



FH Salzburg
Center for Secure
Energy Informatics

8th DACH+ Conference on Energy Informatics

Conference Guide



Technology
Health
Media

Contents

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Welcome to Salzburg University of Applied Sciences!



Dear participants of DACH+ Energy Informatics 2019,

With increasingly more ambitious and necessary climate goals, the role of Energy Informatics as an interdisciplinary research field has become more pronounced. The DACH+ Energy Informatics conference aims at bringing together researchers and practitioners from the areas of energy systems as well as information and communication technology to present new results and discuss future research directions.

This year, we received a record number of 66 submissions: 57 full and short research papers as well as 9 posters and demos have been submitted. For the conference, 23 full and short research contributions were accepted, resulting in an acceptance rate of 40%.

This year's conference is organized and hosted by the Salzburg University of Applied Sciences, with support by the Austrian Computer Society, Salzburg Research and the Austrian Institute of Technology. We gratefully acknowledge funding by the Austrian Federal Ministry for Transport, Innovation and Technology, as well as the Federal State of Salzburg and the Salzburg Chamber of Commerce.

We would also like to sincerely thank the two keynote speakers, the session chairs, the program committee members, and of course, the many helping hands during the conference.

We are happy to have you here and wish you an exciting conference and fruitful exchanges.

Sincerely,



Dominik Engel
Salzburg University of Applied Sciences



Andreas Unterweger
Salzburg University of Applied Sciences



Günther Eibl
Salzburg University of Applied Sciences

The Conference Idea

DACH+ Energy Informatics 2019 is part of a conference series dedicated to promoting the research, development, and implementation of information and communication technologies in the energy domain and to fostering the exchange between academia, industry, and service providers in the German-Austrian-Swiss region and its neighboring countries (DACH+).

The Energy Informatics conference series is a joint initiative of the Austrian Ministry for Transport, Innovation and Technology, the Swiss Federal Office of Energy, and the German Federal Ministry for Economic Affairs and Energy. This year's edition of the conference is also supported by the Austrian Computer Society.

Committees

Conference Chairs

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| Dominik Engel | Salzburg University of Applied Sciences (A) |
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| Andreas Unterweger | Salzburg University of Applied Sciences (A) |
| Fabian Knirsch | Salzburg University of Applied Sciences (A) |
| Michael Brand | OFFIS (D) |
| Peter Dorfinger | Salzburg Reserach (A) |
| Nicole Siebenhandl | Salzburg University of Applied Sciences (A) |

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| Michael Hübner | Austrian Ministry for Transport, Innovation and Technology (A) |
| Michael Moser | Swiss Federal Office of Energy (CH) |
| Dominik Engel | Salzburg University of Applied Sciences (A) |
| Friederich Kupzog | Austrian Institute of Technology (A) |
| Sebastian Lehnhoff | OFFIS (D) |
| Christoph Mayer | OFFIS (D) |
| Astrid Nieße | Leibnitz University Hannover (D) |

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| Verena Tiefenbeck | ETH Zurich (CH) |
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Technical Program Committee

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| Wilfried Elmenreich | University of Klagenfurt (A) |
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| Veit Hagenmeyer | Karlsruhe Institute of Technology (D) |
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| Kai Hufendiek | University of Stuttgart (D) |
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| Mikkel Kjærgaard | Syddansk University (DK) |
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| Fabian Knirsch | Salzburg University of Applied Sciences (A) |
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| Andrea Kollmann | Energieinstitut Linz (A) |
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| Friederich Kupzog | Austrian Institute of Technology (A) |
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| Sebastian Lehnhoff | OFFIS (D) |
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| Zheng Ma | Syddansk University (DK) |
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| Reinhard Mackensen | Fraunhofer Institute for Wind Energy Systems (D) |
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| Ingo Mauser | Karlsruhe Institute of Technology (D) |
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| Christoph Mayer | OFFIS (D) |
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| Peter Palensky | TU Delft (NL) |
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| Daniele Puccinelli | University of Applied Sciences of Southern Switzerland (CH) |
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| Wolfgang Pree | University of Salzburg (A) |
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| Marco Pruckner | Fraunhofer Institute for Wind Energy Systems (D) |
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| Silvia Santini | USI Lugano (CH) |
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| Jens Strüker | Fresenius University of Applied Sciences (D) |
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| Hans-Peter Schwefel | Aalborg University (A + DK) |
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| Michael Sonnenschein | University of Oldenburg (D) |
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| Thorsten Staaake | University of Bamberg + ETH Zurich (D+CH) |
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| Anke Weidlich | University of Freiburg (D) |
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| Christof Weinhardt | Karlsruhe Institute of Technology (D) |
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Program Overview

THURSDAY
26 September 2019

| Time | Program | Location |
|---------------|---|--------------------|
| 08:30 | Registration and Coffee | Foyer |
| 09:00 - 09:20 | Opening and Welcome Address | HS 110 |
| 09:20 – 10:20 | Keynote »A Socio-Economic Perspective on Energy Informatics« Dr. Andrea Kollmann, Energy Institute at the Johannes Kepler University Linz | HS 110 |
| 10:20 – 12:00 | Session 1 »Energy Markets and Local Energy Communities« <ul style="list-style-type: none"> Impact of advanced electricity tariff structures on the optimal design, operation and profitability of a grid-connected PV system with energy storage - Lionel Bloch, Jordan Holweger, Christophe Ballif and Nicolas Wyrsch Clustering Time Series Applied to Energy Markets - Cornelia Krome, Jan Höft and Volker Sander Forecasting Cross-Border Power Transmission Capacities in Central Western Europe Using Artificial Neural Networks - Hazem Abdel-Khalek, Mirko Schäfer, Raquel Alejandra Vásquez Torres, Jan Frederick Unnewehr and Anke Weidlich Trading Solar Energy within the Neighborhood: Field Implementation of a Blockchain-Based Electricity Market - Anselma Woerner, Arne Meeuw, Liliane Ableitner, Felix Wortmann, Sandro Schopfer and Verena Tiefenbeck Trust-less Electricity Consumption Optimization in Local Energy Communities - Fabian Knirsch, Oliver Langthaler and Dominik Engel | HS 110 |
| 12:00 – 13:00 | Lunch | in front of HS 110 |
| 13:00 – 15:10 | Session 2 »Data Analysis, Privacy and Communication« <ul style="list-style-type: none"> Virtualising redundancy of power equipment controllers using Software-defined networking - Ferdinand von Tüllenburg, Peter Dorfinger, Armin Veichtlbauer, Ulrich Pache, Oliver Langthaler, Helmut Kapoun, Christian Bischof and Friederich Kupzog A Study on the Impact of Data Sampling Rates on Load Signature Event Detection - Jana Huchtkoetter and Andreas Reinhardt Pool Detection from Smart Metering Data with Convolutional Neural Networks - Cornelia Ferner, Günther Eibl, Andreas Unterweger, Sebastian Burkhart and Stefan Wegenkittl | HS 110 |

| Time | Program | Location |
|---------------|---|---|
| | <ul style="list-style-type: none"> P6V2G: A Privacy-Preserving V2G Scheme for Two-Way Payments and Reputation - Rebecca Schwerdt, Matthias Nagel, Andy Rupp, Valerie Fetzer and Tobias Gräf Protecting the Grid Topology and User Consumption Patterns during State Estimation in Smart Grids based on Data Obfuscation - Lakshminarayanan Nandakumar, Gamze Tillem, Zekeriya Erkin and Tamas Keviczky Comparison of solar power measurements in alpine areas using a mobile dual-axis tracking system - Jelenko Karpić, Ekanki Sharma, Tamer Khatib and Wilfried Elmenreich | |
| 15:10 – 15:40 | Coffee Break | in front of HS 110 |
| 15:40 – 18:15 | Session 3 »Modelling and Simulation« <ul style="list-style-type: none"> Towards Automated Engineering and Validation of Cyber-Physical Energy Systems - Filip Pröbstl-Andrén, Thomas I. Strasser, Jürgen Resch, Bernhard Schuiki, Sebastian Schöndorfer, Georg Panholzer and Christof Brandauer Towards modular composition of agent-based voltage control concepts - Thomas Wolgast and Astrid Nieße Deriving Policies from Connection Codes to ensure ongoing Voltage Stability - David Ryan, Miguel Ponce De Leon, Niall Grant, Bernard Butler, Markus Mirz, Steffen Vogel and Pádraig Lyons Towards Domain-specific Surrogate Models for Smart Grid Co-Simulation - Stephan Balduin, Martin Tröschel and Sebastian Lehnhoff Architectural and Functional Classification of Smart Grid Solutions - Friederike Wenderoth, Elisabeth Drayer, Martin Braun, Michael Niedermeier and Robert Schmoll Enabling architecture based co-simulation of complex Smart Grid applications - Christoph Binder, Michael Fischinger, Lukas Altenhuber, Christian Neureiter, Goran Lastro and Dieter Draxler | HS 110 |
| 18:30 | Departure Shuttle to Conference Dinner | Forecourt Salzburg University of Applied Sciences |
| from 19:00 | Conference Dinner | Imlauer Sky Restaurant |

Program Overview

FRIDAY
27 September 2019

| Time | Program | Location |
|---------------|---|--------------------|
| 08:00 | Registration and Coffee | Foyer |
| 08:30 - 09:20 | Keynote »The energy transition – an integrative analysis« Prof. Dr. Claudia Binder École Polytechnique Fédérale de Lausanne | HS 110 |
| 09:30 – 10:20 | One-minute Madness | HS 110 |
| 10:20 – 12:00 | Poster & Demo Session (with coffee) | HS 017 |
| 12:00 – 13:00 | Lunch | in Front of HS 110 |
| 13:00 – 15:15 | Session 4 »Load Management and Operations« <ul style="list-style-type: none"> • An optimisation-based energy disaggregation algorithm for low frequency smart meter data - Cristina Rottondi, Marco Derboni, Dario Piga and Andrea-Emilio Rizzoli • State-based load profile generation for modeling energetic flexibility - Kevin Förderer and Hartmut Schmeck • Distributed multi-objective scheduling of power consumption for smart buildings - Marvin Nebel-Wenner, Christian Reinhold, Farina Wille, Astrid Nieße and Michael Sonnenschein • Visualizing and gamifying resource consumption data: lessons learned, challenges and a research agenda for the future - Piero Fraternali, Francesca Cellina, Sergio Herrera, Mark Melenhorst, Jasminko Novak, Chiara Pasini, Cristina Rottondi and Andrea Emilio Rizzoli • A Cooperative Demand-Response Framework for Day-ahead Optimization in Battery Pools - Georgios Chasparis, Mario Pichler, Johanna Spreitzhofer and Tara Esterl • Designing an integrated socio-technical behaviour change system for energy saving - Ksenia Koroleva, Mark Melenhorst, Jasminko Novak, Sergio Luis Herrera Gonzalez, Piero Fraternali and Andrea-Emilio Rizzoli | HS 110 |

| Time | Program | Location |
|---------------|---|----------|
| 15:15 – 15:30 | Farewell and Conference Closing | HS 110 |
| from 15:30 | Demand Management Workshop Energy demand management through consumer engagement and behavior change systems | HS 110 |



Keynote Speakers

Dr. Andrea Kollmann

Energy Institute at the Johannes Kepler University Linz



Andrea Kollmann is project manager at the Energy Institute at the Johannes Kepler University Linz, Department of Energy Economics. She currently coordinates and serves as work package manager in three different Horizon2020 projects.

She studied economics with an emphasis in macroeconomics and holds a PhD in economics from the Johannes Kepler University Linz.

Her research is focused on how customers – private as well as industrial ones – can be motivated and supported in becoming active participants in the energy transition and how novel products and services can be used and implemented to this aim.

Keynote »A Socio-Economic Perspective on Energy Informatics«

Socio-economic research in the energy field benefits from continuously improving access to household-level energy consumption data; most notably the smart metering infrastructure changes the way and depth with which researchers can analyse and understand the drivers of household-level energy consumption. In this keynote, Andrea Kollmann presents results from several research projects exploiting electricity load-profiles of households together with ancillary information about the people behind the meter. She will present the results of field testing a smart phone app with more than 3,000 households, which i) informs users about their energy consumption and creates motivation to reduce electricity demand, ii) supports households to become active customers, iii) and creates incentives for consumers to shift their electricity loads towards times of high renewable production.

She will also show how this data allows the pre-assessment of regulatory measures and how such pre-assessment can improve their accuracy. Furthermore, she elaborates how non-monetary incentives can trigger behavioural change towards a more environmentally friendly lifestyle. Her talk also addresses the challenges for socio-economic research from a European perspectives showing results of a recent pan-EU survey among 18,000 Europeans.

Prof. Dr. Claudia R. Binder

École Polytechnique Fédérale de Lausanne (EPFL)



Claudia R. Binder holds the Swiss Mobiliar Chair for Urban Ecology at ENAC, EPFL and is the head of the laboratory for Human-Environment Relations in Urban Systems (HERUS) at EPFL.

She has a PhD in environmental sciences and a *venia legendi* in Human-Environment Systems, both from ETHZ, Switzerland.

Since 2016 she is member of the research council of the Swiss National Science Foundation. Her research interests lie in analyzing, modeling and assessing transitions or urban systems towards sustainability. Her application areas are in energy, phosphorous, food, in the context of urban and peri-urban areas.

Keynote »The energy transition – an integrative analysis«

The ongoing energy transition is seen as a key constituent for the transition towards a more sustainable society. An important element in the move towards a sustainable energy system is the transition from a mainly centralized, fossil-fuel system to a more localized, renewable one.

This transition, however, requires not only the development of new energy technologies but also radical, systemic shifts in deeply held values and beliefs, in patterns of social behavior, and in governance regimes. Thereby the ecological, technical and social systems have to be conceptualized as Social-Ecological-Technical Systems (SETS) and new integrative, interdisciplinary research approaches are needed which consider the interaction between these subsystems.

We present results of an integrative analysis of energy transitions. We show (i) how institutional development and infrastructure development co-evolve; (ii) scenarios of the energy demand in the housing sector; and (iii) the determinants affecting household decision making and consequently energy demand in the housing sector. Finally, we look into the potential of DSM, platforms in steering energy consumption.

Full and Short Paper Abstracts

Session 1 »Energy Markets and Local Energy Communities«

Impact of advanced electricity tariff structures on the optimal design, operation and profitability of a grid-connected PV system with energy storage.

Lionel Bloch, Jordan Holweger, Christophe Ballif and Nicolas Wyrsh

ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE

The increasing penetration of residential photovoltaics (PV) comes with numerous challenges for distribution system operators. Technical difficulties arise when an excess of PV energy is injected into the grid, causing voltage rise or overloading of the lines. Economic challenges appear because PV owners and consumers are not participating equally in the grid costs. Indeed, PV owners benefit by self-consuming their PV production and by gaining additional revenues when they sell their PV surplus to the grid. Hence, they lower their grid costs. In this paper, we propose a mixed-integer-linear programming approach to solve the design and operation of a PV and battery system efficiently. We use this tool to benchmark five different tariff scenarios, which include real-time pricing, a capacity-based tariff, and a block rate tariff, and evaluate their effect on the design and operation of the system. Carefully tailored metrics show the impact of these tariff structures on the trade-off between the economic viability of privately owned energy systems and their grid usage intensity. Considering both aspects, we show that a block rate tariff is the most promising approach and that capacity-based tariffs rely on PV curtailment alone to curtail the generation peaks.

Clustering Time Series Applied to Energy Markets.

Cornelia Krome, Jan Höft and Volker Sander

AACHEN UNIVERSITY OF APPLIED SCIENCES

In Germany and many other countries the energy market has been subject to significant changes. Instead of only a few large-scale producers that serve aggregated consumers, a shift towards regenerative energy sources is taking place. Energy systems are increasingly being made more flexible by decentralised producers and storage facilities, i.e. many consumers are also producers. The aggregation of producers form another type of power plants: a virtual power plant.

On the basis of aggregated production and consumption, virtual power plants try to make decisions under the conditions of the electricity market or the grid condition. They are influenced by many different aspects. These include the current feed-in, weather data, or the demands of the consumers. Clearly, a virtual power plant is focusing on developing strategies to influence and optimise these factors. To accomplish this, many data sets can and should be analysed in order to interpret and create forecasts for energy systems. Time series based analytics are therefore of particular interest for virtual power plants.

Classifying the different time series according to generators, consumers or customer types simplifies processes. In this way, scalable solutions for forecasts can be found. However, one has to first find the according clusters efficiently.

This paper presents a method for determining clusters of time series. Models are adapted and model-based clustered using ARIMA parameters and an individual quality measure. In this way, the analysis of generic time series can be simplified and additional statements can be made with the help of graphical evaluations. To facilitate large scale virtual power plants, the presented clustering workflow is prepared to be applied on big data capable platforms, e.g. time series stored in Apache Cassandra, analysed through an Apache Spark execution framework.

The procedure is shown here using the example of the Day-Ahead prices of the electricity market for 2018.

Forecasting Cross-Border Power Transmission Capacities in Central Western Europe Using Artificial Neural Networks.

Hazem Abdel-Khalek, Mirko Schäfer, Raquel Alejandra Vásquez Torres, Jan Frederick Unnewehr and Anke Weidlich

DEPARTMENT OF SUSTAINABLE SYSTEMS ENGINEERING, UNIVERSITY OF FREIBURG

Flow-based Market Coupling (FBMC) provides welfare gains from cross-border electricity trading by efficiently providing coupling capacity between bidding zones. In the coupled markets of Central Western Europe, common regulations define the FBMC methods, but transmission system operators keep some degrees of freedom in parts of the capacity calculation. Besides, many influencing factors define the flow-based capacity domain, making it difficult to fundamentally model the capacity calculation, and to derive reliable forecasts from it. In the light of this challenge, the given contribution proposes to model the capacity domain in FBMC by applying Artificial Neural Networks (ANN). Target values are the Maximum Bilateral Exchanges (MAXBEX). Only publicly available data is used as inputs to make the approach reproducible for any market participant. It can be shown that the results obtained in a first implementation already show a high correlation with actual MAXBEX values, and that mean average errors between model output and actual values are small. The approach could fill the gap of missing information on the capacity calculation implemented in practice, and by this provide valuable information for an efficient bidding strategy formulation by market participants.

Trading Solar Energy within the Neighborhood: Field Implementation of a Blockchain-Based Electricity Market.

Anselma Woerner¹, Arne Meeuw², Liliane Ableitner¹, Felix Wortmann², Sandro Schopfer¹ and Verena Tiefenbeck¹

¹ETH ZÜRICH, ²UNIVERSITY OF ST. GALLEN

Due to environmental and resiliency benefits, distributed energy resources (DER) are a potential solution for meeting future electricity demand, but their integration into centralized power markets on the large scale is challenging. Many practitioners argue that blockchain technology can create new market structures for DER like local peer-to-peer energy markets which foster renewable generation. To get an understanding of the status quo of the research on blockchain-based energy exchange, we conducted a systematic literature review on the existing academic articles and industry projects. This article describes the design and technical specifications of the first real blockchain-based electricity market in Switzerland derived from this literature review and outlines the implementation of this market in the real world. The findings provide valuable guidelines for the integration of DER into future sustainable energy markets.

Trust-less Electricity Consumption Optimization in Local Energy Communities.

Fabian Knirsch, Oliver Langthaler and Dominik Engel

CENTER FOR SECURE ENERGY INFORMATICS, SALZBURG UNIVERSITY OF APPLIED SCIENCES

Optimizing energy consumption in local energy communities is one of the key contributions to the so-called smart grid. Such communities are equipped with rooftop photovoltaic power plants or other forms of small power plants for local energy production. In addition, a number of appliances allow for shiftable energy consumption, e.g., heat pumps or electric vehicle charging stations. The ability to shift is, however, dependent on customer preferences. In this paper, we present a trust-less approach for optimizing the electricity consumption in a local energy community given forecasts of energy production and customer demands, along with constraints for shiftable loads. In larger communities, appointing a single party for managing load curtailment, requires a high level of trust. In the proposed trust-less approach, all parties can independently propose optimal solutions for this optimization problem and then globally agree one one solution that meets the defined requirements to the greatest extent.

Session 2 »Data Analysis, Privacy and Communication«

Virtualising redundancy of power equipment controllers using Software-defined networking. *Ferdinand von Tullenburg¹, Peter Dorfinger¹, Armin Veichtlbauer², Ulrich Pache², Oliver Langthaler², Helmut Kapoun³, Christian Bischof³ and Friederich Kupzog⁴*

¹ SALZBURG RESEARCH FORSCHUNGSGESELLSCHAFT MBH, ² SALZBURG UNIVERSITY OF APPLIED SCIENCES, ³ SIEMENS AG AUSTRIA, ⁴ AIT - AUSTRIAN INSTITUTE OF TECHNOLOGY

Power system automation is heavily dependent on the reliable interconnection of power system field equipment and centralised control applications. Particularly important to achieve reliability in automated power systems is the redundant connection of field equipment controllers. Today, the fundamental redundancy management and switch-over processes are handled by the power system control applications itself. This, however, increases the complexity of the control systems and leads to an intersection of concerns. Consequently, the design and the implementation of field equipment controller redundancy is time-consuming and cost-intensive. In this paper, we propose the implementation of a redundancy virtualisation layer for power system controllers based on software-defined networking (SDN). The goal is to relieve the control applications from managing field level redundancy. Thus, our SDN approach allows to detect gateway failures and to perform transparent switch-overs. This significantly simplifies the configuration of the control application with redundant components and finally leads to more flexible and simplified redundancy design, deployment and operation. Arbitrary redundancy topologies, such as triple-controller-redundancy can be implemented without modifying the control applications.

A Study on the Impact of Data Sampling Rates on Load Signature Event Detection.

Jana Huchtkoetter and Andreas Reinhardt TU CLAUSTRAL

The analysis of electrical load signatures is an enabling technology for many applications, such as ambient assisted living or energy saving recommendation systems. Through the digitalization of electricity metering infrastructure, meter reading intervals are gradually becoming more frequent than the traditional once-per-year reporting. In fact, across smart meter generations, samples were initially reported in 15-minute intervals, more recently once per second, and even newer devices capture readings at rates on the order of several kilohertz. This also leads to larger volumes of collected data, which in turn impose greater resource requirements on the collection hardware and communication channel. At the same time, the greater information content is expected to weigh up these downsides by enabling more fine-grained insights when processing such data. It needs to be remarked, however, that the advantages of using such high sampling rates have not been unambiguously demonstrated in literature. We thus choose a widely considered application scenario of energy data analytics, event detection, and assess the impact of the sampling rate choice on the correct event recognition rate. More specifically, we compare the accuracy of three event detection algorithms with respect to the resolution of their input data. The results of our analysis hint at a non-linear relation between accuracy and data resolution, yet also indicate that most event occurrences can be correctly determined when using a sampling rate of approximately 1 kHz, with only minimal improvements achievable through higher rates.

P6V2G: A Privacy-Preserving V2G Scheme for Two-Way Payments and Reputation.

Rebecca Schwerdt, Matthias Nagel, Andy Rupp, Valerie Fetzer and Tobias Gräß

KARLSRUHE INSTITUTE OF TECHNOLOGY

The number of electric vehicles (EVs) is steadily growing. This provides a promising opportunity for balancing the smart grid of the future, because vehicle-to-grid (V2G) systems can utilize the batteries of plugged-in EVs as much needed distributed energy storage: In times of high production and low demand the excess energy in the grid is stored in the EVs' batteries, while peaks in demand are mitigated by EVs feeding electricity back to the grid. But the data needed for managing individual V2G charging cycles as well as for billing and rewards is of a highly personal and therefore sensitive nature. This causes V2G systems to pose a significant threat to the privacy of their users. Existing cryptographic protocols for this scenario either do not offer adequate privacy protection or fail to provide key features necessary to obtain a practical system. Based on the recent cryptographic toll collection framework P4TC, this work introduces a privacy-preserving but efficient V2G payment and reward system called P6V2G. Our system facilitates two-way transactions in an offline and post-payment setting. It provides double-spending detection, an integrated reputation system, contingency traceability and blacklisting features, and is portable between EVs. The aforementioned properties are holistically captured within an established cryptographic security framework. In contrast to existing protocols, this formal model of a V2G payment and reward system allows us to assert all properties through a comprehensive formal proof.

Protecting the Grid Topology and User Consumption Patterns during State Estimation in Smart Grids based on Data Obfuscation.

Lakshminarayanan Nandakumar¹, Gamze Tillem², Zekeriya Erkin² and Tamas Keviczky²

¹ CGI NEDERLAND B.V., ² DELFT UNIVERSITY OF TECHNOLOGY

Smart grids promise a more reliable, efficient, economically viable, and environment-friendly electricity infrastructure for the future. State estimation in smart grids plays a pivotal role in system monitoring, reliable operation, automation, and grid stabilization. However, the power consumption data collected from the users during state estimation can be privacy-sensitive. Furthermore, the topology of the grid can be exploited by malicious entities during state estimation to launch attacks without getting detected. Motivated by the essence of a secure state estimation process, we consider a weighted-least-squares estimation carried out batch-wise at repeated intervals, where the resource-constrained clients utilize a malicious cloud for computation services. We propose a secure masking protocol based on data obfuscation that is computationally efficient and successfully verifiable in the presence of a malicious adversary. Simulation results show that the state estimates calculated from the original and obfuscated dataset are exactly the same while demonstrating a high level of obscurity between the original and the obfuscated dataset both in time and frequency domain.

Pool Detection from Smart Metering Data with Convolutional Neural Networks.

Cornelia Ferner, Günther Eibl, Andreas Unterweger, Sebastian Burkhart & Stefan Wegenkittl

SALZBURG UNIVERSITY OF APPLIED SCIENCES

The rising demand for sustainable energy requires to identify the sites for photovoltaic systems with the best performance. This paper tackles the question of feasibility of photovoltaic power plants at high altitude. A direct comparison between an alpine and an urban area site is conducted in the south of Austria. Two low-cost automatic photovoltaic power measurement devices with dual-axis sun tracking and maximum power point tracking are deployed at two test sites. The systems periodically perform a scan over the southern semihemisphere and execute maximum power point adjustment in order to assess the performance for a given direction. The gathered data shows a higher photovoltaic power yield in the higher altitude test site. Furthermore, the high altitude photovoltaic power as a function of azimuth and elevation angle appears to be not only higher but also more flat than in lower altitudes. This indicates a lower power loss in case of deviation from the optimal solar angles. The results show that even on low-cost hardware a difference in photovoltaic power can be observed, even though in this experiment it amounts to less than 5 % increase of peak power in higher altitudes. However, the measured peak powers on the mountain are more stable and therefore closer to a constant level than the heavily fluctuating peak power values at the low altitude site. Additionally, a slight shift in optimal elevation angles between altitudes can be observed, as the optimum angle turns out to be lower on the high altitude site. This angle shift could be caused by snow reflections on the mountainous test site.

Comparison of solar power measurements in alpine areas using a mobile dual-axis tracking system. *Jelenko Karpić¹, Ekanki Sharma¹, Tamer Khatib² and Wilfried Elmenreich¹*

¹ UNIVERSITY OF KLAGENFURT, AUSTRIA, ² AN-NAJAH NATIONAL UNIVERSITY, PALESTINE

The rising demand for sustainable energy requires to identify the sites for photovoltaic systems with the best performance. This paper tackles the question of feasibility of photovoltaic power plants at high altitude. A direct comparison between an alpine and an urban area site is conducted in the south of Austria. Two low-cost automatic photovoltaic power measurement devices with dual-axis sun tracking and maximum power point tracking are deployed at two test sites. The systems periodically perform a scan over the southern semihemisphere and execute maximum power point adjustment in order to assess the performance for a given direction. The gathered data shows a higher photovoltaic power yield in the higher altitude test site. Furthermore, the high altitude photovoltaic power as a function of azimuth and elevation angle appears to be not only higher but also more flat than in lower altitudes. This indicates a lower power loss in case of deviation from the optimal solar angles. The results show that even on low-cost hardware a difference in photovoltaic power can be observed, even though in this experiment it amounts to less than 5 % increase of peak power in higher altitudes. However, the measured peak powers on the mountain are more stable and therefore closer to a constant level than the heavily fluctuating peak power values at the low altitude site. Additionally, a slight shift in optimal elevation angles between altitudes can be observed, as the optimum angle turns out to be lower on the high altitude site. This angle shift could be caused by snow reflections on the mountainous test site.

Session 3 »Modelling and Simulation«

Towards Automated Engineering and Validation of Cyber-Physical Energy Systems.

Filip Pröbstl-Andrén¹, Thomas I. Strasser¹, Jürgen Resch², Bernhard Schuiki², Sebastian Schöndorfer², Georg Panholzer³ and Christof Brandauer³

¹ AIT AUSTRIAN INSTITUTE OF TECHNOLOGY GMBH, ² ING. PUNZENBERGER COPA-DATA GMBH, ³ SALZBURG RESEARCH

The massive deployment of distributed generators from renewable sources in recent years has led to a fundamental paradigm change in terms of planning and operation of the electric power system. The usage of advanced automation and information and communication technology is a key element to handle these new challenges and to turn the traditional power system into a smart grid. The implementation of such complex systems solutions is associated with increasing development complexity resulting in increased engineering costs. The traditional engineering methods used for power system automation were not intended to be used for applications of this scale and complexity. However, the usage of proper methods, automation architectures, and corresponding tools holds huge optimization potential for the engineering process. Therefore, this work presents a model-based engineering and validation support system, covering the overall engineering process for smart grid applications.

Towards modular composition of agent-based voltage control concepts.

Thomas Wolgast and Astrid Nieße

LEIBNIZ UNIVERSITÄT HANNOVER, GROUP ENERGY INFORMATICS

In the last years, diverse agent-based concepts for voltage control in distribution grids were presented in literature. All these approaches are developed manually. Up to now, no tailoring approach has been presented to adapt these concepts to different – likewise specific – grid situations. As the effectiveness of voltage control schemes is highly dependent on the specific grid situation, this can result in multiple problems with regard to performance, applicability and expandability of the proposed agent-based control. The ideal case would be a customizable agent system that is automatically tailored to the grid it shall be applied to, considering its specific characteristics. To address that complex task, this paper proposes an approach for the modular composition of voltage control agents by recombining existing concepts from literature to new fully functional agent systems. This approach makes the first move to an optimized and scenario-specific creation of agent-based control systems that are specifically designed and automatically tailored to a given power system.

Deriving Policies from Connection Codes to ensure ongoing Voltage Stability.

David Ryan¹, Miguel Ponce De Leon¹, Niall Grant, Bernard Butler¹, Markus Mirz², Steffen Vogel² and Pádraig Lyons³

¹ TELECOMMUNICATIONS SOFTWARE SYSTEMS GROUP, WATERFORD INSTITUTE OF TECHNOLOGY, ² RWTH AACHEN UNIVERSITY, ³ ESB NETWORKS

The management of distribution and transmission networks is becoming increasingly complex due to the proliferation of renewables-based distributed energy resources (DER). Existing control systems for DER are based on static specifications from interdependent network connection documents. Such systems are inflexible and their maintenance requires concerted effort between the networks stakeholders. In this paper we present a new supplementary control approach to increase the agility of the electricity system. The ICT system that underlies smart grids has the potential to offer, by analogy with ICT based network management, a control plane overlay for the modern smart grid. Policy-based Network Management (PBNM) is widely deployed in managed telecoms networks. We outline how PBNM can augment the management of power and energy networks and report on our initial work to validate the approach. To configure the PBNM system, we used text mining to derive connection parameters at the LV level. In our simulations, PBNM was used in collaboration with a Volt-VAR optimisation (VVO) to tune the connection settings at each DER to manage the voltage across all the buses. We argue that the full benefits will be realised when stakeholders focus on agreeing relatively stable high-level connection policies, the policies being refined dynamically, and algorithms such as VVO that set connection parameters so they are consistent with those high-level policies. Thus faults, power quality issues and regulatory infringement can be identified sooner, and power flow can be optimised.

Towards Domain-specific Surrogate Models for Smart Grid Co-Simulation.

Stephan Balduin¹, Martin Tröschel¹ and Sebastian Lehnhoff²

¹ OFFIS - INSTITUTE OF INFORMATION TECHNOLOGY, ² UNIVERSITY OF OLDENBURG

Surrogate models are used to reduce the computational effort for the simulation of complex systems. The power grid can be considered as such a complex system with large numbers of interdependent inputs. With artificial neural networks and deep learning it is possible to build high dimensional approximation models, but a large data set for the training process is required, too. This paper presents an approach to sample the input data and build a deep learning surrogate model of a lower voltage grid. Challenges are discussed and the model evaluated under different conditions. The results show that the model performs well from the perspective of pure machine learning, but has domain-specific weaknesses.

Architectural and Functional Classification of Smart Grid Solutions.

Friederike Wenderoth¹, Elisabeth Drayer², Martin Braun¹, Michael Niedermeier³ and Robert Schmoll⁴

¹ FRAUNHOFER IEE, UNIVERSITY OF KASSEL, ² UNIVERSITY OF THE NEGEV, BEER SHEVA, ³ CHAIR OF COMPUTER NETWORKS AND COMPUTER COMMUNICATIONS, UNIVERSITY OF PASSAU, ⁴ DEPARTMENT OF MEASUREMENT AND CONTROL, UNIVERSITY OF KASSEL

Historically, the power distribution grid was a passive system with limited control capabilities. Due to its increasing digitalization, the paradigms are shifting: the passive architecture of the power system itself, which includes cables, lines, and transformers, is extended by a communication infrastructure to become an active distribution grid. This transformation to an active system results from control capabilities that combine the communication and the physical components of the grid. It aims at optimizing, securing, enhancing, or facilitating the power system operation. The combination of power system, communication, and control capabilities is also referred to as a "smart grid". A multitude of different architectures exists to realize such integrated systems. They are often labeled with descriptive terms such as "distributed," "decentralized," "local," or "central." But the actual meaning of these terms varies considerably within the research community. This paper illustrates the conflicting uses of prominent classification terms for the description of smart grid architectures. One source for this inconsistency is that the development of such interconnected systems is not only in the hands of classic power engineering but requires input from neighboring research disciplines such as control theory and automation, information and telecommunication technology, and electronics. This impedes a clear classification of smart grid solutions. Furthermore, this paper proposes a set of well-defined operation architectures specialized for use in power systems. Based on these architectures, this paper defines clear classifiers for the assessment of smart grid solutions. This allows the structural classification and comparison between different smart grid solutions and promotes a mutual understanding between the research disciplines.

Enabling architecture based co-simulation of complex Smart Grid applications.

Christoph Binder, Michael Fischinger, Lukas Altenhuber, Christian Neureiter, Goran Lastro and Dieter Draxler

SALZBURG UNIVERSITY OF APPLIED SCIENCES

The integration of decentralized prosumers into current energy systems leads to continuously increasing complexity in today's popular term of the Smart Grid. Since conventional engineering methods reach their limits when dealing with the challenges in developing such systems, model-driven approaches like Domain Specific Systems Engineering (DSSE) gain significant importance. Contributing to the agile development of such a System of Systems (SoS), the application of the DSSE approach is furthermore supported by the introduction of the Smart Grid Architecture Model (SGAM) and Mosaik. However, with both concepts being individual methodologies, their interconnection is missing specifications. Therefore, this paper proposes the development of an interface between architecting and simulating a complex Smart Grid. To achieve this, the concepts of SGAM and Mosaik are analyzed in the first place in order to set up a suitable architectural model of an energy system and the corresponding simulation scenario. Subsequently, the applicability of the present approach is demonstrated by utilizing an excerpt of a real-world case study, the charging behavior of an Electric Vehicle (EV).

Session 4 »Load Management and Operations«

An optimisation-based energy disaggregation algorithm for low frequency smart meter data. *Cristina Rottondi¹, Marco Derboni², Dario Piga² and Andrea-Emilio Rizzoli²*

¹ POLITECNICO DI TORINO, ² DSIA USI/SUPSI

An algorithm for the non-intrusive disaggregation of energy consumption into its end-uses, also known as non-intrusive appliance load monitoring (NIALM), is presented. The algorithm solves an optimisation problem where the objective is to minimise the error between the total energy consumption and the sum of the individual contributions of each appliance. The algorithm assumes that a fraction of the loads present in the household is known (e.g. washing machine, dishwasher, etc.), but it also considers unknown loads, treating them as a single load. The performance of the algorithm is then compared to that obtained by two state of the art disaggregation approaches implemented in the publicly available NILMTK framework. The first one is based on Combinatorial Optimization, the second one on a Factorial Hidden Markov Model. The results show that the proposed algorithm performs satisfactorily and it even outperforms the other algorithms from some perspective.

State-based load profile generation for modeling energetic flexibility.

Kevin Förderer¹ and Hartmut Schmeck²

¹ FZI RESEARCH CENTER FOR INFORMATION TECHNOLOGY, ² KARLSRUHE INSTITUTE OF TECHNOLOGY

Communicating the energetic flexibility of distributed energy resources (DERs) is a key requirement for enabling explicit and targeted requests to steer their behavior. The approach presented in this paper allows the generation of load profiles that are likely to be feasible, which means the load profiles can be reproduced by the respective DERs. It also allows to conduct a targeted search for specific load profiles. Aside from load profiles for individual DERs, load profiles for aggregates of multiple DERs can be generated. We evaluate the approach by training and testing artificial neural networks (ANNs) for three configurations of DERs. Even for aggregates of multiple DERs, ratios of feasible load profiles to the total number of generated load profiles of over 99% can be achieved. The trained ANNs act as surrogate models for the represented DERs. Using these models, a demand side manager is able to determine beneficial load profiles. The resulting load profiles can then be used as target schedules which the respective DERs must follow.

Distributed multi-objective scheduling of power consumption for smart buildings.

Marvin Nebel-Wenner¹, Christian Reinhold², Farina Wille², Astrid Nieße³ and Michael Sonnenschein⁴

¹ OFFIS, ² TU BRAUNSCHWEIG, ³ LEIBNIZ UNIVERSITÄT HANNOVER, ⁴ UNIVERSITÄT OLDENBURG

Load management of electrical devices in residential buildings can be applied with different goals in the power grid, such as the cost optimization regarding variable electricity prices, peak load reduction or the minimization of behavioral efforts for users due to load shifting. A cooperative multi-objective optimization of consumers and generators of power has the potential to solve the simultaneity problem of power consumption and optimize the power supply from the superposed grid regarding different goals. In this paper, we present a multi-criteria extension of a distributed cooperative load management technique in smart grids based on a multi-agent framework. As a data basis, we use feasible power consumption and production schedules of buildings, which have been derived from simulations of a building model and have already been optimized with regard to self-consumption. We show that the flexibilities of smart buildings can be used to pursue different targets and display the advantage of integrating various goals into one optimization process.

Visualizing and gamifying resource consumption data: lessons learned, challenges and a research agenda for the future.

Piero Fraternali¹, Francesca Cellina², Sergio Herrera¹, Mark Melenhorst³, Jasminko Novak^{3,4}, Chiara Pasini¹, Cristina Rottondi² and Andrea Emilio Rizzoli²

¹ POLITECNICO DI MILANO, ² SUPSI, ³ EUROPEAN INSTITUTE FOR PARTICIPATORY MEDIA, BERLIN, ⁴ UNIVERSITY OF APPLIED SCIENCES STRALSUND, GERMANY

In this paper we highlight insights drawn from currently ongoing research projects aimed at developing visualization and gamification tools to stimulate individual behaviour change and promote energy and water saving. We address both the design of resource-saving programmes and the methodologies to assess their effectiveness. We conclude by presenting a vision for the future and discussing open issues that could lead future research directions in the field of behavioral change approaches to resource sustainability.

A Cooperative Demand-Response Framework for Day-ahead Optimization in Battery Pools. *Georgios Chasparis¹, Mario Pichler¹, Johanna Spreitzhofer² and Tara Esterl²*

¹ SOFTWARE COMPETENCE CENTER HAGENBERG, ² AUSTRIAN INSTITUTE OF TECHNOLOGY

The continuously increasing electricity and energy demand in residential buildings, as well as the need for higher absorption rates of renewable sources of energy, demands for an increased flexibility at the end-users. This need is further reinforced by the rising numbers of residential Photovoltaic (PV) and battery-storage systems. In this case, flexibility can be viewed as the excess energy that can be charged to or discharged from a battery, in response to a group objective of several such battery-storage systems (aggregation).

One such group objective considered in this paper includes marketing flexibility (charging or discharging) to the Day-ahead (DA) spot market, which can provide both a) financial incentives to the owners of such systems, and b) an increase in the overall absorption rates of renewable energy. The responsible agent for marketing and offering such flexibility, herein aggregator, is directly controlling the participating batteries, in exchange to some financial compensation of the owners of these batteries, while in parallel accommodating potential preferences of the users.

To this end, we present an optimization framework that allows the aggregator to optimally exchange the available (charging or discharging) flexibility to the DA market. The proposed scheme is based upon a reinforcement-learning approach, according to which the aggregator learns through time an optimal policy for bidding flexibility to the DA market. By design, the proposed scheme is flexible to accommodate the possibility of erroneous forecasts (of weather, load or electricity price), while it provides the possibility of re-optimizing in case of updated/corrected forecasts in real-time during the implementation day.

Designing an integrated socio-technical behaviour change system for energy saving.

Ksenia Koroleva¹, Mark Melenhorst^{1,2}, Jasminko Novak^{1,3}, Sergio Luis Herrera Gonzalez⁴, Piero Fraternali⁴ and Andrea-Emilio Rizzoli⁵

¹ EUROPEAN INSTITUTE FOR PARTICIPATORY MEDIA, ² SAXION UNIVERSITY OF APPLIED SCIENCES, ³ STRALSUND UNIVERSITY OF APPLIED SCIENCES, ⁴ POLITECNICO DI MILANO, ⁵ SCUOLA UNIVERSITARIA PROFESSIONALE DELLA SVIZZERA ITALIANA

Stimulating households to save energy with behavioural change support systems is a challenge and an opportunity to support efforts towards more sustainable energy consumption. The approaches developed so far, often do not consider the underlying behavioural change process in a systematic way, or do not provide a systematic linking of design elements to findings from behavioural change literature and the design of persuasive systems. This paper discusses the design and evaluation of a holistic socio-technical behaviour change system for energy saving that combines insights from behavioural theories and the persuasive system design in a systematic way. The findings from these two streams of research are combined into an integrated socio-technical model for informing the design of behavioural change systems for energy saving, which is then implemented in a concrete system design. The developed system combines smart meter data with interactive visualisations of energy consumption and energy saving impact, gamified incentive mechanisms, energy saving recommendations and attention triggers. The system design distinguishes between a version with non-personalized energy saving tips and a version with personalized recommendations that are deployed and evaluated separately. In this paper, we present the design and evaluation results of the non-personalized system in a real-world pilot in Switzerland. Obtained results indicate reduced energy consumption compared to a control group and a positive change in energy knowledge in the treatment group using the system, as well as positive user feedback about the suitability of the designed system to motivate them to save energy.

Poster Abstracts

Towards Price Based Demand Side Management Using Machine Learning.

Mischa Ahrens¹, Jan Müller^{2,3} and Hartmut Schmeck^{2,3}

¹ FZI RESEARCH CENTER FOR INFORMATION TECHNOLOGY, ² KARLSRUHE INSTITUTE OF TECHNOLOGY (KIT), ³ INSTITUTE OF APPLIED INFORMATICS AND FORMAL DESCRIPTION METHODS (AIFB)

In demand side management, variable electricity pricing is often used to shape the load of electricity consumers and producers. The task of finding the right price profile to realize a target load profile is a bilevel optimization problem that varies in complexity depending on the considered distributed energy resources. Solutions to this problem proposed in the literature usually rely on extensive simplifications and often consider only specific device types or load shaping methods. Simple pricing schemes often fail to induce specific target load profiles due to effects like load synchronization.

This poster abstract extends a machine learning based electricity pricing scheme proposed in previous work. Its objective is to generate price profiles based on knowledge about the behavior of energy resources in response to different price profiles and in various situations. Principally, the presented pricing scheme can be used for any device configuration under the assumption that it offers exploitable flexibility and is governed by an automated energy management system aimed at minimizing energy costs.

A Concept for Standardized Benchmarks for the Evaluation of Control Strategies for Building Energy Management.

David Wölfle¹, Kevin Förderer¹ and Hartmut Schmeck²

¹FZI FORSCHUNGSZENTRUM INFORMATIK, ² KARLSRUHE INSTITUTE OF TECHNOLOGY

Given the expected high penetration of renewable energy production in future electricity systems, it is common to consider buildings as a valuable source for the provisioning of flexibility to support the power grids. Motivated by this concept, a wide variety of control strategies for building energy management has been proposed throughout the last decades. However, these algorithms are usually implemented and evaluated for very specific settings and considerations. Thus, a neutral comparison, especially of performance measures, is nearly impossible. Inspired by recent developments in reinforcement learning research, we suggest the use of common environments (i.e. benchmarks) for filling this gap and finally propose a general concept for standardized benchmarks for the evaluation of control strategies for building energy management.

Modeling approach for thermal dependencies in complex industrial energy supply system.

Thomas Kohne, Philipp Aaron Becker, Thomas Weber, Niklas Panten and Eberhard Abele

TU DARMSTADT

Rising digitization in industrial production sites and processes offers the opportunity to implement optimization approaches for operational strategies of decentralized energy supply systems (DESS). Current model-based approaches like mixed integer linear programming (MILP) often neglect modeling temperature dependencies and thermal inertia in complex thermal grids in production sites. In this paper a modular MILP model is presented in a model predictive control (MPC) approach which integrates temperature dependencies and thermal inertia in complex DESS. The validation by simulation shows that the approach manages to map thermal dependencies successfully and reduce energy consumption and cost of the DESS by optimizing temperature levels. Hence the approach enables a stable optimized control of complex DESS.

Estimation of the Regional Electricity Mix.

Philipp Danner¹ and Hermann de Meer²

¹ BAYERNWERK AG, ² UNIVERSITÄT PASSAU

In future electricity systems, flexibility is seen to be the counterpart to the volatile renewable energy resources like

photo-voltaic or wind plants. A flexible usage of mobile (e.g. electric vehicles) and immobile loads (e.g. electric heating systems) could be utilised in order to maximise the usage of energy from renewable sources without neglecting the power limits of the grid. Beside the temporal differences, also the spatial difference of the energy mix is important. Consumption of local renewable energy as near as possible to the actual generation helps to reduce the amount of energy transmission and thus power losses. Spatial electricity mix calculations have only been performed on high level (country, control area or bidding zone) so far. In this work, we propose a method to estimate the electricity mix by modelling the energy demand and supply on municipal level. This is done by utilising statistic data sets and suitable profiles (e.g. standard load profiles) or (simple) generation models in order to incorporate temporal differences. Finally, the dynamic supplies and demands are assigned to high voltage to medium voltage substations using the geographically k-nearest substations and a suitable distance metric in order to create a computable power grid model.

Disruptive Business Models Enabling Large Battery Energy System Deployment.

Egor Mazourenko¹, Philipp Heer², Dr. Elena-Lavinia Niederhaeuser³ and Dr. Dimitri Torregrossa¹

¹ AURORA'S GRID SÄRL, ² EMPA, ³ HEFR

The paper focuses on the economic profitability of Battery Energy Storage System (BESS) in distribution grids, accounting for interests of local Distribution System Operator (DSOs) and residential Prosumers equipped with PV panels. The interplay between the mayor stakeholders in distribution grids have been formalized and implemented in the operation of BESS located at a Prosumer. Measured data form an small distribution grid was analyzed and multiple scenarios with different BESS sizes simulated. Its economic performance of the storage was analyzed for CAPEX in 2019 and 2030. It is argued that ageing aware BESS can benefit both, Prosumers and DSOs, if operated accordingly. Several business model extensions have been accounted for to identify profitability increases for the mayor stakeholders. It was found that for BESS located at a Prosumer most of the benefit accumulates for the local DSO. If optimized for the interests of the Prosumer interests and DSO interest, negative IRR result, but substantial externalities exist. These are partly covered by redistribution in the form of subsidies, but further possibilities for internalization of external benefits exist.

Asset Logging - transparent documentation of asset data using a decentralized platform.

Andreas Zeiselmair, Michael Hinterstocker, Alexander Bogensperger and Serafin von Roon

FORSCHUNGSSTELLE FÜR ENERGIEWIRTSCHAFT E. V.

Documentation of asset data often shows inconsistent approaches. Due to missing standards regarding tamper-proof and available data especially the exchange of asset-specific information in the energy sector is a big challenge. The paper describes the current challenges and the demand of asset-related processes in the energy system, fields of application, the requirements for a standardized platform as well as a proposal for such a system. The proposed implementation builds on the transparent, traceable and tamper-proof properties of the blockchain technology.

Value and Regulation of Local Electricity Markets.

Esther Mengelkamp, Bent Richter, Henrike Maier and Christof Weinhardt

KARLSRUHE INSTITUTE OF TECHNOLOGY

Local electricity markets (LEMs) provide an innovative market design alternative to the centralized, fossil-based energy system in line with the energy transition. We present a structured analysis of the economic, social, technological, and environmental LEM value propositions in literature and current LEM projects in the DACH+ region. Most LEMs see regulatory barriers as the most crucial challenge. We present the German regulatory niche of a Customer System as one opportunity to implement LEMs. However, it is only a temporary solution as network fees would be propagated towards non-LEM participants if Customer System LEMs became the norm.

Sector Coupling with Optimization: A comparison between single buildings and combined quarters.

Lena Heidemann¹, Denis Bytschkow², Alexandre Capone¹, Thomas Lickleder¹ and Michael Kramer¹.

¹ TECHNICAL UNIVERSITY OF MUNICH, ² FORTISS GMBH

The combination of building technologies with renewable energies, storage systems and low carbon technologies, like Combined Heat and Power (CHP) and heat pumps, demands to consider different energy networks in building energy management systems (BEMS) to enable sector coupling. This and the observation that energy equipment in buildings is often oversized and seldom used to its full potential during most time of the year calls for a holistic approach to establish sustainable multi-energy neighbourhoods. In this work, we introduce a model for a district energy system with sector coupling that integrates BEMS and compare the results of this model for the optimized operation of single buildings and the integrated solution to quantify the possible saving potential.

Load management for idle capacity of power grids.

Vincent Layec and Holger Wache

UNIVERSITY OF APPLIED SCIENCE AND ARTS NORTHWESTERN SWITZERLAND

A major issue hampering a rapid substitution of fossil fuels by electricity from sustainable sources is the fear of congestion of the power grid and of associated costs of their reinforcement. The conventional approach prevents any rapid raise of electricity demand by encouraging other energy carriers and sector coupling. However, no approach investigates the utilization of the full capacity of the power grid alone, which are kept idle to provide sufficient reserve for the case of a failure. Therefore, we test a load management approach designed to utilize this reserve capacity. We verify in this paper the correct functionality of the system made of a device manager for cost optimization of schedules and of a grid manager to enforce the respect of power limits of the grid. This novel approach contributes to reduce emission of greenhouse gases without grid reinforcement.

Application Lifecycle Management for Smart Grid Use Cases in the Intelligent Secondary Substation.

Stephan Cejka¹, Florian Kintzler¹, Lisa Müllner¹, Felix Knorr¹, Marco Mittelsdorf² and Jörn Schumann²

¹ SIEMENS AG ÖSTERREICH, ² FRAUNHOFER

An Improved Grey Model for Outages Prediction in Medium-voltage Distribution System.

Yang Zhang¹, Andrea Mazza¹, Ettore Bompard¹, Emiliano Roggero² and Giuliana Galofaro²

¹ POLITECNICO DI TORINO, ² IRETI SpA

The number of outages in a medium-voltage distribution system directly affects the reliability and resilience of power grid. An accurate prediction of the outages is critical for the planning, operation and maintenance of electric power system. In this paper, the grey model GM(1, 1) was introduced to investigate the pattern hidden in the total number of outages in every month. Different from the traditional grey model, the parameter in GM(1, 1) was optimized with the Genetic Algorithm (GA). To avoid the dramatic increase of errors due to multi-steps prediction, a rolling mechanism is also adopted in the grey model to capture the latest trend in the data. The proposed method was applied to predict the outage number in an urban distribution network. The method was verified with the accurate predictions.

Demo Abstracts

Funergy, a hybrid game forenergy awareness.

Piero Fraternali¹, Spartaco Albertarelli² and Sergio Luis Herrera Gonzalez¹

¹ POLITECNICO DI MILANO, ² KALEIDOS PUBLISHING SRL

In this demo we present FUNERGY, a hybrid game, consisting of a card game enhanced with a digital mobile application. FUNERGY aims at promoting energy knowledge and awareness in children and their family, integrating best practices of board and digital game design. Attendees will play a round with the game designers and learn the principles at the base of the construction and evaluation of the game.

enCOMPASS, demonstrating the impact of gamication and persuasive visualizations for energy saving.

Piero Fraternali and Sergio Luis Herrera Gonzalez

POLITECNICO DI MILANO

In this demo we present the enCOMPASS energy awareness app. The app is designed to turn the raw data of smart meter and sensors, installed at the premises of the consumers, into tools for behavioral change and customer relationship management. Sensed data are presented to the user in multiple visualizations, exploited to disaggregate consumption into end-uses, estimate user activity and comfort levels, and ultimately deliver contextual and personalized energy saving recommendations.

BIM4BEMS.

Anna Shadrina¹, Milos Sipetic¹, Max Blöchle¹, Georg Suter², Maryam Monatzer², Stefan Gaida³, Wolfgang Kastner³ and Christian Schiefer⁴

¹ AUSTRIAN INSTITUTE OF TECHNOLOGY, ² DESIGN COMPUTING GROUP, TU WIEN, ³ AUTOMATION SYSTEMS GROUP TU WIEN, ⁴ CAVERION ÖSTERREICH GMBH

The proposed demonstration is a prototype of an interactive data visualization tool developed during a research project entitled "Building information modelling for building energy management systems" (BIM4BEMS)[1]. The prototype is designed as an integrated semantic data model which combines geometric data retrieved from BIM model [1] with the operational data (BEMS). The results contribute to the existing efforts to reduce the amount of manual work in building data analysis in order to cope with the growing complexity of systems and increased requirements for energy efficiency and comfort.

FRIDAY
27 September 2019 - start at 15:30

Workshop

Demand Management Workshop

»Energy demand management through consumer engagement and behavior change systems«

The aim of the workshop is to gather together an interdisciplinary community of experts, practitioners, and business managers engaged in the planning, design, deployment and evaluation of behavior change systems, to share knowledge and experience in the realization of such a complex class of systems. The workshop aims at understanding “what works and what does not work” in the design of persuasive systems for energy efficiency and at distilling the best practices that can help designing effective behavior change systems.

Organizers:

Prof. Piero Fraternali (Politecnico di Milano)
Prof. Jasminko Novak (EIPCM)
Prof. Andrea Rizzoli (SUPSI)

Side Event
26 September 2019 - start at 19:00

Conference Dinner

IMLAUER Sky Restaurant

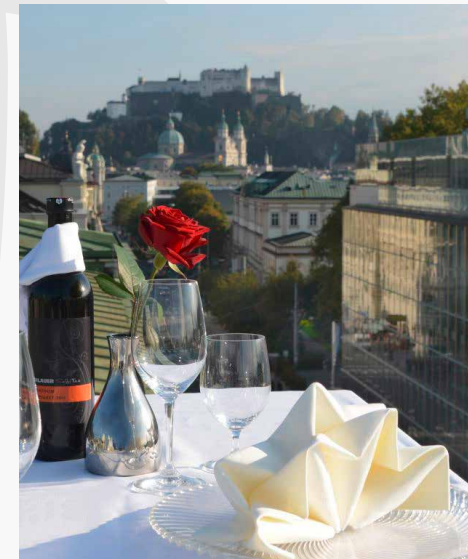
Located on the top floor of the IMLAUER Hotel Pitter Salzburg directly opposite of the congress hall and close to the old town as well as the main train station, the IMLAUER Sky Restaurant offers brilliant cuisine and a wonderful view over the city of Mozart.

IMLAUER Sky – Bar & Restaurant

Rainerstraße 6
A-5020 Salzburg

Shuttle to Conference Dinner

Departure at 18:30 in front of the Salzburg University of Applied Sciences



Venue & Travel Information

Conference Venue
 FH Salzburg
 Campus Urstein
 Urstein Süd 1
 5412 Puch/Salzburg



Arrival & Location plan

A location plan as well as information on how to get to the conference venue (public transport, car) and parking sites can be found at www.energy-informatics.eu/arrival-information.

Please note that there is only a **limited amount of parking spaces available** at Urstein Campus. When arriving by car, please only park in the appropriate sections.

If possible use public transport (the train »S3« directly stops at the campus! Get off at the stop »Puch Urstein«). The regional bus lines 160 and 165 also stop directly at the campus.

Taxi & public transport Salzburg

Taxi: +43 662 8111
 Public Transport Salzburg:
www.salzburg-verkehr.at

Registration & Information

The registration and contact persons can be found in the foyer.

Thursday, 26 September 2019: 08:30 - 12:30

Friday, 27 September 2019: 08:00 - 12:30

Documentation of the DACH+ Conference on Energy Informatics 2019

The responsible organizer of the event will take photos and make videos in the course of the conference (incl. audio tracks) in its prevailing interests of documentation and publication of the event and its contents. Through participating in the event, the data protection policy (www.energy-informatics.eu/privacy-policy) is acknowledged and the Salzburg University of Applied Sciences is authorized to use the above mentioned photos and video footage (incl. audio tracks) without monetary compensation and without any kind of local, temporal and content related restrictions.



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