Abstracts

of the scientific papers of

Chief assistant professor **Nikolay Deyanov Nikolaev**, PhD engineer

for participation in competition for academic position „Associate professor“, in professional field 5.4 Energy for subject „Electric power plants and substations“, in department “Electric Power Engineering” in Faculty of Electrical Engineering in Technical University - Varna, announced in DV issue 105/18.12.2018.

Contents

Abstracts in category B.4 – habilitation work – scientific publications indexed by world-renown referencing databases

[1] N. Nikolaev, Y. Rangelov, V. Valchev, and A. Marinov, "Technique for indirect analysis of domestic power consumers based on power pattern recognition for smart energy metering," in 2013 36th International Convention on Information and Communication Technology, Electronics and Microelectronics, MIPRO 2013 - Proceedings, 2013, pp. 971–974

The current paper presents an approach for measuring energy behavior of domestic power consumers based on power pattern recognition. This approach can be implemented into a central smart energy meter that will be able to identify the energy consumed by each particular power appliance. The suggested approach is based on recognizing the transient power change that occurs during the turning 'on' and 'off' electric devices. This transient power change is then compared against pre-set patterns, where the different devices are recognized using fuzzy logic. The approach is tested in simulation and proves functional for most electric appliances. Implementing it together with a smart energy meter forms an intelligent system that allows users and operators to estimate the contribution of each electric device to the total energy consumption. The advantage of so formed system is that only a single central measuring is required, omitting the necessity of installing a meter to each device.

The developed algorithm for indirect recognition of the switched domestic appliances is stable despite of the disturbances of the power supply (voltage magnitude deviation and presence of harmonics). With its help most of the "passive" appliances, such as boilers, electrical heaters, cookers, lighting bulbs and others are identified. Based on that a database with their individual consumption is collected, providing the costumers with useful information for their energy expenses on each device.

[2] K. Gerasimov, Y. Kamenov, Kr. Gerasimov, and N. Nikolaev, "Application of Monte Carlo method for probabilistic assessment of electric power system small-Signal stability," in International Conference on Power Engineering, Energy and Electrical Drives, 2013, pp. 801–805

The paper treats the problem for of small–signal stability assessment of large electric power system, taking into account uncertainties in the mathematical model. The well-known from robust control theory method of μ–analysis for assessment of robust stability is not applicable large electric power system due to computational problems. Thus the paper proposes a probabilistic approach, based on the Monte Carlo method, which considers specific features of the electric power system. A study is conducted on 4-machine 2–zone test system and the advantages of the proposed algorithm are discussed.

The proposed algorithm for probabilistic assessment of the EPS small–signal robust stability, based on the Monte Carlo method, has the following advantages over the μ–analysis:

- Relatively simple and straight–forward;
- Calculations are uniform and break down to solutions of standard problems for which different computationally optimized procedures already exist;
- Applicable for real–scale multi–machine systems. It is worth mentioning, that in order to obtain results with higher probability, the number of iterations grows considerably. For example, to achieve 90 % probability for error of less than 5 % in the probabilistic assessment for small-signal stability, 460 iterations are necessary. Though for error less of than 1 % (at the same level of probability) the number of necessary iterations raises to 11 513. However, it should be noted that the number of iterations does not depend on the overall size of the analyzed system;
- Allows identification of critical operating states and further analysis, which can be of practical interest for the dispatching centers.

[3] N. Nikolaev, S. Yordanov, and R. Vasilev, An optimization algorithm for simulating smart-grid means for distribution grid balancing, vol. 679. Springer Verlag, 2018

In the near future, Smart-Grid technologies will have an incredible impact on the economics of power systems and on environment. This will be possible thanks to the intelligent communication and computer systems, which would allow the sys-tem to accommodate much more energy from renewables by combining different technologies for energy storage, electric vehicles and demand response. The main contribution of this paper is the development of models for the different components of the Smart-Grid, which can be easily generalized for many different studies. The modelling framework includes energy storage, renewable energy sources, electric vehicles and demand response. We use the problem of distribution grid power balancing to illustrate the application of the models for improving the economic performance of a balancing group. The problem is formulated as a mixed-integer linear program and can help energy companies and costumers to make investment decisions for smart-grid.

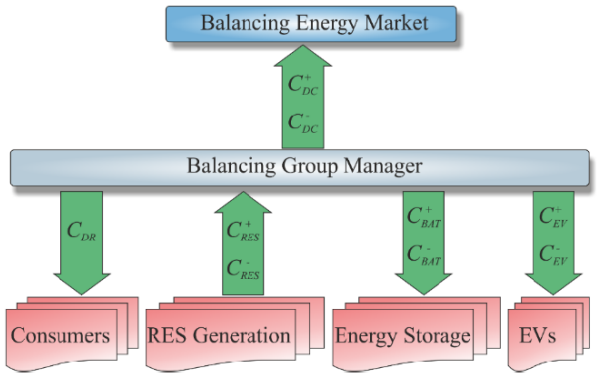


Fig. 1. Energy market structure

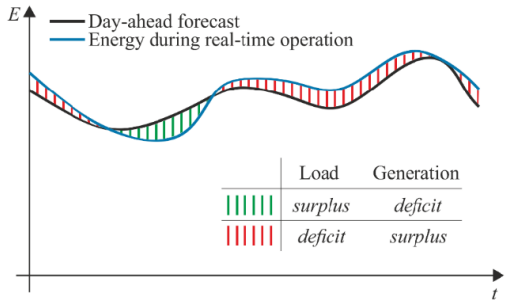


Fig. 2. Definition of deficit and surplus in load or generation context

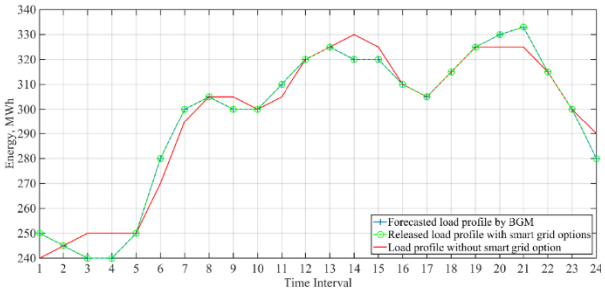


Fig. 4. Load profiles of the balancing group

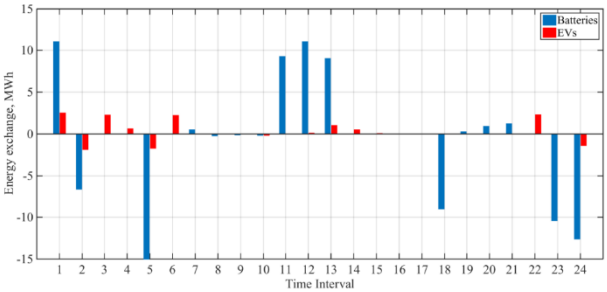
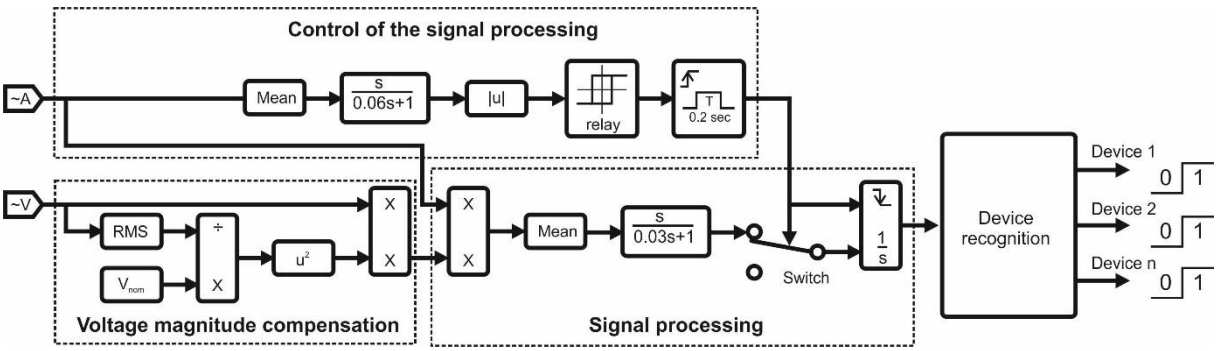


Fig. 5. Energy exchanged by the batteries and EVs

[4] N. Nikolaev, Y. Rangelov, and A. Marinov, "Algorithm for indirect load recognition in domestic power consumption," in PCIM Europe Conference Proceedings, 2013, pp. 1241–1246

The paper presents a specialized algorithm for indirect load recognition in domestic power applications. This approach allows a central digital electrical energy meter to register when a member of a pre-given set of electrical consumers is turned "on" or "off" and thus determine its contribution to the electrical energy consumption in terms of total, active and reactive power. The algorithm recognizes electrical consumers based on their specific power "signature". The main advantage of the concept compared to conventional smart energy metering is that energy consumption of different loads can be differentiated without the use of separate meters for each consumer.

An indirect approach for recognition of domestic electrical devices connected to the grid is presented. The approach recognizes the devices based on their specific "power" signature. For the suggested algorithm the relative change in mean power specific to each consumer is used to determine whether a certain device is being turned "on" or "off". A simulation with three different loads is carried out. The simulation shows the functionality of the algorithm.



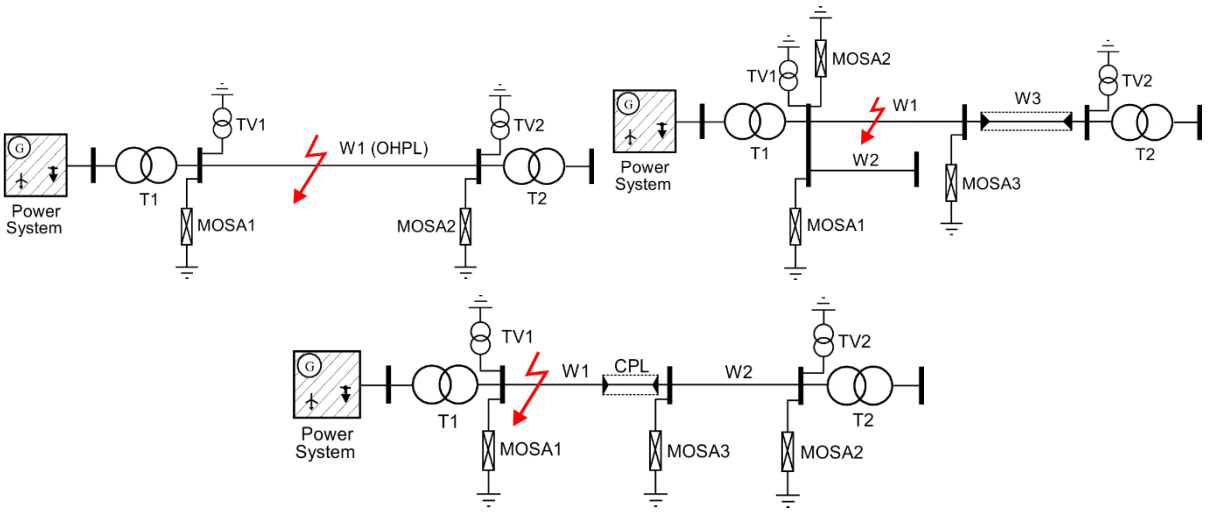
Detailed diagram of the suggested algorithm

[5] M. Vassileva, M. Yordanova, Y. Rangelov, and N. Nikolaev, "Simulation of the process of arising and limitation of lightning surges in medium voltage power grids," in 2013 12th International Conference on Environment and Electrical Engineering, 2013, pp. 180–185

Lightning surges are dominant in the electric power grids for medium voltage and they determine the choice of surge arresters. The paper presents simulation models of electric grid 20 kV, different variants for investigations of the influence of the surges according to the kind of electric power grid and kind of surges as well the results.

The aim of the paper is to simulate possible overvoltages in an electric power grid 20 kV at different schemes for their limitation and thus ensuring protective level and energy capability of the surge protective devices, as well as coordination of the insulation. After such analysis an appropriate choice of devices for surge protection can be made.

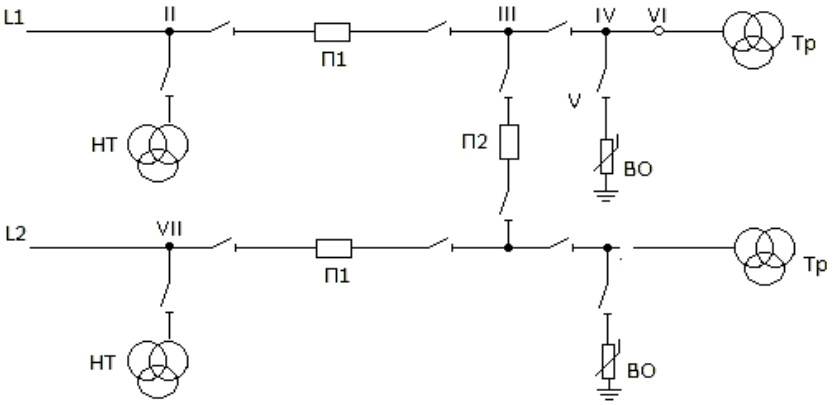
The investigated impact factors are: installation place of SPDs; number of out coming overhead power lines from substation 20 kV; kind of influencing surges. The simulations are performed with Matlab®.



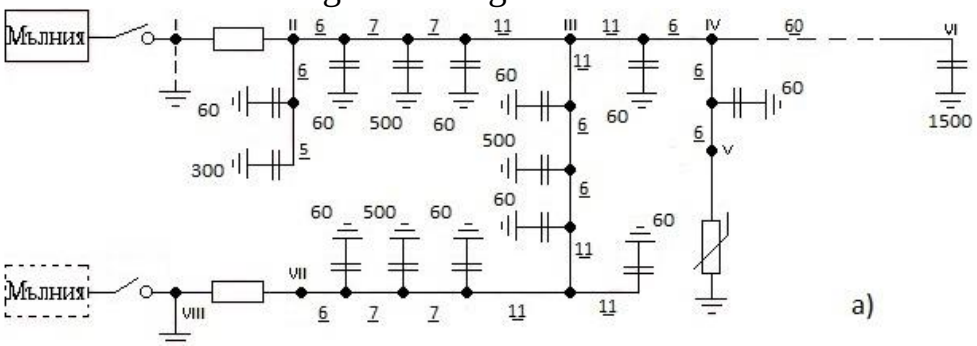
Test systems

[6] M. Vasileva, N. Velikova, and N. Nikolaev, "Model study of lightning protection of 110 kV substation," in 2014 14th International Conference on Environment and Electrical Engineering, EEEIC 2014 - Conference Proceedings, 2014, pp. 113–115

The high-voltage switchgears are frequently exposed to lightning strokes. The arising overvoltage in some cases can exceed the insulation level of the power equipment. A commonly used lightning protection devices are the metal-oxide surge arresters. This paper presents a developed simulation model, appropriate for assessment of the impact of lightning strokes on the insulation of the switchyard equipment. An example 110 kV substation is used for test case. The study illustrates the effect of MOSA's operation in terms of limiting the arising overvoltage. The proposed simulation methodology can be used to make a precise choice of surge protection of high-voltage switchgears.



Single line diagram of the substation



Equivalent electrical circuit of the 110 kV switchgear with one power transformer switched-off

[7] N. Nikolaev, Kr. Gerasimov, K. Gerasimov, and Y. Kamenov, "Mathematical model and computer software for EMT analysis in HV and MV grids," in 2014 14th International Conference on Environment and Electrical Engineering, EEEIC 2014 - Conference Proceedings, 2014, pp. 152–157

The paper presents a computer program, intended for calculations of electromagnetic transients, related to short-circuit and earth faults in distribution grids. Appropriate mathematical models of the main power system devices are developed with the instantaneous currents and voltages. The authors propose a universal structural approach for combining all device models into a single mathematical state-space description. This approach allows easy extension of the models library. The paper also proposes three methods for the solution of the state-space model. The presented comparative calculations prove the adequate modelling and show the advantages of the developed computer program.

The presented software tool *Power Systems Research* (*PSR*) and the developed mathematical models are adequate and describe in details the electromagnetic transients which occur during short-circuits and line-to-earth faults. This statement is supported by the presented comparative results.

The developed structure for the compilation of a common mathematical description of the system in the state-space has the following advantages:

- structural approach allows easy expansion of the library of mathematical models;
- the formulated system of homogeneous differential equations can be discretized and solved by methods invariant with respect to time. In practice this deprives the solution from numerical integration errors;
- numerical problems in simulations of networks with an isolated neutral are not observed;
- the mathematical description can be easily implemented in open source programs.

[8] N. Nikolaev, K. Gerasimov, Kr. Gerasimov, and Y. Rangelov, "Optimal tuning and contribution of wind turbines and PV plants to the power system frequency control," in 2014 14th International Conference on Environment and Electrical Engineering, EEEIC 2014 - Conference Proceedings, 2014, pp. 102–107

The share of energy produced by RES tends to increase during the last decade. New types of generators were introduced and the situation in terms of power system frequency control has changed. The modern wind turbines and PV inverters have functions for power output correction during significant frequency excursions. This contribution presents developed by the authors structure model of the electric power system which is appropriate for assessment of the RES impact on the frequency regulation during large disturbances. The paper also presents a methodology for optimal tuning of the wind turbine frequency responsive controllers. The test case results show that generators based on RES have big potential for contribution to the frequency control. It is also shown that optimizing their controller parameters can significantly improve the overall system response.

The following conclusions can be drawn from this research:

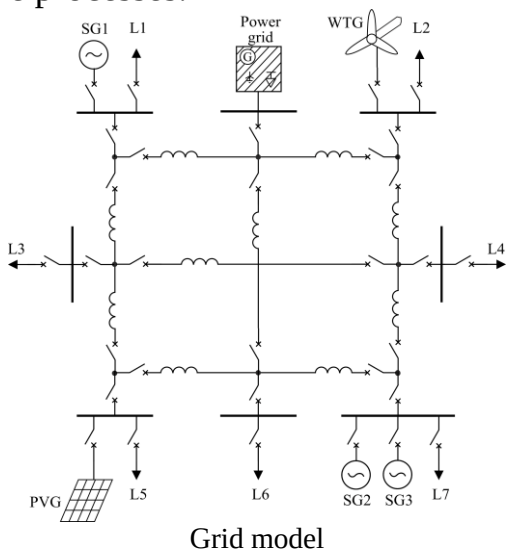
1. The proposed simplified EPS model is successfully applied to study the processes in regard to the frequency control and to perform optimization of the WT control settings.

2. The activation and optimization of the RES's frequency responsive functions improves the quality of the EPS frequency control in terms of better damping.

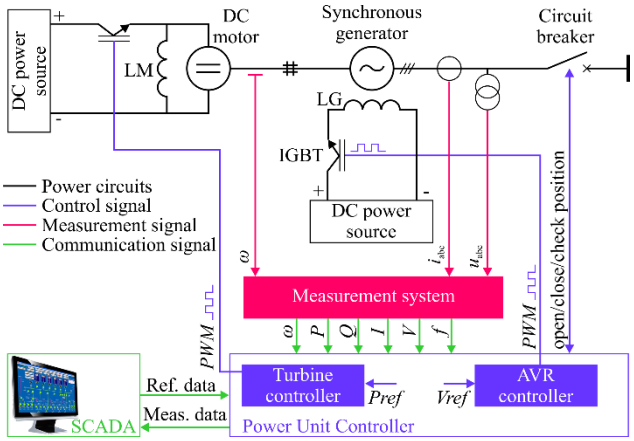
3. The most grid codes do not rely on RES to contribute to the frequency control. This study shows that changes in this regard should be made.

[9] Y. Rangelov, N. Nikolaev, Y. Kamenov, and Kr. Gerasimov, Project of experimental complex for power system stability studies, vol. 680. © 2018, Springer International Publishing AG., 2018

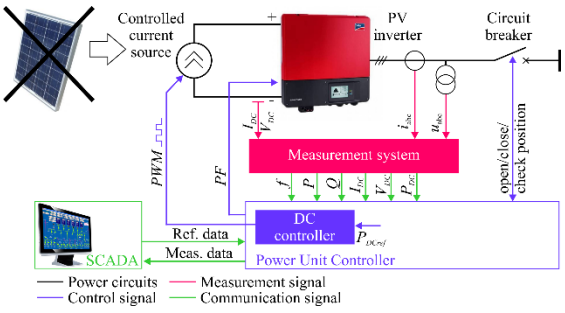
The goal of the publication is to present a project for an experimental complex of a small-scale electric power systems that would allow real-time small-signal and dynamic stability analysis. The model of the power system would allow for simulation of different ratio between renewable and conventional generation. The physical model will be three-phase and will include all main components the electric power systems usually comprise – conventional synchronous units, generators based on renewables (wind and solar), power transmission grid (lines and transformers) and controllable loads. All generation units will be able to control the voltage magnitude and frequency. The system operational parameters will be measured and logged in real-time by using very accurate DAQ system with high sampling rate. The system will allow manual and automatic control of the processes.



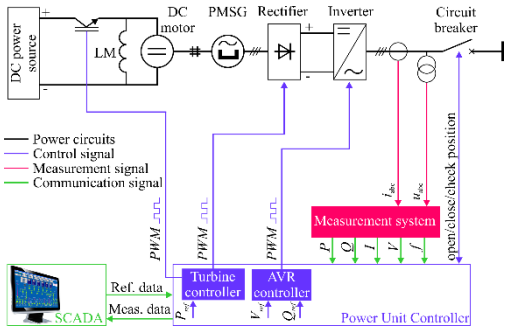
Grid model



Synchronous machine model



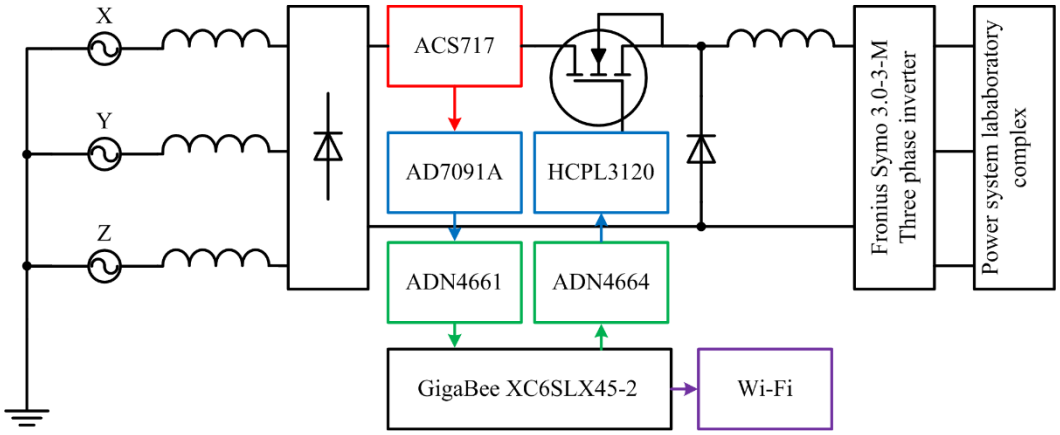
PV generator model



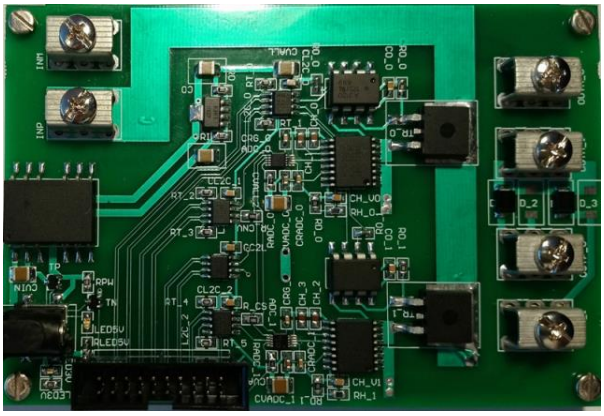
WG model

[10] P. Yankov, P. Popov, N. Nikolaev, and Y. Rangelov, "Wireless controlled solar array simulator," in 2018 20th International Symposium on Electrical Apparatus and Technologies, SIELA 2018 - Proceedings, 2018, pp. 484–487

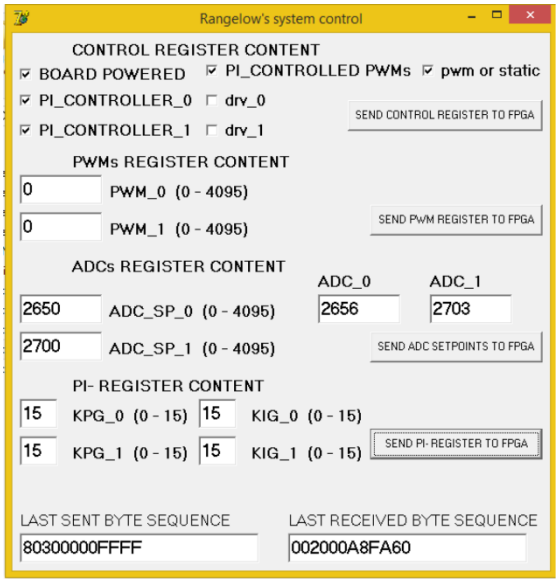
Solar panels/arrays are an important integral part of European Union (EU) electrical grid. Their interaction with the grid and behavior under different operational conditions are to be examined more closely at a scientific laboratory complex. A solar array simulator (SAS) is developed with the use of a power electronic DC-DC converter. A control and wireless communication are established with an FPGA platform. As a result the output parameters of the simulator are accessed remotely through graphic user interface. A comparison is made of SAS output characteristics and I-V curve of a given photovoltaic array. The results are then summarized graphically and tabularly.



Structure of the PV simulator



Hardware implementation of the power switching part



GUI

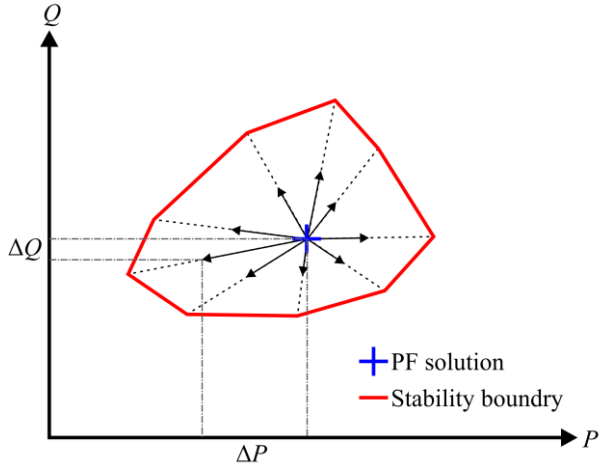
Abstracts in category Г.7 - scientific publications indexed by world-renown referencing databases

[1] N. Nikolaev, "A Monte Carlo algorithm for determining the point of collapse of power flow equations," in 2017 15th International Conference on Electrical Machines, Drives and Power Systems, ELMA 2017 - Proceedings, 2017, pp. 130–134

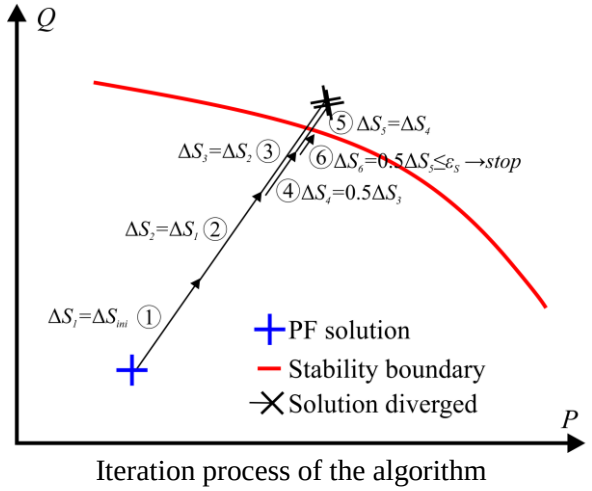
Major drawback of existing algorithms for voltage stability calculations is that they rely on predetermined loading conditions of the network to estimate the distance to system's collapse. i.e. algorithms such as the continuation power flow and others based on optimization routines only consider single possible path to the instability. This paper presents an algorithm for voltage stability boundary assessment based on Monte Carlo method. It is capable to generate many random paths/directions, which are used to load the network until a bifurcation point is reached. This algorithm could be useful as a reference for other algorithms to compare results in terms of minimal distance to collapse. Two test cases are included in the paper to demonstrate and prove the properties and capabilities of the algorithm.

The developed algorithm is simple, yet reliably determines the voltage stability boundary surface. Since it is inherently slow, its application could be useful for verification of other direct and faster algorithms. The test cases prove its accuracy and robustness.

Future improvement of the algorithm could include probabilistic features to modify the boundary limits according to their probability of occurrence. Other possible improvement could be the consideration of operational limits of generating units.



Generating random directions in the multidimensional space of bus power injections

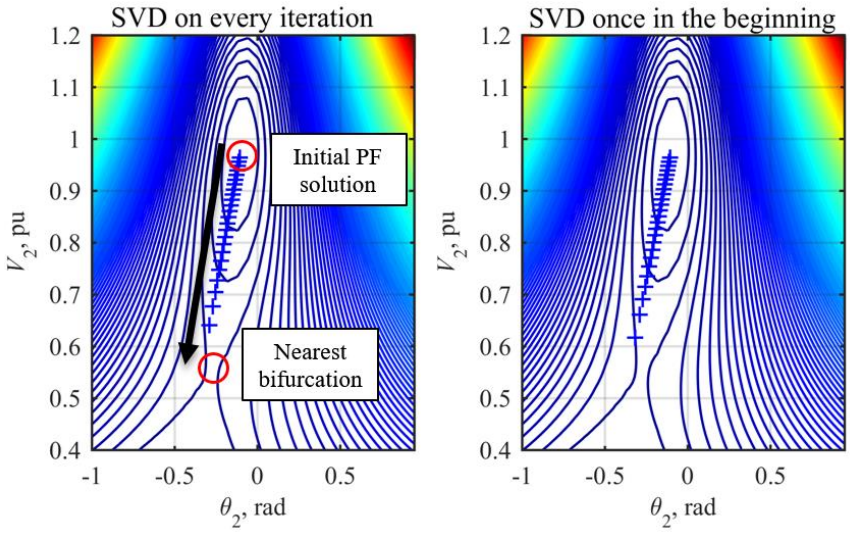


Iteration process of the algorithm

[2] N. Nikolaev, "An algorithm for fast determining the point of collapse of power flow equations based on singular value decomposition," in 2017 15th International Conference on Electrical Machines, Drives and Power Systems, ELMA 2017 - Proceedings, 2017, pp. 135–139

It is of practical and research interest to identify when the power flow equations collapse, i.e. to find the maximum loading point of the power system and its distance from the current operating point. An important information for system operators is the security margin between the operating point and maximum loading one. The existing algorithms use the present load distribution among nodes and multiply it by a loading factor until the saddle node bifurcation is approached. This means that a predetermined direction in the multi-dimensional space of nodal power injections is selected. However, this direction may not necessarily lead to the nearest or most probable bifurcation point. This paper proposes an algorithm based on singular value decomposition (SVD) to identify the shortest path to approach the instability boundary.

The test case results clearly indicate that the most suitable choice for implementation would be the algorithm modification which applies SVD only once in the beginning of the computations. It produces similar results. At the same time it avoids the computation and inversion of the Jacobian matrix on every loop iteration.



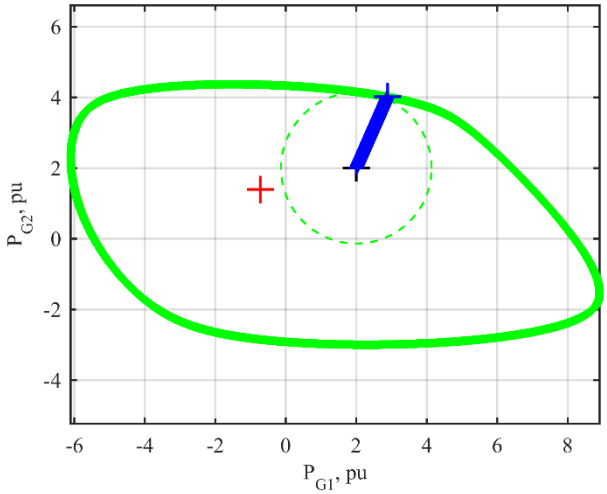
Comparison of the two algorithm versions

[3] N. Nikolaev, Verification of SVD based algorithm for voltage stability assessment against other methods, vol. 680. Springer Verlag, 2018

A novel algorithm for fast computation of the nearest operating point, where the power flow equations collapse was developed, based on singular value decomposition (SVD). It is claimed to be fast and capable to predict the loading direction to approach the maximum loading point of electric power systems, which requires introduction of minim power. This algorithm still needs to be verified against other established algorithms from the literature. This paper compares the SVD based algorithm against two other ones: (i) direct approach based on the second order Newton method and (ii) reference algorithm based on Monte-Carlo method. Several test systems are used as benchmark. The results confirm the robustness of the SVD based algorithm and its possibility for practical application.

The contributions of the paper are:

- Providing strong evidence that the SVDA is capable to find loading direction to the nearest saddle-node bifurcation.
- Issues with the application of the SONM are found and solutions are proposed.



Solution of case 4d on the P_{G1}-P_{G2} axis

[4] N. Nikolaev, "Tuning of power system stabilizer PSS3B and analysis of its properties," in 2018 20th International Symposium on Electrical Apparatus and Technologies, SIELA 2018 - Proceedings, 2018, pp. 306–310

The purpose of the power system stabilizers (PSS) is to provide additional damping to the interarea, local and intrastation modes of electromechanical oscillations and thus to improve the small-signal stability of the electric power systems. There are a number of PSS types, standardized by IEEE. The most widely used and commented in the literature stabilizer types are the dual-input, single band PSS2B and the dual-input, multi-band PSS4B. Very scarcely covered in the literature is the dual-input, single-band stabilizer – PSS3B. This paper aims to fill-in the gaps in terms of PSS3B ability to provide good phase compensation for a wide frequency range. Also, to study the frequency-domain response of the PSS in order to verify its filtering properties by testing different configurations of its structure. The results show that PSS3B can provide very good compensation, comparable to PSS2B. However, its filtering properties should be carefully examined because it has certain drawbacks with respect to that.

Clearly, there are many gaps in the literature with respect to PSS3B. The contributions of this paper are as follows: (i) study the ability of the stabilizer to provide good phase compensation for a wide frequency range; (ii) study the frequency-domain response of the PSS to verify its filtering properties; (iii) consider using some of the blocks as notch filters.

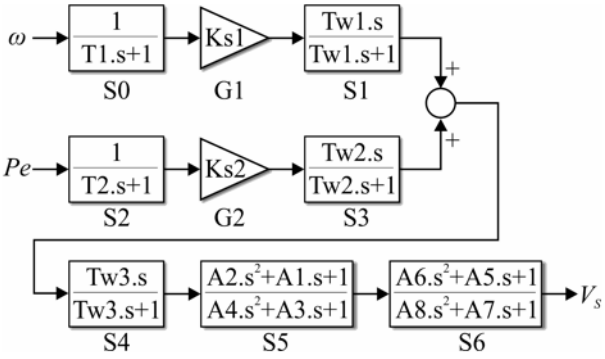


Fig. 1. PSS3B structure diagram

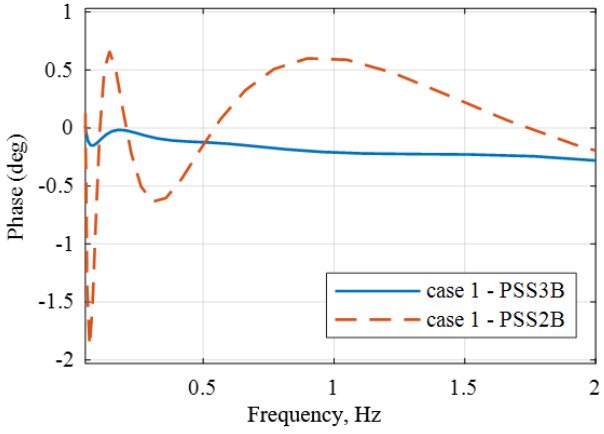


Fig. 4. Compensated P-Vr characteristic for G1-G3 for case 1

Abstracts in category Г.8 – scientific publications in non-indexed journals or in edited collective proceedings

[1] N. Nikolaev, Y. Rangelov, and K. Gerasimov, "Damping low-frequency oscillations by three-channel power system stabilizer PSS4B," in ICEST 2011 - XLVI International Scientific Conference on Information, Communication and Energy Systems and Technologies. Proceedings of Papers, 2011, vol. 3, pp. 973–976

It is a well-known fact the power oscillations in electric power systems consist of many frequencies. The classic type power system stabilizers PSS2A and 2B each have one phase shift block and thus their optimal settings are around a certain frequency meaning that they cannot damp the local and the inter-area oscillation at the same time. In regard to this issue the multiband power system stabilizers, like PSS4B, were developed. This paper reviews the capabilities of the modern three-channel PSS. A comparative analysis in cases with PSS2A either PSS4B is made and graphical results are present.

From the conducted comparative analysis the following conclusions can be made:

1. The use of modern system stabilizers significantly improves the transient processes quality at normal parallel operation of the generators in EPS and even makes them obligatory for generating units with bigger power;

2. The creation of large electric power system unions favors the occurrence of low frequency inter-area and inter-zone oscillations, which can be successfully damped with PSS4B without decrease of the local oscillations damping in the specific machine;

3. In all conducted tests PSS4B behaves better and is far more flexible in terms of tuning;

4. The use of special software for modal analysis of the processes in EPS and for PSS tuning enables the accurate determination of problematic synchronous generators in EPS and appropriate tuning of their stabilizers.

[2] Y. Rangelov, N. Nikolaev, and M. Shotova, "Automated simulation system for analysis of domestic consumption based on a dedicated computer assisted survey," in SIELA 2012 - XVII-th International Symposium on Electrical Apparatus and Technologies - Proceedings, 2012, vol. 1, pp. 286–293

The paper presents a dedicated automated simulation system for a specialized analysis and prediction of domestic electrical energy consumption. The simulation draws data from a computer assisted survey. The paper's main purpose is to show the structure of the developed automated system and the survey as well. Key decisions and design issues are explained and verified. The properties and functionality of the combination of the survey and the automated simulation system are examined and confirmed trough applying a real data simulation. Various applications of the simulation system are presented.

The results based on the described example and the suggested simulation approach can be successively used in order to:

- Find consumption patterns on domestic level – simulations of surveys for specific users can be compared against measured data from consumers with similar parameters in order to find consumption patterns and isolate specific appliances in order to determine their effect on global level.
- Predict domestic consumption – using simulation data from a given social sample can be used to statistically predict the domestic consumption for a given region, and further more give information how the different domestic appliances affect it.
- Integrate and develop smart energy systems – using modern digital signal processing and computing devices, results from the simulations can be integrated into smart energy devices that could be able to recognize consumer patterns in real time based of comparison of the pre-simulated power signatures.
- Generate solutions for increasing energy efficiency and reducing energy consumption – by determining how different appliances affect the consumption of different households a set of advices and direction for improving energy consumption can be given to specific users.

[3] K. Gerasimov, Y. Rangelov, and N. Nikolaev, "Experimental Verification of Algorithm for Indirect Domestic Load Recognition," in ICEST 2013 - XLVIII International Scientific Conference on Information, Communication and Energy Systems and Technologies. Proceedings of Papers, 2013, vol. 2, pp. 743–746

The paper presents experimental verification of the efficiency of a developed by the authors algorithm for indirect domestic load recognition. For this purpose was developed a utility, which measures instantaneous values of current, and voltage at the household's feed in cable. The obtained data is then recorded and processed by software which implements the recognition algorithm. The output of the algorithm is information about the individual electrical consumption of the particular domestic appliances. The experimental results show that the algorithm successfully recognizes the more powerful consumers which form about 80% of a household electrical consumption.

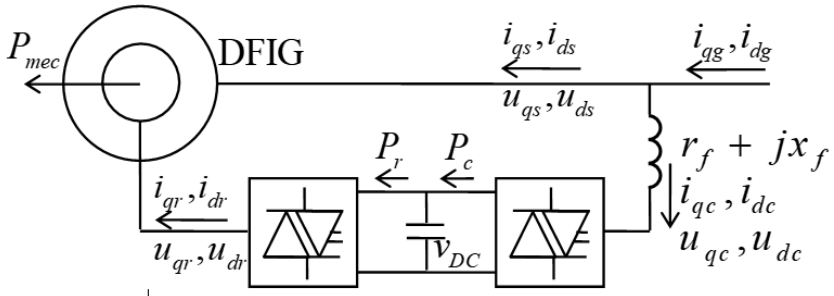
The conducted experimental study with real data from measurements show that the developed algorithm for indirect recognition of the electrical appliances switched on in a domestic household is capable of identifying the source of consumption of about 80 % of the consumed electrical energy.

Future improvements should be done in direction of use of analogue-digital converter with higher accuracy, as well as improvements in the control block. Thus the influence of the measurement noise will be decreased and the capabilities for recognition of lower-power consumers will be improved.

[4] N. Nikolaev, K. Gerasimov, and F. Milano, "Two-stage Approach for the Initialization of Doubly-fed Induction Generator Models," in Proceedings, International Scientific Symposium, Electrical Power Engineering 2014, 2014, vol. 1, pp. 52–56

This paper proposes an exact initialization procedure for doubly-fed induction generators (DFIGs). This initialization problem is formulated as a set of nonlinear algebraic equations and solved by the Newton's method in two stages. The first stage initializes the electrical machine model, whereas the second stage initializes the wind turbine variables. A set of robust initial guesses is proposed in the paper. A comparison with approximated DFIG initialization procedures is also presented at the end of the paper. The proposed approach for the initialization of DFIG machines can be useful for researchers dealing with simulation models for time-domain analysis.

This paper proposes a DFIG initialization method whose main features are: (i) generator and converter losses are taken into account; (ii) the reactive power exchanged via the grid-side converter can be specified; (iii) the algorithm is applicable to both the 3rd and 5th order induction machine models; and (iv) the optimal power-speed curve is modeled in details and accounts for rotor speed limits. As a result, the initial DFIG condition obtained with the proposed method is "exact" and does not show any mismatch with the power flow solution.



Фиг. 1. Структурна схема на DFIG ветрогенератор

[5] N. Nikolaev, K. Gerasimov, and Y. Rangelov, "Representation of Renewable Energy Generators by Synchronous Machine during Three-phase Fault Conditions," in Proceedings, International Scientific Symposium, Electrical Power Engineering 2014, 2014, vol. 1, pp. 58–62

Because of the high amount of Renewable Energy Power Plants in construction and operation, their mathematical modeling is relevant. In practice, specialized computer programs are used for short-circuit current calculations. Often in this programs the renewable generation models are not included.

The main contribution of this paper is an algorithm for representing wind farms and PV power plants with synchronous machine model. The algorithm includes a procedure to estimate the synchronous machine parameters. The short-circuit current results obtained with the synchronous and the renewable energy generators are compared. Simulations for different types of wind turbines and PV generators are presented. The results confirm that synchronous machine model can be successfully used to represent renewable generators for short-circuit calculations.

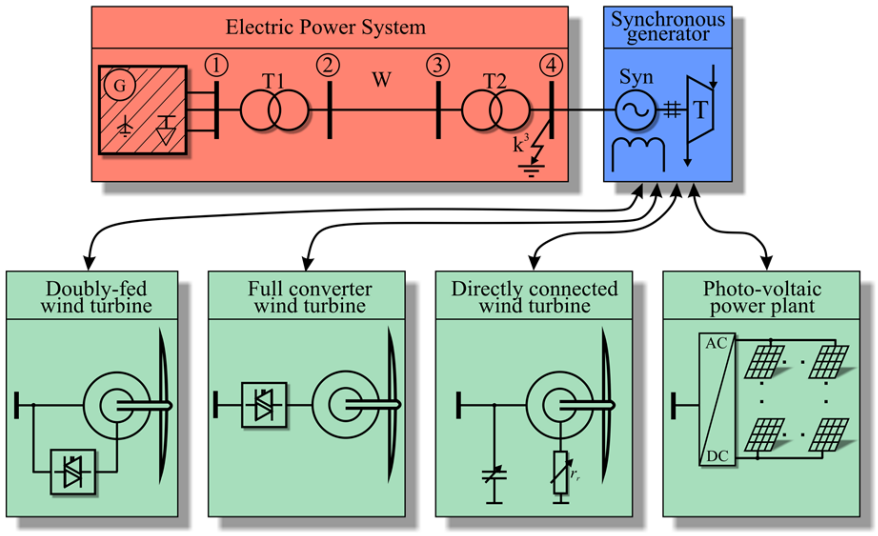


Figure 1. Substitution of the renewable energy generators with a synchronous machine model

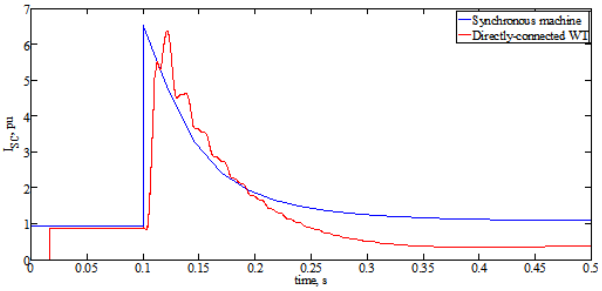


Figure 8. Comparison between SM and directly-connected wind turbine

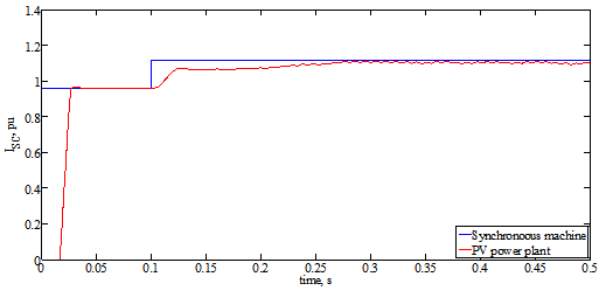


Figure 9. Comparison between SM and PV power plant

[6] Kr. Gerasimov, K. Gerasimov, and N. Nikolaev, "Advanced Tools for Stability Improvement of Interconnected Electric Power Systems," in Proceedings, International Scientific Symposium, Electrical Power Engineering 2014, 2014, vol. 1, pp. 5–9

The paper reviews the modern trends in the development of the European interconnected power system and in particular of the Bulgarian system as an element in a much bigger interconnection. Emphasis is put on FACTS (Flexible AC Transmission System) and PSS (Power System Stabilizer) as advanced tools for stability improvement. Special aspects of PSS operation are discussed for the case when it is tuned by the classical approach based on phase compensation. It is also shown that more efficient PSS operation can be achieved by tuning based on robust methodologies combining weighted input signals from the turbine and the excitation system.

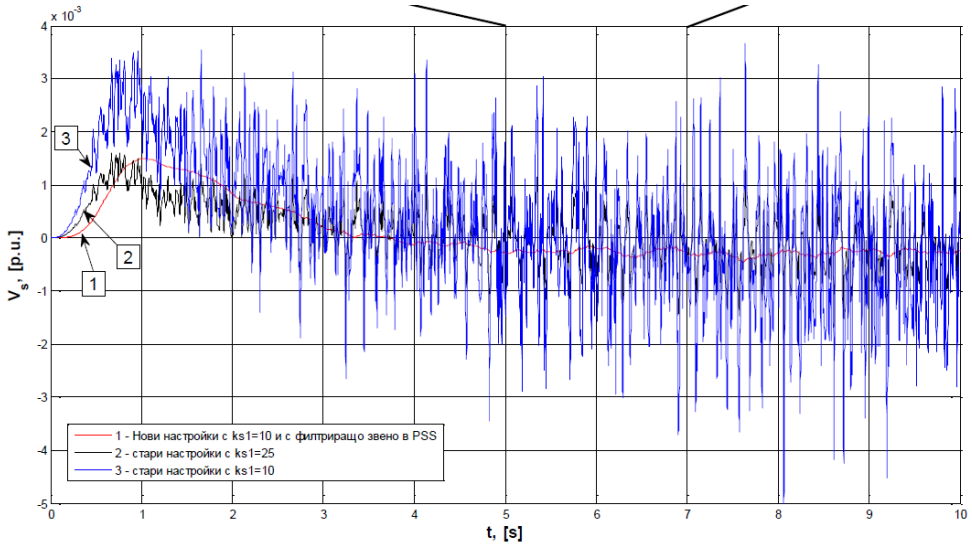


Figure 15. PSS output signal in the process of decrease of turbine power, for the case of: 1 – new settings with gain ks1=10; 2 – old settings with gain ks1=25; 3- old settings with gain ks1=10

[7] Y. Rangelov, A. Avramov, and N. Nikolaev, "Design and Construction of a Laboratory SCADA System," in ICEST 2015 - L International Scientific Conference on Information, Communication and Energy Systems and Technologies. Proceedings of Papers, 2015, vol. 1, pp. 300–303

During the last decade, the industry has become very "digitalized". Industrial, commercial and domestic electricity consumers are becoming part of the digital revolution. In the near future even the light bulb is expected be able to control and monitor itself. The electric power engineering is also subject to digitalization on a global scale. Every electric power facility is either fully or partly equipped with automated controls, numerical relay protections, multifunctional digital measurement devices and other intelligent electronic devices. The energy industry has been looking for years to find a universal approach to deal with the unification of substation automation and communication devices manufactured by different companies. The standardization institutes in Europe and America have developed the common standard IEC61850, which allows the integration of the communication, the information, the control and all other subsystems.

This paper is dedicated to the design and development of electronic system for supervision, control and data acquisition (SCADA) of an operational switchgear. It briefly presents basic aspects regarding the development of a SCADA system for a realistic and fully-operational switchgear in the laboratory "Pow-er Plants and Substations" at Technical University – Varna.

Here we draw the main conclusions of the paper:

1. Based on thorough study on existing internet reports, national regulations and standards an intelligent electronic platform is created, which we call a local controller. It implements all the inputs and output to interface the switching and measurement devices, which are part of existing switchgear and makes connection to the operator's computer station.

3. Approximately 1000 meters of cables are used to connect every component of the switchgear (83 devices) to the local controller in laboratory "Electrical Power Plants and Substations".

4. A human-machine interface is created to observe and control the operation of the laboratory switchgear.

5. The paper shows that it is possible to build a low-cost fully-functional SCADA system with existing open-source microcontrollers, such as Arduino. The required devices and equipment is worth approximately 500 euro.

[8] R. Vasilev, N. Nikolaev, and S. Yordanov, "Successful Implementation of Smart Metering Systems. Influence Factors, Challenges and Mitigation Measures," in PROCEEDINGS - International Scientific Symposium - Electrical Power Engineering 2016, 2016, vol. 1, pp. 44–49

Smart metering systems are relatively new technology. Their complete implementation affects interests of the customers and their habits, work of the electricity power system operators as well as financial relationships between consumers, producers and traders of electricity. Therefore, the successful implementation of the smart metering system requires consideration of all aspects, namely social, regulatory and technical.

From the above mentioned the following conclusions could be outlined:

1. The successful implementation and applying of SMS functions require a certain regulatory framework. Part of the system's functions affect the end-consumer of electricity (households) and its implementation will lead to certain changes in the nature and habits of consumption. In technical aspect, because of its complexity, the system implementation will lead to changes in the work of electricity distribution grid operator. Therefore, for successful implementation of SMS the regulatory, social and technical aspects should be considered all together.
2. In the social aspect, as major obstacle that to be expected is the end consumers' resistance to use the functions of SMS. It originates from customers uncertainties concerning capability of the technology to provide a level of comfort that equals the comfort of conventional electricity consumption. To overcome the distrust the necessary information and awareness campaigns should be planned, as well as a deployment of a system with a required level of reliability.
3. The investments for replacement of existing home appliances with new ones, corresponding to the SMS functions in order to provide system services, are tremendous. Therefore, they should be incentivized with relevant and adequate price packages. It is advisable the new appliances that handle SMS functionality, to be already on store and promoted to customers, especially for the regions where the deployment of the system is planned, in order to provide opportunity for the customers when purchasing a new appliance to choose one that complies with forthcoming market changes.
4. To profit the system functionality in providing balancing services, minor amendments in the legislation should be initiated, which will allow direct interaction between users and providers of balancing energy. This will result in further boosting of competitiveness and transparency in price structure of balancing services.
5. The technical concept and system architecture are the basis for its implementation. In their elaboration few aspects should be scrutinized and considered as: legislative requirements and restrictions, main purpose of the implementation of the system, its functions and expected maximum capacity in respect of number of end devices and data to be collected.
6. And others available in the full paper.

[9] N. Nikolaev, S. Yordanov, and R. Vasilev, "Optimization of Costs for Balancing Through Smart Metering System," in PROCEEDINGS - International Scientific Symposium - Electrical Power Engineering 2016, 2016, vol. 1, pp. 50–62

The main function of Smart grids, in particular of Smart metering systems is load management in energy distribution grids including electrical vehicles and energy storage. This activity should lead to respective financial benefits not only for grid owners but also for owners of end devices managed. Analysis of the potential benefit from system operation related to energy imbalance, considering both financial and energy aspects, represents an essential component in the decision for implementation and can be accomplished by the use of mathematical model.

The main functions of Smart grids, in particular of Smart metering systems (SMS), are load management in energy distribution grid including electrical vehicles and energy storage. This activity should lead to respective financial benefits not only for the owners of SMS but also for owners of end devices managed.

An algorithm, simulating the effect from SMS implementation in distribution grid, is developed for de-termination of required manageable loads connected to low voltage (LV) grid and the financial benefits from their management, aimed at demand response. The algorithm is based on objective function which optimizes imbalance costs to the balancing energy supplier. These expenses are reduced by using cheaper means, namely manageable loads, batteries and electric vehicles.