CIRED

Congrès International des Réseaux Electriques de Distribution

Österreichisches Nationalkomitee

September 2021

Die Österreichischen Beiträge der CIRED-Konferenz 2021

Im Rahmen der 26. Internationalen CIRED-Konferenz, wurden 32 Beiträge aus Österreich eingereicht. Davon wurden 24 Paper zur Präsentation und Diskussion in den diversen Sessions bzw. für die Poster-Tour angenommen. Im Folgenden sind die Abstracts dieser österreichischen Beiträge mit der Angabe des Erstautors aufgelistet. Die vollständigen Publikationen finden Sie auf unserer Homepage www.cired.at unter „Publikationen“.

Austria - List of accepted papers

0004 Future Challenges for Distribution System Operators

Robert SCHMARANZ (robert.schmaranz@kaerntennetz.at)

ABSTRACT

The Distribution System Operators, as the central hub between generation and consumption, play a key role in the energy transition. The new European regulatory framework and the implementation of new market players (e.g. flexibilities) result in major changes especially within DSOs grid operation. In this paper, the ongoing developments in DSO's grid operation from an Austrian point of view are highlighted.

0044 EVALUATING THE POTENTIAL OF FUTURE E-MOBILITY USE CASES FOR PROVIDING GRID ANCILLARY SERVICES

Bernd THORMANN (bernd.thormann@unileoben.ac.at)

ABSTRACT

The fostered implementation of volatile renewable energy sources will trigger a raising demand of grid ancillary services in the upcoming years. However, future electrified road vehicles provide significant energy storage capacities, since they are unused for most of the time. In this regard, this study analyses for various electric vehicle (EV) use cases the potential for providing grid ancillary services based on the vehicle-to-grid technology. Therefore, we estimate the future demand of ancillary services in 2030 in terms of redispatch measures and control reserve. Real-life EV mobility patterns demonstrate, that EVs are perfectly suitable for the provision of ancillary services, even with low discharging power. Assuming a sufficient EV-penetration, private EVs charging at home or at work may cover a substantial share of required grid ancillary services. Besides EV users' mobility patterns, long-term load flow simulations illustrate the limitation of possible grid ancillary services due to local grid restrictions, especially with high discharging and charging power. Consequently, an increase of charging and discharging power only slightly raises the actual share of provided grid ancillary services compared to a lowpower bidirectional power exchange between grid and EV.

0054 Innsbruck´s prototype for a cross-linked energy system

Reinhard Fohringer (reinhard.fohringer@ikb.at)

ABSTRACT

The amount of electricity from decentralized renewable energy sources fed into the distribution grid in the city of Innsbruck has constantly grown over recent years. Both local and national energy strategies promote a heavy expansion of renewable energies, especially photovoltaics and wind, in the next ten years. One unwanted side effect is that demand and supply become less controllable by grid operators due to the increase in generation from fluctuating sources. Flexible adaptation of consumption to the current generation and the use of storage are necessary measures to successfully integrate renewables into the energy system. To ensure cost efficiency, optimization based on the existing infrastructure should always be the first means of choice before a network expansion is carried out. Energy Management Systems, like the one used at the IKB-Smart-City-Lab, make it possible to automatically control and allocate cross-sectoral energy flows and cover short- and medium-term fluctuations. This reduces the need of grid expansion. In order to deal with seasonal fluctuations, additional technologies like hydrogen electrolysis systems can be integrated into the IKB-SmartCity-Lab.

0063 Differences in transient stability between Grid Forming and Grid Following in synchronization mechanism

Ziqian ZHANG (ziqian.zhang@tugraz.at)

ABSTRACT

As the share of inverters in the power system increases, the stability of inverters has an increasing impact on the reliable operation of power electronics dominated power systems. Since the synchronization mechanism plays a leading role in the dynamic performance of the inverter, its stability is one of the keys for the stable operation of the power system. The Grid Forming inverters have emerged in recent years, is completely different from the traditional Grid Following inverter in terms of synchronization mechanism. This paper will analyse and compare the differences in transient stability between the synchronization mechanisms of the two concepts of inverters through large-signal modelling and phase-portrait method. The analysis results show that the Grid Forming inverter is more robust in synchronization mechanism.

0230 Frequency response analysis to assess the application bandwidth of Inductive Voltage Transformers

David GOPP (david.gopp@omicronenergy.com)

ABSTRACT

The accuracy of instrument voltage transformers for power quality measurements must be guaranteed up to higher frequencies. Currently, voltage transformers are only calibrated for rated frequency. Technically sophisticated measurement setups are required to measure the standardized voltage ratio error up to higher frequencies. Accurate measurements require the voltage transformer to be magnetized both with the fundamental component and the higher frequency component. On-site measurements of the frequency-dependent transfer characteristics of voltage transformers are motivated by the fact that the burden significantly influences the measurements. The aim of this paper is to find practical methods for this application, especially suitable for on-site use and to discuss the accuracy and robustness of the introduced method. For that purpose, adequate parameters must be defined that can be used to qualify the devices for higher frequency measurements. In addition, it is aimed to utilize measurement technologies that are already known and established in the power industry. In this paper, the application bandwidth of instrument voltage transformers is discussed as a parameter to qualify the device for higher frequency applications such as power quality measurements. Well-known Sweep Frequency Response Analysis is qualified in this paper, if it can be utilized to determine the application bandwidth of instrument transformers accordingly.

0304 Equivalent cellular based electrical network models for voltage regulation using hybrid conversion technologies at the medium-voltage level

Anna TRAUPMANN (anna.traupmann@unileoben.ac.at)

ABSTRACT

Expanding and integrating renewable energy sources (RES) challenges today´s energy systems, especially, electrical grids. Therefore, efficient RES integration methods have to be developed. This work chooses a multi-energy systems (MES) approach using the modelling framework HyFlow, developed at the Chair of Energy Network Technology. For this approach, simplified cellular-based electrical network models are developed using a specific network reduction method that enables these models to be used as an equivalent of the complex original grid since it shows equal electrical behaviour. As an example, this work uses a medium-voltage European test grid with massive volatile RES (wind and photovoltaic) expansion. This will show how this method can stabilize the grid and improve power quality using hybrid flexibility technologies (heat pumps (HP) and Power-toGas units (PtG)). Thus, grid expansion measures can be avoided, and self-sufficiency can be increased by this approach.

0379 Optimizing load step pre-announcement and bang-bang controller for enhanced islanded microgrid frequency stability

Yi GUO (guo@ea.tuwien.ac.at)

ABSTRACT

A novel control method that can assist conventional frequency control to improve frequency stability of islanded microgrids is presented. As two time parameters strongly affect the performance of the proposed method, definition and influential factors of optimal time parameters are studied, focusing on the dependency on non-controlled generation and load variation. A test islanded microgrid is simulated. Using three optimization criteria, correlations between influential factors and optimal system time parameters are investigated. The effectiveness of the control method is presented in terms of dynamic simulation results.

0384 Compensation of short-term power fluctuations at the transmission grid level by centralized and distributed short-term storage technologies on the example of Austria

Sabrina NEMEC-BEGLUK (begluk@ea.tuwien.ac.at)

ABSTRACT

This paper examines the role of centralized and distributed short-term storage technologies in Austria at the transmission grid level to maximize renewable power generation utilization. A linear optimization problem is evolved for the expansion planning of storage technologies and the operational planning of the entire electrical energy system's plant park to enhance the renewable generation/load balance respectively to minimize the fossil electricity production. In this paper, existing pumped-storage power plants take the role of centralized storage technologies. Batteries and distributed pumped-storage operate as distributed shortterm storage technologies. The model's objective function minimizes the total system costs, the sum of operational costs, and the expanded technologies' annuity costs. Results show that the potential of centralized storage technologies is, in general, sufficient for balancing the short-term power fluctuations when renewables dominate the overall generation characteristic. An installation of distributed storage technologies does not improve the transmission grid level's regenerative load coverage ratio.

0392 Is Power to Hydrogen an appropriate approach to mitigate PV-induced strain on 110 kV high-voltage grids?

Thomas KIENBERGER (thomas.kienberger@unileoben.ac.at)

ABSTRACT

Within this work, we investigate how the PV-induced strain of rural 110 kV power-grids can be relieved through hydrogen production via electrolysis. Therefore, we simulate a PEM-electrolyzer in the vicinity of large PV-plants and vary its capacity. The produced hydrogen is subsequently transported to the high-level gas-grid. Due to gas-grid standards, a maximum H2 concentration of 10 Vol% is allowed. However, due to its high capacity, the gas-grid can incorporate H2 from PV-power generation, even in time frames when the 110 kV grid is not able to do so. In the work, we perform a techno-economic analysis on this H2-based grid congestion mitigation approach. Therefore, we gathered cost information for the PEM, the balance-of-plant components of the H2 sub-system as well as for the H2-pipeline from scientific literature, considering futureprices for 2025. Our results show that site-dependent leveraging effects occur. This means that with the installation of an electrolyzer with a certain capacity, up to 7.5-times higher PV-capacities can be installed without grid-congestions. Smaller electrolyzer installations turned out to be more efficient. The cost perspective shows that the investment costs for the H2-based grid congestion mitigation approach evolve to be in the same order of magnitude as for classical grid-reinforcement.

0450 Simulation Tool for Techno-Economic Analysis of Hybrid AC/DC Low Voltage Distribution Grids

Nina FUCHS (nina.fuchs@ait.ac.at)

ABSTRACT

Partial operation of the distribution grid in DC instead of AC has been identified as a possible strategy for cost-effective management of future grid scenarios driven by international decarbonisation goals. By applying a simulation tool for technoeconomic analysis on synthetic test grid models, it has been shown that the conversion of AC low-voltage grid feeders to DC is a suitable solution to mitigate overloading and decrease voltage fluctuations caused by, inter alia, integration of electric vehicles (EVs), photovoltaic systems (PV) or increased energy demand. Cost models were applied to the simulation results. The economical findings indicate that the implementation of DC in low-voltage grids can be financially beneficial, especially when future developments and learning curves of DC technologies are considered.

0499 Digital (low voltage) grid - using new technologies to optimise planning and operational processes

Markus RADAUER (markus.radauer@salzburgnetz.at)

ABSTRACT

Using new technologies and data made available through cheaper communication technology, as well as a completed Smart Meter rollout will offer a lot of opportunities. Salzburg Netz has developed a GIS-based system for analysing low voltage grids using real time data provided by measurements in secondary substations, digital switching records and Smart Meter data. Having a real time switching state in every low voltage grid enables ranking the quality of every low voltage grid down to each branch. Without measuring them individually, it optimises the planning process for low and medium voltage grids, and helps to integrate technologies like charging stations, heat pumps, or PV-systems.

0632 Earth resistivity tomography for earthing system design

Benjamin JAUK (benjamin.jauk@tugraz.at)

ABSTRACT

Well designed earthing systems are needed to ensure that occurring fault currents can be safely transported into the ground. Soil models are a key parameter for the dimensioning process of earthing systems. In previous research the soil is often assumed to be homogeneous or layered in its resistivity distribution. But the soil is arbitrary in its resistivity distribution. This work will give an input, which errors on the earth surface potential and step voltage will occur, if the soil model is not constructed accurately enough. Different standardized methods are used to interpret the measurement of soil resistivity to build a soil model. To get the measurement values, Wenner's array is used within an earth resistivity tomography (ERT). For the interpretation, the method shown in IEEE Std. 80 will be used and compared with inversion theory. The impact of the different methods on the occurring earth surface potential and step voltages is analysed within a finite element method (FEM) simulation. It is expected, that the different methods for finding the soil model will influence the behaviour of the mentioned potentials. This analysis will help to use new methods to build up appropriate soil models for the designing process of earthing systems. The outcome can improve the efficiency of earthing systems and enhance personal safety.

0710 Functional scalability and replicability analysis framework for distribution grids

Sergio PORENCIANO (Sergio.Potenciano-Menci@ait.ac.at)

ABSTRACT

The current increase of renewable energy sources (RES) connected within medium voltage (MV) and low voltage (LV) networks, along with their system integration, is expected to continue to expand and increase their presence for the foreseeable future. It is therefore necessary not only to analyse the potential impact of the integration of these sources into the network but also to quantify their impact in combination with their respective control strategies which will be implemented when the devices are deployed at MV or LV. The Austrian Institute of Technology (AIT), therefore, aims to present a scalability and replicability framework to provide a standardized approach. This framework is a product of the developments acquired from various projects in which AIT participated as the leader of the scalability and replicability analysis (SRA) in distributed networks for the European projects, InteGrid and InterFlex, and the national funded project in Austria, LEAFS.

0720 LOW-VOLTAGE GRIDS IN TRANSITION – AUTOMATIC GRID RECONFIGURATION APPROACH FOR FUTURE SMART GRIDS CHALLENGES

Daniel HERBST (daniel.herbst@tugraz.at)

ABSTRACT

Current trends, such as the increasing spread of electric vehicle charging stations (EVCSs) with and without battery storage combined with heat pumps (HPs) and air conditioning systems, replacing classical heat supply, are challenging the operation of low-voltage (LV) grids. This can result in noteworthy load flow and short circuit problems in traditional existing power LV grids. A crucial example is the overloading of line segments by loads with significant simultaneity (e.g. EVCSs, HPs, air conditioning systems). Moreover, high local infeed caused by decentralised power generators (e.g. photovoltaic (PV) systems, small hydropower plants, battery energy storage systems (BESSs)) can lead to power quality problems (e.g. voltage limit violations, voltage drop, very short interruption). The project 'Power System Cognification' (PoSyCo) defines six Use Cases (UCs) to tackle these challenges. It aims to implement a 'SOFTprotection' system, which contributes to fault prevention and serves as an add-on for the conventional 'HARDprotection' (fuses, circuit breakers (CBs)). This paper presents an overview of PoSyCo's UCs but is focusing on algorithm for UC4: overload prevention by temporary meshing.

0726 Coordinated Electric Vehicle Charging – Performance Analysis of Developed Algorithms

Daniel-Leon SCHULTIS (daniel-leon.schultis@tuwien.ac.at)

ABSTRACT

The increasing use of electric vehicle charging stations with high simultaneity may provoke overloading of low voltage grids. These congestions can be managed by using algorithms that coordinate the distributed charging processes. This study includes a load flow-based performance analysis of three coordination algorithms that allow for charging with either minimal or maximal power. The algorithms differ in the number of control signals they specify: the use of one global control signal, one control signal per feeder, and one control signal per charging station is considered. The performance of each algorithm is analysed for complete and rudimentary knowledge of the photovoltaic production and the consumption of household appliances. Results show that all algorithms effectively mitigate transformer and line segment overloading. The more individual control signals are specified, the lower is the resulting average charging time, and the higher is the energy loss. In the analysed scenario, the lack of knowledge concerning the power contributions of photovoltaic systems and household appliances does not significantly impair the performance of the algorithms.

0857 A first analysis of the implementations of energy communities in EU's member states' national law

Stephan CEJKA (stephan.cejka@siemens.com)

ABSTRACT

Energy Communities and different forms of self-consumption, as introduced by the European Union's 'Clean energy for all Europeans package', may become an important elements of future energy systems. Their acceptance and implementation will importantly depend on their transposition into member states' national law. In this paper, we investigate the ongoing national transpositions, in particular regarding their integration in the electricity network structure and related grid tariffs. As an example, we focus on the corresponding draft laws in Austria, and undertake a comparison with other EU member states. Actual implementations may be either supported or hampered by details of the legal framework. Accompanying support measures necessarily need to take the national structure of the energy system into account.

0887 Electric vehicle car park charging simultaneity and grid connection power requirement analysis

Daniel STAHLEDER (daniel.stahleder@ait.ac.at)

ABSTRACT

The increasing market penetration of electric vehicles (EV) induces changes in many industries. Developers of real estate, large residential buildings and car parks must include future e-mobility shares into their current project planning to ensure that the rising numbers of EVs can be handled by the building's infrastructure. This paper discusses a tool for simulating various charging scenarios of large centralized electric vehicle parking solutions and compares the outcome with respect to the simultaneity factor to current planning rules and real-world experiences. Additionally, the involvement of charging algorithms is simulated and the impact on needed power capacity for local transformers is analysed. Besides verifying that the observable simultaneity of charging is mostly in line with other studies, this work provides a more detailed investigation of different use cases such as home, work and shop charging. Furthermore, it is proven that simple peak shaving can drastically reduce the maximum power of EV parks without interfering with the usage patterns of the vast majority of EV owners.

0889 Resource Adequacy Methodologies – future flexibility options added to Austria's generation fleet and its impact on adequacy

Marlene PETZ (marlene.petz@apg.at)

ABSTRACT

Since the overall generation system in Europe is undergoing drastic change, away from big thermal generation units towards high volatile generation from Renewable Energy Sources (RES), the incorporation of future flexibility options is of outmost importance to ensure security of supply within the European transmission system. Transmission System Operators (TSOs) perform regular assessments to provide information on security levels of supply, by executing resource adequacy assessments. By performing those assessments a probabilistic approach is used, which enables to take into account stochastic uncertainty resulting from RES generation. Not only the change on the generation side needs to be closely monitored, but also the increase in demand due to additions like heat pumps, electronic vehicles or data centres needs to be observed. Within this paper, the development on the demand side and its impact on adequacy indicators is assessed by performing calculations using a trilateral test model. This model is also used to get a first insight on result development when adding possible flexible sources like batteries and Demand Side Response (DSR) to the generation system. First results of these additions are discussed within this paper, but it needs to be highlighted that future fine-tuning of the modelling approach is needed to properly reflect flexible sources in future adequacy models.

0894 Earth fault localization in isolated uninterruptible power supply (UPS) networks – a new approach

Georg ACHLEITNER (Georg.Achleitner@apg.at)

ABSTRACT

In this paper a new approach for earth fault localization in isolated uninterruptible power supply networks is presented and the fault location procedure is described in detail. This paper is focused on DC voltage systems. The detecting device is based on monitoring devices, which recognize the earth fault, a switching device for periodic grounding the faulty phase and a current measurement in each branch. It is based on well-known insulation monitoring systems and enables a quick and reliable location of the faulty branch in DC systems without switching consumers, as protection devices or other critical control devices off and on for earth fault localization. Additional experiences from substations are presented, where this system is already installed and in operation.

0910 “Variable Voltage Limits” – an instrument to increase the utilization of existing infrastructures

Daniel-Leon SCHULTIS (daniel-leon.schultis@tuwien.ac.at)

ABSTRACT

The compliance to the voltage limits defined by grid codes is the major hurdle for the large scale integration of distributed energy resources. The conventional approach, in which the state of the medium voltage grid is calculated and checked against constant limits, does not support the complete utilization of the existing infrastructures: narrow voltage limits are set in medium voltage level that guarantee limit compliance in low voltage level also under worst case conditions. This paper uses the LINK-based holistic architecture to extend the lumped model of low voltage grids by variable boundary voltage limits (BVL).This ensures internal limit compliance without involving safety margins when calculating and operating medium voltage grid. The BVLs are quantified for different test grids and the effect of the feeder properties on the limit deformation is identified. The formulated use case allows to operate medium voltage grids closer to their factual limits, increasing the utilization degree of infrastructures.

0936 Practical proof of cable shield and equipment loads as well as the correct functioning of selective earth fault location through decentralized compensation in urban medium-voltage networks.

Oliver SKRBINJEK (oliver.skrbinjek@e-netze.at)

ABSTRACT

The increasing cabling of medium voltage grids is also increasingly influencing the operation of electrical grid, which are often, due to historical origin, operated as compensated distribution grid. That is why the decentralized compensation has become a focus again, which, however, also has been raising many questions that must be resolved from the operator's point of view. These include additional thermal loads on equipment like cable shields or transformers and the proper continued functioning of existing systems such as the selective earth fault detection. In the paper, practical approaches and methods for determining these influences and limits are shown and the results are used, to answer the open questions, considering existing framework conditions.

0969 Decentralized earth fault compensation in MV-grids - challenges and solutions

Katrin FRIEDL (katrin.friedl@tugraz.at)

ABSTRACT

Decentralized earth fault compensation coils (EFCC) in resonantly grounded medium voltage networks are becoming increasingly popular. Their installation imposes several requirements on the earthing system in terms of equipment and personnel safety as well as the functionality of the ground-fault protection devices. Based on two practical examples of networks (urban and rural), the challenges and their possible solutions are presented and verified by on-site measurements. Due to the impressed current of the distributed EFCC, the earth potential rise (EPR), the touch voltage, the transmitted voltages to neighboring stations and to the low voltage installation (PEN conductors) have to be analyzed. The role of cable shields in relation to earthing and the influences on the distribution of the zero sequence currents discussed. In addition, this work investigates the currents flowing on the interconnecting cables between two different network areas under fault conditions with different distributions of compensation. The cable shields grounded at both ends are loaded by flowing zero sequence currents. This leads to additional heating of the cables. It is analyzed which zero-sequence currents are permanently permissible in order to avoid a maximum insulation temperature and to prevent additional aging of the cables

1061 Implementation of a mobile uninterruptible power supply – device

Hans-Juergen Wernegger (hans-juergen.wernegger@kaerntennetz.at)

ABSTRACT

Uninterruptible power supply systems (UPS-Systems) were used especially in the electrical power generation, transmission and distribution to supply primary and / or secondary components. Due to serious disadvantages of the "old" UPS-emergency concept the KNG-Kaernten Netz GmbH realised in cooperation with the company Sapotec a new mobile UPS-device. Since then, the KNG has a unique device available for maintenance in the field of UPS-systems, which combines the properties "quickly available", "mobile", "universally applicable", "efficient / effective", "reduced risk potential and ergonomic stress on employees" in one system. The device has already proven itself in numerous missions in power plants, sub- and switching stations and is representative for an innovative improvement for the maintenance in the field of UPS-Systems.

1135 Redundancy for Power Utility Communication Networks

Fred STEINHAUSER (fred.steinhauser@omicronenergy.com)

ABSTRACT

Redundancy has always been a topic for the protection, automation, and control (PAC) of electrical power systems. Where deemed required, there were duplicated systems deployed. The duplicated protection systems typically got their information from different CT/VT cores and issued their commands to dedicated trip coils of the circuit breakers. The systems were named "Main" and "Backup" or "Main 1" and "Main 2" or so. This caused considerable efforts. If certain installations were regarded as not so important, compromises were made by saving parts of the duplications or by applying no duplication at all. The experiences from these PAC systems and the classification of the importance of the assets and the related amount of duplication could also be a guidance for the selection of an appropriate degree of communication network redundancy. Possibly, the expenses for a highly redundant communication network architecture are not adequate for an installation that would not have had any duplicated systems when implemented in conventional technology. On the other hand, fully redundant communication networks appear only logical in substations where fully duplicated PAC systems had been deployed in the past.