customer gets his electricity following exactly a specific load prognosis, or a full delivery which permits the customer to deviate from the load prognosis, i.e., the electricity actually delivered can be higher or lower than has been predicted. For both type of deliveries – in order to evaluate a fair offer price – one has to distinguish between the price for the electricity itself and the price for remaining risks within the contract offer

which are implicitly taken by the utility. BIT@EPI.PFO supports the user by solving these different pricing problems.

The traditional supply contracts are augmented by two supplementary variants: (i) pure feed-in contracts, where the client in fact produces energy (mostly from renewable energy sources) and sells this energy to the utility, and (ii) combined supply and feed-in contracts, i.e., the client receives (scheduled or flexible) energy from the utility and simultaneously may produce own energy feeded back into the grid. In particular, the latter combined-type contracts exhibit an increased risk in case the expected supply and production are not provided as separate data but only in a netted way: Because in such cases, the effective volume and related price risks may be underestimated substantially for the separate supply and feed-in side.

All procedures mentioned above also apply – with some slight adaptions – to the related problem of investigating the utility's own net position and analyzing the inherent risks. Additionally, specific restrictions can be imposed for the analysis which are characteristic for managing a utility's net position: in particular, limits for the acceptable peak and off-peak long or short net position (still remaining after being hedged optimally) over specific time intervals.

As far as hedging strategies are concerned, two alternative approaches can be pursued: a quantity-oriented which fit best the expected energy quantity to be delivered (received, repsectively), or a value-oriented one which is geared towards the expected value of the energy to be delivered/received (obtained by valuing the predicted load with the current HPFC). Depending on the pursued hedging strategy of the utility, a purchase list at optimal cost is calculated.

Such purchase lists ideally directly lead to deals which should have to be performed. Intended and performed deals may be enterered and administered within BIT@EPI.PFO, together with relevant information for internal accounting purpose. (Just the trades themselves must be executed in an external trading system.) Special functionalities, which are related to trade products or to accounting periods, allow to review former procurement situations and to monitor the status of pending procurement activities.

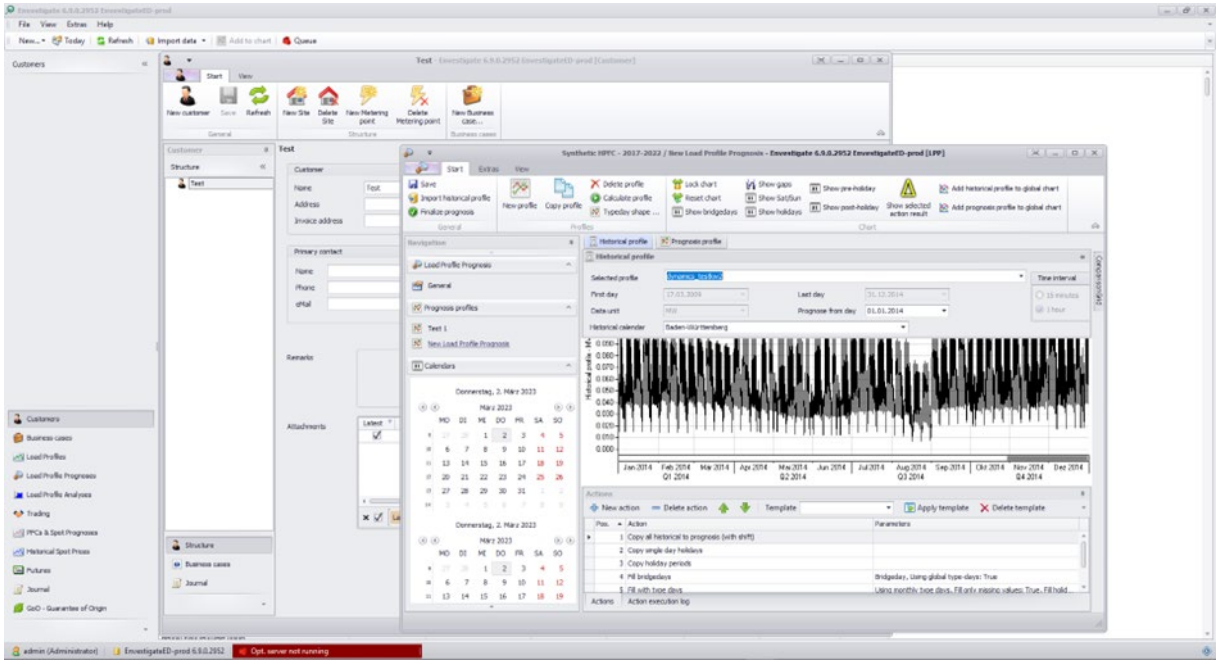
Even after the chosen hedge has been implemented, several risks may remain the utility is faced with. These risks are due to still existing imponderables: price risks (prices of hedge products may change during the contractual offer period or during the period which is necessary to buy the hedge products) as well as conjoint quantity and price risks caused by an imperfect hedge (any residual open position has to be closed afterwards at the cost of the uncertain future price) or by a price/load correlation in case of full supply contracts (typically, the customer's demand is higher than predicted in those periods where the spot prices are higher than usual and vice versa).

For these and further risk categories, BIT@EPI.PFO quantifies the contract-specific risk such that adequate risk premia may be imposed to the intrinsic electricity price. Along with the provided profit&loss distributions and corresponding statistical indicators, a sophisticated risk analysis can be carried out by the user. Offer reports support the sales department in its activities: these customizable reports may be generated in an automated way and rely on the fair price for the electricity and on the evaluated risk premia.

BIT@EPI.PFO is enhanced by a supplementary workflow module which incorporates the operative workflow process into the software: Triggered by inquiries of the sales department and other incidents, the relevant steps within the interaction of the back office, sales department and procurement department can be carried out in a transparent and retraceable way. Recurring tasks, like contract valuations based on newly arrived HPFCs, can be scheduled and run in an automated, event driven way.

For already procured Guarantees of Origin (GoO), available amounts and current prices can be deposited. A link between a signed or offered contract and a GoO leads to a reservation or to a definitive reduction of the necessary number of GoO certificates. A tabular overview provides for all types of parametrizable GoO the current state of procured, used, reserved, and still available amounts. In this

way, the remaining free amount for all GoO types is known to all users of the software, thus reducing the risk of selling green energy without being backed-up with the required GoOs.



Decision support system

On the technical and operational level, the software BIT@EPI.PFO represents a powerful and flexible decision support system by an integrated provision of the following features: a graphical user interface, multitasking capability, export/import and filtering features, tabular and graphical representations, pdf report generation, and user management as well as archiving and managing functions for all types of relevant data (contracts, calculations, load predictions, HPFCs, historical spot prices, etc.) in an attached database.

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4.1.6 Valuation and hedging of complex energy contracts

The software package BIT@EPI.VPP (Virtual Power Plant) provides a stand-alone solution for the valuation of energy contracts. As concerns the spectrum of possible contracts, the application covers the whole range between rather simple products without flexibility (e.g., standardized futures) and sophisticated virtual power plants which are characterized by inherent rights and/or duties. Being designed for the valuation of such complex contracts with inherent flexibilities, BIT@EPI.VPP solves multistage optimization problems which incorporate the uncertain future price evolution based on an hourly price forward curve and a forward price model. In addition to the fair contract value, the results also include the optimal expected exercise strategy and the therewith involved profit and loss distribution. Supplementary statistical indicators may serve as a basis for advanced risk analyses, and numerical data allow the implementation of a delta-hedging strategy – both for a weekly and monthly granularity. The application BIT@EPI.VPP offers a graphical user interface for the parameterization of energy contracts and for the management of the optimization runs and results.

At the energy exchanges, mainly the standardized futures (i.e., instruments without any flexibility) are really liquidly traded. Trade volumes of options are rather negligible, for example the trade of the (European style) Phelix options at the European Energy Exchange EEX. These two observations may be seen as an indication that market participants prefer to negotiate complex energy contracts (i.e., with a more sophisticates design compared to the standardized futures) on a bilateral basis. Thus, OTC arrangements of price, maturity, ingerent rights and duties particularly gain more importance.

Managing the design and controlling the risk of these types of 'flexible' energy contracts turn out to be key success factors in an increasingly competitive situation.

The software packages BIT@EPI.VPP is a powerful valuation instrument which fulfills the relevant functional requirements: extensive parameterization options for standardized and complex energy contracts, numerical valuation of the specified contract, quantification of important statistical indicators, and reporting on hedging strategies. The numerical results are clearly structured and contain the following information in table form and/or in graphic representations: the fair contract value, the optimal expected exercise strategy, the profit&loss distribution at the horizon of the contract period, and the corresponding hedging strategies on a weekly and monthly basis. Furthermore, well established statistical indicators (expected value, variance, value at risk, etc.) of the profit&loss distribution and of the probability distribution of exercised energy are stated.

In order to ensure the consistency of the fair contract value with the market under consideration, the applied valuation method must meet two core demands: an appropriate modeling of the uncertain future spot prices and the determination of an optimal exercise strategy within the remaining contract period. BIT@EPI.VPP overcomes these challenges in an integrated way by use of a multi-stage stochastic optimization problem: the evolution of the uncertain spot prices is driven by a parameterized stochastic process which exhibits the typical characteristics (mean reversion, seasonality, jumps, etc.). The exercise strategies are determined on an hourly basis in such a way that exercises of subsequent stages – i.e. in the more distant future – may depend on the exercise in previous stages.

A graphical user interface and a wide variety of administrative functions facilitate the management of the energy contracts and their analyses. All contracts and calculations are stored in an attached database such that contract specifications and results are permanently available for an actualization or further processing; required price forward curves can be imported from text or Excel files. Even for complex energy contracts, computation times on a standard PC lie in the range of minutes, thus fulfilling the typical operational requirements in daily business.

In conjunction with the attached database, BIT@EPI.VPP enables its users in the fields of energy trading, procurement, and supply to evaluate and manage manifold energy contracts. The provided results support the implementation of hedging strategies against price or load variation. In addition, the risks of a speculative trading can be quantified. The software comes as a stand-alone solution which is easily set up by an installer package.

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4.1.7 Regime-dependent natural gas price forward curves

In order to value natural gas supply contracts, price forward information is required for the respective market/hub under consideration as well as for the entire contract period. The ior/cf-HSG offers such price forward information with daily granularity for two market areas/hubs, which are operated by the *Dutch Title Transfer System* (TTF) and by the all-German *Trading Hub Europe* (THE) – the latter having arisen in October 2021 from the merger of NCG and the former Gaspool Balancing Services (GPL). The provided information for the covered hubs consists of two price forward curves (PFCs) each: these PFCs represent two regimes determining the shape of the respective curve, a cyclical one and an anti-cyclical one. A mechanism for generating these regime-dependent price forward curves has been implemented in the software module BIT@GAS.PFC. For the above-mentioned market areas, respective cyclical and anti-cyclical gas PFCa are automatically generated on a daily basis. Subscriptions to the information service may be received by e-mail and are downloadable from a special website.

A price forward curve (PFC) is supposed to be free of arbitrage possibilities with respect to traded forward or future contracts and to feature typical seasonal price patterns, if applicable. Due to limited storage capacity for gas, its primary use for heating purposes, and the fact that natural gas is traded on regional markets (versus a global market like for heating oil), a certain degree of seasonality can be expected to be present in natural gas spot prices. Therefore, this seasonality also needs to be incorporated into the PFC for natural gas deliveries. Comparable to electric power HPFCs, assumptions about seasonality are especially crucial if the availability of traded contracts with respect to future delivery periods diminishes. If for example only a single future price is available for a longer future time interval, the shape of daily forward prices of that respective period is completely determined by the underlying seasonality assumptions and futher structural patterns (weekdays, weekends etc.).

When turning to typical spot price patterns, it can be stated that prices for the market areas under consideration move closely together and that there is no stringent historical price pattern. Several of the past years were characterized by periods of detectable temperature dependency and by periods of rather sideways or flat price development in accordance with the development of storage levels. Based on these observations, we deem it appropriate to speak of two regimes: the degree to which gas storages were filled at a certain point in time in comparison to the actual demand, serves as one explanatory factor for the two regimes. The first regime results in a strong seasonal price pattern stressing mainly the temperature dependency of natural gas spot prices: such an expectation can be thought of being the effect of rather low future storage levels compared to the expected demand. The second regime, presumably a situation of high future storage levels, is characterized by a spot price expectation exhibiting a much weaker seasonality. We name these two regimes cyclical and anti-cyclical, respectively, leading to a related cyclical and anti-cyclical PFC, respectively.

Ior/cf-HSG offers its PFCs with daily granularity for the German Trading Hub Europe (THE) and the Dutch Title Transfer System (TTF). The respective futures prices, which are used to ensure the PFCs to be free of arbitrage, and the spot prices are taken from European Energy Exchange EEX Group.

Subscribers to the information service offered are supplied with two PFCs per trading hub and trading day: the PFCs corresponding to the cyclical and to the anti-cyclical regime. All convex combinations of these two PFCs are again free of arbitrage, representing the full bandwith of possible seasonality effects. The subscriber may use several convex combinations of the two regimes for scenario analyses or can choose a single combination in accordance with his subjective assessment of future evolutions.

Project staff: *Dr. Gido Haarbrücker, Claus Liebenberger*

4.2 Finance

The ior/cf-HSG offers software products and services for the financial industry.

4.2.1 Margin Optimizer

Margin Optimizer is a software for the control and quantification of the potential risk of non-maturing assets and liabilities in a bank's balance. Based on the analysis of a large number of repre-sentative scenarios for the evolution of future interest rates and volumes, the tool calculates dynam-ic replicating portfolios that take into account the risk inherent to changes in these factors. Com-pared to static approaches that are currently still standard in the banking industry, the dynamic replication allows a substantial increase and stabilization of the margins of variable positions.

Usually, a bank's balance consists to a large extent of assets and liabilities without contractually defined maturity. This includes in particular savings and sight deposits as well as variable mortgag-es. The characteristic feature of these so-called non-maturing assets and liabilities (NoMALs) is that the bank may always adjust the client rate – at least partially – to the current level of market rates. On the other hand, clients have the option to withdraw their investments or repay their mortgages, respectively, anytime at no penalty. It can often be observed that customers react to changes in mar-ket rates, e.g., by substituting their variable mortgages for fix-rate mortgages when interest rates are below their long-term average. Likewise, investors shift their savings deposits during periods of high rates into bonds with long maturities. Therefore, significant fluctuations in the volumes of these positions result on both sides of the balance. This makes the management of these accounts particularly difficult.

Although clients may withdraw or repay the corresponding volumes anytime, the money usually remains in the accounts over longer periods. From the bank's point of view, it would be inappropri-ate to designate them as daily maturing positions, as in reality the funds are available much longer. It is therefore required to assign a realistic "term profile" to an account without contractually de-fined maturity. To this end, the bank defines a so-called replicating portfolio that mimics the cash flows of the original position. In this way, uncertain cash flows are transformed into (apparently) certain ones and managed as such. However, this transformation depends strongly on assumptions and requires an adequate modeling of the problem.

The software tool "Margin Optimizer" is based on a multistage stochastic programming model. It uses stochastic models for the dynamics of the relevant risk factors: market rates, client rates and volume of the underlying position. The market rates are currently described by a term structure model with factors for the level of the yield curve and the spread between its short and long end. The model for the client rates reflects their characteristic tardiness. Finally, the volume model takes the dependency on interest rates into account.

The software generates a large number of representative scenarios for the future outcomes of the risk factors in such a way that their relevant statistical properties (i.e., certain moments) are pre-served. Then the optimal transactions along each scenario are determined. The resulting decision on the replication of the variable position exhibits not only an optimized risk profile. It is also more efficient since the multistage dynamic optimization of the portfolio anticipates a future reinvest-ment or refinancing risk (and the corresponding profits or losses for different future rates).

The experience made so far indicates that the margins of non-maturing assets and liabilities may be substantially increased and stabilized by the implementation of future investment or refinancing strategies.

Project staff: *Dr. Michael Schürle*

4.2.2 Benchmarking of Replication Strategies for Non-Maturing Assets and Liabilities

The ior/cf-HSG has vast experience in modeling non-maturing assets and liabilities (NoMALs) from research as well as practical projects with industry partners that go back to 1993. Activities in this field include the assessment of standard approaches for the construction of replicating portfolios, modeling the evolution of client rates and product volumes as well as the design of a dynamic repli-cation model based on multistage stochastic optimization methods. This experience is offered to banks for an assessment of their current approaches for managing NoMAL positions.

Since the future cash flows of NoMAL positions are uncertain due to their inherent options, banks usually determine a replicating portfolio to transform uncertain payments into apparently certain ones. On this basis, the associated interest rate risk is managed, and transfer prices are determined that split the margin into a compensation of the retail business unit which acquired the funds and the contribution of the treasury for a possible term transformation. The determination of an "accurate" replication is therefore of utmost strategic importance for a retail bank.

The common approach applied by most banks in Switzerland (and other European countries) is the construction of a replicating portfolio using simple money and capital market instruments. This method is also explicitly supported by the Swiss Financial Market Authority (FINMA). The total volume is split into time buckets that consist of several tranches with the same initial maturity. In each time bucket, every month one tranche matures and is renewed by an instrument with the same initial maturity. When the product volume changes, all tranches are proportionally increased or decreased. Thus, the non-maturing position is translated into a portfolio with constant duration.

However, this approach has several deficiencies both from a theoretical as well as from a practical point of view. The assumption of constant durations is problematic as usually the product volumes are highly sensitive to changes in interest rates and may vary significantly over time. This can be critical in the current market situation, as interest rates are historically low. In case they rise in the near future, it must be expected that clients withdraw liabilities. Then, positions in the replicating portfolio must be squared, which can lead to the realization of losses when these are originated from times of low market rates.

As an alternative, which is also suggested by the Swiss regulator, the bank's option to adjust the client rate and the clients' option to add or withdraw volume can be modeled directly. This means that stochastic models for the dynamics of market rates, client rates and volumes must be defined and calibrated to the available data. Then, client rates and volumes are projected into the future by Monte Carlo simulation over a certain time horizon. Specific characteristics of the client rate dynamics like caps, floors or asymmetric adjustments may easily be considered as well.

The simulation of the client rate cash flows and volume changes over the time horizon allow a valuation of the non-maturing position. In general, the value of an asset product is above and that of a liability product below par. This reflects the fact that mortgage or loan rates are higher than the level of market rates while deposit rates are lower, i.e., the marketing of non-maturing products provides an additional value over investment or refinancing in the interbank market. In particular, a stochastic pricing method allows the derivation of a transfer price directly.

This approach allows that the management of the non-maturing products and the marketing policy is guided by the outlook for the bank. For instance, expected changes in the client rates and/or volumes may lead to a negative indicated margin under the current pricing regime (i.e., the present value of an asset product is below and that of a liability product above par). In this way, a required change in the client rate of the corresponding product is indicated, or the current pricing strategy must be reconsidered in general. Furthermore, the interest rate sensitivity of the non-maturing product can be determined by passing stressed yield curves to the valuation model. Retail and treasury departments can therefore coordinate their pricing and hedging strategies to produce stable incomes.

Both methods require a deep understanding of the underlying assumptions and a careful application: In case of the apparently simple standard replication model because of its pitfalls, in case of the stochastic modelling approach due to its complexity. The ior/cf-HSG offers interested banks an assessment of their currently used methods for the replication and management of NoMAL positions. This allows potentials for increased margins and reduction of risks to be unlocked. Both have become a challenge of strategic importance for retail banks in the current low interest rate environment.

Project staff: *Dr. Michael Schürle*

4.2.3 Modelling Volumes and Client Rates of Retail Banking Products

The volumes of retail banking products show significant variations over time that can be attributed to changes in clients' demand, depending on the current level as well as the expected evolution of interest rates, offered product rates or other factors. The identification of the relations of product volumes on these factors provides valuable information for various applications like risk management, budget planning etc.

Over many years, the ior/cf-HSG has built competences for the modelling of retail banking products in the context of developing decision models for non-maturing assets and liabilities in cooperation with the industry. Non-maturing accounts have no contractual maturity, which offers bank clients the option to add or withdraw money anytime. Therefore, they are characterized by significant volume fluctuations. On the other hand, the bank may adjust the client rate of such products at discretion.

One result of these research activities are models that allow the verification and quantification of observed or suspected dependencies of product volumes on market rates, the corresponding client rate and other (macro-) economic variables. Furthermore, specific characteristics of the client rate dynamics like delayed or asymmetric adjustment to changes in market rates can be explained. Beside the use for the valuation and hedging of the risk of variable banking products, models of this type may also be exploited for the budget planning of banks, and the methodology might be extended to explain the volumes of fix-rate positions as well.

In an ongoing collaboration with a retail bank, the volume flows between different asset and liability positions are analyzed that are caused by clients' reaction to changes in the level of interest rates. The bank uses risk management software that requires the specification of transition matrices for these volume flows where a large number of parameters must be specified for different interest rate regimes that are estimated from historical data. Particular challenges are structural breaks in the existing time series as well as the unavailability of certain data over the complete historical sample period. Therefore, a special approach was based on a Kalman filter was implemented that estimates simultaneous time series of latent variables for which no observations are given. This new method allows an extension of the historic sample period and leads to a much better in-sample and out-of-sample fit to the observed data. A further important aspect of the bank's risk management is the evaluation of the impact of interest changes on earnings, which is quantified by a measure called earnings-at-risk. This requires models that reflect the dependency of client rates for the various retail banking products on market interest rates. The development of such models is not trivial due to the specific characteristics of client rates for typical products like delayed, incomplete, and asymmetric adjustment to market rate changes. The institute has developed a model for the product rate of savings accounts that reflects all these features and replaces the simplified built-in model of the bank's risk management software in the quarterly risk evaluation.

Project staff: *Dr. Michael Schürle*

4.2.4 Report on "Perspective Pro"

The increasing financial requirements of pension funds and the fragmentation of available data and parameters make it more difficult for managing directors and foundation board members to have a full overview of all relevant data clusters to steer the financial balance sheet and the challenges resulting from this. This has been the motivation for developing the tool "Perspective Pro" in close cooperation with a consultant company.

The primary objective of an asset and liability analysis is to determine whether the respective investment strategy, the performance targets (contributions, benefits, interest) and the risk-bearing capacity of the pension fund are coordinated. To this end, an asset and liability study first examines, evaluates, and compares the links and interdependencies between the assets and liabilities of a pension fund.

The design of pension schemes requires a long-term assessment not only of the development of liabilities but also of capital market risks (e.g., impact of low interest rates, crisis scenarios and their recovery period, possible development paths).

„Perspective Pro"enables a scenario-based simulation of the development of investments and liabilities and thus the identification of the risk ability (structurally and financially) over a perspective time horizon (e.g. 10 years). It enables the board of trustees to make a comprehensible assessment of the potential developments of the pension funds (investments, liabilities, risk capacity, reserves, target return vs. realised return) and its balance sheet (Swiss Gap, HGB) under various interest and inflation rate and capital market scenarios.

The development of investments, obligations, reserves, risk-bearing capacity and the required and achieved return over a longer time horizon is dynamically simulated and presented. Transparent scenario paths show the effects of stress phases and their recovery.

It supports managing directors, pension fund experts and foundation board members in steering the balance of the financial obligations and the funding in a comprehensive way. Fundamentals of this tool are a huge amount of data clusters and financial market data for revealing key drivers and dependencies between these data as wells to provide peer assessments.

The tool provides a wide range of data clusters to give a full overview of what the status quo of a pension fund is and what this status is in comparison to the relevant peer group. The dashboard comprises clusters for the following nine subcategories: financial status (e.g. economic cover ratio), portfolio strategy (e.g. performance ratio, volatility), funding (e.g. target return, net cash flow ratio), capability to restructure (e.g. demographic ratio), performance (e.g. return, performance ratio), compliance (e.g. spectrum of portfolio strategy, limitation of categories), risk trend (e.g. benefit cases, new cases of disability), cost (e.g. management cost, TER cost in %) and market (e.g. increase of insured person and retirees, demographic ratio of new contracts). Furthermore, these data clusters are analyzed regarding their dependencies among each other and their key drivers (endogenic and exogenic). In addition, an interactive tool shows the board of trustees the possibilities of intervention and their effects.

The integrated document management system provides central administration of the documents of the foundation board and other management bodies.

Project staff: *Ass. Prof. Robert Gutsche Ph.D., Dr. Gido Haarbrücker, Claus Liebenberger*

5 Teaching

The University of St. Gallen (HSG) covers the fields of Business Administration, Economics, International Affairs, Law, and Law and Economics. Academic degrees can be obtained at the bachelor, master, and doctoral level. The degree courses at HSG start with the Assessment Level of one year providing an introduction to the academic subjects, requirements, and objectives of the University of St. Gallen. In this first academic year, the students are familiarized with the requirements of studying and acquire their first academic competences. Teaching in this Assessment Year acquaints students with the basic knowledge of their respective disciplines as well as of scientific methods. It enables them to work on and solve theoretical as well as practical problems within an appropriate period of time. On the Assessment Level, all students pass through the same stages together in order to qualify for the Bachelor level.

Students who have passed the Assessment Year examinations as a whole will be able to proceed to the bachelor level and opt for one of the majors “Business Administration”, “Economics”, “International Affairs”, “Law”, and “Law and Economics”. As a rule, undergraduate courses extend to a total of 6 semesters, namely two semesters at the assessment level and four semesters at the bachelor level. The awarded degree “Bachelor of Arts (HSG)” is a first academic degree that qualifies the graduates for professional work and enables them to enter working life. After having obtained a bachelor’s degree, one may continue with studies at the master level. This level aims to carry out in-depth theoretical and practical work in certain fields with selected specialties. The University of St. Gallen offers eleven master programs in the fields of Business Administration, Economics, International Affairs, and Law. The programs take three or four semesters and end with the award of the degree “Master of Arts HSG”.

The ior/cf-HSG offers courses on bachelor (across all majors) and master level. With regard to teaching on the master level, the institute participates in the master programs “Banking and Finance” (MBF) and “Accounting and Finance” (MAccFin).

5.1 Trading Room

As part of a project of the rectorate, the SoF Chair "Operations Research" and the ior/cf-HSG were commissioned in 2014 with the conceptual design and further management of a new trading room and investment lab with 21 trading desks for HSG. In recent years, various lectures have been designed for the Trading Room on topics related to "Energy Finance" and "Equity Analysis & Security Trading", which have been in great demand from students. Located in the Tellstrasse building, it offers an experience-oriented learning environment. From traditional stock and bond markets to complex energy trading, from plain vanilla products to complex derivatives, the HSG Trading Room opens a virtually unlimited horizon in terms of simulating real market conditions.

The HSG Trading Room reproduces a trading floor equipped with trading software and a ticker band, as well as access to the financial databases Bloomberg and Thomson Reuters. The HSG Trading Room significantly enhances active learning opportunities at the University of St. Gallen. Its objective is to support and promote sustainable and responsible learning and research in energy, finance, and related fields. Due to the high demand by students, teaching in the trading room has reached a bottleneck. Initially driven by the Covid pandemic, virtual trading room was set up, allowing access via the internet and offering a virtual space for a larger number of students than the existing physical room. In addition, it allows students to practice their trading skills also outside of the regular course hours.

5.2 Bachelor level

5.2.1 Asset-backed Commodity Trading

Lecturers: *Ass. Prof. Robert Gutsche Ph.D., Prof. Dr. Florentina Para-schiv, Dr. Alexandru Rif, Dr. Michael Schürle*

In the last years there has been a notable influx of energy trading as markets were liberalized and producers and consumers have a need to hedge the risk of their future supply and de-mand. Fluctuations in intermittent generation from renewables, as well as higher volatility in fuel prices, have increased these risks in both the short term (intraday) and long term (up to a few years). In addition, financial institutions began to view commodities in general and energy in particular as a distinct asset class, leading to increasing capital inflows from these market participants.

The course introduces students to the trading fundamentals of selected energy markets, energy investment concepts, as well as trading techniques and strategies for energy and correspond-ing derivatives. The focus in on oil, gas, and electricity. We also illustrate the climate impact of the use of fossil fuels and discuss the consequences of the transition towards a carbon-neutral energy system for energy markets. In the spring semester, the contents of the lectures were briefly adapted to current events, namely the turmoil on the energy markets triggered by the Russian invasion of Ukraine. In particular, the influence on the gas markets was discussed and, using data not yet known to the public at the time, it was shown how the Russian side had already prepared for a gas bottleneck the year before by cutting gas supplies and emptying the storage facilities controlled by Gazprom in Western Europe. In fall, the lecture was updated with the latest developments and options for substituting Russian gas supplies were discussed to secure energy supply for the coming winter season.

5.2.2 Fundamental Business Analysis: Using Financial Statements

Lecturer: *Ass. Prof. Robert Gutsche Ph.D.*

The financial statements are the primary means of communication of corporate information to investors and at the same time also the primary source of information for investors. The information contained in the financial statements are highly relevant for investment decisions. For this reason, a competent evaluation and interpretation of financial statement information is of central importance for the allocation of resources. The aim of this course is to enable students to read financial statements, to understand and to be able to derive investment decisions based on this analysis. The course combines the analysis of financial statements and the evaluation of securities from the investor's perspective.

The course has the very practical emphasis on methods for analyzing and valuing firms using financial statements. Several case studies are integrated. By completing this course, students will feel competent in writing a thorough, credible equity research report or investment analysis that meets the highest standards. The course is of interest to those contemplating careers in investment banking (particularly in equities), security analysis, equity hedge funds, private equity, consulting, public accounting, and corporate finance. In addition to that, it is also helpful with personal investing.

5.2.3 Bloomberg Seminars

Lecturer: *Dr. Michael Schürle*

The Bloomberg Terminal is an information system that provides price quotes, news and all kinds of economic key indicators which drive financial and commodity markets in real time. It has become a standard tool for the financial industry with hundreds of thousands of installations worldwide. The terminal offers also access to historical data and is therefore a valuable source for research in finance and economics. Particularly for students who strive for a career in the financial sector, knowledge of the Bloomberg Terminal is a marketable skill that will improve their chances on the job market.

The University of St. Gallen provides access to seven Bloomberg Terminals in the Dataroom 01-U206 (main building) plus an additional Terminal in the library exclusively for its students and faculty members. In order to promote this unique resource that is only available at few universities due to the high license fees, the institute offers frequently preparation courses for the use of the Bloomberg Terminals for HSG students of all levels.

5.2.4 Strategic Management of Utility Companies

Lecturers: *Dr. Ivo Schillig, Dr. Christian Opitz*

The imminent full liberalization of the Swiss electricity market and the integration of renewable energies, combined with increasing convergence of energy sources, confront energy utilities with far-reaching entrepreneurial challenges. In addition, the rapid progress of digitization is blurring previous industry boundaries – the end of traditional business models of Swiss energy utilities is foreseeable. In this turbulent environment, energy utilities face the challenge of achieving their economic and environmental goals without compromising security of supply.
The aim of the course is to show the students strategic issues due to the changing framework conditions of the Swiss energy industry and to collectively develop implications for the strategic management of an energy supply company based on concrete practical examples.

5.3 Master Level

On this level, the institute participates in the *Master Program in Banking and Finance (MBF), in* the *Master Program in Quantitative Economics and Finance (MiQE/F)* and in the *Master Program in Accounting and Finance (MAccFin)*. The ior/cf-HSG teaches various compulsory courses, core electives, and independent electives. A major aim of these courses is to provide the program participants with a well-founded methodical competence in the respective subject matters.

5.3.1 Financial Programming with Matlab

Lecturer: *Dr. Michael Schürle*

This course introduces programming and solving relevant problems in Finance (mainly pricing derivatives) with numerical tools. It uses the programming system and language MATLAB, which is an easy to learn, but versatile and powerful programming environment. The design of the sys-tem allows to write powerful programs for complex real-world problems with a few lines of code. Thus, MATLAB has become a standard tool also in the financial industry and a solid background is a useful qualification in the job market.

The course aims at students with no or little previous experience in programming in MATLAB. Furthermore, the concepts behind common financial models and numerical solution methods are introduced. By learning how to make programs robust against inconsistent input and numerical errors, students acquire competences that are relevant for own academic research as well as for the industry.

5.3.2 Risk-Adjusted Performance Measurement

Lecturer: *Prof. Dr. Karl Frauendorfer*

The lecture deals with the tension between hedging and proprietary trading. On the basis of selected spot and futures markets, risk-appropriate parameters for performance measurement are introduced, which help to assess the basic risks and the effectiveness of hedging with futures and options (including the effects of dependency structures and volume uncertainties). Challenges in the distinctions between hedging and speculative proprietary trading are highlighted. Trading strategies can be com-

pared on the basis of their risk-return structures. Finally, the application of hedge accounting for selected financial reports is critically reflected.

5.3.3 Valuation for Accounting and Corporate Valuation

Lecturer: *Ass. Prof. Robert Gutsche Ph.D*

Every asset has a value. The accountants just have to find it. When a high degree of uncertainty is involved, the measurement of assets, liabilities or equity becomes complex and requires expert knowledge to determine their recognition and measurement in the balance sheet according to the International Financial Reporting Standards (IFRS). We address complex valuation topics in accounting from a theoretical and practical perspective. It provides a framework for valuation and illustrates valuation problems with case studies and high-profile guest speakers from practice.

The focus of the course is on practical application and integration of corporate finance, valuation, and accounting concepts to valuing companies, strategies, corporate assets, corporate debt or equity. The course uses case studies that students have to present in class.

Students who successfully complete this course will have the knowledge and skills to face even unusual valuation problems in accounting. They will be able to apply expert valuation techniques in the areas of business combinations, including the valuation for goodwill and intangibles, financial instruments, and investment property.

6 Competence Center Energy Management

The competence center, based at the Institute for Operations Research and Computational Finance, deals with strategic issues in the fields of energy, disposal/recycling and sustainabil-ity. Central topics are the decarbonization of our energy system (while ensuring security of supply) as well as the transformation of our economy towards a circular economy with a special focus on municipal and construction waste. In addition to numerous activities in the field of executive education, the activities of the competence center increasingly include third-party funded research projects as well as consulting projects that create concrete added value for utility companies or public administration while integrating current research results.

6.1 Conferences

Our competence center organizes conferences in the energy sector and related fields. The gatherings facilitate personal meetings, discussions, and the launch of new projects. The range of topics cover natural and renewable gas, electricity and associated fields like heat or waste management.

6.1.1 Waste Symposium

The Waste Symposium 2022 was dedicated to different facets of the circular economy: The innovative handling of water cycles in the city of St. Gallen, activities of the city of Zurich in the field of avoiding and reducing municipal waste, but also insights from the practice of con-struction material recycling. Finally, the global view on the pollution of our oceans rounds off the contents of this symposium. The event is organized on a yearly basis by the Competence Center Energy Management (ior/cf-HSG) in cooperation with the municipal waste disposal department of St. Gallen (ESG) and the Waste Management Association St. Gallen-Appenzell (A-Region). www.recyclingtagung.ch

6.1.2 Gas Conference

The Federal Council's commitment to net-zero is putting a strain on fossil natural gas – even though gas utilities' pipeline systems can play an important role in the overall context of the energy transition. The path to green gases is technically and economically challenging, and the outcome is uncertain. The 2022 Gas Conference, organized by the Competence Center Energy Management (ior/cf-HSG), addressed these key issues, which the gas industry, large-scale consumers and politicians alike must confront. www.gastagung.ch

6.2 Executive Education

6.2.1 Management of Recycling Companies (Recyclingmanager) (CAS-HSG)

The advanced executive training aims to enable the participants to adequately meet the up-coming challenges connected with the fundamental change of the Swiss waste management industry towards a circular economy triggered by the newly introduced Ordinance on the Avoidance and the Disposal of Waste. The program organized by the Competence Center En-ergy Management (ior/cf-HSG) is designed for executives from disposal and recycling compa-nies, its supply industry and political and administrative leaders. www.recyclingmanager.ch

6.2.2 Governing Energy Transitions (CAS-HSG)

Governing Energy Transitions (GET) is an action learning program to develop a common un-derstanding of the challenges and opportunities arising from the Swiss energy transition. The execu-tive training is tailor-made for interested executives in order to develop a thorough un-derstanding of governing the social, technical, business/economic and regulatory dimensions of the energy transition, as well as the competencies required to apply this knowledge at the local level. The overall aim of the program is to facilitate a dialogue between a group of pas-sionate industry experts, government offi-cials and academics and to actively foster a GET-community. www.governing-energy-transitions.ch

6.2.3 Management of Utility Companies (EVU-Manager) (CAS-HSG)

The advanced executive training aims to enable the participants to adequately meet the up-coming entrepreneurial challenges connected with transformation towards a decarbonized and decentralized energy system triggered by the Energy Strategy 2050 and the Federal Coun-cil's commitment to net-zero emissions by 2050. The program organized by the Competence Center Energy Management (ior/cf-HSG) is designed for executives from utilities, its supply industry and political and administra-tive leaders. www.evu-manager.ch

6.3 Focus

In the area of energy, recycling, and sustainability we focus on the following topics:

- Cooperations and partnerships
- Customer needs and customer experience
- Trend-based strategy development
- Strategy development and positioning
- Transformation of the energy system
- Decarbonization strategies
- Business model analysis and development

6.3.1 Forecast “Energy Future 2050” for the Association of Swiss Electricity Companies

The study "Energy Future 2050" examines possible options for the transformation of the Swiss energy system and their effects, especially with regard to the fulfillment of Switzerland's en-ergy and climate goals. The analysis is based on four representative scenarios along the di-mensions of domestic ac-ceptance for new energy infrastructure (defensive vs. offensive ex-pansion) and energy policy rela-tionship with Europe (isolated vs. integrated).

The modeling and analysis of Switzerland's overall energy system was commissioned by the Association of Swiss Electricity Companies (VSE) and carried out by the electricity industry in collaboration with the Swiss Federal Laboratories for Materials Science and Technology (Empa) and the Competence Center Energy Management (ior/cf-HSG) as scientific partners. The study is the first scientific model that simulates Switzerland's overall energy system across all sectors up to the year 2050, taking neighboring countries into account.

Project staff: *Dr. Christian Opitz, Dr. Michael Schürle*

6.3.2 Market Monitoring of Energy-Performance Contracting

The Energy Strategy 2050 foresees a 43% reduction in average energy consumption per person by 2035, compared to 2000 levels. swissesco was created as a professional association with the aim of promoting the development of contracted or guaranteed efficiency measures in the energy and climate sector. On behalf of swissesco and with the support of the Swiss Federal Office of Energy, the Competence Center Energy Management (ior/cf-HSG) investigated the Swiss market for energy-performance contracting. The aim was to get a more precise idea of the size and functioning of the market for contracted or guaranteed energy efficiency services in Switzerland.

Project staff: *Dr. Christian Opitz*

7 Competence Center Security Analysis

7.1 Activities

Prof. Robert Gutsche, Ph.D. is an assistant professor for financial and management accounting and the vice director for equity research and head of the CC Security Analysis that the ior/cf-HSG implemented in 2015.

The CC Security Analysis aims at providing

- Practice-oriented solutions for the analysis of profitability, growth and risk
- Independent research and teaching in the area of Fundamental Analysis, Corporate Finance and Security Valuation, Risk Management, Performance Management and Analysis of Risk and Return, Financial Reporting, Regulation and Standard Setting

Bridging systemic and idiosyncratic risk analysis through the integration of fundamental risk analysis as well as behavioral aspects into quantitative risk analysis. Fostering critical reflection of investing and trading is not a "natural science"; it is driven by market dynamics, crowd behavior and fundamentals.

The CC Security Analysis is active in the executive education and offers executive courses, such as:

- Taktical Asset Allocation
- Value Investing & Active Investment Analytics: Tools for active investment decisions
- Financial management of pension funds - identifying and monitoring key risks

The CC Security Analysis aims at expanding the practice-oriented research activities to develop independent, innovative and tailor-made solution for investment managers together with our partners.

7.2 InnoSuisse Project

The CC Security Analysis under Prof. Robert Gutsche, Ph.D. at the ior/cf-HSG, the ZHAW & the Association of Swiss Asset Managers agreed to a project with the support of KPMG's Global Valuation Team & Maerki Baumann, aimed at researching and implementing an innovative big data investment profiling technology to enable SPBS-tailored investment research.

The idea is to break the investment analysis up into manageable components–tailored building blocks–that can be easily analyzed by SPBS firms and merged into the big picture. The platform is based on reverse engineering, big data & machine learning analytics to reach a fundamental investment risk pro-file. The InnoSuisse project was granted in 2021 and is scheduled to be finished in 2023.

Project Staff: Ass. *Prof. Robert Gutsche, Ph.D., Dr. Alexandru Rif, Dr. Florian Deglmann*

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