From modeling an electrical microgrid to creating smart grid

[1]*Michal IVANČÁK (3rd year)*
Supervisor: [2]*Juraj KURIMSKÝ*

[1,2]Department of Electric Power Engineering, FEI TU of Košice, Slovak Republic

[1]michal.ivancak@tuke.sk, [2]juraj.kurimsky@tuke.sk

***Abstract*— Intelligent networks or smart grid are currently the most frequently mentioned theme, so research in this area is expected. This paper describes modelling electrical network through software like Neplan or Matlab Simulink that replaces mathematical computation, facilitates and speeds up this process. The data are used from real distribution system from the average village in Slovakia, with 1500 residents and around 250 loads. This model also tests its reliability as well as the impact of various attributes such as prediction.**

***Keywords*— microgrid, renewable energy source, smart grid, smart grid projects.**

I. Introduction

In these days is word "Smart" very popular term. It usually refers to different products with an increasing degree of computing power. Smart products such as smart phone, smart TV or other smart electronics with a variety of features and applications are now very popular. Electricity is currently a strategic "raw material" and its importance in the future years is clearly growing. For this reason, increasing emphasis is placed on the stability, safety and security of the electricity supply to end customers. Therefore, the computerization is increasingly being introduced into the electricity system during the time. Very popular is also the new term “Smart Grid”.

The many of projects, articles and publications focus on theme of Smart Grid, as well as foreign and domestic conferences. Despite the great popularity, there is a wide inconsistency in the definition of this term. Nevertheless, Smart Grid is often referred also to as the network capable of using more renewable energy sources and distributed production than the current network.

Comprehension of the current Smart Grid network is rather difficult and from costs perspective expensive. It is a long-term process that binds capital over many years. Therefore, it requires a strong commitment from all stakeholders. In addition, it is still not fully verified how the individual technologies within Smart Grid will work together.

II. Implementation of the Smart Grid

Smart Grid networks have the following features and benefits over classic networks. The biggest difference is the different network topology due to the inclusion of distributed production that causes different energy flow directions. The change is also thanks to the new technologies, two-way communication and the presence of active elements and sensors throughout the system, self-monitoring as well as rapid detection and localization of failures.

Thanks to new technologies, higher reliability, better security, greater convenience for customers and higher efficiency in the use of electricity are expected. Intelligent systems also envisage semi-automatic renewal and auto-regeneration as well as adaptive protection and isolation of a potential problem. Customers are thus provided with the integration and provision of new services.

From the distribution point of view, it is the use of centralized resources along with decentralized resources.

Decentralized sources of small capacities deployed across Europe are in line with the European Union's commitment and commitment to increase its share of renewable energy production to 20% by 2020. A high degree of automation in distribution and transmission systems is expected to reduce system losses and the associated increase in ecology, economy and operational efficiency as well as support for scattered production along with the development and research of new management methods. results.

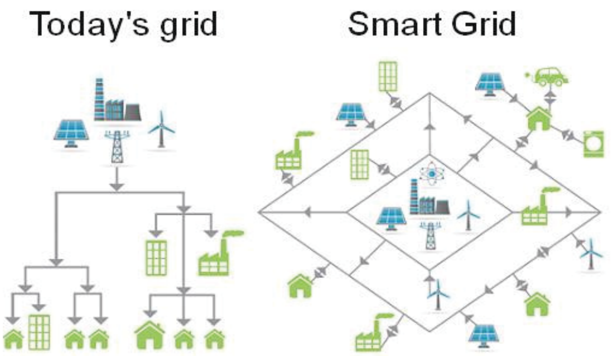

Fig. 1. Comparation of today’s grid and the smart grid

III. Modelling microgrid

In the research of modeling microgrid and smart grid was used more types of software. Program Neplan was the first option of modeling microgrid. This software includes a very wide range of computational options, like analyzing, planning, optimizing, and simulating the network. The user-friendly graphical interface allows the user to perform case studies very efficiently. Customizable software has a modular concept and covers all electrical aspects in transmission, distribution, industrial networks. It is best suited for renewable energy sources and smart grids.

2nd option was software product from Matlab - Simulink. Simulink is a MATLAB extension for simulation and modelling of dynamic systems. It provides the user with the ability to quickly and easily create dynamic system models in the form of block diagrams. Models can be described by equations or can be assembled from blocks representing real system elements. Besides models of physical systems, it is possible to model also control system algorithms including their automatic tuning, signal processing systems, communication and image processing.

This example in Simulink (Fig. 2), shows a vehicle-to-grid system used to regulate the frequency on a microgrid when events occur during a full day. The phasor mode of Simscape™ Power Systems™ allows a fast simulation of a 24 h scenario.

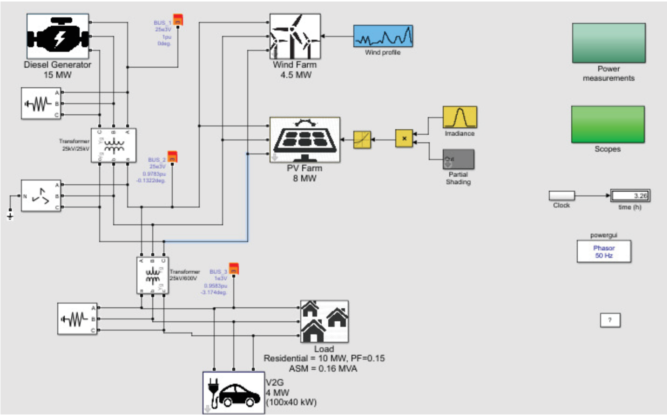

Fig.2. Model of micro grid in Matlab - Simulink

IV. Model in Matlab - Simulink

This paper describes a simulation that includes power sources (a 15 MW diesel generator, a photovoltaic and wind power plant with outputs of 8 and 4.5 MW), electricity consumption (with a maximum of around 10 MW) and a model of electric vehicle charging as reserve electricity in case of network drops or surpluses. The system also includes unpredictable sources that in combination with the diesel generator and the electric car system keep the network running.

Because of the model is the off-grid system it is not connected to a larger system, it depends on the reliable operation of the largest source. The base is a diesel generator that is not dependent on wind and solar power but provides the maximum space for energy from renewable energy sources. Several measurements have been performed within the model, demonstrating the functionality of the model and its stability under the given conditions. On a given model, it would still be appropriate to monitor the quality of electrical energy, especially the frequency, since large frequency fluctuations have an undue influence on the functionality of the elements in the network.

V. Conclusion

In this paper was describes option of modelling microgrid and smart grid in in mathematical software like Neplan and Matlab – Simulink, but it was more theoretical. Research should be more practical.

From beginning of school year 2018/2019 was at the Department of Electric Power Engineering, FEI, TUKE built laboratory for testing Smart Grids. This laboratory offers many opportunities for intelligent network research. The lab can co-operate with real renewable resources, which consist of photovoltaic panels and wind turbine. Part of this lab is also charger for electric cars. Future work will consist mainly of measurement and simulation from this laboratory.

Acknowledgment

This work was supported by the Ministry of Education, Science, Research and Sport of the Slovak Republic and the Slovak Academy of Sciences under the contract No. VEGA 1/0372/18.

References

[1] F. P. Sioshansi, *Smart Grid: Integrating Renewable, Distributed & Efficient Energy*. Academic Press, 2011. 510 p. ISBN 978-0-12-386452-4

[2] V. Volčko, *Smart grid – Vplyv na prevádzku, bezpečnosť a stabilitu elektrizačnej sústavy* (Doctoral dissertation, STU, 2015). Bratislava, Slovakia: STU. Retrieved from October 30, 2015, https://www.fei.stuba.sk/buxus/docs//2015/autoreferaty/Volcko_autoref.pdf.

[3] CEN-CENELEC-ETSI, Smart Grid Coordination Group, First Set of Standards. November 2012. online: http://gridscientific.com/images/Smart_Grid_Reference_Artichtecture.

[4] S. Borlase, *Smart Grids: Infrastructure, Technology and Solutions*. CRC, 2013, 577 p.

[5] J. Momoh, *Smart Grid: Fundamentals of Design and Analysis*, IEEE P., 2012, 216 p.

[6] AT&P Journal, *SCADA systém je viac ako len softvérová aplikácia*. (2010, April). Retrieved from http://www.atpjournal.sk/buxus/docs/casopisy/atp_2010/pdf/atp-2010-04-26.pdf

[7] J. Naščáková, M. Gergeľová, *Smart grids ako piliere budúcej energetiky v podmienkach Slovenskej republiky*. In: Transfer inovácií, 24(2012), 143-147. Retrieved from: <https://www.sjf.tuke.sk/transferinovacii/pages/archiv/transfer/24-2012/pdf/143-147.pdf>

[8] Ness Technologies: Smart Grid Solutions – *Budoucnost v energetice je tady*, [online]. Retrieved from: <http://www.nesstechnologies.com/assets/cz/Documents/Leaflets/S_Grid_cz.pdf>

[9] P. Mareček: Smart grids A0M15EZS – Elektrické zdroje a soustavy, České vysoké učení technické v Praze. 2011. Presentation. Retrieved from: <https://www.powerwiki.cz/attach/EZS/prednaska_05.pdf>

[10] Iniciativa Futur/e/motion. [online]. Retrieved from: <https://www.cez.cz/edee/content/micrositesutf/odpovednost2011/cs/environment/ochrana-zivotniho-prostredi.html>

[11] SCADA System. [online]. Published: 19.11.2015. Retrieved from: <http://www.electronicshub.org/scada-system/>

[12] Program efekt: Využívaní Smart Grid v domácnostech. Výsledky výzkumu Smart Grid zařízení v domácnostech ČR pro podporu jejich rozšíření. Retrieved from: <https://www.mpo-efekt.cz/upload/7799f3fd595eeee1fa66875530f33e8a/brozura_2016.pdf>

[13] M. Kolcun, J. Dudiak, Inteligentné siete. [online]. Published 6. novembra 2014. Retrieved from: <http://people.tuke.sk/dusan.medved/Porac/2014/Kolcun_Dudiak.pdf/>