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ABSTRACT BOOK

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VÝSTAVIŠTĚ ČESKÉ BUDĚJOVICE

CONFERENCE PARTNERS:



SESSION 1

PILOT INSTALLATION OF A 9 MVAR INDUCTOR WITH SWITCHABLE TAPS FOR REACTIVE POWER COMPENSATION

Ing. Dominik Bokšanský, Ing. Milan Danko, Ing. Peter Frák, PhD., Ing. Matúš Kolej, Ing. Robert Janke, Ing. Jozef Tomčík, Ing. Jozef Tomiš

Východoslovenská distribučná, a.s.

The change in the legislation related to the energy sector in the Slovak Republic will introduce an obligation for distribution system operators to comply with reactive power flow limits, which will be specified in a subsequent decree of the relevant regulatory authority. This is due to current operational conditions related to reactive power flows as well as medium-term trends in this area. There is a clear need to take measures to stabilise reactive power flows from distribution to transmission systems. In general, the current situation is rightly identified as critical and unsustainable without appropriate action in the professional discussions between the operators of the relevant stages of the electricity system. This is because of the potential impacts on the safety and reliability of operation, for the time being primarily of the transmission system. The reactive power supply, caused by the change in the nature of the distribution system equipment and also its users, contributes to overvoltage conditions in some of the nodes of the system. Potential measures to avoid these abnormal conditions consist in the implementation of compensating means (chokes) or in the provision of so called non-frequency support services. In this context, several pilot projects are being carried out by system operators to gain practical experience in reactive power compensation and to verify the expected reduction of the upward trend in reactive power flows at transmission and distribution system interfaces. The solution described in this paper represents one of the possible approaches, whereby a reactor with switchable taps was installed in the 110/22 kV Košice Juh power station at a voltage level of 22 kV. The connection of the compensating choke to the HV section was proposed due to the increasing reactive power flow from the city cable system, thus the chosen installation location will allow to influence not only the local but also the total reactive power values. A compensating choke with an installed capacity of 9 MVA_r with stepped power control with tap changer is described here in terms of overall design, global and local control concept and technological solutions.

USE OF LOW POWER PASSIVE TRANSFORMERS FOR MEASUREMENT APPLICATIONS

Lukáš Český ABB, Michal Bernard ABB, Jiří Hula Elcom, Jiří Válek Elexim, Petr Jakubík ČMI, Leoš Michálek ABB

Low power passive transformers, also known as high voltage sensors, are nowadays often used in conjunction with electrical protection. Along with the development of new applications in high voltage networks, such as renewable energy sources, EV chargers or data centers, there is a growing need to use these devices for measurement purposes as well. This presentation discusses solutions for power tariff and power quality measurement using low power passive transformers with direct connection to the metering equipment. The presentation also presents the advantages and applications where these devices are used from primary to secondary distribution.

ECONOMICAL WAY OF EQUIPPING SECONDARY SUBSTATIONS WITH SENSORS AND INTELLIGENCE

Hamed Rezaei, TE Connectivity; Jan Zander, Kries Energietechnik; Lukáš Český, ABB

This paper presents an innovative and cost-effective method of equipping secondary transformer stations and network cabinets with sensors and intelligence to improve their operational efficiency and reliability. Traditional transformer stations often lack monitoring and intelligence features, which lead to problems in the operation of today's grids. The transition to digital solutions requires a large number of sensors and intelligent electronic devices (IEDs) to be deployed in power networks. This paper proposes a cost-effective approach to convert secondary substations to digital and to retrofit existing transformer stations and main grid switchgear (HSR). The method aims to minimize the number of

sensors needed inside transformer stations by using intelligent algorithms within the IEZ equipment (so-called cross-calibration), to enable remote monitoring, fault detection and predictive maintenance, thereby minimizing outages, reducing pro-operating costs and improving overall system performance.

INSTALLATION AND OPERATIONAL EXPERIENCE WITH FIBER OPTIC CABLE WRAP AROUND CONDUCTOR TECHNOLOGY

Filip Reiskup, Vratislav Štěpka, Filip Girszewski, Petr Úšela; všichni EG.D, a.s.

The paper summarizes present experience from pilot projects with Access wrap technology (wrapping of optic cable around the phase conductor). This technology raises another possibility in optic fibre installation on medium voltage overhead lines. In comparison to the standard technologies utilized in EG.D is beneficial mainly from the side of usage of the current infrastructure (lines), speed of the realization process and mitigation of the authorization procedure. On the other hand, it brings some complications in the daily operation/maintenance of the line. This technology implies usage of special applications such as short branches or lines with high residual value. This article sums up the experience from the installation process as well as the maintenance in a daily operation.

DIAGNOSTICS AND REPAIRS OF STEEL STRUCTURES OF SUPPORT POINTS IN POWER ENGINEERING INCLUDING CONCRETE FOUNDATIONS

Kamil Čihák, ČEZ Distribuce, a. s.; Petr Lehký, EGÚ Brno, a. s.

The paper contains recommended unified procedures for assessing and designing measures for the treatment of steel structures of support points and concrete foundations for overhead power lines 110 kV, HV and LV. The paper incorporates results from studies carried out by EGÚ BRNO, a.s., i.e. STUDY OF THE AGING OF STEEL STRUCTURES FOR ENERGY and the STUDY OF FOUNDATION OF SUPPORT POINTS IN ENERGY In the conclusion, a recommendation is given to distribution system operators to develop a management document to minimize erroneous approaches to assessment and design of measures that, when subsequently implemented, can cause serious deficiencies in line safety and reliability.

CHANGES IN THE ESTABLISHMENT OF SUPPORT POINTS IN THE ENERGY SECTOR

Marek Ženka, ČEZ Distribuce, a.s., Jan Zavadil, EGÚ Brno, a.s.

The main topic of this paper is to inform about changes in the implementation of concrete foundation structures for support points of overhead power lines, especially (but not only) for voltage level 110 kV. The changes are based on or thematically related to the rather extensive study on the foundation of support points in the power industry. The main findings of this study have already been presented in the paper Problems of design and implementation of block foundations for truss towers of distribution system operators published in the proceedings of the CIRED 2022 Conference. The changes described in the paper have been incorporated into the relevant PNE and then into the governing documents of distribution system operators and.

SYSTEMIC SOLUTIONS FOR BIRD CONSERVATION FROM ACCIDENTS ON POWER LINES AS A RESULT OF STRIKING WIRES OR GROUND WIRES

Jan Volek, EG.D, a.s., Vratislav Štěpka, EG.D, a.s., Pavel Matíášek, ČEZ Distribuce, a.s.

The paper presents the development and history of the processing of system solutions, including the final output in the form of the prepared methodological instruction of the Ministry of the Environment of the Czech Republic Ensuring the protection of birds from injuries on power lines due to impacts with conductors or grounding ropes, from 2017 to the present. The project was carried out in cooperation with representatives of PDS and PPS, the Ministry of the Environment, the Agency for Nature and Landscape Protection and the Czech Ornithological Society.

GERESTAP – DEVICES FOR MEASURING TOUCH AND STEP VOLTAGES

Petr Bernat, Martin Pešek, Martin Sobek, EGU TECH, a. s., VŠB-TUO

This paper deals with the development of an innovative device for measuring touch and step voltages on non-living parts of a device using an imposed current of a different frequency from the mains frequency. The device has been developed and tested within the partnership of EGU TECH and VŠB-TUO, Faculty of Electrical Engineering and Computer Science in the framework of a research and development project and consist of a regulated and stabilized current source of selected frequency and a selective voltmeter with advanced functionalities. The design of the device allows measurements to be carried out by one employee in a short time, while the individual parts of the set are dimensionally and weight friendly, mobile and safe for the operator. The measuring current generator also has high robustness and resistance to backlash, which was a priority for the project team from the beginning. In addition to functional prototypes, the project has also resulted in the necessary production documentation, enabling the device to be put into production and offered to customers.

SESSION 2

DEVELOPMENT AND REVISION OF ANNEX 3 PPDS: 2011 AND PNE 333430-0:2015

Karel Procházka, EGC-EnerGoConsult ČB s.r.o.; Jiří Drápela, Vysoké učení technické v Brně; Jiří Drápela, Vysoké učení technické v Brně

The first part of the report presents the main changes in the upcoming revision of Annex 3 of PPDS:2011 "Voltage quality in the distribution system, methods of its detection and evaluation", based mainly on ČSN EN 50160:2023, EU Regulations 631/2016, 1338/2016 and 2017/1485. The second part informs about the forthcoming revision of PNE 33 3430-0 "Calculation of the assessment of backflow effects of distribution and transmission system customers and sources": 2015, which, in addition to a major revision of the structure of the standard and updating of the assessment procedures for each type of backflow effects, extends the scope of validity to backflow effects of new elements such as storage, charging stations for e-mobility and heat pumps, and further extends the scope of application to the transmission system in addition to public distribution systems.

VOLTAGE QUALITY IN DS PER UNIT VOLTAGE LEVELS IN SUM FOR ALL DISTRIBUTORS

Jan Petrásek, František Kysnar, Josef Hrouda, EGC-EnerGoConsult ČB s.r.o.

The first part of the report presents the main changes in the upcoming revision of Annex 3 of PPDS:2011 "Voltage quality in the distribution system, methods of its detection and evaluation", based mainly on ČSN EN 50160:2023, EU Regulations 631/2016, 1338/2016 and 2017/1485. The second part informs about the forthcoming revision of PNE 33 3430-0 "Calculation of the assessment of backflow effects of distribution and transmission system customers and sources": 2015, which, in addition to a major revision of the structure of the standard and updating of the assessment procedures for each type of backflow effects, extends the scope of validity to backflow effects of new elements such as storage, charging stations for e-mobility and heat pumps, and further extends the scope of application to the transmission system in addition to public distribution systems.

FIRST ANALYSIS OF PS FROM THE PERSPECTIVE OF EN 50160 AND THE NEW DPQ HEADQUARTERS

František Rajský, Michal Šerks, Marcel Heide za ČEPS, a.s.

The paper Voltage quality in the distribution network deals with the evaluation of the monitored parameters of the quality of electricity supply, the transfer points between the TS and DS, 110 kV points of consumption, 110 kV/VN substations are evaluated. The evaluation is carried out by looking at both continuous phenomena and voltage phenomena. Regular semi-annual intervals of voltage quality assessment provide insight into the long-term evolution of the monitored characteristic parameters - voltage magnitude, Plt, Pst, uu, THDu. PS/DS transfer points have been evaluated since 2006. The paper summarizes the results of the evaluation, lists the problem parameters at the measurement points where the required limits according to EN 50160 are not met.

PILOT PROJECT FOR THE DEPLOYMENT OF LV OUTLET METERING IN PRE-DISTRIBUTION STATIONS, A.S.

Tomáš Sýkora, Michal Šolle, PREdistribuce, a.s.

The article deals with the implementation of a pilot project for measuring LV outlets in smart distribution stations. On the basis of technical and economic selection, 2 variants of instrumentation for cabinet and grid LV switchgear were tested. The paper presents the technical solution for the placement of the measuring instruments, the implementation in the stations and the use of the measured data in the end systems (SCADA, PQ Central).

PROPAGATION OF VOLTAGE DROPS ACROSS VOLTAGE LEVELS IN THE DISTRIBUTION NETWORK

Miloslava Tesařová, ZČU v Plzni

Martin Kašpírek, EG.D, a.s.

The paper deals with the propagation of voltage sags in the distribution system across voltage levels. The introductory part briefly summarizes the theory of voltage sag propagation/transmission at a given voltage level or across voltage levels. The issue of voltage sag propagation is illustrated on a selected part of the network where analyzers are installed at all voltage levels. The number of recorded sags in the period under consideration is analyzed, as well as the transmission of sags between voltage levels.

VOLTAGE QUALITY IN LV DISTRIBUTION NETWORK WITH EXTREME PENETRATION OF VOLTAGE

Martin Kašpírek, Zdeněk Horák, Vladimír Štěřba; EG.D, a.s.

The basic rules for assessing the connectivity of generating plants to the DS are described in Annex 4 of the PPDS. With the current high penetration of RES, there are overflows of active power from lower to higher voltage levels and the question is how to take this into account in the calculations. Similarly, the correlation between the installed capacity of the generating plant, the inverter rated capacity and the reserved capacity (R_v) of the generating plant needs to be discussed, taking into account the actual potential impact on the power grid. For example, it is possible to consider generators with implemented $Q(U)$ and $P(U)$ characteristics for connection at the LV level - but these must be correctly set up and operational throughout the life cycle of the generator. Last but not least, practical examples of generation plant connectivity calculations are given, e.g. the problem of the influence of voltage ratios by generators on adjacent outlets or the connectivity of a load point type of combination of a generator and a battery is addressed. The paper is then intended to contribute to the discussion on the revision of the existing methodology of assessing the connectivity of generating stations in order to find possibilities for connecting additional customers, under the conditions of compliance with the voltage ratios in the network defined by the standard ČSN EN 50 160. The paper also describes a measurement campaign of a sample of 18 different LV distribution networks, which were deliberately selected so that their capacity for connecting additional generating plants is already exhausted. Based on the measurements made with portable PQ analyzers, the voltage quality parameters are evaluated according to EN 50 160 with a focus on voltage deviations. The results of the measurements are discussed in relation to the connectivity requirements of the generating plants.

EXPERIENCE WITH CONNECTION AND OPERATION OF "BALCONY" FVE 300 W

Martin Kurfiřt, Martin Kašpírek, Tomáš Valta, Radim Ille, Jiří Čeleda, EG.D, a.s.

The paper describes the legislation concerning the connection conditions for this type of small PV power plants. It compares the requirements for micro-inverters up to 800 W specified in the Distribution Network Operation Rules - Annex 4, with the actual requirements/functionalities that individual inverters can/do in reality. This assessment is based both on laboratory testing of specific samples of micro-inverters and on actual measurements at specific customer sites. The aim of the work was to verify which products and with which characteristics are realistically connected to the distribution network today and whether we as DSOs have the right process procedures corresponding to this category of generating plants.

COMPARISON OF ALGORITHMS AND MEASUREMENT ACCURACY OF PORTABLE PQ ANALYZERS

Valta Tomáš, Kurfiřt Martin, Ille Radim, Kašpírek Martin; EG.D a.s.

The paper aims to compare 6 types of portable PQ analyzers used by the KDE department at EG.D a.s. The PQ analyzers are subjected to several tests to compare the algorithm and measurement accuracy of these devices. The tests are focused on the measurement of I_{max} , U_{min} and U_{max} during different events such as motor load start-up or simulated fault waveform in the network. In addition, PQ analyzers are tested to ensure that they correctly categorize voltage events such as voltage sags or interruptions, including duration. Finally, testing is devoted to measuring and evaluating short-term P_{st} flickers during rectangular or triangular voltage changes. Using a power simulator, it is also possible to model voltage waveforms with different representations of higher harmonics, which are also analyzed. The paper builds on and significantly extends the testing performed in 2010.

ACCURACY AND METHOD OF CALCULATION OF EARTH RESISTANCES BY ANALYTICAL CALCULATION IN ACCORDANCE WITH PNE 33 0000-4

Václav Vyčítal, David Topolánek, Michal Ptáček, Petr Toman, Vysoké učení technické v Brně

The basic parameter for evaluating the safety of power systems is the magnitude of the contact voltages and therefore the magnitude of the earth resistances. The procedure for calculating the earth resistance has been transferred and extended from the international standard EN 50522 to the company standard PNE 33 0000-4. One of the frequent pitfalls of this analytical calculation is its inaccuracy. This paper then discusses the possible sources of this inaccuracy and focuses mainly on errors due to inappropriate analysis of soil properties. These enter the calculation as practically the only key parameter in the form of soil resistivity. The accuracy of the analytical calculation is demonstrated using three variants of the calculation procedure and compared with more accurate methods based on electric field solutions. The presented calculation variants were investigated during the revision of the existing 4th edition and will be used for the 5th edition of the company standard PNE 33 0000-4.

RESPONSE OF ACTIVE POWER AND ENERGY METRICS TO RAPID CHANGES IN ENERGY FLOW DIRECTION

Jan Klusáček, Jiří Drápela, Vysoké učení technické v Brně; Roberto Langella, University of Campania Luigi Vanvitelli; Jan Meyer, Technische Universität Dresden

Distributed generation combined with switched adaptive loads that optimise energy consumption in prosumer installations causes bidirectional energy flows in distribution networks. If the changes are regular or even periodic with a period close to the length of the meter window, the values in the export and import registers can differ significantly from the actual energy passed. As a result of incorrect energy registration, concepts for the budgeting of distribution charges to customers may fail. This paper describes and compares different algorithms (metrics) for active power and energy measurement that are either implemented in current billing meters or derived from other active power and energy measurement applications. The ability of the metrics to determine active power and energy and then assign to an export or import register is tested with a set of power flow scenarios resulting from the deployment of realistic power flow control devices. The results show the limits of the use of each metric depending on the frequency of changes in the direction of active energy flow. It is also shown that the most widely used metrics in billing meters show the largest deviation from the actual energy passed at the point of measurement/connection.

Sekce 3

SESSION 3

2016/631 REGULATION UPDATE

Oldřich Rychlý; ČEPS, a.s.

The Network Code for the requirements for connection of generating plants to the electricity grid issued in 2016 as Regulation 2016/631 is already implemented in the Czech Republic and gradually applied to new installations during the connection processes. In view of the dynamic evolution of installations connected to the electricity grid and the more detailed identification of system needs to ensure reliable and secure operation of the electricity grid, it is necessary to extend the applicability of the connection regulations to respect current developments. To this end, the process of amending the grid connection codes has been launched. The contents identified for amendment and completion were published by ACER last year. Revisions to the existing text of the Connection Network Codes are

being prepared in a step-by-step process managed by ACER during this year. This paper sets out the procedural and substantive elements of the revisions to the network codes, as well as more detailed proposals for selected technical requirements.

THE OZ CAPPING PLAN AND ITS ACTIVATION AT EASTER 2023

Jan Tesař, Oldřich Rychlý, Tomáš Hába; ČEPS, a.s.

The safe and reliable operation of the electricity system requires that clear rules of operation are established and in case of deviations of monitored parameters it is necessary to stop the deterioration of the operating condition by applying gradual operational and technical measures and then to ensure the return of the monitored operating parameters to the limits of operational safety. The transmission system operator ČEPS, a.s. is responsible for providing system services. The article presents what system services are provided and examples of individual measures and the suitability of their application in the event of deviations of monitored parameters of the operation of the electricity system. Furthermore, the article describes the use of the RES curtailment plan at Easter 2023.

LOAD CONDITIONS OF POWER TRANSFORMERS AND A BRIEF ANALYSIS OF THEIR FAILURE RATE

Jaroslav Pospíšil, Protection & Consulting, s.r.o., Tomáš Kovaččík, BEZ Transformátory, a.s.

The paper analyses the load conditions of power transformers according to Czech and Slovak standards - ČSN EN standards 50708-2-1 and STN IEC 600 76-7. The causes of transformer failures in photovoltaic production plants, their transformer stations and the analysis of the failure of power transformer T31, 630 kVA, 33/0,4 kV in the 400/110 kV / RS / substation, which was caused by non-functional tap regulation of power transformer T402 and "subsequently" T31, are presented.

CURRENT DEVELOPMENTS IN U/Q CONTROL IN NETWORKS ČEZ DISTRIBUCE

Jan Švec, ČEZ Distribuce, a. s.

The paper describes the current status, the development in the past period and the future outlook in the field of voltage and reactive power control in the CEZ Distribuce networks, especially on the voltage levels of HV and MV. It also highlights some specific aspects that need to be taken into account for U/Q control in the development of the control concept, in the actual operational control and in ensuring the functionality of control and telecommunication systems.

In spite of all the automation of U/Q control, the paper shows that operational supervision by the human factor is still necessary in this approach, whether it is manual control of the elements or reliability check of telemetry data. The paper provides examples of U/Q control in several specific areas, including Krasikov UO after the shutdown of the synchronous compensators. The paper also shows the use of the control potential of HV generating plants to meet the needs of higher voltage levels and a comparison of two types of control.

SPECIFICATION OF 110/23 KV TRANSFORMERS - ASSESSMENT IN TERMS OF VOLTAGE REGULATION IN CONDITIONS OF DS PREDISTRIBUCE, A.S.

Aleš Krula, Radek Hanuš, PRedistribuce, a.s.; Filip Brož, Josef Hrouda, EGC - EnerGoConsult ČB s.r.o

The paper deals with the assessment of the specification of 110/23kV transformers from the point of view of the maintained voltage level in the conditions of the DS PRedistribuce, a.s. and identification of possible problems with voltage regulation of existing 110/23 kV transformers in the context of changing DS conditions (development of decentralized intermittent sources, e-mobility, increasing DS load and provision of support services).

MODELLING FLEXIBLE TECHNOLOGIES FOR NETWORK FREQUENCY SUPPORT

Karel Máslo; ČEPS, a.s.

Jan Koudelka, Branislav Bátor, Jan Klusáček; VUT v Brně

The paper discusses the possibility of using non-traditional means of frequency control in an emergency, such as charging stations for electric vehicles, battery storage and hydrogen generation. These devices are connected to the grid via power electronics, thus contain no spinning parts and can provide fast frequency response. In this paper, their dynamic models are presented and used to analyze the different frequency response variations when the grid frequency goes out of the 49.8 - 50.2 Hz limits of normal operation.

THE IMPACT OF MODERN TRENDS ON RETAIL NATURE

Milan Krátký, Tomáš Kolacia, Adam Linka, Miroslav Šajdler, EG.D, a.s.

Along with the changes in the nature of the load points at the low voltage level, the load and supply profiles are changing. The paper shows with real data the transition from previously standard load profiles to load profiles influenced by modern trends such as photovoltaic power plants, electric heating, e-mobility. Examples are used to present the potentially fatal consequences of the behavior of active customers who use their connections up to the limits of current contract parameters.

AUTONOMOUS DISTRIBUTED GENERATION SOURCES FOR POWERING CRITICAL INFRASTRUCTURE UNDER ISLANDED CONDITIONS

Martin Čerňan¹, Jiří Halaška², Zdeněk Müller¹, Josef Tlustý^{1,2}; ČVUT v Praze, ¹FEL, ²FBMI

Along with the changes in the nature of the load points at the low voltage level, the load and supply profiles are changing. The paper shows with real data the transition from previously standard load profiles to load profiles influenced by modern trends such as photovoltaic power plants, electric heating, e-mobility. Examples are used to present the potentially fatal consequences of the behavior of active customers who use their connections up to the limits of current contract parameters.

THE LONG-TERM DEVELOPMENT OF CONSUMPTION IN THE PRAGUE AGGLOMERATION AND THE REQUIREMENTS OF GRID SUPPLY

Jiří Ptáček EGÚ Brno, a.s.
Radek Hanuš PRedistribuce,a.s.
Andrew Kasembe ČEPS,a.s.
Petr Křesálek ČEZ Distribuce a.s.

Although the long-term load in the Prague agglomeration is rather stagnant or only slightly increasing, specific areas have recently been detected where significant development of long-term consumption can be expected. The main drivers of growing consumption in the Prague agglomeration include the development of e-mobility, further electrification of public transport (rail, public transport), the increase in the number of heat pumps, or even the requirements for power supply electricity for new data centers. The development of networks (transmission and distribution 110 kV) in the Prague agglomeration is significantly limited by the high land use. As the planning and design of energy infrastructure is a very time-consuming process, it is necessary to reflect already today on the growing consumption requirements in the region and the possibilities of network development to meet the demands of consumers in the future.

VERIFYING COMPLIANCE OF VM IN THE FRAMEWORK OF THE UP AXIS - PRACTICAL EXPERIENCE

J. Drápela, J. Dvořáček J. Klusáček, P. Mastný, J. Morávek, M. Vojtek, M. Vrána, VUT v Brně

UEEN FEKT was/is involved in the UPOS compliance verification (preparations) for the photovoltaic generation plants of category B1 and B2 (non-synchronous VM) and participated in the compliance verification for the generation plant of category B2 with cogeneration unit (synchronous VM). The article describes the experience with the course and execution of the VM verification, the extent of readiness of the individual plants according to the RfG and PPDS and the complete schedule of preparations for the actual execution of the compliance verification for the individual plants. Furthermore, the outputs of the tests carried out, both laboratory and field, are described in summary.

OPERATIONAL EXPERIENCE WITH THE INSTALLATION OF MEDIUM POWER GENERATORS IN POLAND IN COMPLIANCE WITH THE CURRENT RFG CODE

Jaroslav Pospíšil, Protection & Consulting, s.r.o.

The subject of the technical assistance for the power evacuation of the 1.25 MW / 400 V generator at Ciechanow and the 2.3 MW, 15 kV generator at Bodaczów in Poland is the design of their protection system, including their implementation and commissioning, in compliance with the Polish RfG Network Code. For the project of the power output of the generators the following scope of work was required:

- single line diagram design (modification),
- design of the type and ranges of generator protection,
- design of measuring elements
- design of generator breaker control

OPERATIONAL RELIABILITY OF PHOTOVOLTAIC POWER PLANTS. EXPERIENCE AND HOW TO PROCEED?

Jan Petrov, VŠB-TUO; Bedřich Beneš, ModemTec s.r.o.

Photovoltaic power plants bring a number of benefits to their owners, but there are also downsides to their operation. Apart from mechanical damage to the PV panels themselves, the biggest scare is the potential risk of fire. This danger is mainly due to the effects of the electric arc. Although this is a relatively unlikely phenomenon, it must be kept in mind and given sufficient attention. Several types of electric arc can occur in the PV area. The three basic types of arcs are series, parallel and parallel to ground. How does an arc manifest itself and can it be reliably detected? What technical means of detecting arcs are currently used and how reliable are they?

SESSION 4

DISPATCHING SIMULATOR

Roman Vaněk, Stanislav Čepelák, ČEZ Distribuce, a. s.

The distribution system is a complex network with many connections. Power plants, transmission lines, transformers are just the most obvious power facilities. There is a significant amount of control technology installed on lines and transformers that must behave selectively. Dispatching is also about knowing the basic physics and the connection between control technology and power equipment. Knowledge and experience is always passed on when a new employee is being trained. In the case of dispatching, there is then a baptism by fire at the first fault, where dispatchers help each other with advice. In the past, dispatchers used to go to the training center in Přeštice. Since 2022, ČEZd has its own trainer. It is a single-pole model of a selected part of DS 22kV and 110kV with a part of PS. It is a copy of a real DDS. The simulator is a part of the training program, which includes spoken presentations with standard topics, seminars with actual topics, test - E-learning and finally the simulator. My lecture will be about my experience with the simulator.

LINE DISTANCE PROTECTION

Jiří Bermann, Hitachi Energy s.r.o.

The paper shows the development of line spacing protection for its primary and basic purpose from its inception to today, the principles of measuring its impedance so that it is proportional to the distance to the short circuit and for all types of short circuits equally, the principles of selecting a short circuit loop in the Bauch effect, the differentiation of resistive and remote short circuits from the operating conditions of loaded lines

SETTING OF OVERCURRENT PROTECTIONS IN THE MV/NN DISTRIBUTION GRID

Vít Krčál, David Topolánek, Viktor Jurák, Jaroslava Orságová, VUT v Brně

Jan Vaculík, Aleš Procházka, EG.D, a.s.

The paper deals with the issue of setting overcurrent protection in the HV/NV distribution network, where the LV system is operated in a grid connection. The overcurrent protection must act selectively in case of a fault on the HV network and prevent the fault from being fed from the LV network. In this paper, software is presented that has been designed to optimize the settings of overcurrent protections in congested networks using a numerical network model. The use of the software is demonstrated on a selected case of grid network operation. Furthermore, the paper discusses the variants of single/two-stage and individual/global settings of overcurrent protection with an evaluation complemented by the experience of the system operator.

INNOVATION OF VOLTAGE-FREQUENCY PROTECTION U-F ACCORDING TO THE CURRENT REQUIREMENTS OF PNE 33 3430-8-2 CZ18.2

Jaroslav Pospíšil, Protection & Consulting, s.r.o.

The requirements for the upgrade of voltage-frequency protection are based mainly on the company standard of power engineering PNE 33 3430-8-2 CZ 18.2, point 4.9.3, especially point 4.9.3.4, where overvoltage protection is specified. Undervoltage overvoltage bridging / UVRT /, clause 4.5.3 for synchronous and non-synchronous generation technologies and short-term overvoltage bridging / OVRT /, clause 4.5.4 are also subject to innovation. The characteristics of the upgraded protection in this design for the "interface" of generation modules / VM / non-synchronous and synchronous type A,B / 800 W to 30 MW /, for LV, HV and HV networks - with communication function - are briefly described.

ANALYSIS OF FAULT WITH PHASE INTERRUPTION ON HV NETWORK WITH RESONANT GROUNDING OF N NODE

Tomáš Škumát, Západoslovenská distribuční a. s.

The paper analyzes the effects of a basic, series type fault (phase interrupted) on HV distribution networks with resonant grounding of node N. The fault is analyzed in terms of the basic theory (no-load condition) and the extended theory (component systems with load consideration). The fault has some similarities to a ground fault, but unlike this most common type of fault, the network may, in an interrupted phase, acquire voltage ratios exceeding the nominal network pool voltage, i.e. the voltage which in normal operation is assumed to be the maximum with respect to the ground fault, while this condition is quasi-stationary and usually lasts until this overvoltage is sustained by some of the distribution equipment - a consequent fault is generated.

Furthermore, the paper analyses, within the MATLAB simulation environment, what influences the fault progression and what is the impact on the secondary (LV) network downstream of the fault location within the radial operation of the HV distribution network. The entire simulation is done to correlate the 2 basic operating states of the extinguishing choke tuning, namely, the slightly under-tuned state with the slightly over-tuned state.

The paper also presents a specific case from real practice where due to this fault, the over-operation of the protections (ANSI 50N) occurred. This fault was further simulated in a real distribution network and its impact was measured and recorded. The paper concludes with a summary of the options to mitigate the impact and effects of this fault on the distribution network.

EV CHARGING CONTROL IN DS

Jiří Randa, PREdistribuce, a.s.

Analyses of the integration of a larger number of charging stations into the DS carried out in the framework of the NAP SG, as well as experience from abroad, clearly show that if the integration of slow (AC) charging of electric vehicles is to be effective in the future, it is necessary to ensure their smooth management, which will reflect the current load on the distribution network both at the HV level and especially at the local LV level. This paper presents the first outputs of the PREdistribuce pilot project, which focuses on the smart management of public AC charging stations based on near-to-online measured HV/NV TS loads, including load measurements of individual outlets.

NEW METHOD OF RESIDUAL CURRENT ESTIMATION BY EBERLE CHOKE CONTROLLER

Karolína Čechová, EG.D., a.s., Jaroslava Orságová, VUT v Brně

Due to the increase in capacitive currents due to the cabling of overhead lines, there is an increase in the demands for reliable and safe operation of compensated high-voltage networks. The safety of the compensated network is closely related to the level of residual current, which is essential for the correct design of earthing systems and the determination of the contact and step voltages in the case of earth connection. Based on the findings of the experimental measurements carried out to verify the accuracy of the new method of estimating the residual current by the Eberle controller, the impetus was given to map the current state of compensated networks in terms of the residual current level in the distribution territory of EG.D. and to check the accuracy of the Eberle choke controller settings, the results of which are presented in this paper.

VERIFICATION OF CORRECT OPERATION OF THE INDUCTOR CONTROLLER USING A REAL-TIME SIMULATOR AND IEC 61850 COMMUNICATION

Viktor Jurák, Jaroslava Orságová, David Topolánek, VUT v Brně

The current possibilities of verifying the correct operation of the damper controller are very limited due to the fact that the controller needs feedback from the controlled device to function. For this reason, it is virtually impossible to test its functionality through conventional secondary tests. This paper presents a method for testing a closed-loop control of a quench inductor controller through a real-time simulator. The concept of digital control of the quench inductor using IEC61850 is used in the testing, and the tests also include an evaluation of the accuracy with which the controller determines the residual ground coupling current.

SENSORS FOR ANALYSIS AND MONITORING OF OVERHEAD NETWORKS

Petr Medek, Megger CZ s.r.o.

Today's modern overhead networks are often stressed from increasingly complex distribution systems and generation mix, with frequent changes in power flows. Limited visibility of grid operations can lead to increased outages of extended duration. Deploying smart overhead network sensors helps detect and locate faults more quickly, especially in complex terrain, enables continuous data analysis, and helps detect atypical events and vulnerabilities, ultimately helping to reduce both SAIDI and SAIFI. The sensors and SW provide a comprehensive overview for the operator that is not currently available, making visible to maintenance teams the weak points that need to be addressed. Sensors are an ideal complement to existing solutions, not a replacement. In this article you will learn about the technical solution and practical examples of sensor deployment.

SESSION 5

INTENTION TO USE HIGH-TEMPERATURE WIRES IN ČEZ DISTRIBUCE, A. S.

Martin Mach, Milan Kincl, Jiří Richterek, David Stránský, ČEZ Distribuce, a. s.

The increase in the number of renewable energy sources and electric vehicles, the increasing demands on reliability and quality of supply, and the requirements for secure supply in crisis situations place new and higher demands on distribution networks. One way to meet the leapfrogging requirements for connectivity, transmission and distribution of power between transformers and nodes is to use high-temperature conductors at the 110 kV level. In general, in terms of distribution system design, we are moving towards the use of higher cross-sections of conductors, which often means the complete dismantling of existing, often technically non-terminal, lines and the construction of new lines. The use of high-temperature conductors, on the other hand, under the right conditions, makes it possible to use existing pole structures and just replace the conductors and the necessary fittings, thereby increasing not only the transmission capacity but also, more importantly, shortening and cheapening the actual process of reinforcing the line. At present, based on the technical studies we have prepared, we are preparing specific plans for the retrofitting of existing lines with high-temperature conductors.

HIGH TEMPERATURE WIRES AS A REPLACEMENT FOR ALFE240 WIRE

Ivan Banas, Západoslovenská distribučná, a.s., Čulenova 6, Bratislava; Miroslav Bindzár, PROVED, s.r.o., Miletičova 23, Bratislava

The paper solves on the basis of technical-economic analysis of selected lines currently armed with ALFe240 conductor possible replacement with the most suitable high-temperature conductor providing an increase in transmission capacity of overhead HV lines in order to achieve the transmission capacity of the conductor 434-AL1/56-ST1A i.e. min. 720 A without major interference to the existing support points of overhead HV lines. The properties of high-temperature conductors are firstly illustrated on the example of a fictitious sample span on a 110 kV line and then 4 types of high-temperature conductors are selected and compared on real line profiles with a total length of about 62 km, where there is a realistic expectation of using the potential of high-temperature conductors and their use in the distribution system. The article provides the technical professional public with an insight into the possibilities and potential of using high-temperature conductors on HV lines in the distribution system during their reconstruction or construction of new HV lines.

ALTERNATIVES FOR BUILDING NEW HV FEEDER LINES MAXIMISING THE USE OF EXISTING ONES NETWORK

Petr Skala, Zbyněk Brettschneider, Jan Hejhal – PREdistribuce, a.s.

Increased demands for the connection of new large loads raise a number of issues related to maximizing the use of the existing network. This paper focuses on the possibility of creating new feeder lines in the HV cable network to meet the needs of customers for whom the implementation of partial modifications of the existing network is not sufficient for power reasons. The natural step at such a moment is to create a completely new line. This can be built on a "one-off" basis (in direct connection with a specific consumption) or with at least partial use of pre-investments in suitable routes. The alternative, which maximizes the use of the existing network, is then to 'empty' one of the existing lines and then use it for a new off-take. It is possible to map and compare the possibilities of creating a completely new line even without knowing the specific location of the new tap. The results then have the character of indicating the price range for a given pair of adjacent HV/LV transformers and recommending an alternative suitable for primary development. It is in this perspective that this paper presents some more general results for the territory of PREdistribuce, a.s..

DEVELOPMENT AND PREDICTION OF CUSTOMER REQUIREMENTS AND THEIR IMPACT ON INVESTMENTS IN ČEZD

Adam Teringl, Daniel Plšek, Jan Berka, ČEZ Distribuce, a.s.

The paper responds to the increasing number of requests for PV connections and looks at the prediction of the amount of customer investment and its impact on the overall investment budget, particularly for refurbishment. Much emphasis is placed on the synergy of investments in terms of aging technology and growing demand, either on the consumption or production side. At the same time, the paper briefly mentions the DtV (Design-to-Value) principle applied in CEZd to maximize the value of the invested crown.

RISK INDEX MATRIX AND INVESTMENT PRIORITISATION IN EG.D

Daniel Kašpar, Jan Kopecký, EG.D, a.s.

Investment prioritization and TOTEX efficiency is ensured in EG.D by a risk-oriented data model, the Risk Index Matrix (RIM). For each element of the technical inventory and its parent aggregates, risks and impacts are calculated, divided into five basic RIM segments and subsequently visualized in a geographic information system (GIS). Together with other RIM parameters and technical inventory attributes, technical needs tables (TTPs) are created for each voltage level and asset class. The ordering of aggregated units in the TTP determines the priority for restoration and is an input, along with other information, for initiating construction plans. Part of the construction order generation includes a RIM polygon in the GIS environment over the distribution system (DS) area of interest. The polygon automatically calculates the RIM parameters of the construction and these are used for construction prioritization and planning. Restoration effectiveness is regularly monitored, evaluated and visualized in the MS Power BI environment.

INVESTMENT DASHBOARD

Tatiana Bošanská, Peter Žiak, Západoslovenská distribučná a.s.

The Investment Dashboard provides managerial and operational reporting focused primarily on the area of capital spending of ZSD capital projects. The Dashboard displays and compares planned expenditures versus forecast or actual expenditures. In addition to financial indicators, it also tracks material and time indicators on individual projects or investment chapters. It allows data to be displayed through various dimensions, interactive filters and charts within individual reports at different levels of detail.

EVALUATION OF THE QUALITY OF ELECTRICITY SUPPLY FOR 2022

Jan Liška, Energetický regulační úřad (ERÚ)

The paper deals with the evaluation of the quality of electricity supply and related services in the Czech electricity sector for the year 2022. The main focus is on the evaluation of the achieved level of continuity indicators, including the link to incentive regulation of quality. The paper includes a more detailed breakdown of the continuity indicators by interruption category, as well as a look back at the 10-year history of electricity quality regulation and how the set and achieved Q component values have evolved.

AUTOMATION OF FAULT ISOLATION AND SUPPLY RESTORATION IN THE POWER SUPPLY AND DISTRIBUTION NETWORK - PILOT PROJECT WITHIN PREDISTRIBUCE, A.S.

Ota Schmidt, Jan Štěpánek, PREDistribuce, a.s.

After a brief introduction of the PREDi HV networks (power supply and distribution), the article describes the basic principles and the course of preparation and implementation of the PREMIOS project. It is a higher SCADA function used to automatically locate the fault, define the affected area and restore the supply in the unaffected part of the distribution network in order to increase the availability of EE supply. The application will gradually work in several operating modes, ranging from listing the design of manipulations to the dispatcher to full automation. The application will maintain a topological model of the network that can be used for future SCADA applications.

INSTALLATION OF REMOTELY CONTROLLED ELEMENTS ON OUTDOOR OVERHEAD LINES IN THE NETWORKS OF EG.D, A.S.

Michal Kučera, Milan Krátký EG.D, a.s

The paper deals with the installation of remotely operated elements (ROPs) in outdoor HV lines in the networks of EG.D, a.s., primarily focused on the installation of reclosers. These help to reduce the impact of HV faults by contributing to a reduction in the time to locate the fault; moreover, some customers are not affected by the fault at all. The methodology used to select the most suitable sites for installation is described, the evolution of the number of DOPs is described, as well as the target number of reclosers, which was determined on the basis of an expert study. Furthermore, the expected and already visible impacts on the SAIDI and SAIFI quality parameters are mentioned.

RELIABILITY EVALUATION IN A POWER BI ENVIRONMENT

Tereza Jeřábková, PREDistribuce, a.s.

Within PREDistribuce, a.s., an analytical tool was created in the Power BI environment for continuous evaluation of the Q component and faults in the network at the high and very high voltage level. As part of the development of the tool, a new fault categorization was created and events in the PREDistribuce network over the last 10 years were analyzed. The tool provides a comprehensive view of what is happening in the network and based on this, measures to enhance reliability have been identified and evaluated.

THE CURRENT STATE OF ANALYTICAL TOOLS FOR DISTRIBUTION COMPANIES AND THE USE OF LARGE LANGUAGE MODELS AND AI

Petr Lžičař, Jakub Šatka - Awesense

One of the innovative features is the use of a "sandbox" (a digital twin of synthetic data) that allows distribution companies and their partners to test and model different scenarios without the risk of impacting the production environment. This means that new approaches can be explored, operations optimized and strategies tested without having an adverse impact on operations. Creating "use cases" is becoming increasingly easy and accessible for different levels of users. Thanks to advances in tools and technology, distribution companies are able to quickly create and modify analytical scenarios, improving their ability to respond to changing conditions. AI is also helping in this regard, making it possible to even use text to analyze data without any knowledge of code.

SESSION 6

FLEXIBLE PROVISION OF SVR AS A NEW REALITY

Martin Kašák, ČEPS

The development of aggregation blocks for the provision of power balance services is a reality. For the time being only within the framework of the so-called Integrated Aggregator. The next step is the expected development following the general concepts of aggregation, flexibility, accumulation, which are part of the "transposing amendment" of the Energy Act. In the opinion of ČEPS, the arrival of the Independent Aggregator will allow massive development of flexibility not only for power balance services but also for commercial flexibility. This flexibility will be drawn mainly from distribution companies. Let's discuss together what all will change in the future flexible world.

USING A PROBABILISTIC APPROACH TO SUPPORT THE DEVELOPMENT OF LOW-VOLTAGE FLEXIBILITY

Zbyněk Brettschneider, Radek Hanuš, Václav Růžek, PREdistribuce, a.s., Miroslav Müller – katedra elektroenergetiky, FEL ČVUT Praha

Recently, there has been a gradual opening of the electricity flexibility market. Flexibility providers are now connected to very high and high voltage distribution networks in the Czech Republic. At the same time, steps are being taken to connect low-voltage flexibility providers as well. The behavior of flexibility providers at lower voltage levels may cause specific problems for the DSO, as distribution networks have not yet been built for this form of operation. Therefore, new operational and investment measures need to be put in place to continue to maintain the security and reliability of network operations. However, flexibility is also a tool that can bring benefits to the DSO if managed correctly. For this purpose, PREdistribuce and in cooperation with the CTU, Department of Electrical Power Engineering, have developed a software tool CFF (Capacity for Flexibility) that supports the network semaphore function. This tool determines the available capacities for flexibility transactions at individual distribution outlets, both for the current time and for the future. CFF works with a probabilistic model of load and generation. It uses metering data from both instantaneous and non-instantaneous meters. It also allows real-time dispatch processing as input to the calculation, if available at a given location in the distribution network. Using a probabilistic approach, the CFF tool thus facilitates the development of flexibility at the low-voltage level and allows the full use of the capacity of the existing infrastructure.

THE IMPACT OF THE MASSIVE DEPLOYMENT OF PV AND COMMUNITY ENERGY ON THE REGULATED REVENUES OF DISTRIBUTION COMPANIES AND THE INDUCED RISKS OF COST SOCIALIZATION

Lubomír Lízal, Hynek Beran, Pavel Hrzina, ČVUT Praha

Using realistic PREdi distribution areas, we model the effect of massive PV deployment, both without and with batteries, on the change in distribution revenues at current (unchanged) distribution rates. We compare three scenarios, namely installation without overflows (i.e. not generating ancillary costs), installation in a size leading to "zero district" (annual production equals annual consumption), and the theoretical maximum possible installation (theoretical space limit of usable areas), against the current (reference) situation. Under the current regulation (revenue cap approach), the regulator has to increase charges in the future to compensate for the decrease in revenue due to lower transmission volumes. Calculations show that distribution tariffs may thus increase very significantly, leading to risks arising from significant socialization of costs through inappropriate setting of distribution tariffs. As a result, current energy policies pose a serious regulatory problem, with socially unsustainable consequences, and consequently a significant political problem.

THE NEW ROLE OF THE ENERGY AND DISTRIBUTION SYSTEM

Hynek Beran a kol., Cygni® & ČVUT Praha

We have inherited a fine-tuned and functional energy system from our ancestors. At present, this system is divided, which is also not a dogma in neighbouring European countries (municipal city companies - Stadtwerke in German), but it is also partly out of tune with the inappropriate implementation of RES and, apart from the Czechoslovak industry, it serves mainly stock exchange processes and partly ideological processes, coming mainly from the neighboring country, often without appropriate technical solutions and engineering logic, including new requirements for system management with higher penetration of RES and corresponding tariff policy. New decentralized investments require a clear signal on how they are to operate in the future and what will be beneficial for them, at the moment we only have chaos and repeated EU admonitions for legislative inaction.

GREEN FLEET - ELECTROMOBILITY AT ČEZ DISTRIBUCE

Stanislav Hes, Jan Kůla, Kateřina Pěnkavová, ČEZ Distribuce, a.s.

The paper contains information about the ongoing CEZ Distribuce project, which deals with the broad deployment of electromobility within the company with the aim of ensuring a share of electric vehicles in the fleet of at least 30% by 2030. The Green fleet project addresses the construction of non-public charging infrastructure for the needs of fleet vehicle charging, the deployment of local control systems for charging management with respect to the available power at individual locations, the implementation of a central monitoring and control backend system for managing charging stations and the possibility of using charging stations as a tool to provide flexibility in changing active power for the needs of the distribution system operator (tested within the European OneNet project, which is supported by the European Commission under the Horizon 2020 software). The paper also contains information on the expected future use of the features tested in the project, follow-up actions and benefits for CEZ Distribuce.

LOAD MANAGEMENT FOR THE MODERN POWER INDUSTRY

Ondřej Mamula, CIIRC ČVUT Praha, Aleš Mikula, ZPA Smart Energy, Martin Střelec, ZČU Plzeň

Regional DSOs will start implementing the AMM system in 2024. Smart meters will be gradually installed at consumption points with annual consumption above 6 MWh and at all two-tariff consumption points. The existing load control and tariff management via HDO is incompatible with the AMM solution. The DeCoDiS project is developing concepts and solutions that will provide DS operators with practical load management tools that meet the needs of the modern power sector. The deployment of machine learning will enable detailed analysis of different operating scenarios, including impacts on DS quality or reliability indicators. When calculating control interventions (in the form of a change in the generation or consumption profile at the LV level compared to the baseline), the use of a linearized DC model of the network and the deployment of linear or quadratic optimization methods are envisaged. The solutions are developed to enable PDS to effectively manage the power balance in a defined DS area, reduce the DS load across the board, stabilize load profiles and thus maximize the usable DS capacity.

Optimized flexibility loading, which is under the control of the PDS, will ensure compliance with the specified power or current limits of the lines on selected critical elements (lines, transformers) of the distribution network.

The tools under development will fully exploit the expected functionality of the AMM infrastructure, which will be extended by edge computing, thus increasing the efficiency of optimization tasks and reducing data flow requirements. The project will also offer solutions for flexible communication with devices nested in the OM, e.g. charging stations, static storage, PV inverters, etc.

CYBER SECURITY TESTING OF SMART METERS

Petr Mlýnek, Pavel Mašek, David Kohout, Ján Sláčik, Tomáš Lieskovank, VUT v Brně

The current period of selection and implementation of smart meters in accordance with the Metering Decree shows the need to test cyber security due to several challenges of current meters (DLMS Security Suite 2, hardware requirements, etc.). The aim of this paper is to present the testing challenges with respect to the considered communication technologies and the current market status. At the same time, the paper will present the possibilities of certifying meters for cyber security.

OPTIMIZING THE USE OF OPTICAL INFRASTRUCTURE FOR SMART METERING

Zbyněk Brettschneider, Pavel Glac, PREdistribuce, a.s.

Since 2017, PREdistribuce has been using LV and HV cables with an integrated optical tube for the future installation of the optical network for the renewal and development of the distribution network. In addition to its use for network control and monitoring, its major potential lies in smart metering communication. This can be maximized by choosing an optimal strategy that includes both the installation of the fibre network elements and their connection to the backbone network, as well as planning for the deployment of AMM. This paper focuses on mathematical modelling and finding the optimal solution for the above technologies.

APPLICATION OF ČSN EN 61850 IN A DATA MODEL OF AN ELECTRICAL STATION STRUCTURED ACCORDING TO ČSN EN 81346

Josef Fritschka, Jan Hyrák, Technodat Elektro, s.r.o.

The paper deals with the application of the set of standards ČSN EN 61850, which define the unification of communication protocols, to the information model of the building (IMS) of the electrical station (ES) structured according to ČSN IEC 81346 in the Engineering Base platform. In the field of documentation of ES technology, the development is directed towards the introduction of a data model based on the BIM methodology with an object-oriented database of elements. The design is being developed in the form of an IMS, where all the necessary information for mutual communication will be entered in the form of database records in the attributes (metadata) of information electronic device (IED) objects and their links. The individual IED objects in the IMS unipolar schemas respect the embedded information according to the conditions of use of the description language for configuring IEDs in the EC. This language is called the System Configuration Description Language (SCL). The technology part of the IMS is processed in such a way that configuration data is generated and backed up to a normative SCD file based on the topology of logical nodes and IEDs. This provides a link between the physical and functional definition for each IED.