

1. "Technical and economical analysis of building new 35/10 kV substation Mrčajevo",

Ordered by: Public Utility "Elektrosrbija", Kraljevo  
Project Manager: Ana Šaranović, MSc.  
Associates: Saša Minić, MSc.  
Danka Kecman, MSc.

The objective of this analysis is to find out if it is justified to build new 35/10 kV substation Mrčajevo. This is dilemma derived from study "Distribution network further development and medium voltage level selection for the area of Public Utility "Elektrosrbija" Kraljevo - Distributive area of Čačak" and new energy and network conditions. The study includes analyses of energy consumption development for the period up to the year of 2006 as well as load and energy consumption forecast until the year of 2020. Detailed analyses of 110 kV, 35 kV and 10 kV networks present condition (including physical state of networks, load of elements, voltage conditions and losses) have been accomplished.

Based on those analyses, results of load forecasting, techno-economical analyses and comparison of two possible variants, the most prosperous solution of distributive network further development in the considered area for the period up to the year of 2020 has been suggested including conclusion about building new substation.

Size of Project: 95 pages  
Finished in: 2007.

2. "Study of long-term prospective Serbian transmission network development up to 2020(2025)",

Ordered by: Public Utility "Elektroprivreda Srbije", Belgrade, Public Utility "Elektromreža Srbije", Belgrade  
Project Manager: Srđo Mrđa, MSc.  
Associates: Saša Minić, MSc.  
Danka Kecman, MSc.  
Tijana Janjić, MSc.  
Ivan Stanisavljević, MSc.  
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Milan Ivanović, MSc.  
Branislav Čupić, MSc.

In this study detailed technical and economy analyses of Serbian transmission network possible development variants has been given. These analyses has been carried out with respect to age of existing 220 kV equipment, necessity of replacing it with new ones, age of 220 kV lines in transmission network and investments for their revitalization. Possible variants for transmission network development have been considered from the aspect of the urban planning. Based on results of load forecasting, techno-economical analyses and comparison of possible development variants, the most prosperous solution of transmission network further development for the period up to the year of 2025 has been suggested.

Size of Project: 250 pages  
Finished in: 2007.

3. "Long-term distribution network development plan up to 2025 in the wider urban area of Public Utility Elektrodistribucija Beograd",

Ordered by: Public Utility "Elektroprivreda Srbije", Belgrade, Public Utility "Elektrodistribucija Beograd", Belgrade

Project Manager: Nada Obradović, MSc.

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Danka Kecman, MSc.

Milan Ivanović, MSc.

Vladimir Sovrlić, MSc.

Maja Marković, MSc.

Petar Kovačević, MSc.

Igor Belić, MSc.

Mr Viktor Maksimović, MSc.

The objective of this study is development of prospective 110 kV and 35 kV networks in the wider urban area of "Elektrodistribucija Beograd", south from river Danube and East from river Sava for the period 2010 to 2025. This area has population ~1 million (~450000 electrical energy consumers with 3.8 billions kWh annual consumption and ~1000 MW annual active power peak). The study includes analyses of energy consumption development for the period up to the year of 2004 as well as load and energy consumption forecast until the year of 2025. Detailed analyses of 110 kV and 35 kV networks present condition (including physical state of networks, load of elements, voltage conditions and losses) have been accomplished.

Based on those analyses, results of load forecasting, techno-economical analyses and comparison of possible development variants, the most prosperous solution of distributive network further development in the considered area for the period up to the year of 2025 has been suggested.

Size of Project: 396 pages

Finished in: 2007.

4. "Rationalization of the own electrical energy consumption in Thermal Power Plant "Morava" Svilajnac",

Ordered by: Public Utility "Thermal Power Plant Nikola Tesla", Obrenovac

Project Manager: Ivan Stanisavljević, MSc.

Associates: Vladimir Sovrlić, MSc.

Miloje Kostić, PhD.

Thermal Power Plant "Morava" has one aggregate whose total power is 120 MW.

Its own consumption is about 6.5% of the plant's power (about 7.8 MW) as well as about 6.5% of total produced electrical energy. 6 kV asynchronous motors participate about 95% and 0.4 kV asynchronous motors participate with about 5% in the thermal plant's own consumption. Within this study in the first phase the study "Energy analysis of own consumption and selection of proceedings for the rationalization" was made.

It contains 3 chapters:

1. Energy analysis of own consumption and loads, based on estimations and/or calculations of total losses in 6 kV and 0.4 kV asynchronous motors, and the structure of losses.
2. Selection of measures for the rationalization according to the analysis specified in previous thesis. For the rationalization of plant's own consumption (that is, of the electromotive drive), following measures have been chosen:
  - Identification of the optimal voltage values within  $U_n \pm 5\%$ , for the 6 kV network;
  - Selection of the consumers with economically justified reactive power compensation;
  - Application of asynchronous drives with the speed regulation for chosen drives and,
  - Individual energy rationalizations for 6 kV network, 6/0.4 kV transformers and motors.
3. The savings attained by rationalization of plant's own consumption have been estimated to about 0.2% (1350000 kWh per year).

The second phase included:

- Projects of concrete measures for reducing own electrical energy consumption;

- Realization of projected measures for reducing own electrical energy consumption;

Size of Project: 58 pages

Finished in: 2007.

5. "Analysis of generator transformers transmission ratio changing adequacy in HPP Bajina Bašta"

Ordered by: Public Utility "Drinsko limske HE", Bajina Bašta

Project Manager: Saša Minić, MSc.

Associates: Petar Kovačević, MSc.

Igor Belić, MSc.

Branislav Čupić, MSc.

Vladimir Sovrlić, MSc.

Miloš Stojković, MSc.

The objective of this project was analysis of possibility to change generator transformers transmission ratio in HPP Bajina Bašta since this power plant is about to be rehabilitated. Four possible transmission ratios were analyzed considering transmission network conditions in future (up to 2025) and possibilities of voltage regulation at generators bus bars.

Based on those analyses, optimal solution of generator transformers transmission ratio has been suggested.

Size of Project: 221 pages

Finished in: 2007.

6. "Specific regimes behavior checking for revitalized generators in HPP Bajina Bašta connected to 220 kV transmission network"

Ordered by: Public Utility "Drinsko limske HE", Bajina Bašta

Project Manager: Dragan Popović, PhD.

Associates: Miloš Stojković, MSc.

Saša Minić, MSc.

Ivan Stanisavljević, MSc.

The objectives of this project were static stability analysis and generators self-excitation situations checking for revitalized generators in HPP Bajina Bašta connected to 220 kV transmission network. Two scenarios of transmission network development up to 2025 were considered (one with 220 kV network connected to HPP Bajina Bašta subsistence and another with its substitution with 400 kV network) with two different generator types.

Performed analyses showed that no problems were expected considering static stability and generators self-excitation situations.

Size of Project: 16 pages

finished in: 2007.

7. "Analysis of 10-110 kV distribution networks functioning and load forecasting for distribution area of Kraljevo and Vrnjačka Banja",

Ordered by: Public Utility "Elektrosrbija", Kraljevo

Project Manager: Ana Šaranović, MSc.

Associates: Danka Kecman, MSc.

Igor Belić, MSc.

Saša Minić, MSc.

The objective of this project is analysis of distribution 110 kV, 35 kV, 20 kV and 10 kV networks functioning and load forecasting for the period up to 2025 in the distribution area of Kraljevo and Vrnjačka Banja. The population of analyzed area is ~151000 (~60000 electrical energy consumers with 445000 MWh annual consumption and ~120 MW annual active power peak). The purpose of the first part of the project is to find better way of network exploitation by applying optimal network operation measures. Expected annual financial effects are about 64000 EUR. In this part of project network bottlenecks are clearly marked. Detailed analyses of 110 kV, 35 kV, 20 kV and 10 kV networks present condition (including physical state of networks, load of elements, voltage conditions and losses) have been accomplished.

The second part of project includes analyses of energy consumption development for the period up to the year of 2006 as well as load and energy consumption forecast until the year of 2025. Initial network size: ~780 MV/LV substations.

Size of Project: 170 pages

Finished in: 2007.

8. "Specific regimes behavior checking for revitalized generators in HPP Bajina Bašta connected to 220 kV transmission network - Transient stability analyses"

Ordered by: Public Utility "Drinsko limske HE", Bajina Bašta  
Project Manager: Dragan Popović, PhD.  
Associates: Miloš Stojković, MSc.  
Saša Minić, MSc.  
Ivan Stanisavljević, MSc.

The objectives of this project were transient stability analyses for revitalized generators in HPP Bajina Bašta connected to 220 kV transmission network. Two scenarios of transmission network development up to 2025 were considered (one with 220 kV network connected to HPP Bajina Bašta subsistence and another with its substitution with 400 kV network) for selected generator type.

Performed analyses showed that no problems were expected considering transient stability.

Size of Project: 74 pages

Finished in: 2007.

9. "The choice and analyses of generator and block-transformer optimal parameters in hydro power plants connected to Serbian 110 kV and 35 kV networks"

Ordered by: Public Utility "Elektroprivreda Srbije", Belgrade  
Project Manager: Dragan Popović, PhD.  
Associates: Miloš Stojković, MSc.  
Saša Minić, MSc.  
Ivan Stanisavljević, MSc.

The objectives of this study were the choice and analyses of generator and block-transformer optimal parameters in hydro power plant (new power plants and power plants planed for revitalization) connected to Serbian 110 kV and 35 kV networks. The following parameters were observed: generator power factor, block-transformer reactance and change, inertia time constant, short circuit ratio, d-axis and q-axis synchronous, transient and subtransient reactances and various generator time constants. Also, generator excitation system and voltage regulator were analyzed. The expected peak-load and low-load conditions for years 2010, 2015 and 2020 were analyzed.

The whole analysis of steady-state and transient stability were performed using computer programs UCOSFI, DEFNAPON, STATSTAB and DINST, developed in the Nikola Tesla Institute, Belgrade.

The principal aims of steady-state stability analysis were:

- Calculation the dynamic behavior after a "small regular disturbance" (the hypothetical simultaneous small increase (10 %) of active and reactive power in each load node in Serbian network).

The results of steady-state stability analysis, including additional large amounts of exchange programs and cases of unavailability of some relevant elements, confirmed relatively satisfactory level of steady-state stability reserve.

The principal aims of transient stability analysis were:

- Critical fault (three-phase short circuit) clearing time (CFCT) evaluation for the relevant nodes in power system of Serbia. The CFCT, compared to the real total fault elimination time, gives a good assessment of the transient stability margin or reserve for the considered state of interconnection.
- Three-phase short-circuit on the same relevant lines effects calculation. The effects of three-phase short circuits on all interconnection and some relevant internal lines were analyzed for cases where the fault is cleared after 0.15 s by three-phase permanent tripping of the faulted line.

The results of critical three-phase fault clearing time evaluation indicate a high level of transient stability reserve of the examined interconnection, bearing in mind that usual setting of distance lines protection relays is about 0.15 seconds in 110 kV voltage level.

The results of performed analyses enable the choice of "natural" values of examined parameters, which are the best solution, according to the technical and economical aspects.

Size of Project: 91 pages

Finished in: 2007.

10. "Upgrading of reactive power compensation in EES EPS using existing capacitor batteries - the 4<sup>th</sup> phase for the area of Public Utility "Jugoistok" Niš, i.e. ED Niš, ED Prokuplje, ED Pirot, ED Leskovac and ED Vranje",

Ordered by: Public Utility "Elektroprivreda Srbije", Belgrade

Project Manager: Miloje Kostić, PhD.

Associates: Petar Kovačević, MSc.

Igor Belić, MSc.

Tijana Janjić, MSc.

Upgrading of reactive power compensation has been realized by using Procedures for increasing usage of capacitor batteries in networks of small and medium consumers. Complete realization of the Program included study phase, project phase and also the proposed solution realization phase (without investment and also in short term: endmost in 1 - 2 months at the concrete consumer). Beside energetic analysis, needed analysis of the higher harmonic regimes have also been performed, both for consumers' network and for supplying distribution network. Project has been realized for 46 consumers. As a result of the project realization, capacitor batteries, whose overall power is about 16,400 kVar, are working in a permanent regime now. Amount of produced reactive (capacitive) energy increased about 143 673 Mvarh/ year in regard to previous case, where capacitor batteries were with automatic regulation.

Size of Project: 66 pages

Finished in: 2007.

11. "Combined Thermal Power Plant Novi Sad engagement effects analysis",

Ordered by: Public Utility "Elektroprivreda Srbije", Belgrade

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The first aim of this project was to analyze Combined Thermal Power Plant Novi Sad engagement effects on condition that Serbian transmission network wasn't a part of UCTE interconnection, and on condition that it was part of UCTE interconnection. Influence of Power Plant engagement was analyzed from network voltage conditions, other power plants active and reactive engagement, and transmission network losses points of view. Altogether forty different network states were restored for these analyses.

The second aim of this project was to find optimal way of connection to transmission network for new Combined Thermal Power Plant Novi Sad. New Power Plant is located near old one, which will serve as a reserve, and its capacity is about 400 MW. Five alternatives of connection to 110 kV and 400 kV transmission networks were analyzed.

As a result of this project, effects of Combined Thermal Power Plant Novi Sad engagement were presented and optimal way of connection to transmission network for new Combined Thermal Power Plant Novi Sad is proposed.

Size of Project: 430 pages

Finished in: 2007.