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THE IMPACT OF SOLAR PLANTS ON THE STABILITY OF POWER SYSTEM

Astrit BARDHI
Ajakida ESKI
Bajram LEKA

SCOPOUS OF THE PAPER

In this article, we will analyze the impact of energy penetration in power system generating by solar plants. Firstly, we have analyzed the power system in steady state conditions where are shown the voltage level at nodes and power losses in transmissions line. The simulation is realized with ATP (NEPLAN) software. Also, we have analyzed the power system stability by amount of energy production from solar plants. Due to penetration of considerable of energy production by solar plants the power system stability worse.

CONTENTS

A BRIEF HISTORY OF THE DEVELOPMENT OF SOLAR ENERGY IN ALBANIA

Production of energy in 2023

Type of generation	Yearly energy production [MWH]
PPE/ hydropower connection at OSSH	982,392
PPE/ hydropower connection at OST	1,085,256
Private hydropower connection at OST	1,204,759
Lanabregas hydropower	23,244
Ashta hydropower	287,628
PHOTOVOLTAIC PLANT	61,989
HydropoWer menage by KESH	5,131,482
TOTAL	8,795,635

THE DATA OF SOLAR PLANTS INSTALLED AND POWER SYSTEM AT FIERI REGION

SOLAR PLANT	INSTALLED CAPACITY MWp
Voltalia	140
Akernia	100
Nova Solar System	70
Argo Solar Park	5.5
Park Fotovoltaik Bilisht	50
Green Vitality Park	5.5
Park Fotovoltaik Veko	30
Impiant Fotovoltaik Libohovë	93
Park Fotovoltaik Blue1	57.6
Park Fotovoltaik Euron Solar	150
Park Fotovoltaik Nord Power	10

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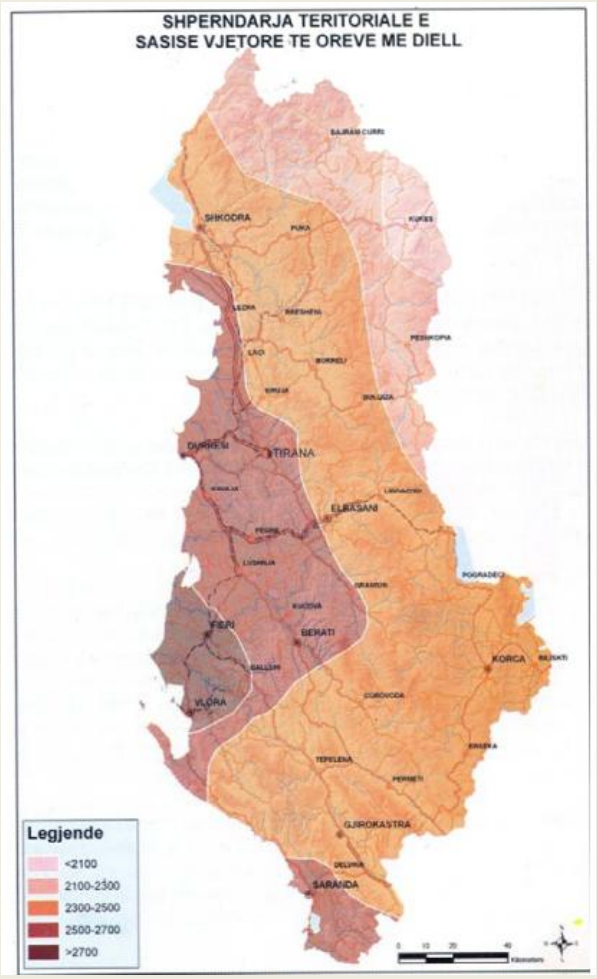

Solar plant	Installed capacity	Grid connection
	MWp	kV
Karavasta	140	220
Lushnjë	100	110
Hoxharë 1	250	220
Hoxharë 2	300	220
Vlora 1	50	110
Vlora 2	150	110
Erseke	100	110
Fier 1	100	110
Fier 2	150	110
Belsh	50	35
Total	1,390	

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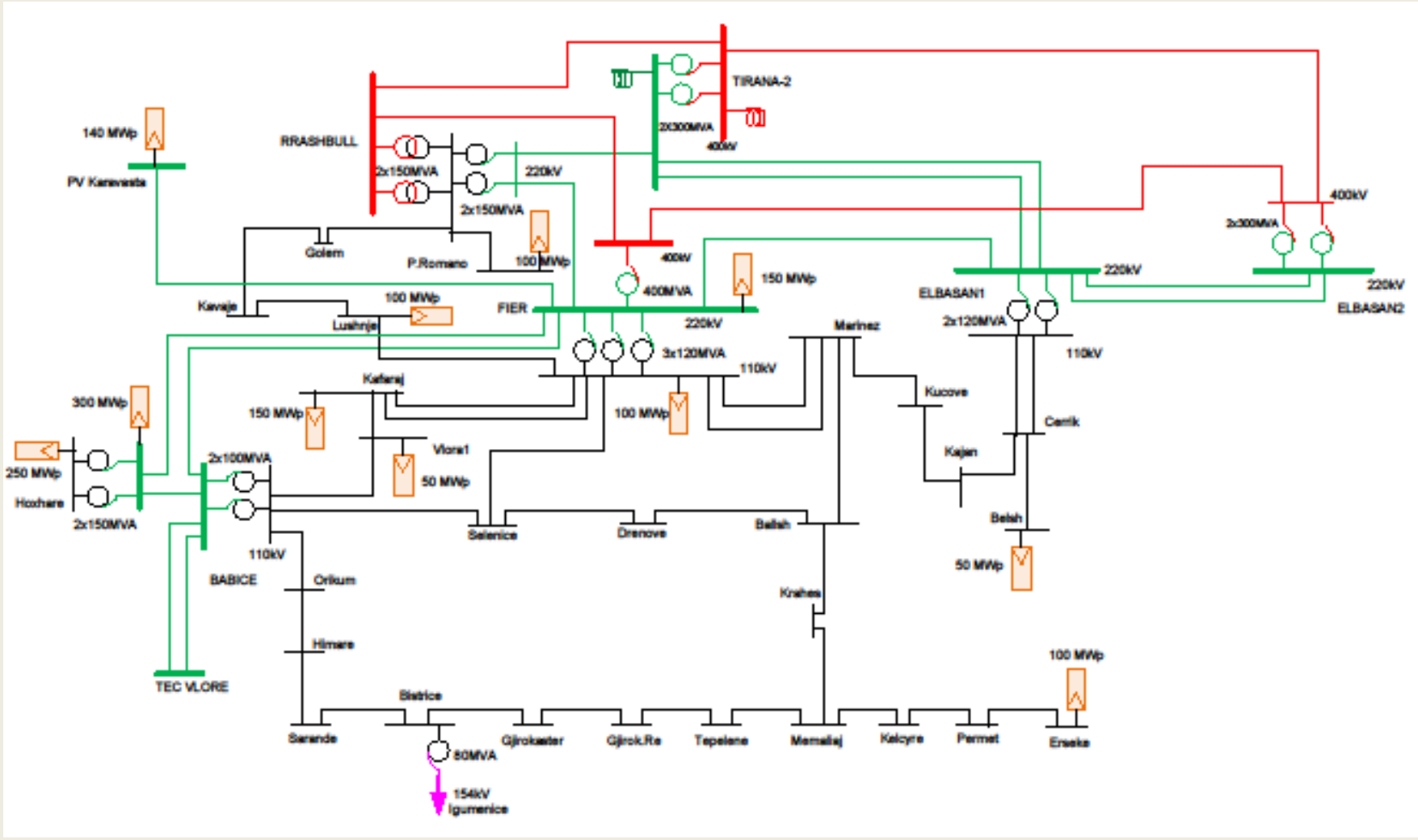
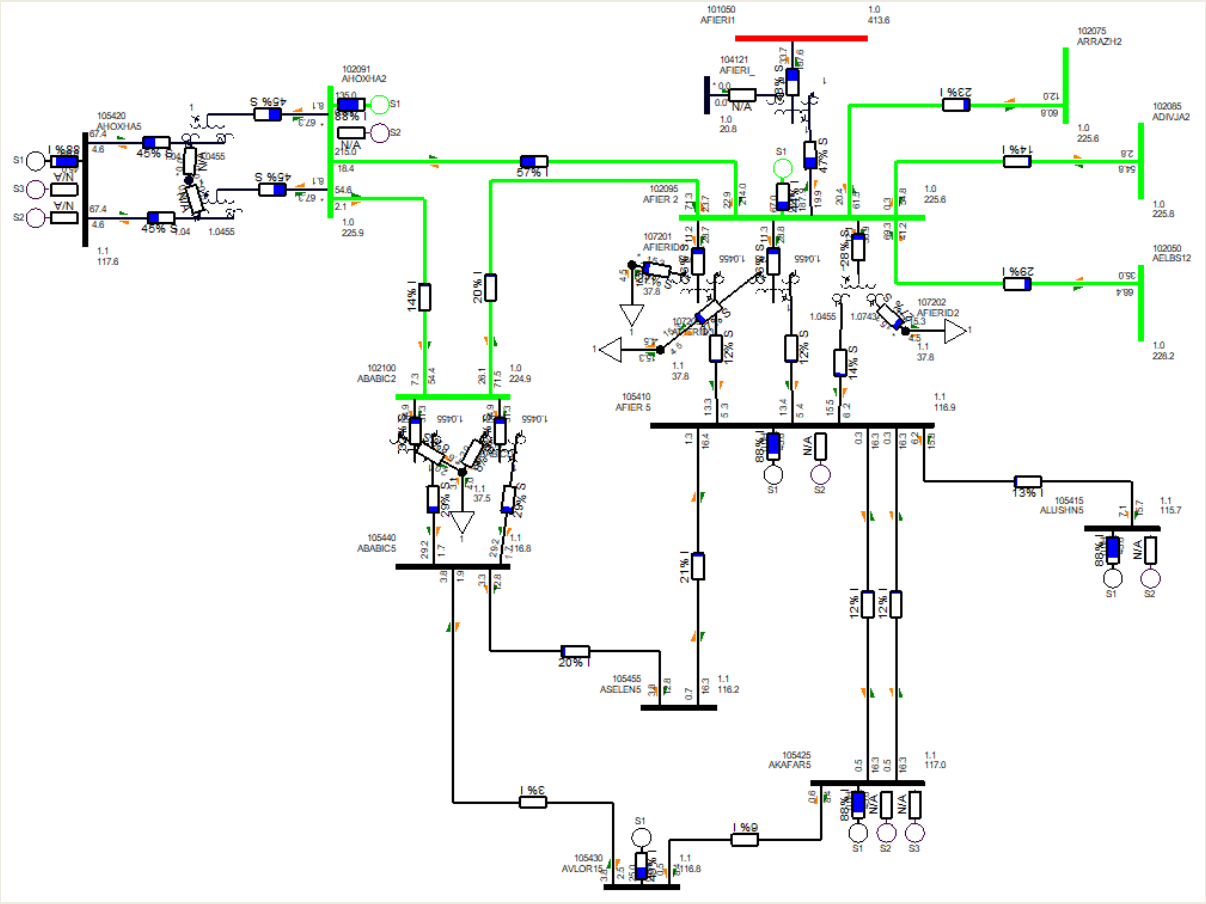


ANALYSIS OF POWER SYSTEM DURING PENETRATION OF ENERGY PRODUCTION BY SOLAR PLANT

a. Analysis of losses, voltage level and energy distribution in the electrical system

A.1 First scenarios - PV 50% of installed capacity, the load in system pik



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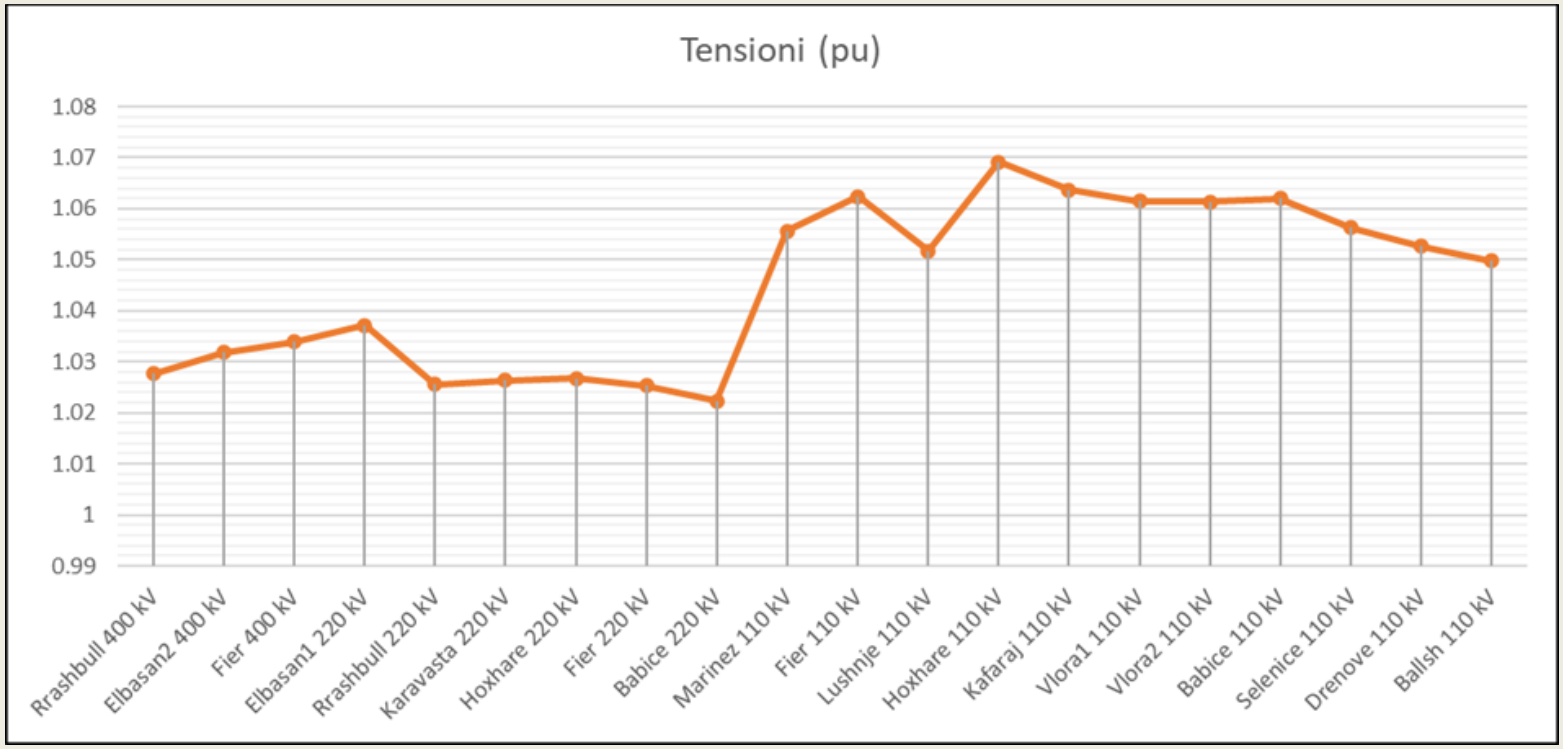

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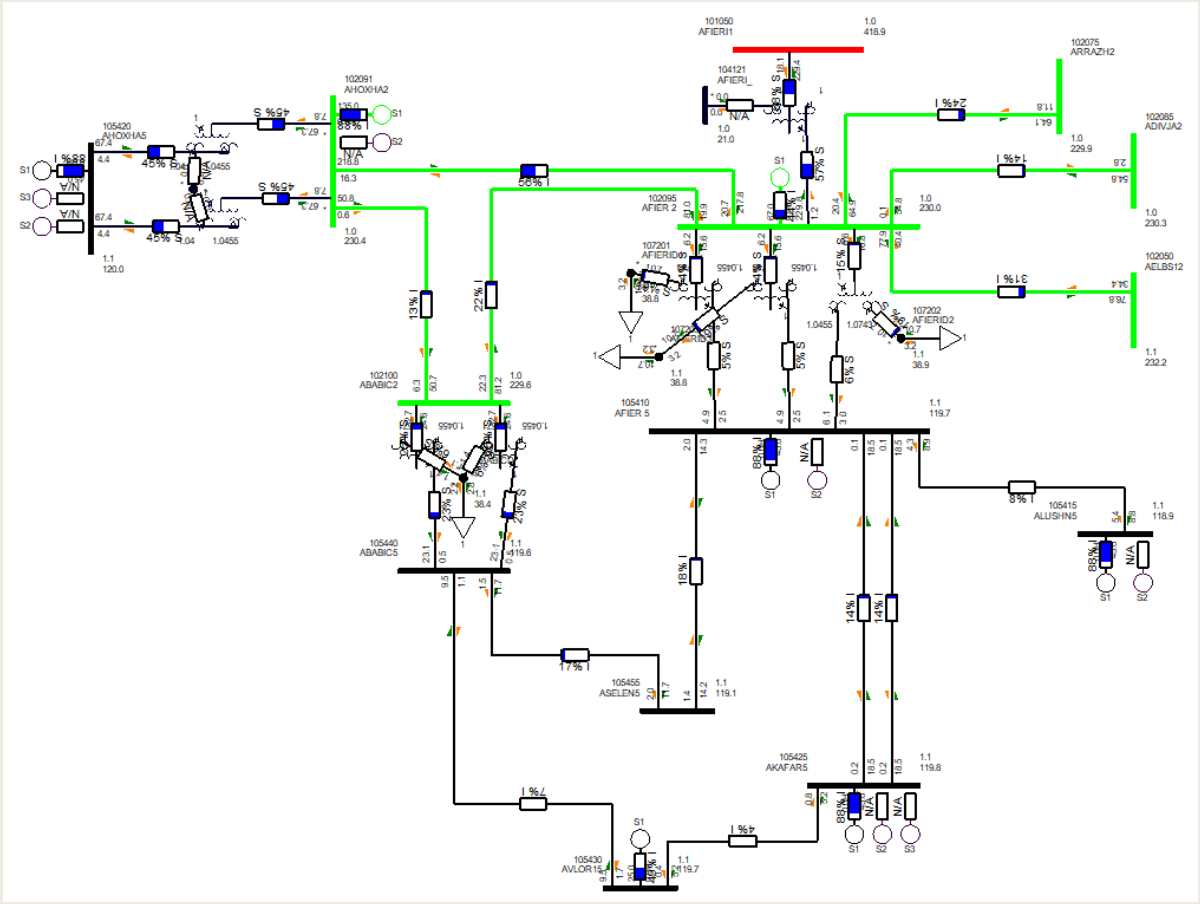

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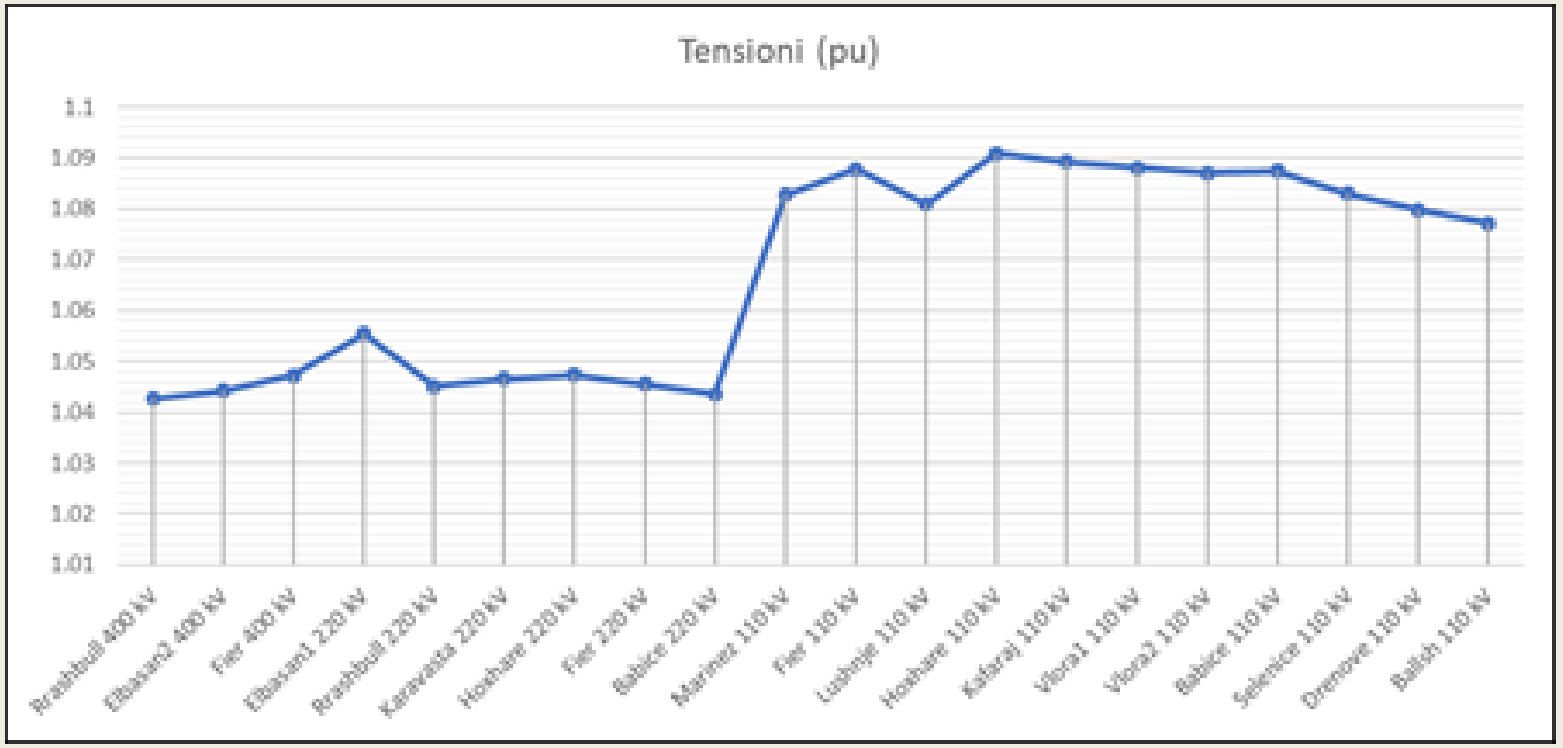

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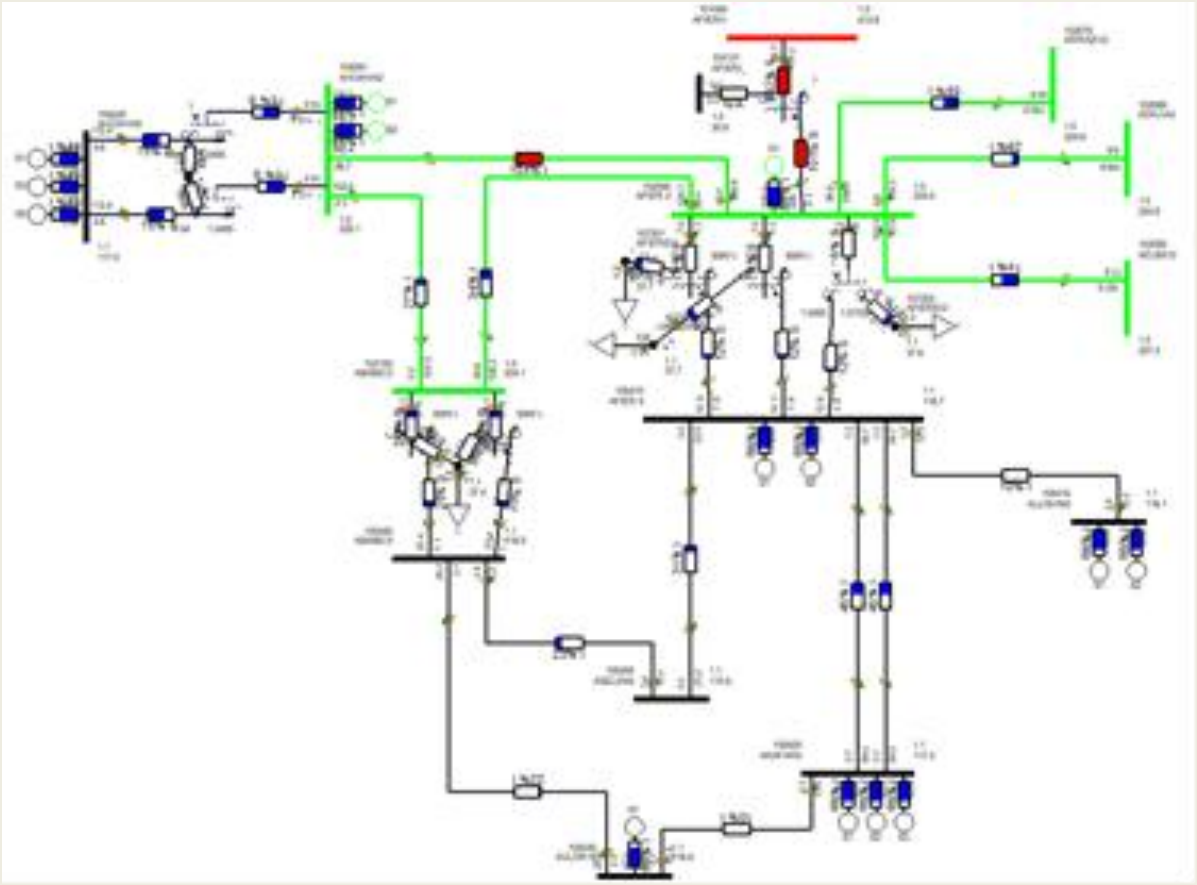
A.1 Thirst scenarios - PV 100% of installed capacity, the load in system pik



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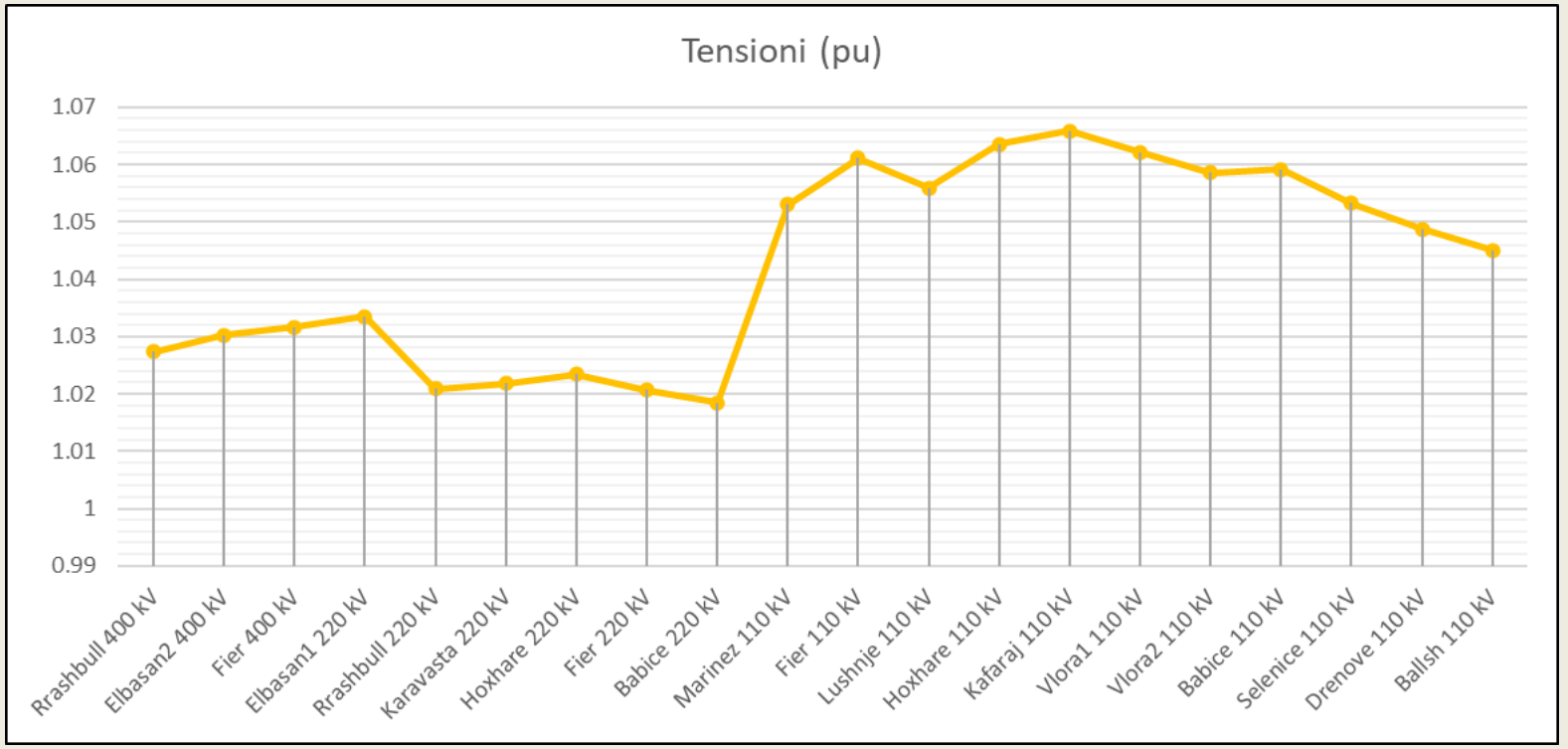

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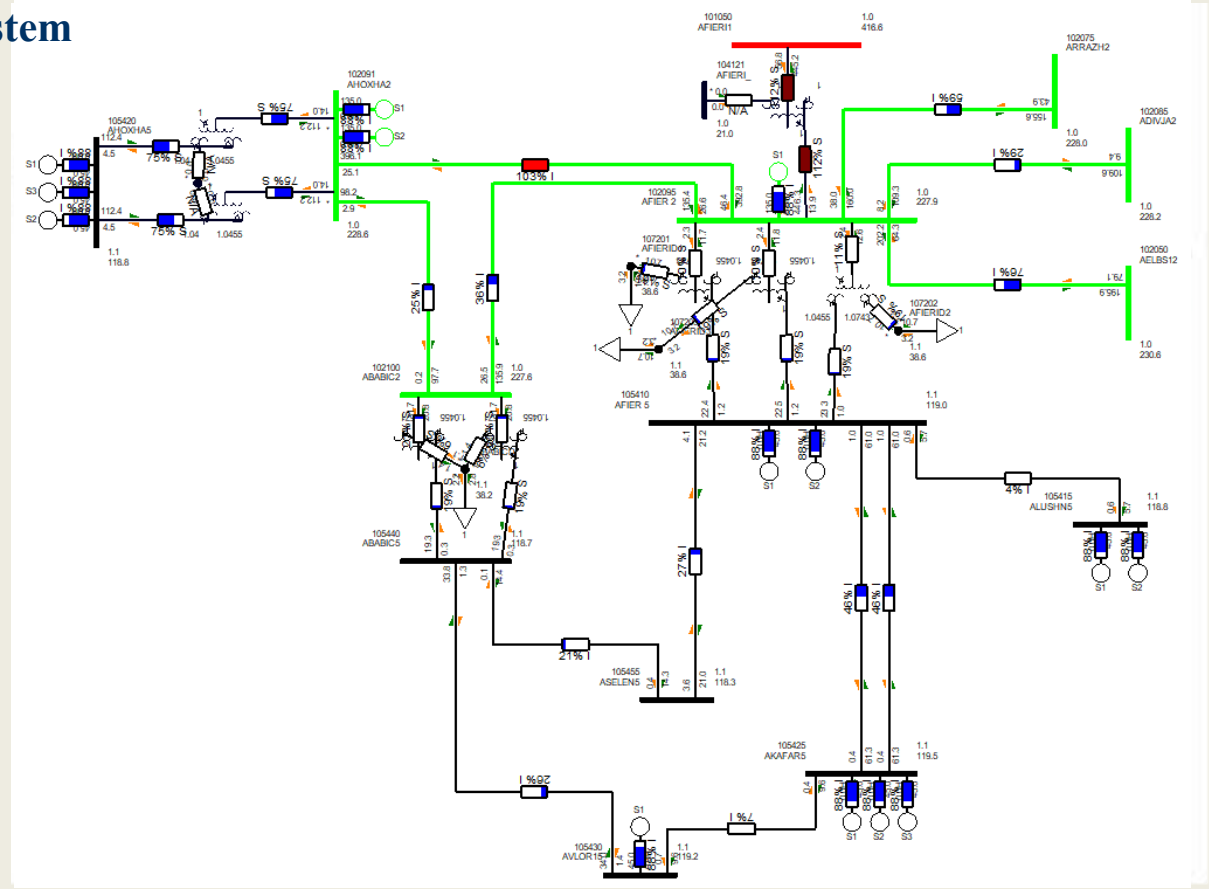
A.1 Fourth scenarios - PV 100% of installed capacity, average load in power system



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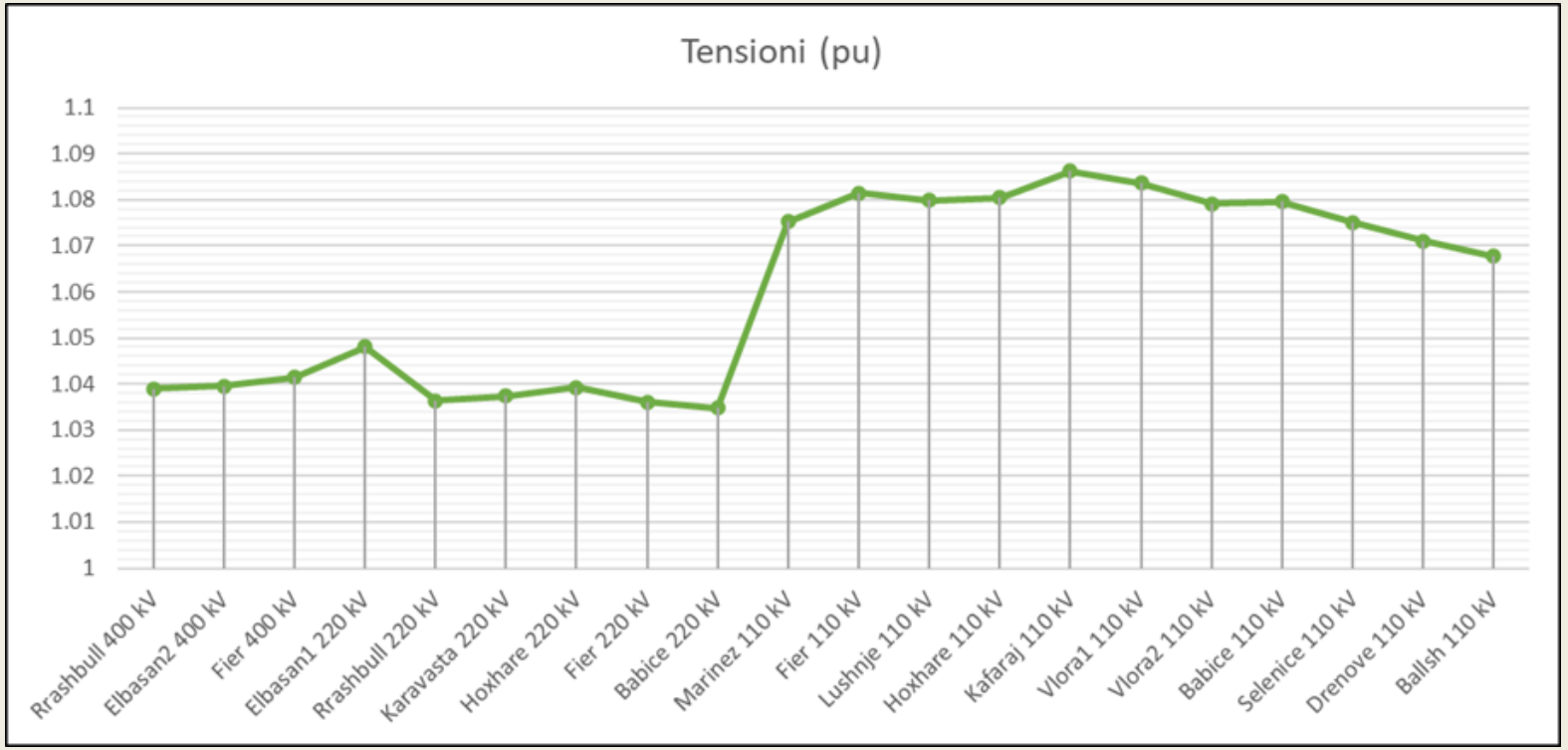

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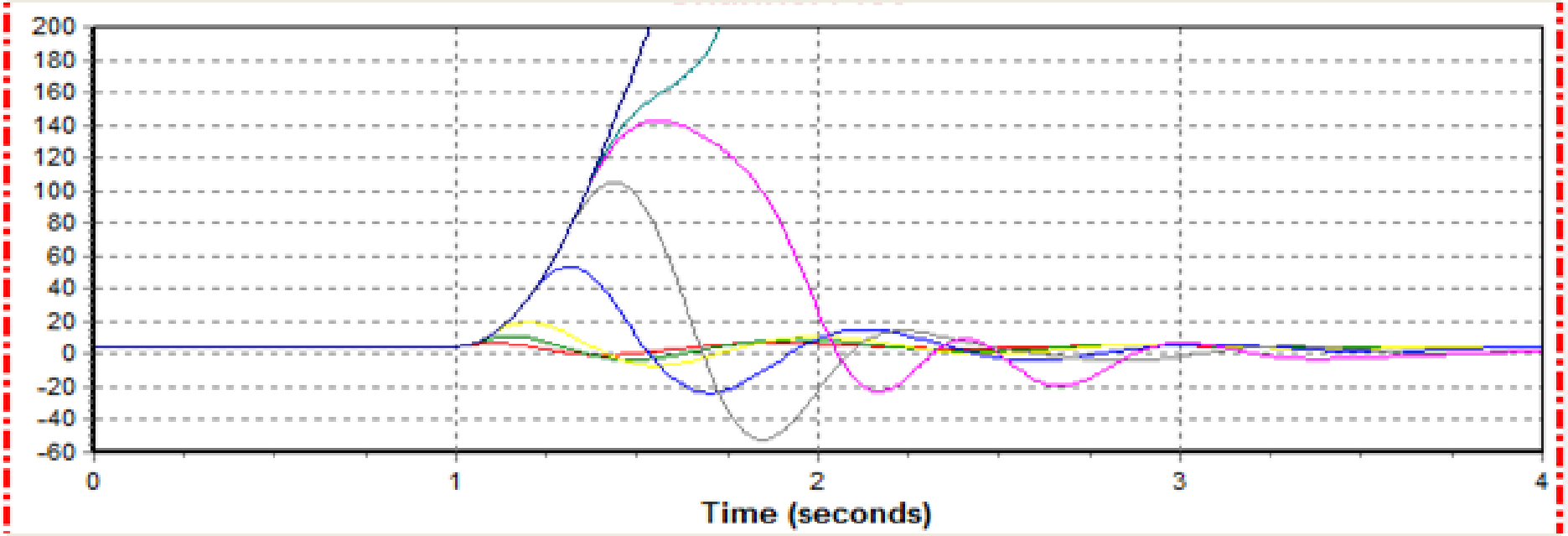
1. The electrical grid in the Fier region in this regime does not fulfill the N-1 criterion.
2. The transmission line as well as the 400/220 kV autotransformer are overloaded.
3. In some cases when disconnect the 220 kV line in the region, the crucial elements in the system overload up to 140%.
4. Also, in the case of AT 400/220 kV disconnect in the Fier substation, it causes overloading of 220 kV lines in the region.
5. In case of one of the autotransformers disconnect in Hoxhare, 220/110 kV will cause the loading of the other autotransformer about 150%.

SMALL-SIGNAL ANALYSIS

Generator parameter	Unit	Value
Rated power	kVA	50,000
Rated voltage	V	10,000
Rated current	A	192
Rated rotor speed	rpm	125
Stator resistance	mΩ	5.26
Short circuit ratio	%	0.67
d – axis synchronous reactance	%	160
q – axis synchronous reactance	%	92
d – axis transient reactance	%	28.4
q – axis transient reactance	%	92
d – axis subtransient reactance	%	18.2
q – axis subtransient reactance	%	17.2
Stator leakage reactance	%	17.6
d – axis open – circuit transient time costants	s	2.87
d – axis short – circuit transient time costants	s	0.51
d – axis short – circuit subtransient time costants	s	0.025
Inertia costant	kgm^2	360

SMALL-SIGNAL ANALYSIS



CONCLUSIONS

The high penetration of energy produced by photovoltaic plants causes problems in the electrical system such as:

✓The load on the electrical system, based on statistical data, is expected to increase moderately, therefore it is not enough to absorb the additional generation from photovoltaic plants.

✓Increase in losses in the system,

✓High voltage levels (close to max values in some nodes),

✓Non-fulfillment of safety criterion N-1 for characteristic operating regimes.

✓The existing network, which is unable to support a penetration of the energy produced by the photovoltaic plants built in the region of Fier.

✓In the dynamic stability of the electrical system

RECOMMENDATIONS

- ✓ Strengthening of interconnection lines for the export of surplus energy produced.
- ✓ In order to manage the voltage levels in the nodes of the electrical system, the installation of reactors in the nodes of the electrical system is required.
- ✓ Photovoltaic plants must contribute in accordance with the transmission code.
- ✓ The addition of transformer capacities in the substations of the area as well as the need for the creation of a new transformation node at the 400 kV level.
- ✓ Installing batteries with significant capacity near power sources. Construction of a scada system near the dispatch center for their efficient use.