CONNECTION OF NEW GENERATORS IN THE ELECTRICAL POWER SYSTEM OF KOSOVO

Rexhep Shaqiri[1], Bogdanov Dimitar[2]

[1]Technical University - Sofia,
E-mail: rexhep_shaqiri@hotmail.com).
[2]Technical University - Sofia, 8 st. Kliment Ohridski Blvd., 1756 Sofia, Bulgaria
E-mail: dbogdanov@tu-sofia.bg

Abstract

The power system of Kosovo is a compact and integrated structure in hierarchical aspect. It plays an important role in the process of transmission and distribution energy to the consumers. Based on this importance analysis is necessary in order to estimate the medium and long term plans of production of electric energy and development of the power generation plants. Object of study in this article is the project for connection of generators to the substation in Decani. This article describes the simulations of the power system of Kosovo (on date 21.01.2014 at 19.00h when the load in the system is 996.978 MW) in order to emphasize the importance of the connections of generators in Decani substation. Decani substation is an important node point with specifics of the power flow distribution. The analysis of the Kosovo electric power system by means of ETAP software and using as a reference the standards applied in Kosovo, the created models aim to justify if the plans for improvement of Kosovo grid are appropriate and what kind of changes in the voltage levels and short circuits values can be expected.

Keywords: Connection, Hydro Power Plant, Voltage profile, Synchronous generator, Improvement, Power System, Operation

1. Introduction

The task of the electric power system is to supply the customers with qualitative electric power, with a high degree of reliability, but economically accepted. The generation, transmission and distribution are three main components of the electric power system. Kosovo power system consists of power plants, the main grid, regional networks, distribution networks, and consumers of electricity. The main grid serves power producers and consumers, enabling electricity trade throughout Kosovo and also across Kosovo borders. Electrical power system of Kosovo mainly operates power plants using coal resources for electricity production, thus has lack of energy of renewable resources. In result of this there is increased interest of investment in the field of the alternative resource, such as hydro power plants. The impact of the connection of generators to the distribution system, respectively in the substation Decani, substation will be studied in details.

In the distribution system different cases may appear when new generators are connected, because the system in this particular case was not designed as transmission structure, but aimed for energy distribution to consumers. The connection of the new generators can affect the stability of the system, quality of the energy and the reliability of the system.

2. Effects of new generators connected to the existing network

The connection of a generation to an electricity network has impact on the operation and performance of that network. The connection of a generator to the system will result in some changes to the characteristics of the network. There are some cases when generators can enhance the performance of the network. New and existing generators connected to the network have to fulfil the requirements: frequency stability, voltage deviation, voltage waveform, voltage symmetry, power factor, operational and earthing and insulation level of detail defined in Kosovo network (www.kostt.com).

The Kosovo companies (Transmission system and market operator) are responsible for the operational planning and supervision of the main grid, for grid maintenance and grid development. The main grid in Kosovo includes approximately 188,49 km of 400kV transmission lines, 231,88 km of 220kV transmission lines, 803 km of 110kV transmission/distribution lines, 400/220 kV -1 substation, 400/110 kV –2 substations, 220/110 kV – 3 substations, and 110/35 kV, 110/10 kV - 29 substations. The Kosovo system is connected to the Macedonia, Serbia and Albania transmission systems on 400kV, 220 kV and 110 kV by overhead power lines.

In the electric power system of Kosovo the generation units are: Thermo power plant in Kosovo A (A3-150 MW, A4-150 MW, and A5- 150 MW) is in total 450 MW and Kosovo B (B1-300 MW and B2- 300 MW) is in total 600 MW, generator A1 and A2 are not in operation. While hydro power plants in electric power system are: Ujman (U1, U2) is 32 MW, Lumbardh (B1 and B2) is 8 MW.

There are also several sources of small hydro power plants with capacities such as: Burim (G1 and G2) 0.47 MW, Dikance (G1 and G2) -1, 32 MW, Radavc (G1 and G2) - 0.28 MW. In electrical power system of Kosovo, substation Kosovo B 400/220 kV has three transformers with tap changers, where the tap changers are in middle position and they do not change position with load, so are static, in other substations, the transformers have tap changers that working on the load.

Presented below is a part of electrical power system when load in system is 996.978.MW (Figure 1).

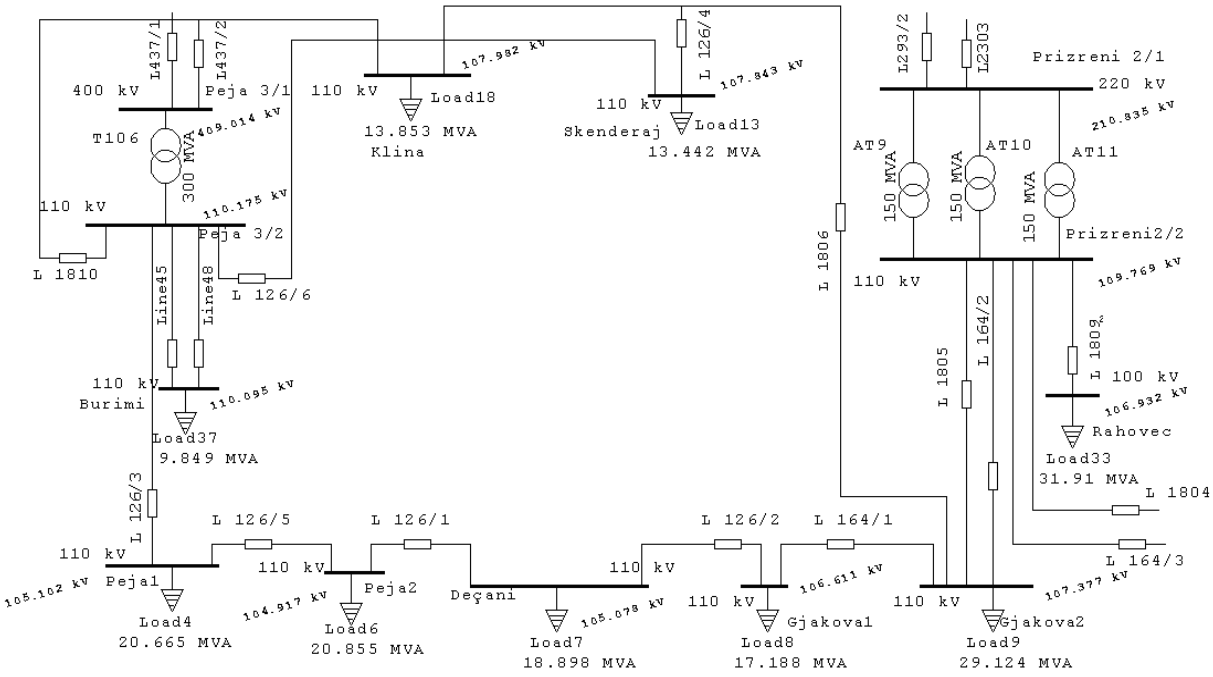

Figure 1. Voltage profile at some busbars in electrical power system of Kosovo when load is 996.978 MW.

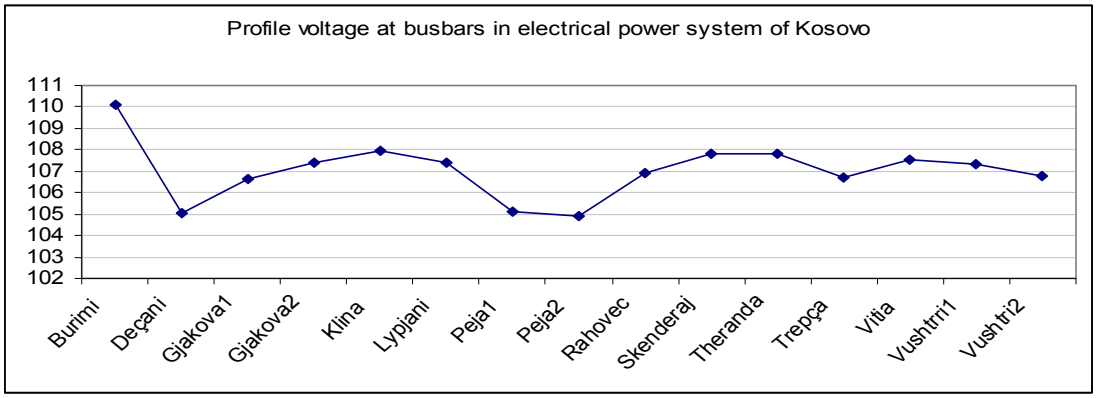

Figure 2. Voltage profile at some busbars in electrical power system of Kosovo.

According to code of the electrical equipment in Kosovo system voltage limits are permitted according to the table shown below (Transmission , system and market of operator of Kosovo) (www.kostt.com).

	Voltage in normal conditions		Voltage in extreme conditions	
	Min. Voltage	Max. voltage	Min. voltage	Max. voltage
400 kV	380 kV	420 kV	360 kV	440 kV
220 kV	209 kV	231 kV	198 kV	242 kV
110 kV	99 kV	121 kV	88 kV	130 kV

Table1. Voltage tolerances in Kosovo system.

In the electrical power system of Kosovo there are some important substations which do not fulfil criteria N-1 such as Peja 3-400/110 kV and Ferizaji 2-400/110 kV, these two substations have a transformer with power 300 MVA. In the development plan for electrical power system of Kosovo for these two substations shall be provided with additional transformers with power 300 MVA. Greater impact in Decani substation has any change in Peja 3 substation, because is close to Decani substation.

In the current situation, when the line 164/1 is out of operation, busbar voltage profile of the system is presented (Figure 3).

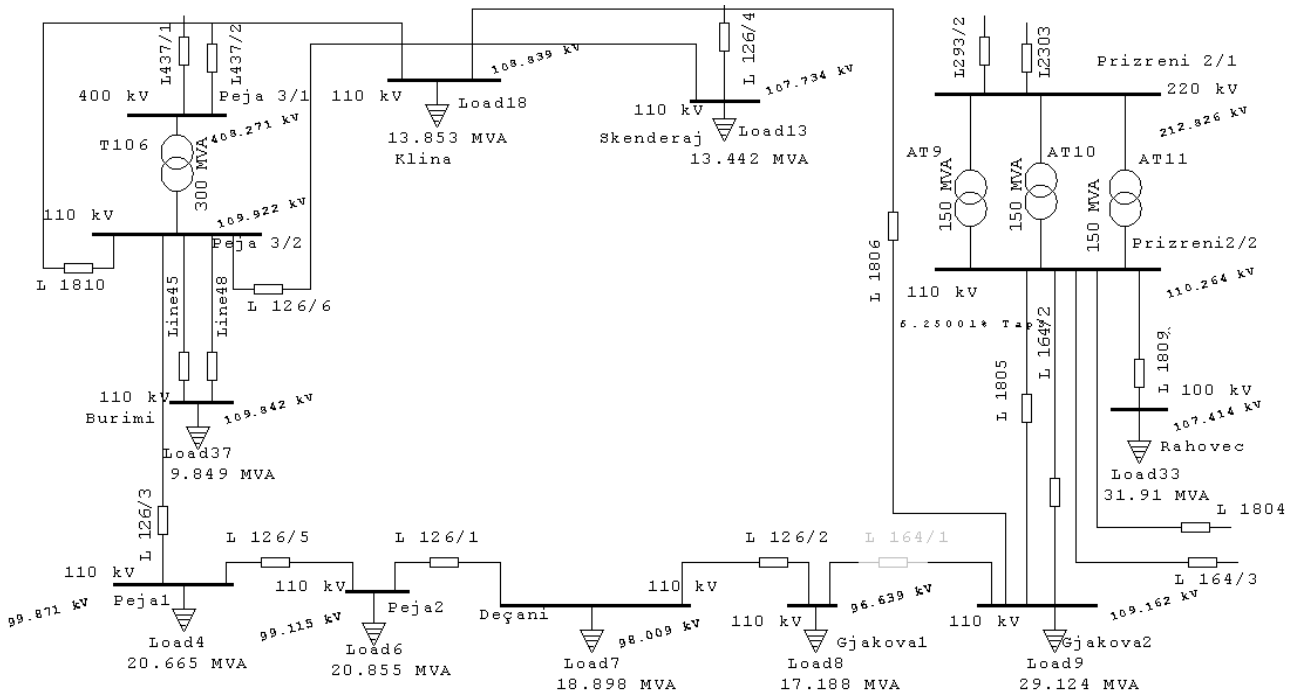

Figure 3. Voltage profile in electrical power system of Kosovo when the line 164/1 is out of operation.

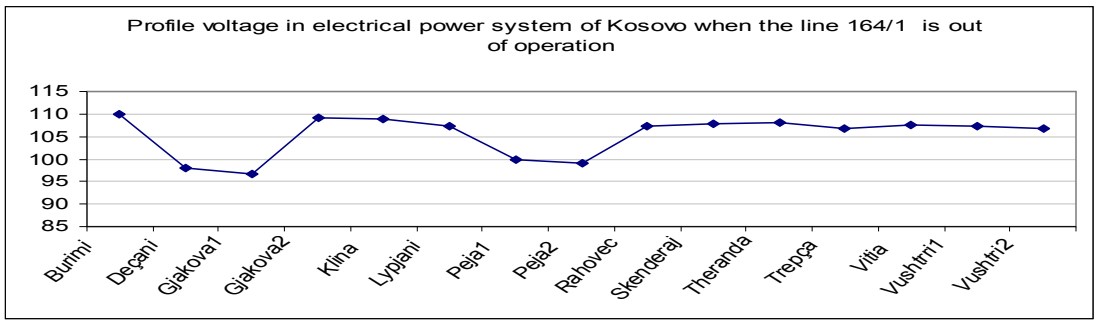

Figure 4. Voltage profile in electrical power system of Kosovo when the line 164/1 is out of operation.

The chart shows that the profile of voltage in every substation is in the permissible range for the value of 110kV except substation Gjakova 1, which is considered according to the grid network of Kosovo, as substation that not allowed being in operation, except in extreme conditions.

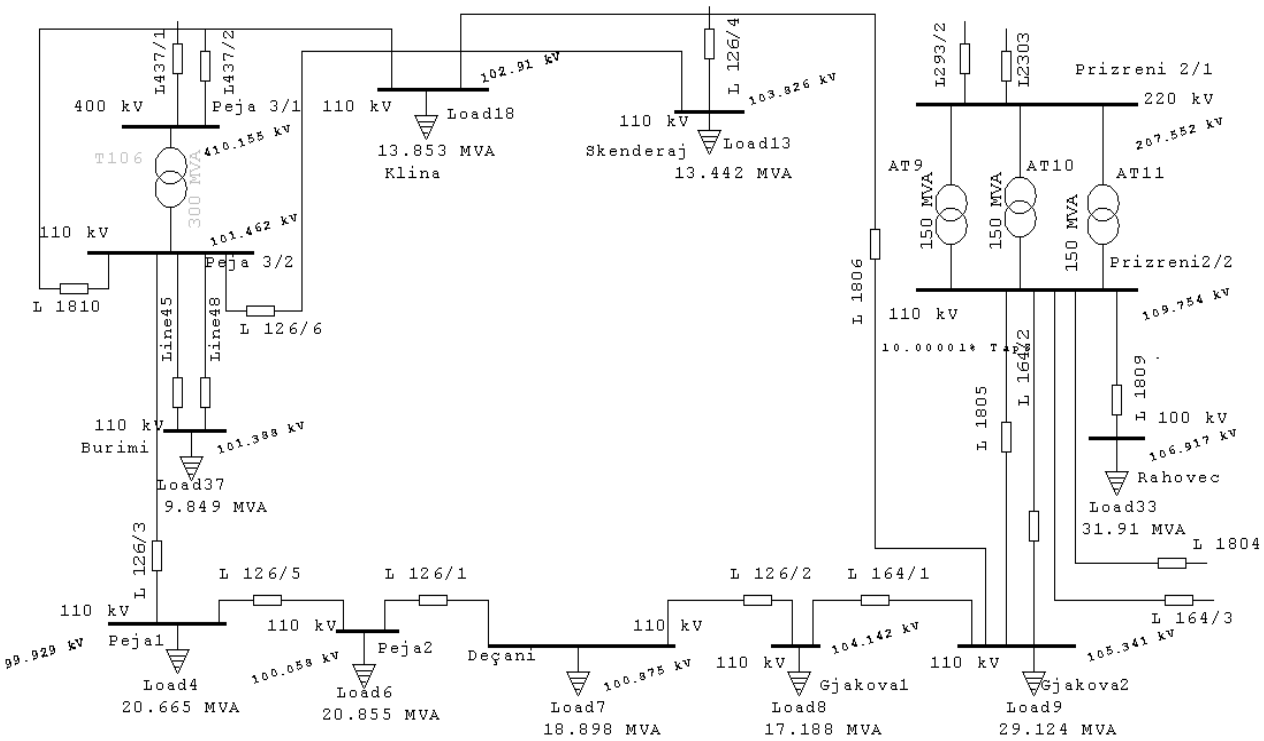

Figure 5. Voltage profile at electrical power system of Kosovo when the transformer is out of operation.

In the current situation, when the transformer is out of operation in Peja 3 substation, busbar voltage profile of the system is presented (Figure 5).

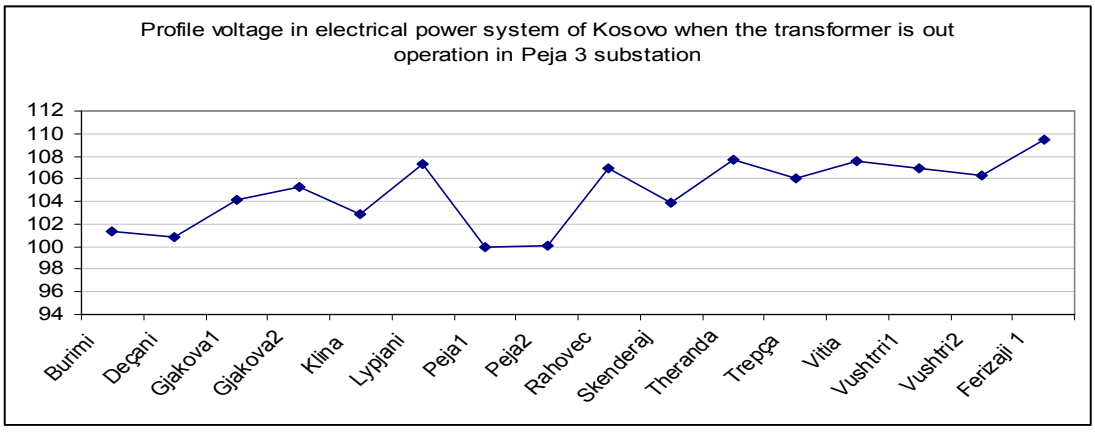

Figure 6. Voltage profile in electrical power system of Kosovo when the transformer is out of operation.

The chart shows that the profile of voltage in every substation is in the permissible range for the value of 110kV except substations as: Peja 1, which is considered according to the grid network of Kosovo, as substations that are not allowed to be in operation.

2.1. New energy sources

The connection of new generation sources in the power system changes the power flow, customer's voltage conditions and the requirements of the utility equipment. In a fault situation, distributed generators modify the current contribution to fault, and therefore it influences the behaviour of network protection. The influence will depend on the number, type, location and size of generators. The distributed generators are mainly designed to be connected directly to the distribution network near load centers.

Regarding the utilization of alternative renewable energy sources, Kosovo is not in the appropriate levels. Approximately only 3% of the electricity produced in Kosovo is from renewable energy sources. As Kosovo has signed the treaty for electricity and according to Directive 2009/28/EC1 on the promotion of the use of energy from renewable sources (the "Renewable Energy Directive") established mandatory targets to be achieved by 2020 for a 20% overall share of renewable energy in the EU and a 10% share for renewable energy in the transport sector.

Based on this, as well as the duty of fulfilment the standards of EU for the renewable energy, hydro power plants are under construction, such as the Decani river cascade with installed power about 35 MW. Other small HPP along Decani river are: HPP Lumbardhi (8.3 MW, 22 GWh annual production), HPP Decani (14.3 MW annual productions 41.9 GWh), HPP Belaja (8.1 MW annual productions 24.8 GWh), HPP Lumbardhi 2 (4.8 MW annual 17 GWh). Presented below is the configuration of the connection of these generators in the power system of Kosovo (Decani substation) (Figure 7).

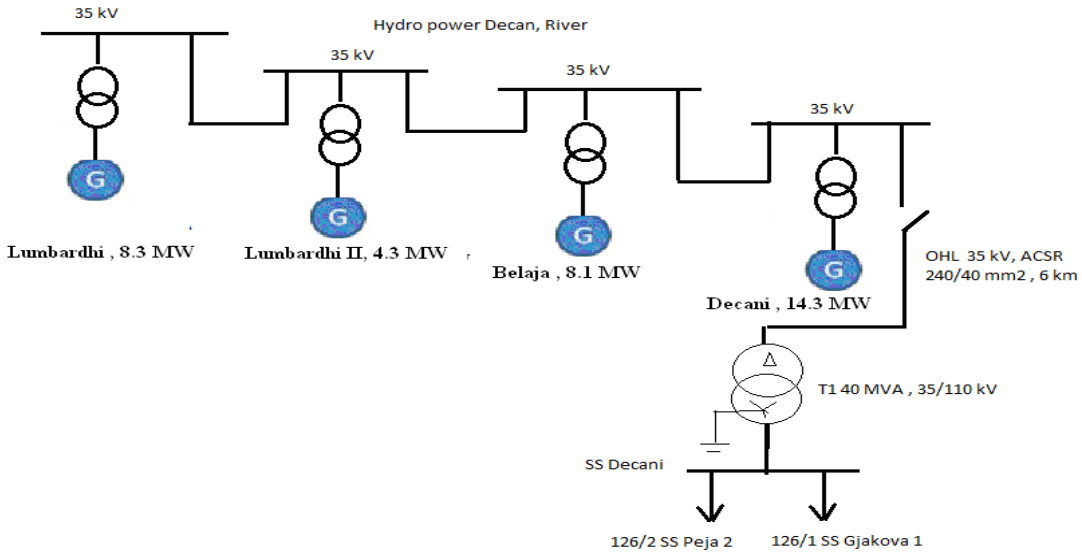

Figure 7. Connection of new generators in electrical power system of Kosovo (Substation Decani).

It is known that connection of the generators affects the voltage profile, the power flow and the losses in power system, the stability of the system and the short circuit currents.

2.2. Voltage profile of electrical power system of Kosovo

Profile of the load in 24 h profile in Decani substation is present the following chart (Figure 8).

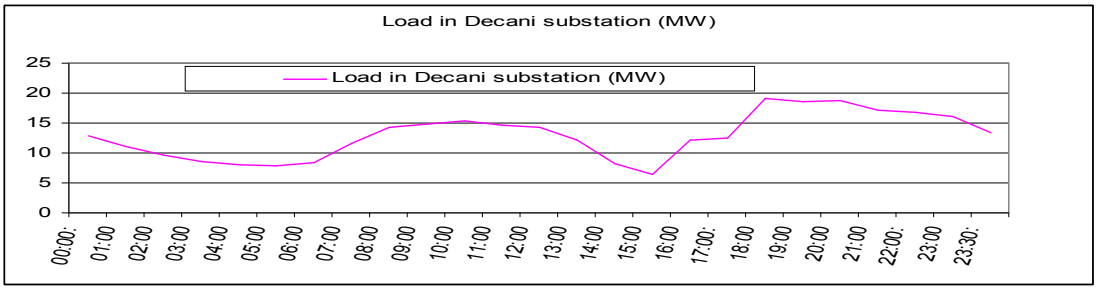

Figure 8. Depending on the time, loads in Decani substation.

Graphically are presented the bus bar voltage changes that occur when generators are connected to the power system. In this case, when the generators are connected, the voltage level is increased at the nodes which are part of the analysis. The expected values of voltage approach the nominal value.

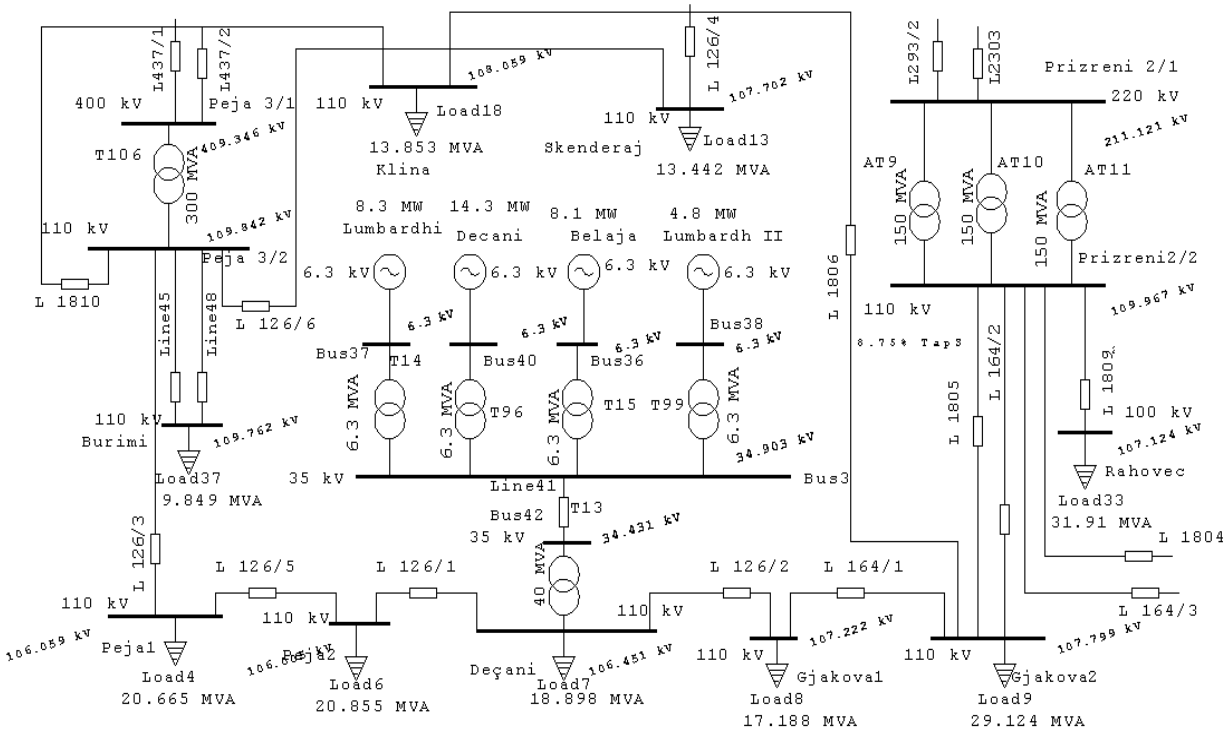

Figure 9. Voltage profile at some busbars when are connected generators (35 MW) in Decani substation.

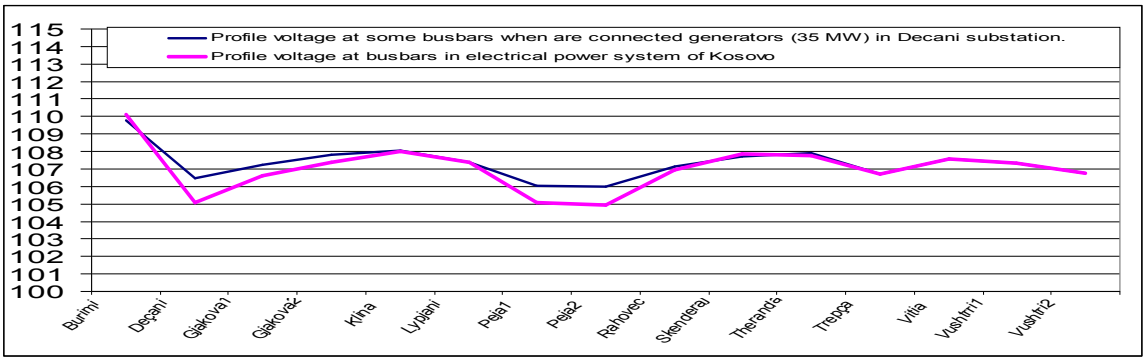

Figure 10. Variation of the voltage at busbars in the substations in Kosovo

Therefore, when the generators are connected the voltage level is increased at all bus bar system in Kosovo. In case, when transformer in Peja 3 substation is out of operation, the voltage profile at the substation buses of the electrical power system of Kosovo is presented (Figure 11).

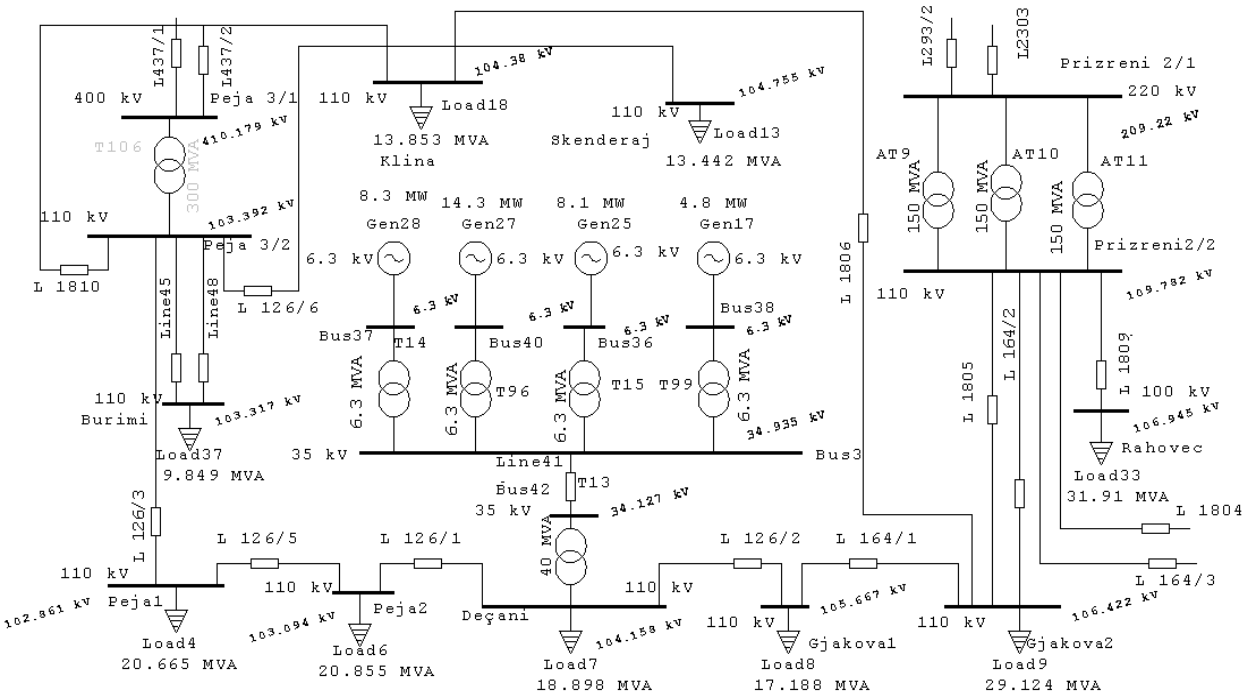

Figure 11. Transformer while out of operation in Peja 3 substation, but generators are connected (35 MW) in Decani substation.

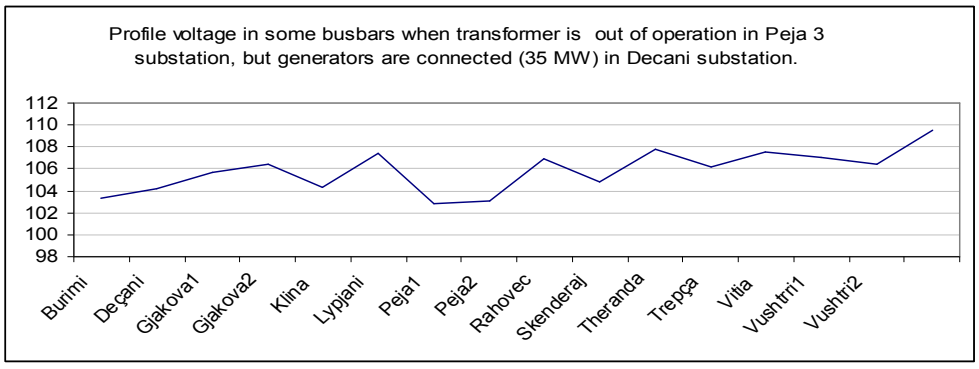

Figure 12. Voltage profile in some busbars when transformer is out of operation in Peja 3 substation, but generators are connected (35 MW) in Decani substation.

The chart shows that the profile of voltage in every substation is in the permissible range for the value of 110kV according to the grid network of Kosovo.

In case when line 164/1 is out of operation, profile voltage at the substation buses of the electrical power system of Kosovo is presented (Figure 13).

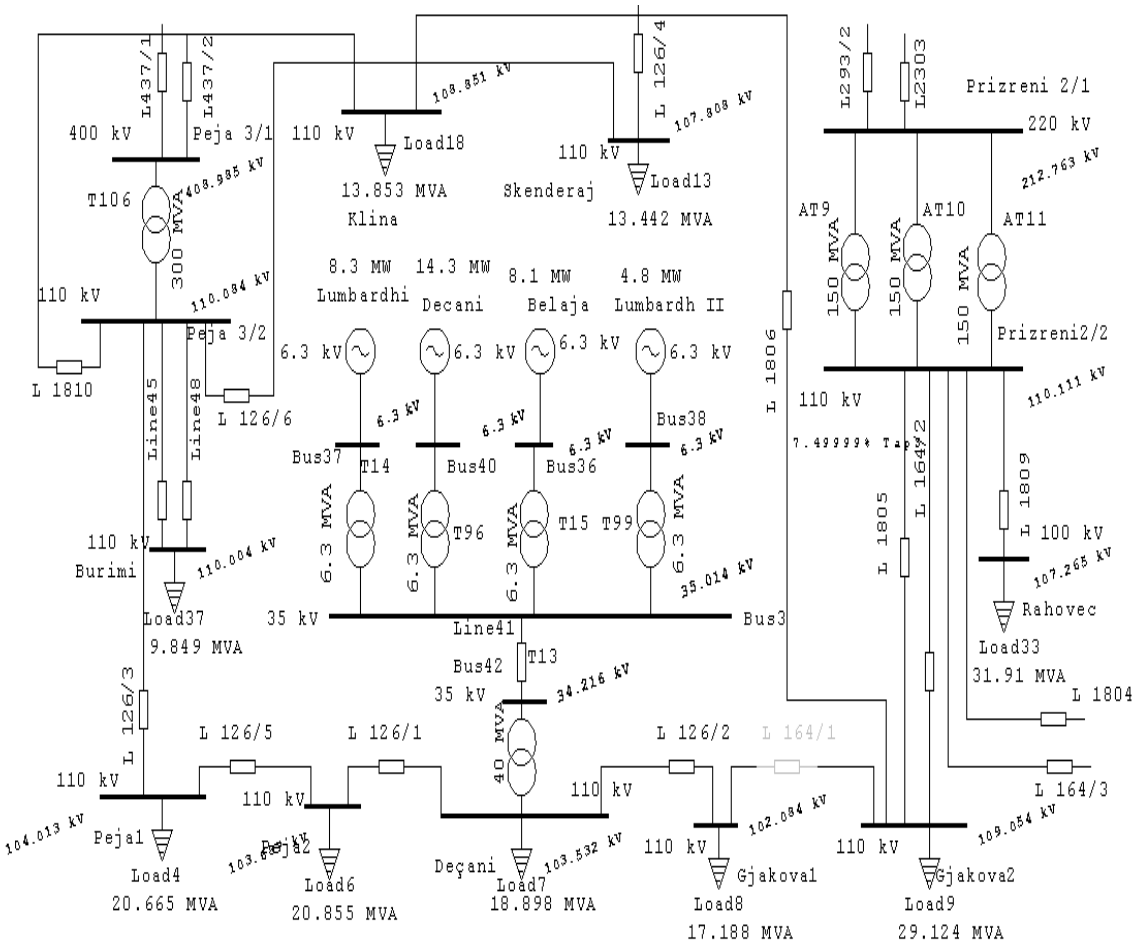

Figure 13. Voltage profile at some busbars when line 110 kV - 164/1 is out of operation.

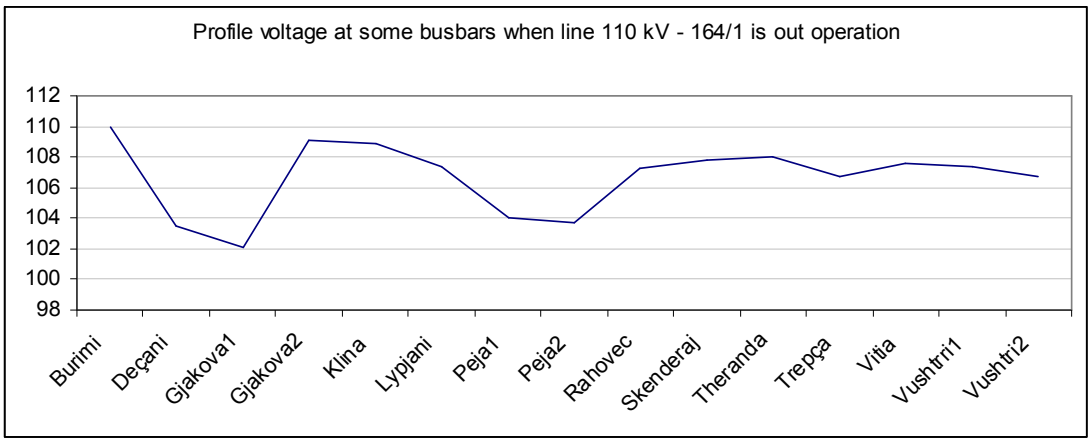

Figure 14. Profile of voltage at electrical power system of Kosovo when the line 164/1 is out of operation.

Presented below is the case when line 126/5 is out of operation (Figure 15).

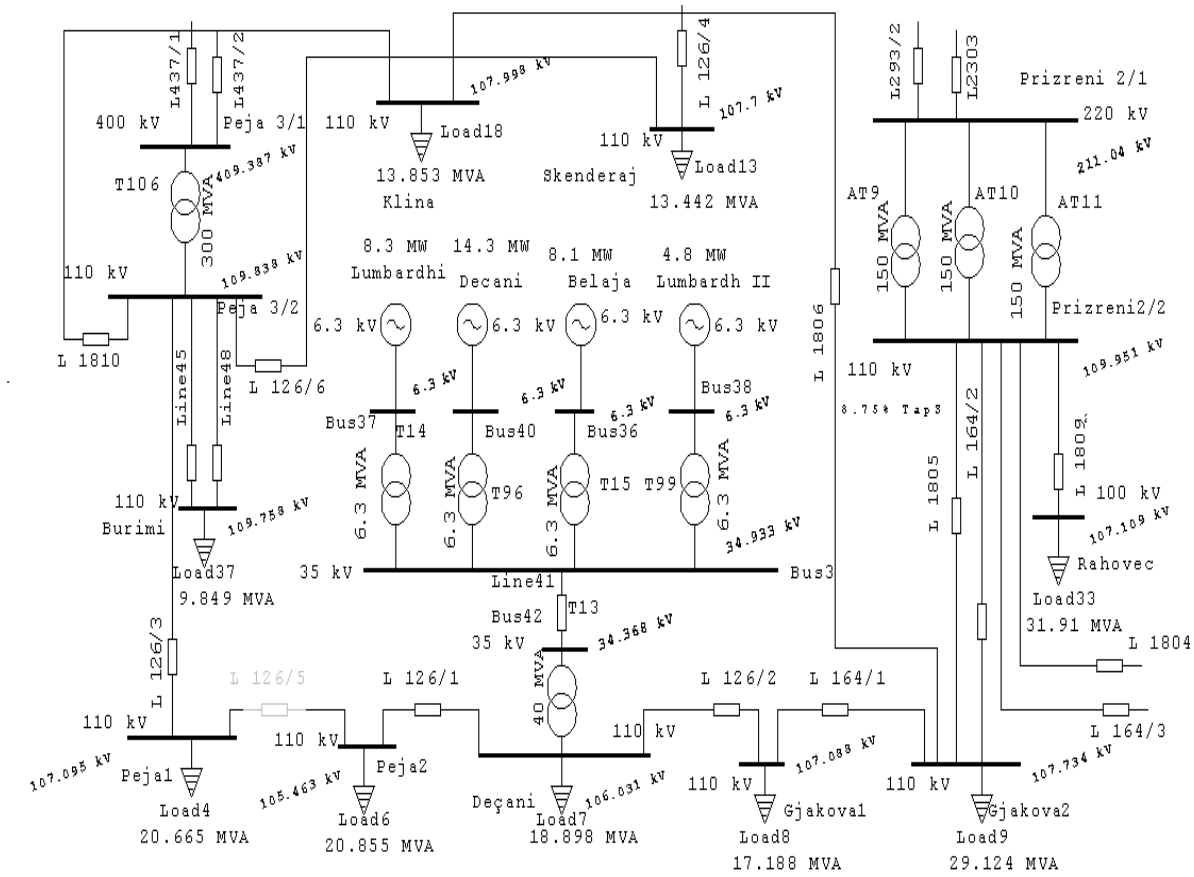

Figure 15. Profile of voltage at some busbars when line 110 kV- 126/5 is out of operation.

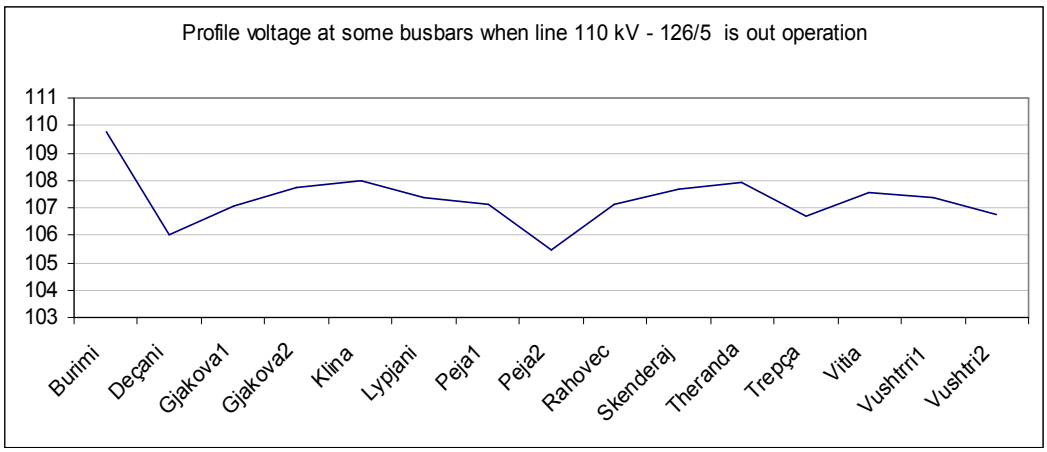

Figure 16. Profile of voltage at electrical power system of Kosovo when the line 126/5 is out of operation.

The worst case is when lines 126/5 and 164/1 are out of operation (Figure 17).

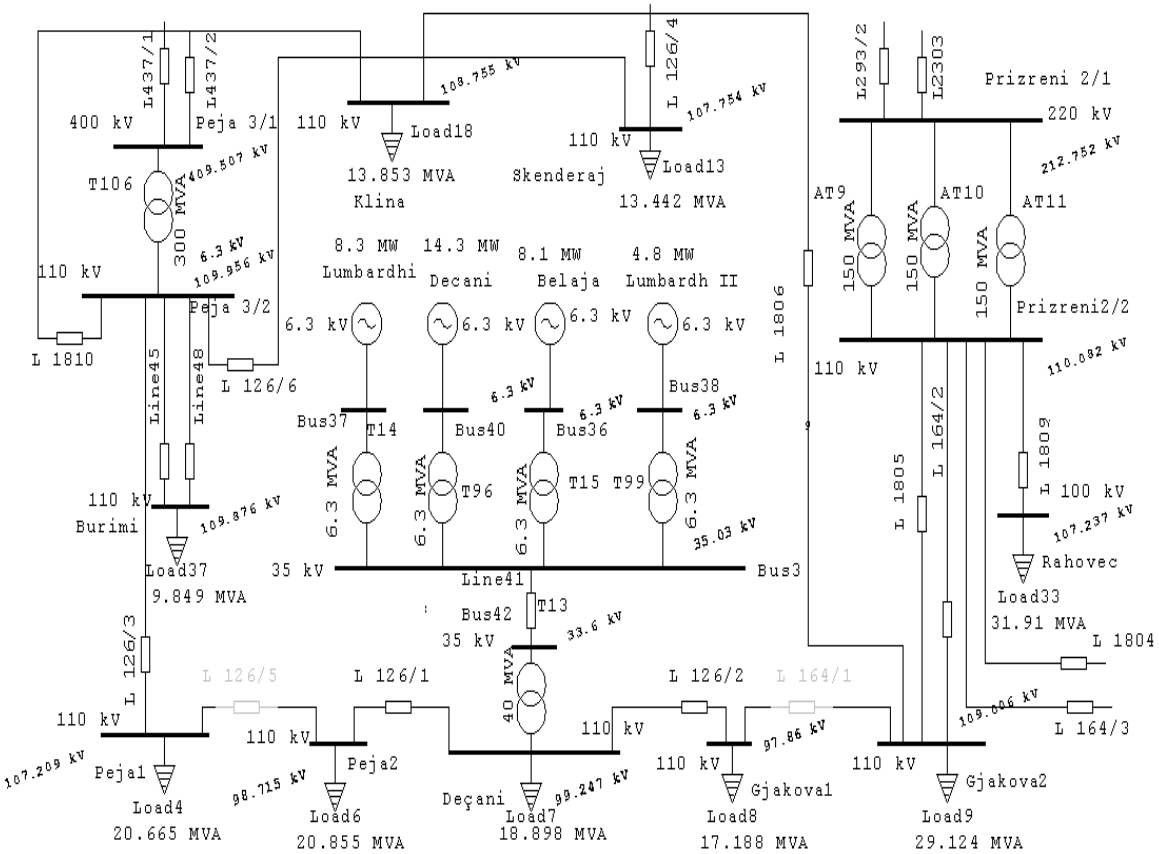

Figure 17. Profile of voltage at some busbars when lines 126/5 and 164/1 are out of operation.

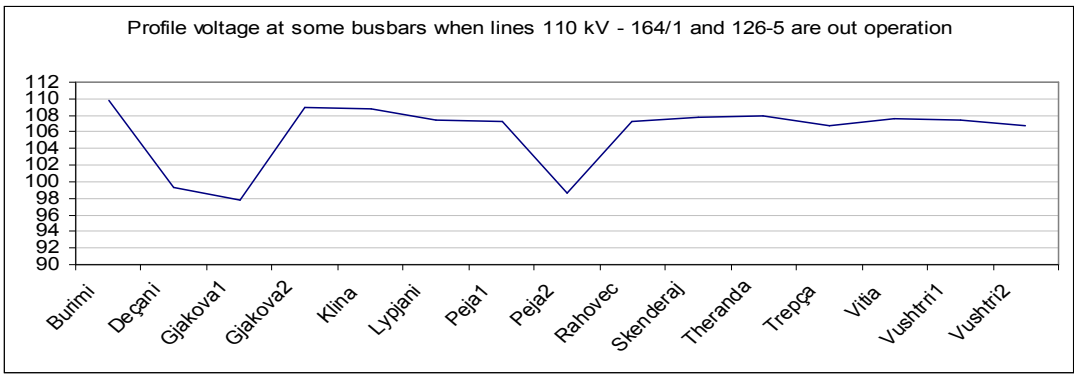

Figure 18. Profile of voltage at electrical power system of Kosovo when the line 164/1 and 125/5 are out of operation

In this case substation Decani, Peja 2 and Gjakova 1 are not allowed to be in operation. The chart shows that the profile of voltage in every substation is in the permissible range for the value of 110kV except substations as: Peja 1, Peja 2, Decani and Gjakova 1, which are considered according to the grid network of Kosovo, as substations that are allowed to be in operation just for short time.

3. Conclusions

In this paper the impact of the distributed generators connected to the electrical network system of Kosovo was analysed.

From the presented simulation results a conclusion can be made that the distributed generators can greatly influence the node voltages. The results show that new generators to be connected to substation Decani will have a great impact on network voltages. Voltage profile problem in the presence of distributed generation is much prominent than in the case without them.

Based on the current energy situation in Kosovo, the installation of hydro generators plays a significant role in increased security besides the supply of customers, as well as to meet the criteria for the share of alternative (renewable) energy in the energy mix of Kosovo.
Connection of new generators in Decani substation has impact on the voltage profile of the electrical power system of Kosovo, especially in substations Decani, Gjakova 1, Peja 1 and Peja 2.

Also, if any of the elements of the electrical power system such as lines 126/5,164/1, 1805, 164/2 or transformer in Peja 3 substation are out of operation, connection of new generators in Decani substation has impact that the profile of voltage in every substation is in the permissible range for the value of 110kV according to the grid network of Kosovo.
The construction of the particular new plants with hydro generators will play a significant role, including security of the power system, the quality of voltage, increase generating capacity, as well as more secure in the supplying of customers.

Also, the connection of generators is important as an option as grid reserve and grid restoration generation in cases of commutations, outage of grid components and as well as in case of planned outages of other generation facilities in the power system.

4. References

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Rexhep Shaqiri was born in Gjilan, Kosovo. He received the engineer electrical from the Faculty of Electrical Engineering and Computer, Prishtina, and received Master degree from the same university in 2009. His field of interest includes electrical networks, planning, renewable energy sources of energy to grid, evaluation of grid short circuit levels. He has excellent experience on coordination engineering feasibility studies, developing alternatives for proposed capital projects, developing and updating facilities and system master plans.
Rexhep Shaqiri is PhD Student in the Technical University - Sofia, also assistant in the Faculty of Electrical Engineering and Computer, Prishtina (rexhep_shaqiri@hotmail.com).

Dimitar Bogdanov was born in Sofia, Bulgaria. He graduated from the Technical University - Sofia, and received Master degree from the same university in 1998. He has received a PhD degree from Technical University - Sofia in 2009 in Electrical Power Engineering. His field of interest includes electrical relay protections and automation, electrical networks, nuclear power plants (electrical systems, control and safety aspects), renewable energy sources. Currently he is associate professor in the Faculty of Electrical Engineering of the Technical University – Sofia, dpt. head of chair "Electrical power engineering". He works on studies related to improvement of the protection schemes for connection of renewable sources of energy to the grid, evaluation of grid short circuit levels and grid control. Dimitar Bogdanov is with the Faculty of Electrical Engineering, Technical University of Sofia, 8, st. Kliment Ohridski Blvd., 1756 Sofia, Bulgaria (e-mail: dbogdanov@tu-sofia.bg).