TRANSMISSION DEVELOPMENT PLAN

2023-2032

November 2022

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Abbreviations

ENTSO/E – (European Network of Transmission System Operators for Electricity)

KOSTT – Transmission System, and Market Operator JSC

KEDS – Kosovo Electricity Distribution and Supply Company J.S.C.

DSO – Distribution System Operator

OPGW – Optical Ground Wire

TSO – Transmission System Operator

PSS/E- Power System Simulator/Engineering

TDP – Transmission Development Plan

EES –Power system

SCADA/EMS – Supervisory Control and Data Acquisition/Energy Management System

SECI – South East Cooperative Initiative (Regional transmission planning project)

EMS – Environment management system

CBA – Cost Benefit Analyses

IT – Information Technology

ERO – Energy Regulatory Office

KfW - “Kreditanstalt für Wiederaufbau”

EBRD- “European Bank for Riconstruction and Development”

ALPEX- (Albanian Power Exchange)

MCC- “Millennium Challenge Corporation”

1. INTRODUCTION

The Transmission Development Plan (TDP) 2023-2032 represents Kosovo's network development plan for the next 10 years. This 10 year plan introduces projects that are needed to ensure a reliable and secure operation of the transmission system, in order to achieve security of supply, support the energy market and competition, support the integration of renewable and complementary thermal sources.

Electricity sector as one of the most important industrial sectors in the economy of Kosovo should be developed and planned appropriately and in time. Transmission network, which is operated by KOSTT, plays an important role in the energy and electricity system enabling the transmission of power from local generators and imports to large customers and distribution nodes.

The development of the society and the growing dependence on electricity requires a secure, reliable and efficient transmission network. The growing dependence on electricity means that tolerance to the power outage should be minimal, and the over-extended outages are unacceptable.

In future, this will inevitably require high standards of supply from the transmission network.

Since the establishment of KOSTT until the end of 2022, capital investments amounting to about 300M€ have been made in the transmission network, mainly in the development and reinforcement of the transmission network capacities, revitalization and advancement of support systems. Based on all measurable performance indicators recorded in the last decade, ongoing investments in the new infrastructure of the transmission network; modernization of transmission system support systems; revitalization of substations and lines have contributed to an ongoing increase of security, reliability and performance of the transmission system operation. All this has helped stabilize the electricity sector in the Republic of Kosova.

The requirements for increasing the security of supply and development of transmission capacities in order to support the increasing load, integration of generation from both conventional and renewable sources represents the main factor for KOSTT to continue with investments in the network for the following years.

Achievement of adequate security of electricity supply, further market integration and development, integration of new generating capacities, are related to proper transmission system planning.

1.1 Legal Requirements

Related to the above-mentioned responsibilities on the transmission system development and legal obligations, KOSTT hereby drafts the Transmission Development Plan (TDP), which represents one of the main foundations of development planning of KOSTT**.** The importance of application such document is faced also in the legislative requirements related to the preparation and treatment of this document and as such belong to the primary and secondary legislation. In following are presented the legal requirements for compiling of this document.

1.1.1 Law on Energy

Each year the Electricity Transmission System Operator, Electricity Distribution System Operator, Thermal Energy Distribution System Operator, and Natural Gas Transmission System Operator shall submit to the Regulator the ten (10) year network development plan, based on the current and estimated demand and supply, after consultation with all relevant stakeholders. The network development plan contains efficient measures, in order to guarantee system adequacy and security of supply.

1.1.2 Law on Electricity

TSO shall be responsible for preparation of ten (10) year plans in compliance with the Law on Energy and fulfilment of obligations related to such plans.

1.1.3 Law on Energy Regulator

The Regulator shall examine whether the ten (10) year system development plan submitted by the Transmission System Operator covers all investment needs identified during the consultation process, and may require the Transmission System Operator to amend its ten (10) year system development plan.
The Regulator shall monitor and evaluate the implementation of the ten (10) year transmission network development plan.

1.1.4 Licenses for the Transmission System Operator

Pursuant to Article 10 of the Law on Energy and Article 16 sub-paragraphs 1.11, 1.12 and 1.13 of the Law on Electricity, the Licensee shall develop and publish a medium-term (5 years) investment development plan that shall derive from long-term development plan (10 years) of transmission system. Such development plans shall be drafted in conformity with the applicable legislation in consulting with current and potential system users. Before its, publication, the plan shall be submitted to ERO for approval. The Regulator shall monitor and evaluate the implementation of the ten (10) year system development plan.
Before the publication of the development plan, it shall be aligned with those of the DSO and shall be submitted to ERO for approval. During the planning of the operation of the electricity transmission system, the Licensee shall cooperate with the Market Operator, the Distribution System Operator, the transmission system users and the neighbouring transmission system operators.

1.1.5 Grid Code – Planning Code

Each year TSO will prepare and submit to Energy Regulatory Office Ten (10) Year Transmission Development Plan based on current and anticipated supply and demand after consultation with all relevant stakeholders.

1.1.6 Rule on licensing energy activities in Kosovo

The Applicant who is applying for Transmission System Operator License, in addition to the requirements of Article 8 of this rule, shall submit to the Regulator the Transmission Development Plan, as defined in Article 10 of the Law on Energy, including the system development's impact in the tariffs approved by ERO.

1.1.7 ENTSO-E Requirements:

According to the article of the (EC) Regulation No. 714/2009 of the 3-rd package that defines the coordination of the operation and development of the transmission system "an extensive network plan for the community-wide should include modeling of integrated network, scenario development, an adequacy concept generation and an assessment of the resilience of the system". Furthermore, TDP (Transmission Development Plan) should "build on national investment plans and, if appropriate under the guidelines for network development".
ENTSO-E publishes the 10-year Transmission Development Plan every two years, which contains the outlined and agreed national plans of all countries of Continental Europe operating in the synchronous area.
Pursuant on the above mentioned legal obligations, KOSTT is obliged to draft and after approval from Energy Regulatory Office, to publish and implement such document, which is drafted in full compliance with Energy Strategy of Kosovo.

1.2 Current Kosovo Transmission System

Kosovo's transmission network is developed over the last 60 years in several stages of construction, expansion, reinforcement and consolidation. The current transmission network (2020) consists of 1410.5 km of lines, including:

- 279.5 km at 400 kV voltage level,

- 238.5 km at 220 kV voltage level, and
- 912 km at 110 kV voltage level

The installed transformer capacity of the horizontal transmission network consists of 16 autotransformers with a total capacity of 3750 MVA, including:

- 1200 MVA auto-transformer at 400/220 kV voltage level (3 ATRs)
- 1200 MVA auto-transformer at 400/110 kV voltage level (4 ATRs)
- 1350 MVA auto-transformer at 220/110 kV voltage level (9 ATRs)

The installed transformer capacity of the vertical transmission network consists of 65 transformers with a total capacity of 2320 MVA, including:

- 160 MVA transformer at 220/35/10 kV voltage level and at 220/10 kV voltage level (4 TR)
- 340.5 MVA three-pole transformer 110/35/10 kV (8 TR-3winding)
- 618 MVA transformer at 110/35 kV voltage level (19 TR)
- 1201.5 MVA transformer at 110/10 kV voltage levels (34 TR)

In the frame within the high voltage transformers connected to the transmission network that are not managed by KOSTT are:

- 320 MVA 220/35 kV (2 TR- Feronikel)
- 126 MVA, 110/35/6.3 kV and 110/6.3 kV (4 TR Trepca, actually 3 out of service)
- 40 MVA, 110/6.3 kV (2 TR- Sharr-Cem)
- 20 MVA, 110/6.3 kV (Ujman- IberLepenci)

Kosovo Transmission Network operates with 37 substations of different voltage levels, as follows:

- 1 substation 400/220 kV,
- 2 substations 400/110 kV
- 3 substations 220/110 kV
- 1 substation 220/35/10(20) kV and 1 substation 220/10(20) kV
- 7 substations 110/35/10(20) kV
- 6 substations 110/35 kV, and
- 16 substations 110/10(20) kV

The transmission network also includes three substations managed by the industry such as Feronikel (220/35 kV), Trepça (110/35/6.3 kV) and Sharr-Cem (110/6.3 kV).

Kosovo transmission network is characterized as a fairly well connected network with the regional network with lines:

- 400 kV
  - SS Kosovo B - SS Koman (Albania)
  - SS Kosovo B - SS Nish (Serbia)
  - SS Peja 3 - SS Ribarevina (Montenegro)
  - SS Ferizaj 2 - SS Shkupi 5 (North Macedonia)

- 220 kV
- SS Prizreni 2 - SS Fierza (Albania)
- SS Podujeva - SS Krushevci (Serbia)

Two 110 kV cross-border lines with Serbia are also in operation, SS Vallaq - SS Novi Pazar and SS Berivojce - SS Bujanovc.

The geographical extension of the Kosovo Power System according to the current situation (2022) is shown in Fig. 1-1.

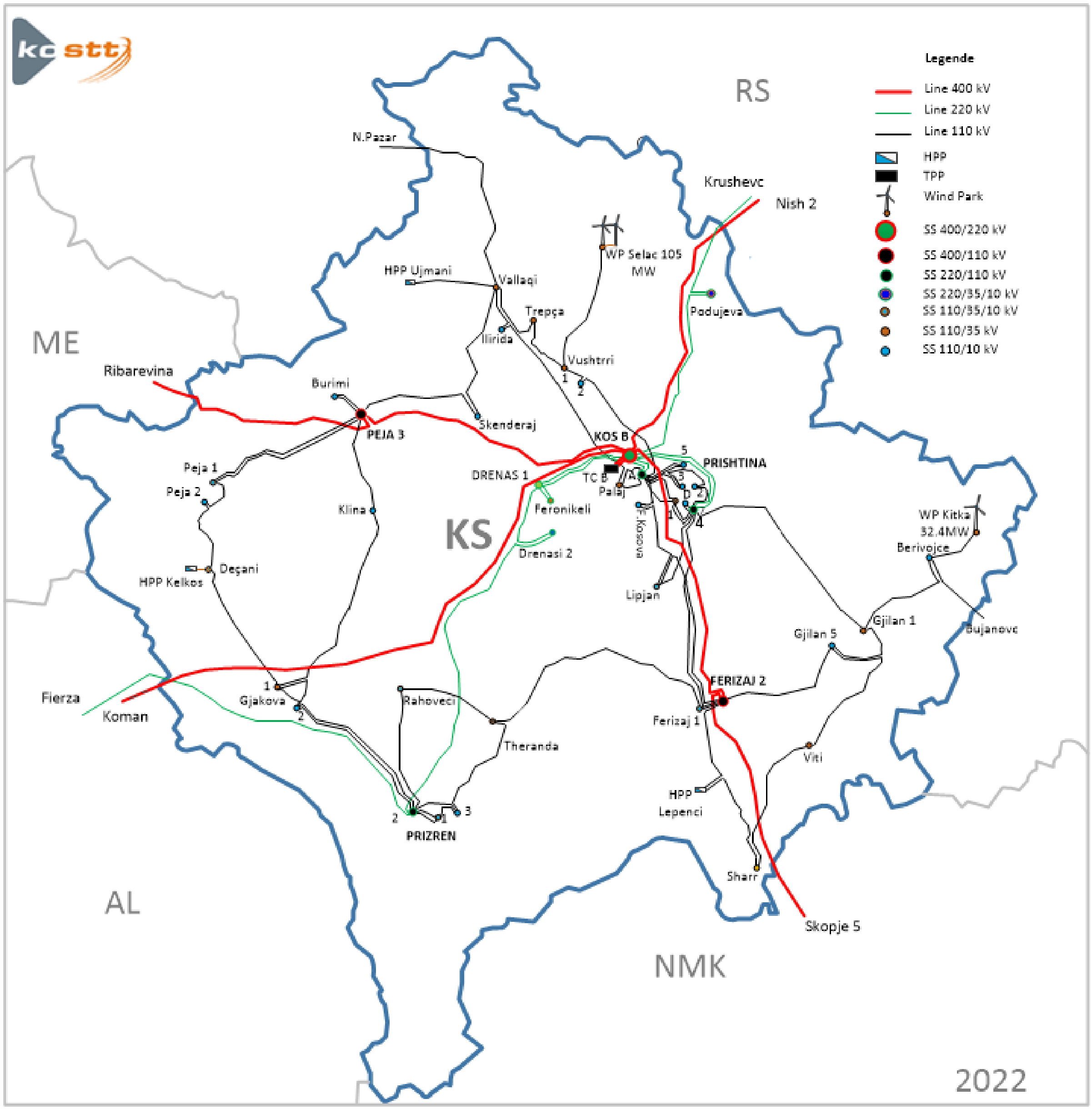


Figure 1-1. Geographical extention of the transmission network in the territory of the Republic of Kosovo according to the current situation (2022)

1.3 Long-term planning objectives of the transmission system

The planning and development of the transmission network is a dynamic and complex process. Transmission system planning is a process aimed at making decisions for the development of new or reinforcement of existing transmission system elements, to ensure long-term energy forecasts and supply, so as to make possible the supply of consumption for the long term forecast domain. Planning as a process involves a number of activities, such as network development in relation to forecast of electricity demand, forecast to generation, enabling the identification of necessary reinforcements and extensions required to achieve a reliable and environmentally sound network operation. Although TDP uses as a reference the prediction for a defined period provided in the Long-Term Energy Balance, the plan must also follow the strategic developments of the transmission system in the long term period.
The planning process has evolved over the time as a result of the restructuring process of the energy market and differs from the earlier concept of centralized planning applied for vertically integrated companies.

The main reasons for the difference are:

- Uncertainties coming from the market environment and input data.
- Uncertainties in the development of gas generation and infrastructure
- Different objectives of various network users (generators, traders, suppliers, customers and network operators),
- Incompatibility - disproportion between technical, economic, environmental and social requirements,
- Uncertainties derived from the integration of energy from renewable sources, especially those connected to the distribution network, and
- Delays in the expropriation of properties associated with the expansion of the transmission infrastructure.

Also the need for regional market integration requires enhancement and strengthening of interconnection capacities, which affects the planning process at national level. From December 14, 2020, KOSTT operates as a Regulatory Area within the Regulatory Block AK (Albania – Kosova). Network development options are based on Planning Code and general planning rules recommended by the ENTSO-E. The defining methodology, which relies on the N-1 security criteria, is the basic methodology applied in this plan, with the aim of identifying and defining the list of projects required for the development of the transmission network. Zonal forecasting of the load and generation is fundamental in determining the required transmission infrastructure in the long-term.

This plan includes information on the development and reinforcements expected to occur in the Kosovo transmission network for the next 10 years, in the following areas:

- Construction of new transmission and transformation capacities,
- Reinforcement of existing transmission and transformation capacities,
- Construction of interconnection lines with neighboring countries,
- Revitalization of existing high voltage facilities (lines and substations)
- Development of transmission system support systems
- New connection of generation and load.

The main objective of ten-year plan is to identify projects which will increase capacity, reliability and efficiency of the transmission network operation with direct support for the security of quality electricity supply to customers.

This plan will inform customers, energy market participants, energy producers, prospective investors on the transmission development plan for the next ten years.

This document presents development plan drafted in KOSTT, covering a period of ten years, from 2023 until 2032, in line with the ENTSO-E requirements, where the 2022 year represents the reference year, or the so-called year zero.
The document is a continuation of previous plans and includes the necessary changes identified during the previous and current year. All information in the development plan such as: project details, expected date of project commissioning, applications for connection to the transmission network that occurred during the previous year and continue to be completed until end of 2022, are taken into consideration in the drafting of this document.
For the drafting of this development plan relevant calculations were carried out with the use of PSS/E software, simulating power flows, shorts circuits and dynamic processes in computer models in the system, based on data provided by KOSTT and network users, as well as based on demand and generation forecast for the next 10 years.

Load and generation forecast for the next 10 years is based on the data from the Long-term Energy Balance as well as from the draft Energy Strategy 2022 - 2031. Data on interconnections expected to be developed in the region, are provided by studies made under the Planning Group for Regional Transmission Network-SECI, within the framework of ENTSO-E in which group KOSTT also contributes, as well as the 10 year Transmission Development Plan published every two years by ENTSO-E.

For each planning year, relevant power flow studies have been conducted, conveying at the same time the demand increase for maximum load and that for two critical regimes: winter and summer.

Calculations of breakdowns in different time periods have also been carried out. Based on calculations results, it is possible to provide estimates of how the network will operate for the estimated next years. Bottlenecks/overloads in the network were identified and possible solutions have been presented, including analysis of their impact to improve the transmission network operational performance.

The transmission system is also analyzed in terms of minimal load operating conditions, with the aim of identifying possible problems of the network with over-voltages that can occur in summer minimal load regimes. In this case, the regional study was used, which examines the problem of overvoltages in the network of Southeast Europe and the solution of this problem, which has already appeared in our region.

1.4 Content of the Plan

TDP is structured in 8 chapters including the Introduction:

Chapter 1– Introduction

Chapter 2 – Grid Code Technical Requirements - the data collection process, planning criteria and standards, and the configuration of substations according to the voltage level of 400 kV, 220 kV and 110 kV are presented.

Chapter 3 - Presents the electricity demand forecast, broken down in the consumption of the past three years and forecasted consumption for the next 10 years.

Chapter 4 - List of existing generators and planned ones. It is also presented the renewables generation and KOSTT policies in support of this technology.
Chapter 5 - Describes the KOSTT network transmission, and interconnection with its neighbors. A part of this chapter describes in details the future developments of the network.
Chapter 6 - Includes access of environmental planning in relation to the Transmission Development Plan.
Chapter 7 - It contains summarized results expected from implementation of the Transmission Development Plan**.**
Chapter 8 - Contains a list of references.

2. PLANNING PROCESS OF TRANSMISSION NETWORK

2.1. Introduction

One of the main KOSTT objectives is development of the transmission system with the purpose of safe, efficient and reliable operation in order to enable electricity transmission, fulfilling the demand in compliance with the legal requirements. Transmission System Operator has planned developments of the network based on long-term electricity needs. A requirement for electricity transmission depends on many factors: increased consumption, installation of new generating units, new cross-border lines and regional, transit of electricity, development of heavy industry, development of energy market, etc.
The need for reinforcements in the transmission network is determined based on the study of network performance against the planned technical standards outlined in the Grid Code respectively Planning Code. The Grid Code covers the operational procedures and provisions governing the interaction between KOSTT and users of the Transmission System in Kosovo. This code also includes the processes of planning, connection, operation and balances system in normal and emergency situations. Planning processes of transmission network include different periods based on the situations in the past, current situation and long-term domain.
The Planning Code specifies technical criteria and procedures and network design to be applied by KOSTT in planning and development of the Transmission System of Kosovo. Even users of the Transmission System during the planning and development of their systems should consider the Planning Code. This code also sets requirements for the collection of reliable information from users, so that KOSTT can make planning and development of transmission system in Kosovo.
Based on Article 14 of the 'License of the Transmission System Operator' Transmission System Operator also has developed the basic planning criteria which are detailed in the document approved by the ERO, "Transmission System Security and Planning Standards”. This document defines a range of criteria and methodologies that KOSTT should adopt (enforce) in the planning process of developing the transmission network in Kosovo.
The 400 kV, 220 kV and 110 kV network planning criteria and the medium voltage network (35 kV and 10 (20) kV) managed by KOSTT. Kosovo’s transmission system in the 400 kV and 220 kV level has technical and economic characteristics which differ from the 110 kV network. Investment costs and dimensioning criteria are much higher than those of the 110 kV. The transmission system is interconnected with regional transmission systems through a 400 kV and 220 kV network, thus the impact of network investments in the 400 kV and 220 kV voltage is not isolated, but rather has a regional character.
KOSTT has developed the transmission development strategy, focused in strengthening/ development of the 400 kV and 110 kV network, while the 220 kV network will not be further developed, except for specific cases where no other solutions can be found.

Transmission network planning is made according to the criteria defined in the Grid Code, considering the fulfillment of N-1 criteria, meaning that the system must be capable of normal operation in case of occurrence of the fault in the network (in Kosovo or in other systems) and the loss of one of each element such as:

- *airline or cable lines*
- *transformer,*
- *compensator, reactor*
- *generator*
- *a busbar from the double busbar system (the case of emergency failures according to ENTSO-E).*

In case lost of one of each above elements as a result of failures, transmission system must fulfill the following operation conditions:

- *transmission lines should not be loaded above their thermal limits,*
- *reduction of the supply capacity is not allowed*
- *level of voltage and speed change cannot exceed allowed limits,*
- *transient and dynamic stability of the Power System should not be endangered, and*
- *power transformers should not be over-loaded.*

The 110 kV network, which development is done in accordance with the Transmission Connection Charging Methodology of KOSTT, includes all equipment, voltage 110 kV (lines and facilities) transformers 110/10 (20) kV and 110/35 kV and 220/35/10(20) kV transformer including respective fields.
In normal operating conditions the performance of the transmission system should be in accordance with operating criteria outlined in the Grid Code.

2.2. Transmission System Planning Methodology

The approach of the transmission network planning methodology consists of the following steps:

- *Collection of input data (creation of data base for computer modeling of the network).*
- *Definition of different scenarios taking into account factors strengthening the development of generation, load, applications for connection, balance of power system, exchanges etc.*
- *The creation of computer models of the network transmission format to PSS/E.*
- Evaluation of network performance for different scenarios and different operating conditions against the technical requirements of the Grid Code and other applicable standards.
- *Cost benefit analysis for each scenario according to the ENTSO-E methodology,*
- Determining the optimal development plan of the transmission network

Figure 2-1 shows the planning methodology algorithm for the capacity strengthening and operational performance of the transmission system.

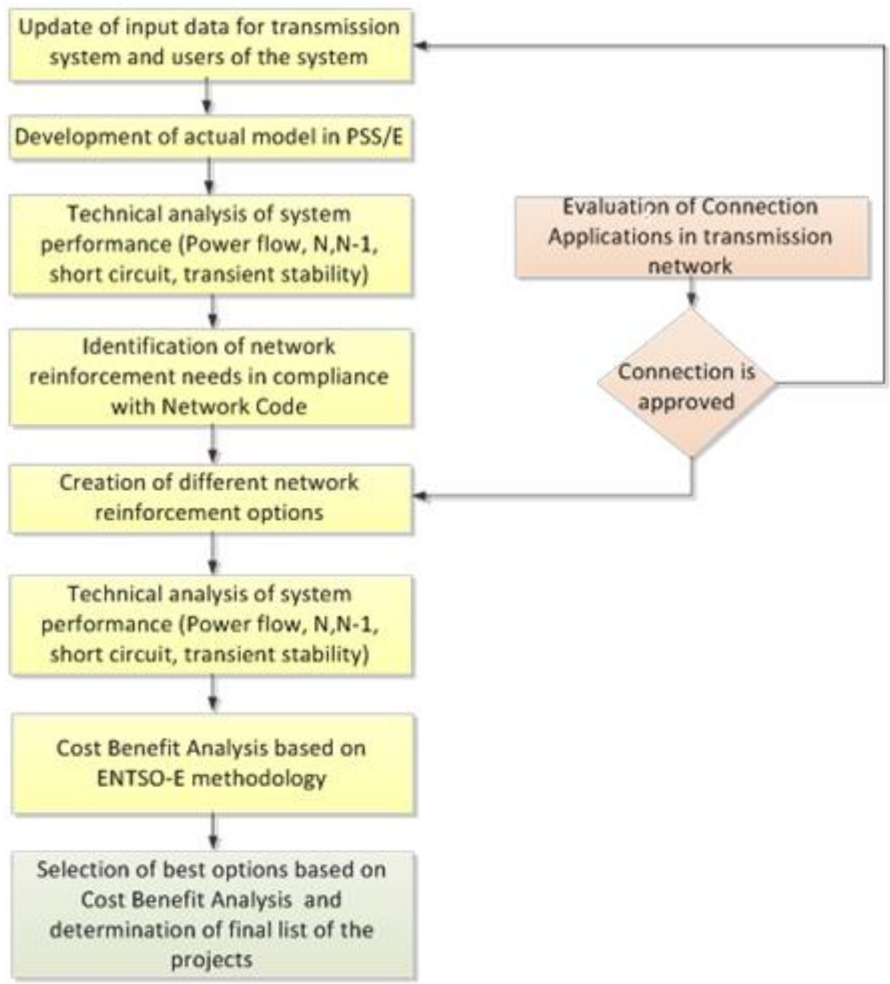


Figure 2-1 The planning process of Transmission network development

2.3. Planning process for the revitalization of the existing network

2.3.1 Introduction

The transmission system consists of a number of elements, such as lines, cables, transformers, circuit breakers, separator and much more. Each EES component has an inherent risk of failure. Many external factors affect the potential failure of components, damages by third parties (human/animal), and trees. Atmospheric conditions such as temperature, humidity, pollution, wind, rain, snow, ice, lightning and solar effects can have a crucial role in the failure of components. It is frequently assumed that the life cycle of installed electrical equipment/ components is about 35-40 years. However, to estimate the lifetime period of various components, it is necessary to consider multiple factors, such as the range of extreme operating conditions and environment, as well as the changing level of previous maintenance. Most transmission companies use components beyond 40 years, if they are not faced with extreme occurrences, such as atmospheric discharges. Any short circuit in and near the substation causes large power flows currents over

the equipment, and the more frequent they are, the more likely it becomes that the equipment will suffer a breakdown. Substations near generation are at the highest risk from this occurrence, where the short circuit currents are larger.
The statistical rate of failures increases over the years based on the bathtub curve as presented in Figure 2-2. The bathtub curve consists of three periods: (1) The period of failures in the beginning of the commissioning of the equipment with a high rate of continued failure (2) second period “optimal life cycle” with the lowest and most consistent rate of failure. The third period (3) “end of the life cycle” is the critical period of the component with a high degree of failure.

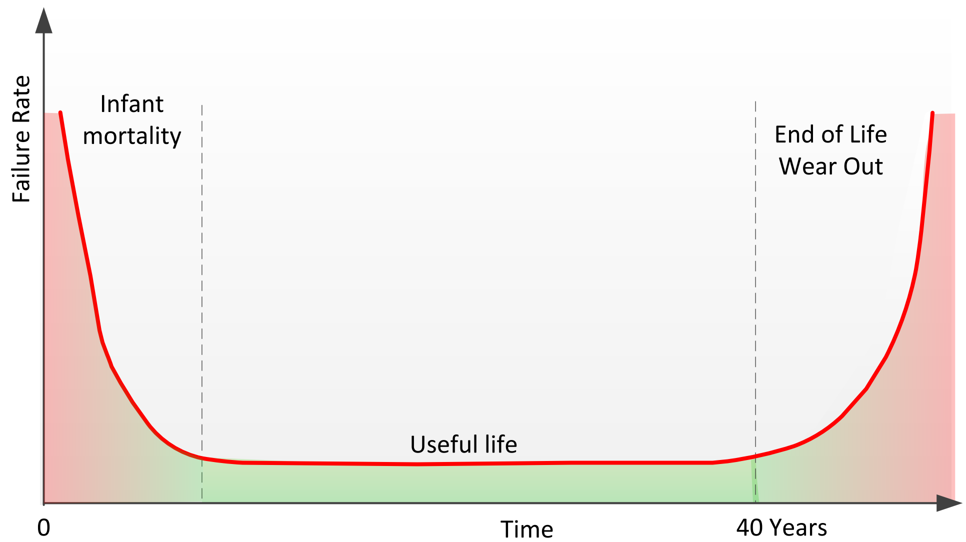


Figure 2-2 The bath tub curve: hypothetical failure rate depending on time in operation

2.3.2 Planning methodology for the network’s revitalization

The revitalization plan of the transmission system facilities such as overhead lines, transformers, cables and substations, generally depends on the technical condition, their age and intensity of use of such facilities in retrospective. The revitalization plan of transmission network facilities is developed as follows:

- **Overhead lines**: Their revitalization depends on two factors: their age and level of losses incurred in the long-term. For phase and protective conductors, insulators, bridges, exceeding 50 years represents a condition for inclusion in the revitalization list. The frequency of failures in line is an additional indicator for the selection of the line in the revitalization list.

In terms of losses, the revitalization list includes cross lines of 150 mm^2, which are also connected with the first factor, as in the initial transmission network development phase (1950-1970) 110 kV lines are built with cross section conductors of 150 mm^2. The concept of developing new capacities in transmission network lines focus on 400 kV and 110 kV lines, with no intended further development for the 220 kV lines. This development concept is being applied in almost all transmission systems of ENTSO-E. 220 kV lines are considered as older lines (> 50-60 years) as their construction was mainly conducted in the 60s and 70s. The concept of European countries is that 220 kV lines will be gradually upgraded in 400 kV lines, mainly using

only their route. Problems with expropriation of private property for purposes of building new lines are significant in all European countries.
The following figure shows the age of the transmission lines according to the voltage level that are in operation.

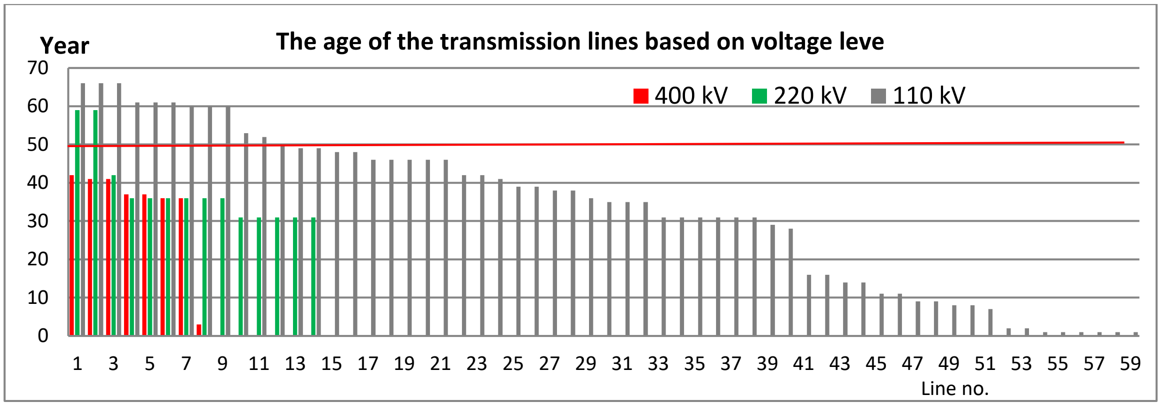


Figure 2-3. The current age of the lines in operation in the transmission network according To the voltage level

- **Power transformers:** The plan to replace power transformers of the transmission network is based on their expected lifetime, estimated at 40 years. Another important factor that influenced the inclusion of transformers in the list of replacements is their technical real situation, monitored by maintenance teams through periodic testing. Historical statistical data on events on particular transformers (level of load, number and frequency of transformer protections, gas analysis, etc.) are important factors in the selection of transformers which should be replaced with new transformers. In specific cases where the technical condition of the transformer is considered to be good, it may continue to operate even over the age of 40 years.

Another factor that is considered for the decision to change the transformers on the border with DSO is the conversion of the 10 kV to 20 kV network in some areas selected by KEDS. In this case, the replacement of transformers with the possibility of operation at 20 kV is applied, and on the other hand, in coordination with KEDS, the replacement of transformers is applied, mainly with high age.

Figure 2-4 shows the age of 65 power transformers installed in the substations at the border with the distribution system operator. From the figure it can be seen that 13 transformers have passed the projected lifespan, five others will reach the critical age value within the next three years and another 19 transformers, after 10 years in operation, will reach the age of 40.

Figure 2-5 shows the age of 16 auto-transformers operating in the transmission network, where two auto-transformers in SS Prizren 2, has passed the age of 40 years. Within the next 10 years and 6 auto-transformers with pass the critical age.

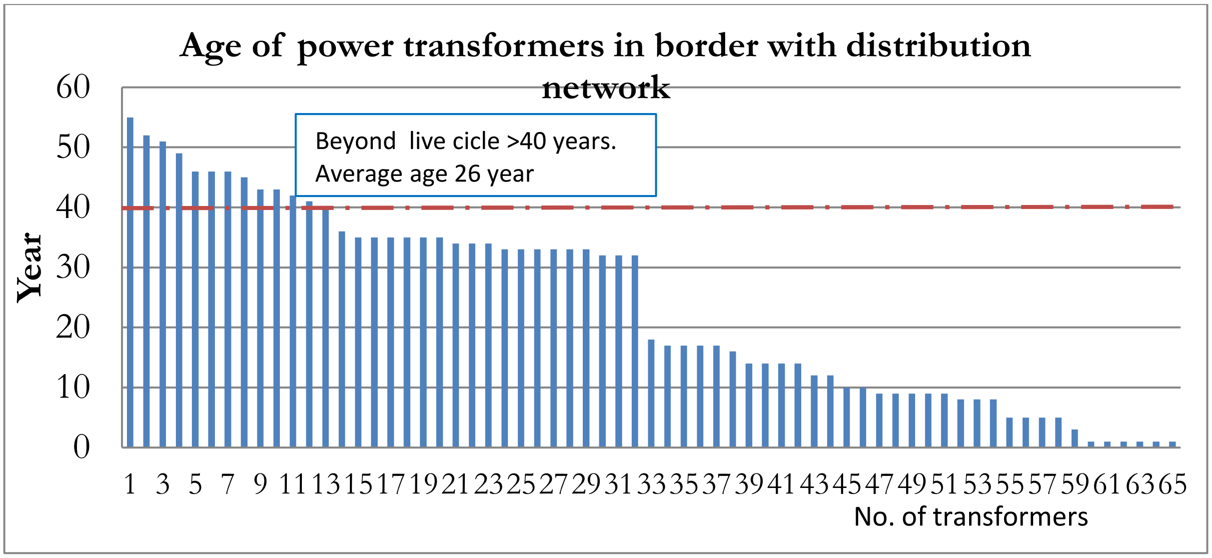


Figure 2-4. Current transformers age in operation in the power transmission network

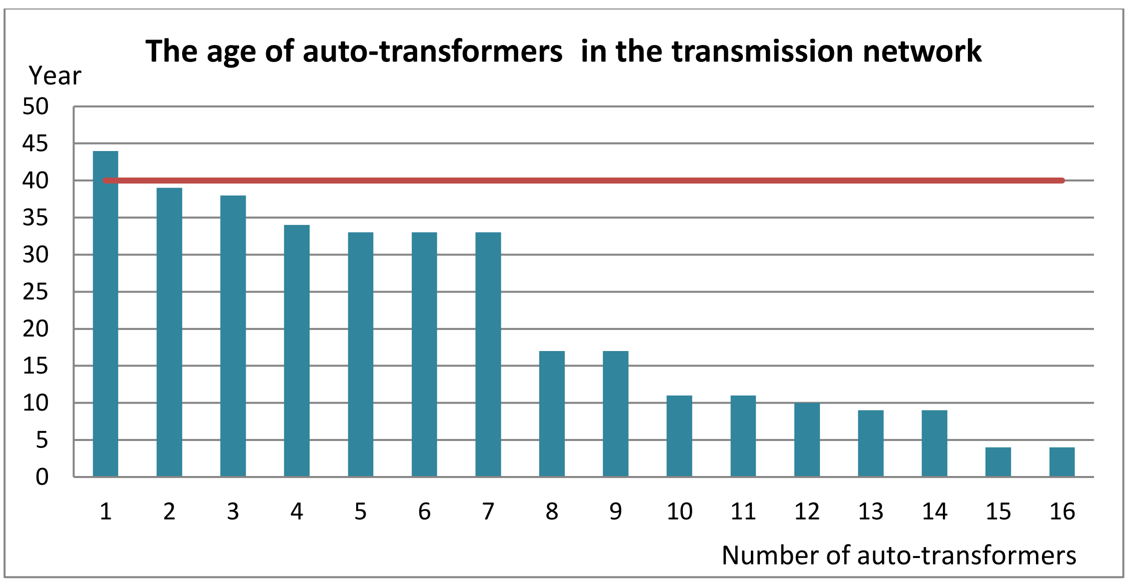


Figure 2-5. Current age of auto-transformers in operation in the transmission network

- Substations (lines fields and transformers): Revitalization plan for substations fields, which are included in the defined transmission network boundaries, is also based on the age of the facilities and their actual situation. Priority in revitalization lies with substations with a high impact on the transmission system, but also all substations the life cycle of which has passed 40 years. Substations with a high impact on the transmission system, but also all substations whose lifespan has exceeded 40 years, have priority in revitalization. Systematic replacement of oil-based circuit breakers with SF6 gas is objective almost 95% realised. In addition, the replacement includes all elements of relevant fields (transformer, lines) installing a motorized separator commanded through the SCADA/EMS system. The double busbar system with a connecting field is preferred for substations which have sufficient space.

Access to planning methodology for transmission network revitalization consists of the following steps:

- *Collection of input data, historical frequency of breakdowns in facilities, lines, cables, transformers etc., age of equipment and general evaluation of the technical state of electric equipment for the reference year (the current year).*
- *Analyze the performance of equipment and technology in order to identify new technologies provided by the global market that can resolve issues in the performance of the equipment.*
- *Identify equipment in locations, or lines/cables to be included in the process of verifying the under performance.*
- *Analyze the need for improvement or advancement of equipment. If equipment are not necessary, and not worth the investment, a decision to be made to decommission them. Otherwise, the process continues with a detailed assessment of the state of problematic equipment.*
  - Analyze possible options of revitalization with a regular maintenance process, or inclusion in revitalization projects in the Development Plan.

In figure 2-6 is presented the algorithm of network refurbishment planning methodology.

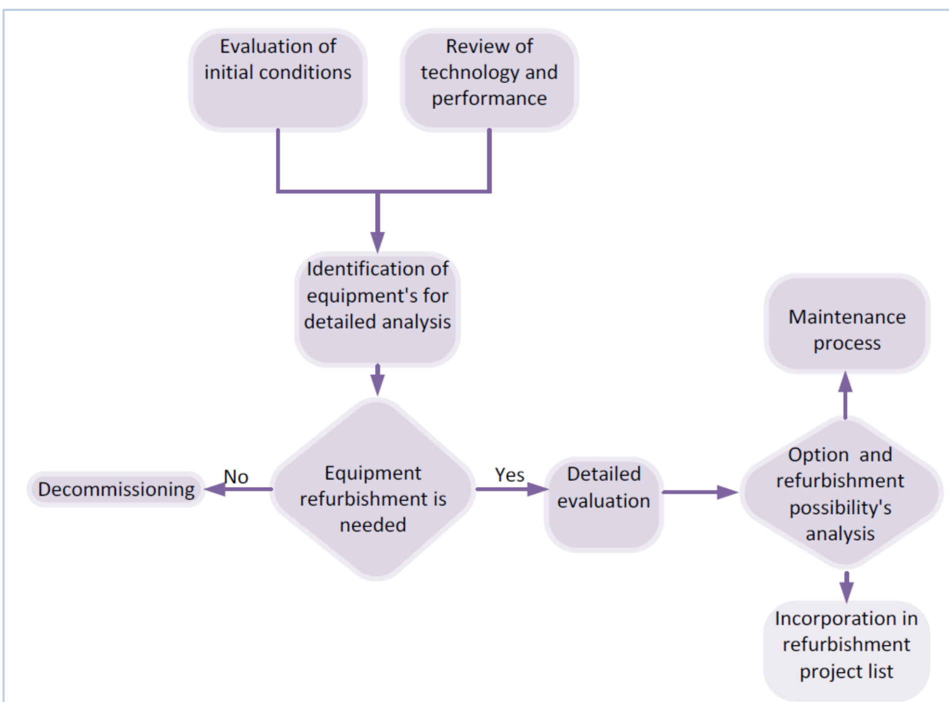


Figure 2-6 Planning process for revitalization of transmission system

2.4. Transmission projects cost-benefit estimation methodology

In accordance with the Regulation ERO/No. 13/2017 on the Assessment of Capital Projects in the Transmission and Distribution Network in the Electricity Sector, KOSTT is obliged to prepare the cost-benefit assessment of projects deriving from the 10-year Transmission Development Plan related to the 5 year time period, namely the 5 year investment and development plan of transmission.
The aim of the project's cost-benefit analysis is to determine the impact of the network infrastructure and transmission system development in the society's socio-economic welfare. The modified CBA (cost-benefit analysis) methodology published by ENTSO-E has been used by KOSTT in accordance with the ERO Regulation no. 13/2017 approved by the Energy Regulatory Office. This methodology compares the impacts of each project based on a range of indicators set by ENTSO-E. Assessment of transmission network projects is a complex task due to different categories of projects. For some projects mainly related to security of supply, efficiency, integration of renewable resources, new interconnection etc., it is easier to identify the measurement parameters of a significant number of indicators. Whereas for some projects that are mainly related to the transmission system's support processes, it is very difficult to weigh the assessment indicators as they are not directly related to any of the indicators set by ENTSO-E. For example projects related to software platforms, adaptation of IT systems according to requirements and changes occurring in ENTSO-E, defence and monitoring measurement systems, etc. do not have specifics that may relate to indicators such as security of supply, efficiency, etc. These projects are necessary for the secure and efficient operation of the transmission system, but nevertheless they cannot be weighed and cost-benefited in terms of the indicators set by the CBA methodology.

The CBA methodology is based on the following factors:

- *Security of supply*
- *Safety of transmission system operation*
- *Integration of generation, RES, reduction of CO2*
- *Network efficiency*
- *Promotion of the market for socio-economic benefit of the society*
- *Project's cost calculation (fixed and variable)*
- *Environmental and social impacts*

The table below describes the structure of projects for which the CBA can be applied.

Table 2-1 Categorization of projects for implementation of CBA

Projects/Network reinforcement: • New line or cable • New transmission substation • New Transformer (or Replacement) • Upgrading the existing line capacity • Network for the connection of conventional new generators and RESs • Interconnection line • Reactor or compensator	CBA indicators can be fully implemented

• Energy accumulators for the "storage" needs)	
Projects / Load Support: • New substation with interconnection lines	All of the CBA indicators can be fully implemented, efficiency gains are mainly transferred to the distribution network
Projects / Revitalization: • Substation as a whole • Specific line fields or transformers	The CBA indicators may be partially implemented
Projects / system support • Measuring and protection systems • IT market systems • SCADA / EMS systems • Telecommunication systems • GIS systems • Software for system analysis, etc.	The CBA indicators cannot be applied. They are necessary for the optimal operation of the transmission system based on the Grid Code and the requirements from ENTSO-E

2.4.1 Benefit indicators

The assessment of transmission network projects represents a complex process which in itself entails the linkages between all the first determined costs that are necessary in the development of the project and the project's expected benefits by examining environmental and social impacts as inevitable factors for any kind of project that takes place in residential or protected areas.

Figure 2-5 shows the basic structure of project evaluation.

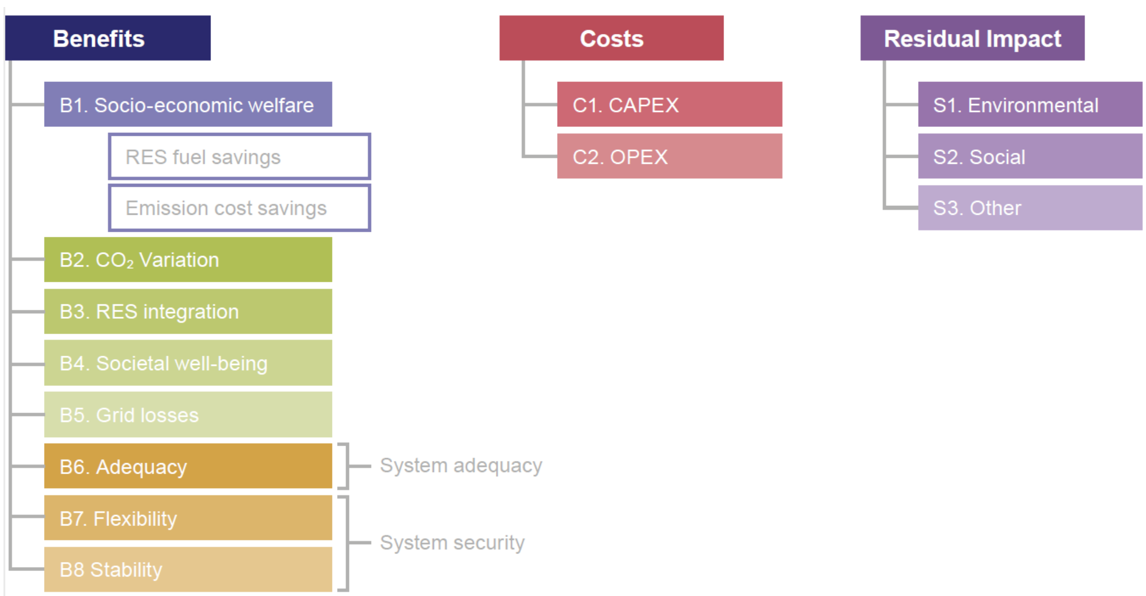


Figure 2-5 The basic structure of the project evaluation process in transmission

During the project assessment process based on the ENTSO-E adopted methodology, there are various indicators classified as:

- *Benefit Indicators*
- *Project cost*
- *Environmental and social impacts*
- *GTC network transmission capacity*

There are eight Benefit Indicators, which are defined as follows:

B1. Socioeconomic Wellbeing (SEW) or market integration is characterized by the possibillity of the project in the reduction of the congestions and thereby ensuring the increase of transmission capacity which enables the increase of commercial exchanges, so that electricity markets can be traded in the most economical way.
B2. The change in CO2 represents the reduction of CO2 emissions in the power system due to the project. This reduction is due to the change in the dispatching generators and the activation of the RES potential. The goal of CO2 reduction explicitly represents one of the European Union targets and is therefore considered as a separate indicator.
B3. Integration of RES, namely the support for integration of RES is defined as the ability of the power system to enable the connection of new RES and activate existing and future RES, minimizing reductions of electricity produced by RES. Integration of RES is one of the goals of EU-20-20-20.
B4. Changes to social welfare*,* as a result of CO2 reduction and RES integration, there is an increase to social welfare beyond the economic effects that are identified during the assessment of the B1 indicator. The CO2 emission reduction and RES integration into the electricity system because of the project is partially attributed to indicator B1 (SEW). The CO2 emission reduction and RES integration results in the change of variable generation and emission costs due to electricity production from conventional generation with non-zero variable costs and emission costs (e.g. carbon tax) affecting the rise of system costs. However, this may very well not reflect the entire social welfare having more RES in the system or in the total social cost of CO2 emission (damage caused by the emission of ton of CO2 will not necessarily reflect on the emission certificate costs which manufactures must pay). These additional effects are reported in this indicator.
B5. Change in transmission network losses represents the cost of compensating thermal losses (Joule losses) in the energy system because of the project. Otherwise, this represents an energy efficiency indicator expressed as cost in Euro per year.
***B6.* Security of Supply: Adequacy of demand supply** characterizes the project's impact in the ability of the electricity system to provide sufficient supply of electricity to fulfil the demand for prolonged period of time. The effects of climate changes and production from RES is taken into account.
B7. Security of Supply: System flexibility: characterizes the project impact on the power system's ability to accommodate rapid and deep changes of (net) demand in the context of introduction at a high level of non-dispatchable electric generators.
B8. Security of Supply: System stability: characterizes the project impact on the system stability to provide secure power supply according to the technical criteria defined in the Grid Code (Criterion N and Criterion N-1/power flow, short circuits, transient stability, voltages stability).

Other project impacts are defined as:

S.1 Environmental impact represents the project impact as assessed by preliminary study, and aims to provide a project-related environmental sensitivity meter.

The environmental impact is related to the local impact of the project on nature and biodiversity, as assessed through preliminary studies. It is expressed in terms of how many kilometres of overhead or underwater/underground lines can pass through a sensitive environmental area (urban areas, protected areas, archaeological areas, national parks etc.).

S.2 Social impact represents the project's impact in the local population affected by the project as assessed through the preliminary studies, and aims to provide a measure of social sensitivity related to the project.

S3 Other impacts represent the indicator that will include all possible project impacts.

These three indicators refer to the remaining impacts, after the implementation of measures to minimize impacts. Therefore impacts which are minimized due to additional measures should not be presented in this category.

Project cost is defined as:

C1. Capital Cost (CAPEX). This indicator shows the value of investment for project implementation, which contains elements such as: costs of obtaining permits, for conducting feasibility studies, expropriation, for the construction parcel, for pre-preparation, design, equipment and materials and installation or dismantling. The project's capital cost is estimated by comparing it to similar projects implemented, and based on parameters from public information concerning similar project costs. CAPEX is expressed in EUR.

C2. Operational Cost (OPEX). These costs are based on the project operational and maintenance cost. The operational cost of all projects should be estimated based on the current cost values and distributed per years expressed in EUR per year.

Grid Transfer Capability (GTC) is defined as:

GTC represents the network's ability to transmit electricity from an area to another. The interconnection of two areas represents a bottleneck in the energy system where the transmission capacity is insufficient to accommodate possible power flows (resulting from the scenarios). For the internal part of the network, the GTC may be affected by new lines as well as additional transformers installed in existing substations or new substations. In the new interconnection lines, GTC over 500 MW, in fact, represents a significant regional impact of the new line, as defined by ENTSO-E. Mainly 400 kV lines can affect the upgrading of the GTC to 500MW.

3. ELECTRICITY GENERATION AND LOAD FORECAST

3.1. Introduction

One of the basic data determining future transmission capacity development is to forecast electricity load or power. The load forecast represents an integral part of network planning, generation and transmission and distribution system operation. The main source of data for development of load forecast in the next 10 years is the demand forecast model developed by KOSTT. This model represents a 10-year forecast, hour by hour, of the electricity demand. As such, this model enables the prediction of load, hour by hour, for the next 10 years, including peak loads (winter and summer).

3.2. Historical information of the load, and current situation

The historical chart of maximum load development in our country is shown in Figure 3-1. Unusual characteristics of the load curve over the years reflects the political and socio-economic conditions in which our country has passed in the last three decades. The maximum load value recorded so far is the load of 2021 (December) which has reached the value of 1398 MW.

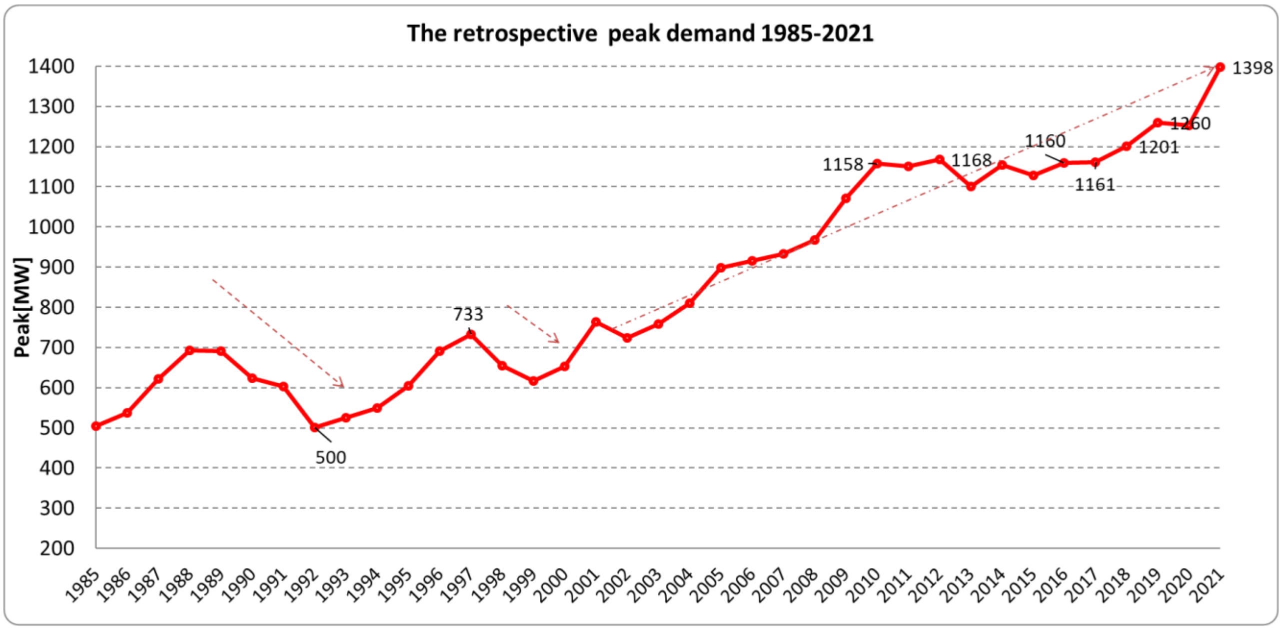


Figure 3-1 Peak load history over years in Kosovo

The table 3-1 shows maximum loads registered for years 2004-2021, for winter and summer seasons.

Tab. 3-1 Maximum active loads, summer and winter, for the period 2004-2021

Year		2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Winter Peak	MW	811	898	916	933	967	1072	1158	1150	1168	1101	1154	1129	1160	1161	1201	1260	1253	1398
Summer Peak	MW	569	617	637	690	764	795	810	798	815	799	775	774	764	744	751	805	689	840

3.3. Demand profile

Features of the load duration curves for Kosovo's Electricity System has went through constant changes, both in terms of proportional growth but also in terms of load factor change. Figure 3-2 shows the load duration curve for the previous year 2021, as well as basic characteristics of load.

In figure 3-3 is presented load duration curve hour by hour for the year 2021.

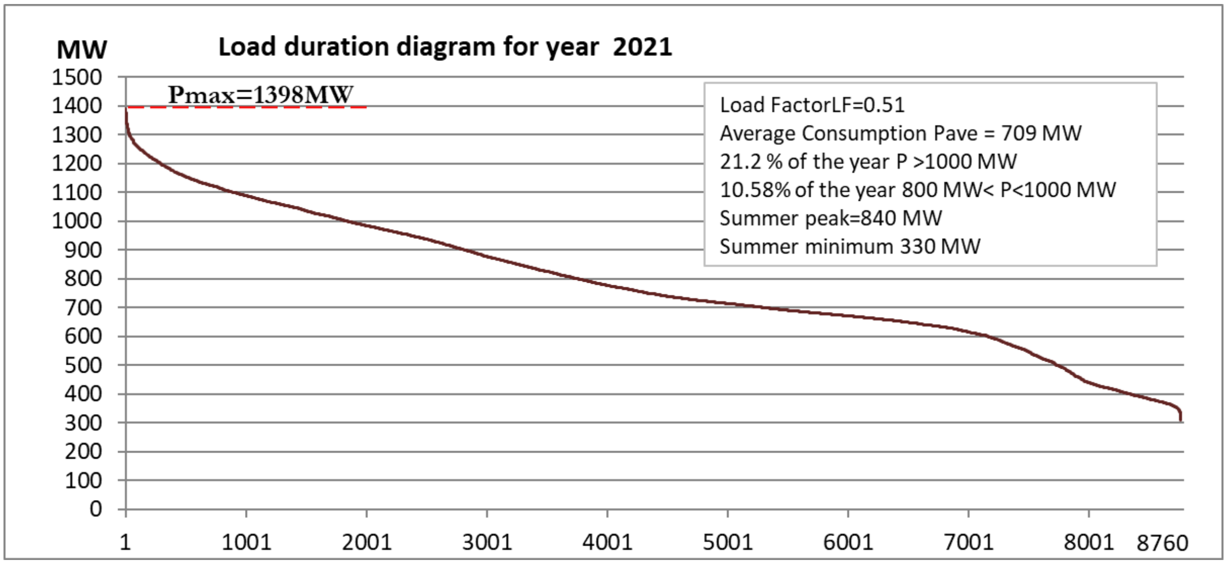


Figure 3-2 System Load duration curve for the year 2021

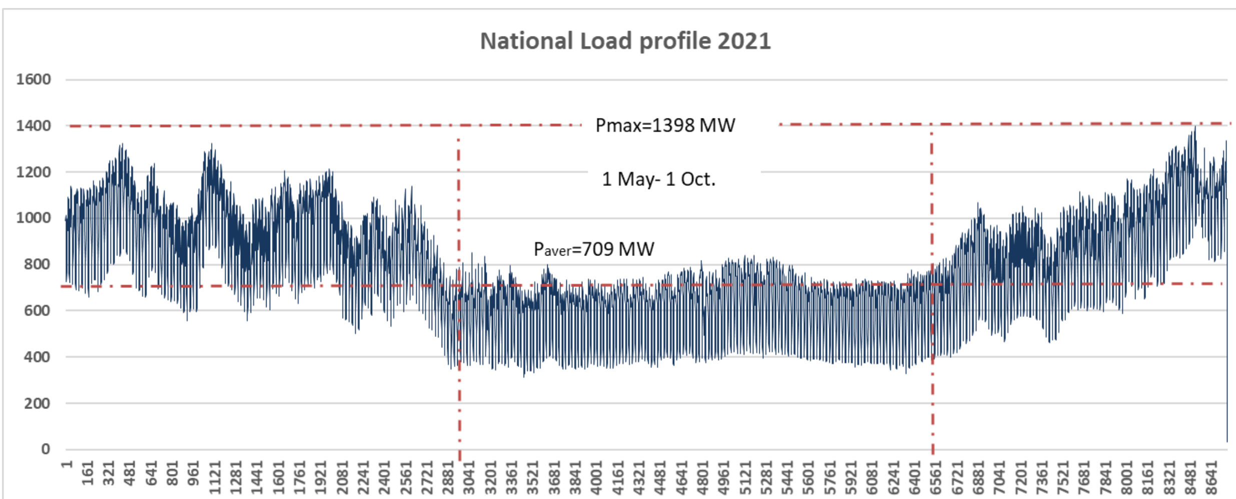


Figure 3-3 The diagram hour by hour of annual loads carried out during 2021

The diagram of the maximum and minimum load change for 365 days of 2021 year is shown in Figure 3-4. The difference between the maximum and minimum value of daily consumption during 2021 has shifted in the range from 280 till 506 MW.

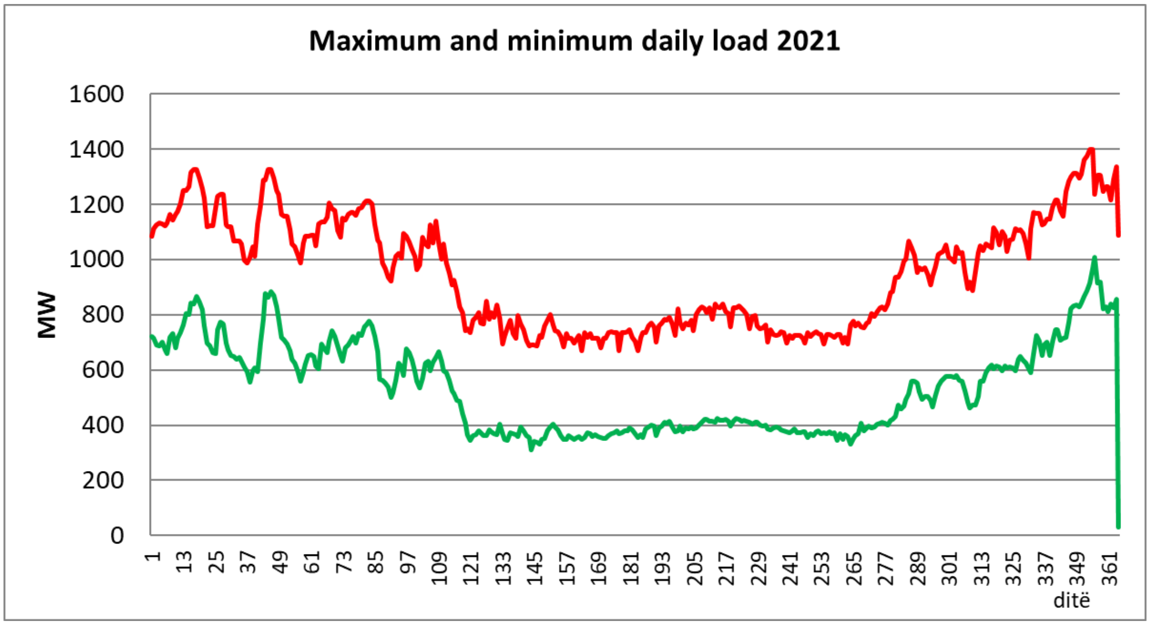


Figure 3-4 Diagram for maximum and minimum daily load for 2021

The weekly load diagram in the winter season, of a typical week of January and July of 2022 now realized is shown in Figure 3-5. There is a decrease in consumption over the weekend, which reperesents a change in consumer behavior from previous years.

Figure 3-6 shows the daily diagram of national consumption of electricity for a typical day of January 2022 and of July 2022, which correspond to reference points according to ENTSO-E.

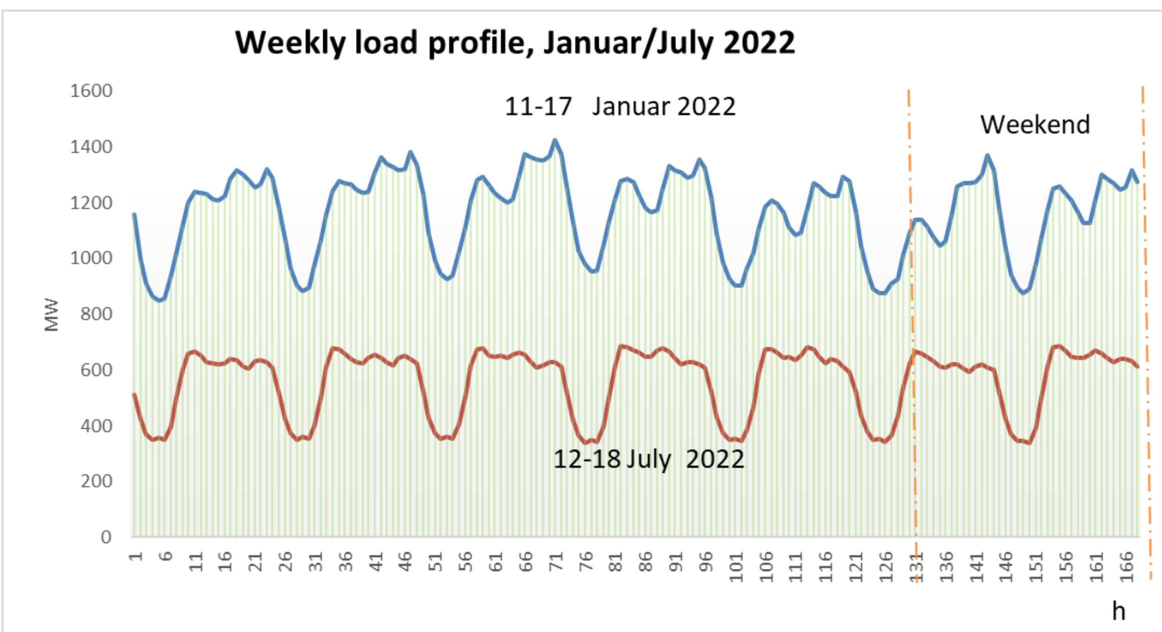


Figure 3-5 Weekly typical diagram of January and July 2022

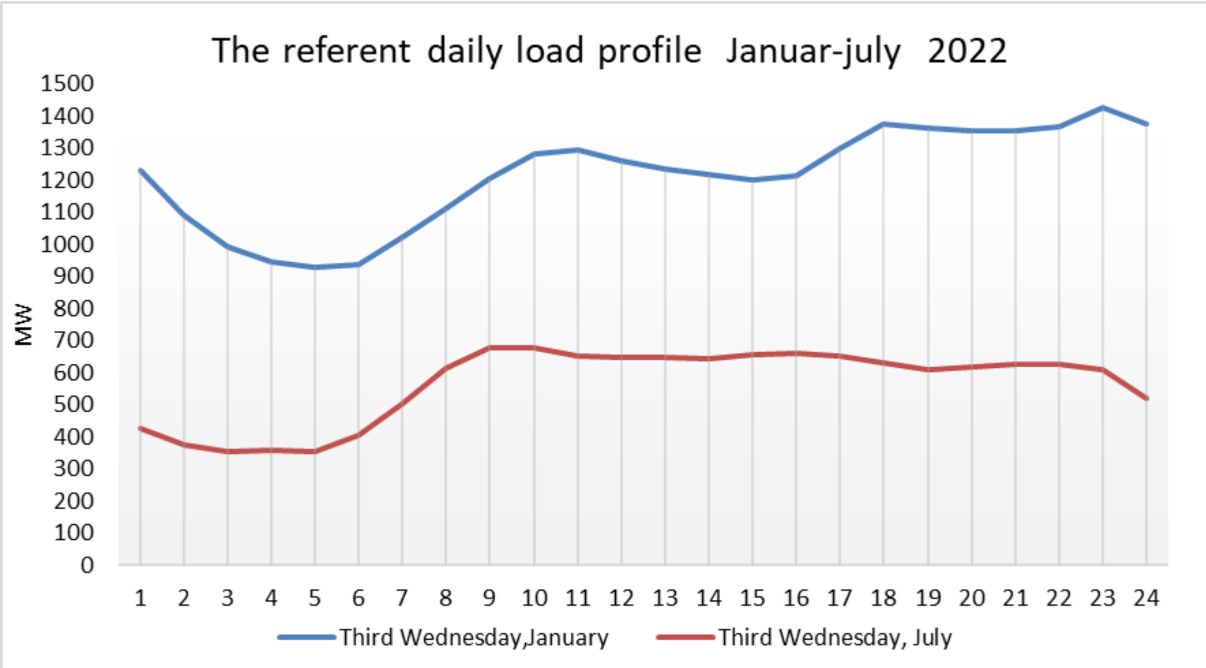


Figure 3-6 Daily load diagram for the referent point (3-rd Wednesday, January 2022 and July 2022) according to ENTSO-E

Table 3-2 shows simultaneous maximum loads in 220 kV and 110 kV consumption divided by distribution districts, the industry connected to the transmission network and losses in the transmision network for the current year 2022. System models in PSS/E which reflects the current situation is based on the data presented in Table 3-2.

Cumulative consumption by districts of which KEDS consists, the industry connected to the transmission network and losses in the transmission network is illustrated in Figure 3-7.

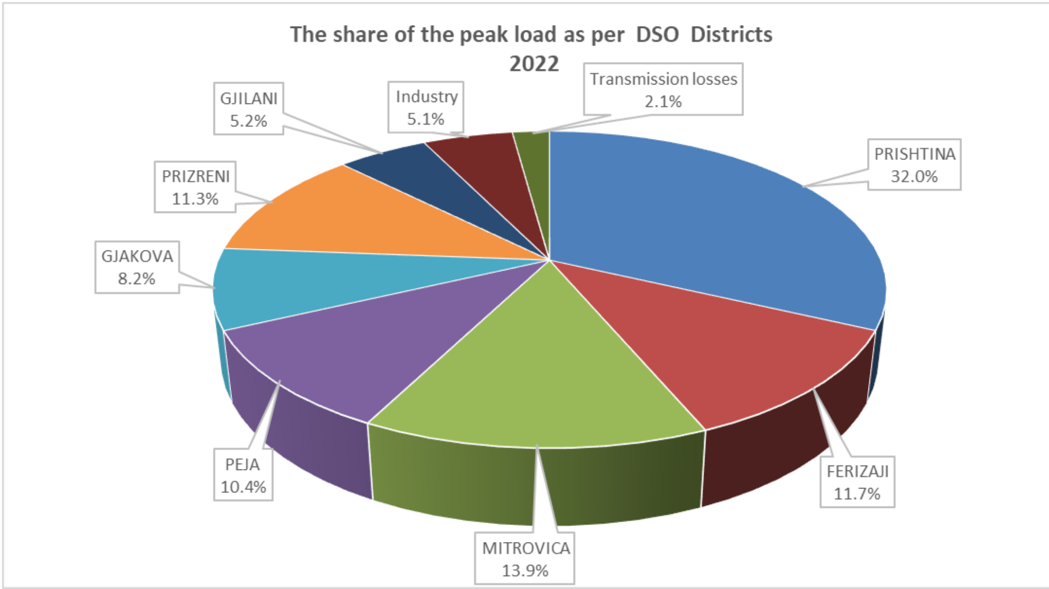


Figure 3-7 Maximum load by DSO districts, industry connected to the transmision network and losses in KOSTT

Table 3-2 Loads in distribution substations forecasted for 2022

District	Simultaneous substation peak demand 2022		
	Substation	Instaled Capacity [MVA]	Simultaneous Peak
	Prishtina 1	126	77.0
	Prishtina 2	143	73.0
	Prishtina 3	71.5	43.0
	Prishtina 5	71.5	37.0
	Dardania	80	24.0
PRISHTINA	Prishtina 7	80	49.0
	Bardhi(Palaj)	111.5	20.0
	Drenasi	80	23.0
	Podujeva	80	51.0
	Kosova A+B	/	50.0
	Total Prishtina	**852**	**447.0**
	Ferizaj(Bibaj)	103	91.0
FERIZAJI	Sharri	/	8.0
	Lipjani	103	64.0
	Total Ferizaji	**206**	**163.0**
	Vallaq	94.5	75.0
	Ilirida	80	52.0
MITROVICA	Vushtrri 1	31.5	0.0
	Vushtrri 2	63	45.0
	Skenderaj	71.5	23.0
	Total Mitrovica	**340.5**	**195.0**
	Peja 1	71.5	46.0
	Peja 2	63	35.0
PEJA	Deçani	91.5	25.0
	Burimi (Istogu)	63	17.0
	Klina	31.5	23.0
	Total Peja	**329**	**146.0**
	Gjakova 1	40	29.0
GJAKOVA	Gjakova 2	63	37.0
	Rahoveci	63	49.0
	Total Gjakova	**166**	**115.0**
	Prizreni 1	103	70.0
PRIZRENI	Prizreni 2	63	39.4
	Theranda	71.5	48.2
	Total Prizreni	**229**	**157.6**
	Gjilani 1	63	37.0
	Gjilani 5	31.5	25.0
GJILANI	Vitia	51.5	35.0
	Berivojca	63	16.0
	Total Gjilani	**197.5**	**113.0**
	Feronikeli	320	50.0
	Sharr Cem	40	14.0
INDUSTRIA	Trepça	63	6.0
	Tjera	/	3.0
	Total Industry	**454.5**	**72.9**
	KOSTT network losses		29.8
	Total Capacity without Indus.	**2320**	
Peak (MW)			**1439**

3.4. Maximum annual load forecast 2021 - 2030

Forecast of the electricity is based on the modeling of the demand according to the foreseen data of the demand from the parties connected to the transmission network.

This forecast is in harmony with the forecasts made in the draft Energy Strategy 2022 – 2031 adding the year 2032 and updating the peak value for the previous year 2021 according to the measurements made.
The forecast of the development of electricity demand for the time period 2023-2032 under three different growth scenarios is shown in Figure 3-8, and numeric data corresponding to Figure 3-8 are shown in Table 3-3.
The baseline scenario of load development is characterized by an annual average growth of around 1.98%. This load development scenario will be the key input in evaluating the operating performance of the transmission network.

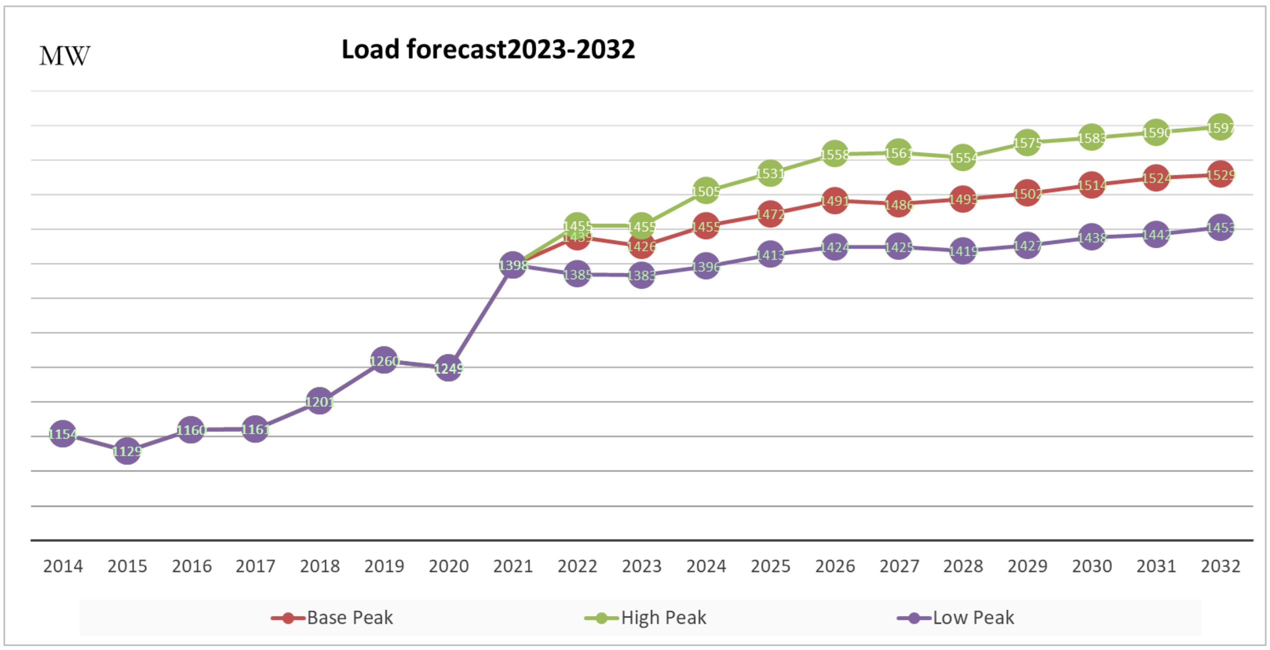


Figure 3-8. Low, base and high growth scenarios for the peak load (maximum load)

Table 3-3. Respective data of peak forecast, related to Figure3-8

Peak Load Forecast	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
Low Peak [MW]	1154	1129	1160	1161	1201	1260	1249	1398	1385	1383	1396	1413	1424	1425	1419	1427	1438	1442	1453
Base Peak [MW]	1154	1129	1160	1161	1201	1260	1249	1398	1439	1426	1455	1472	1491	1486	1493	1502	1514	1524	1529
High Peak [MW]	1154	1129	1160	1161	1201	1260	1249	1398	1455	1455	1505	1531	1558	1561	1554	1575	1583	1590	1597

4. GENERATION CAPACITIES OF KOSOVO'S ELECTRICITY SYSTEM

4.1 Introduction

The power flows in the transmission network are affected by the distribution of system loads, generation capacity and location and the power balance linking to the interconnection network depending on the level of imports or exports. The changes to the generation capacity, along with new capacity development and decommissioning of generation have a greater impact on changing the power flows compared to the loads.

Construction of any type of generator requires the development of a transmission network that would allow the generator to be connected into the grid and create the path for injection of power produced in the electro-energetic system. If the power flows of the new generator do not affect the safety of the transmission network operation, such connection is considered to be a shallow connection and does not implicate additional investment in the transmission network. If the security of some parts of the network is affected as a result of the change of power flows caused by the new generation connection, in addition to the interconnection network, the transmission network should be reinforced wherever the overloads occur. This case is considered to be a deep connection and implicates additional investments to maintain the security of the transmission system.

The connection of new generators into the transmission network, particularly large-capacity generators, results with increased level of short circuits powers in parts of the grid close to the generation and may implicate additional investment in equipment for limiting power failures or changing disconnection facilities at risk.

The impact on future transmission network development will most certainly be attributed to the development of renewable sources. It would be more economical to connect RES with relatively low capacity (<10 MW) into the distribution network, if the network provides generation security and power evacuation. On the other hand, higher-capacity RES mostly applies for connection to 110 kV network. In this case a 110 kV network should be developed which enables the RES connection to the transmission network. RES connected to the distribution network directly affects the reduction of power flows in the transmission network as well as the reduction of network losses. This necessarily provides a better forecast of the RES capacity development and their geographic distribution so as to avoid unnecessary investments in the transmission network determined by the initial network operation conditions.

4.2 Current generation capacities in Kosovo

The electricity produced in Kosovo is dominated by two relatively large power plants: TPP Kosovo A and TPP Kosovo B which participate with 93.2% in total electricity production in Kosovo according to realized production in 2021 year. After the start of the operation of WP Selaci 105 MW, the participation of RES in the total generation will increase during the current year 2022.

Table 4-1 shows the latest relevant information to the units of the TPP Kosovo A and B.

Table 4-1. Main features of TPP Kosovo A and TPP Kosovo B generation units

TPP	Unit	Installed Capacity [MW]	Net Capacity [MW]	Available Capacity [MW]	In Operation
	A3	200	176	120-130	1970
TPP KOSOVA A	A4	200	176	120-130	1971
	A5	210	185	120-135	1975
TPP KOSOVA B	B1	339	305	200-260	1983
	B2	339	305	200-260	1984
Total TPP		**1288**	**1147**	**760-915**	

Table 4-2 shows existing capacities of hydro power plants in Kosovo connected to the transmission network, a part of which is categorized as renewable sources, whereas Table 4-3 shows the total capacity according to the type of renewable generation connected to the transmission grid, which currently is operational. Current net capital from renewable sources reaches 139 MW from wind and 63.2 MW from hydropower plants.

Table 4-2. Main features of existing hydro-power plants of Kosovo connected to the 110 kV Transmission System

HPP	Unit	Installed Capacity (MW)	Net Capacity (MW)	In Operation
HPP Ujmani	G1	17.5	16	1981
	G2	17.5	16	1981
Lumbardhi 1	G1	4.04	4.00	57/2005
	G2	4.04	4.00	57/2005
Lumbardhi 2	G1	5.4	6.19	2018
Belaja	G1	5.29	5.00	2015
	G2	2.79	2.50	2015
Deçani	G1	6.66	6.50	2015
	G2	3.15	3.00	2015
Total in Transmission		**66.37**	**63.19**	

Table 4-3. The capacities of Kosovo's existing RES connected to the transmission network

RES	Type of RES	Installed Capacity [MW]	Operation year	Point of connec. [kV]
WP KITKA	Wind	32.4	2018	110
PE SELACI 1,2&3	Wind	105	2021	110
Totali	Wind	137.4		

Table 4-4. Capacities of Kosovo’s existing RES connected to the distribution network

RES	Installed Capacity [MW]
HPP	68.11
Solar	11.35
Wind	1.35
Total RES in DSO	**80.81**

4.3 Projection of the development of new generation capacities 2021 - 2030

Projection of electricity generation remains the main challenge in the process of transmission network planning, due to the high uncertainty of their realization. The basis of information for the generation forecast in the next ten years is the Draft Energy Strategy, which will be in line with the National Plan for Climate and Energy, which is currently being worked on by the Government of the Republic of Kosovo. These two documents will define Kosovo's objectives for the 5 key dimensions pre-defined by the European Community:

- ***Security of Supply***
- ***Market Integration***
- ***Energy Efficiency***
- ***Decarbonization of the electricity sectors***
- ***Research, innovation and competition***

The dimension of security of supply sets medium and long-term objectives and standards related to security of supply, including the development of diversification of energy sources, infrastructure, energy accumulation, response to demand, willingness to cope with limited or interrupted supply of one source of energy, and the construction of alternative internal sources. This dimension also includes projections or scenarios for the development of electricity sources. Based on the Energy Strategy 2022-2031, the two units of TP Kosova B will undergo general revitalization, enabling their operation with optimal technical parameters both in terms of capacity and in meeting the emission level according to European standards. Also, two units of TP Kosova A are expected to be revitalized in compliance with European standards and as such will operate as a strategic reserve during periods of time when the demand is very high (3 months a year). On the other hand, the main orientations of the Energy Strategy are in the direction of decarbonization of the energy sector, where renewable sources from the wind and the sun as well as energy efficiency will be the main pillars of decarbonization. The process of transitioning from fossil resources is expected to be gradual and long-term (2030-2050), but this type of resource will be the main pillar of security of supply for Kosovo for a long period of time. Fossil energy sources will be gradually replaced with renewable sources, accompanied by the development of flexible units, energy storage facilities which will be necessary to enable the integration of RES in the system.

In the next ten years, the gradual increase of RES capacities is planned with the aim that by 2031 the capacity of new sources from the wind will be increased by 600 MW (738 MW with the existing capacities) and also 700 MW from the sun, of which 100 MW is expected to be of the "self-consumption" category. The integration of these capacities from variable resources requires proper planning of the transmission network as well as the provision of flexible resources to achieve real-time system balancing. In this context, until

2027, about 170 MW Accumulator Batteries are expected to be installed with a duration of two hours within the framework of support from the United States of America through the Compact project from MCC. The batteries will enable balancing of the system and the integration of RES in the electricity system of Kosovo. They will provide secondary (aFRR) and tertiary (mFRR) regulation to the System Operator. They will also be used to shift the peak through the optimal charging and emptying process.

The energy market integration dimension sets out objectives related to market competition, market integration and convergence, establishing flexibility in the energy sector, including the development of short-term markets, competition in demand response services, and the use of smart technologies and smart networks. The operation of KOSTT as a regulatory zone within the regulatory block AK (Albania-Kosovo) from 14 December 2020, as well as the establishment of the Albanian Power Exchange ALPEX, in which KOSTT is also a shareholder, will create favourable conditions for optimizing the operation of both power systems and the reduction of operating costs of both systems. The two complementary systems have great potential for supporting the electricity sector, creating a competitive and transparent market, and increasing security of supply for both countries. The common market will make it significantly easier to integrate RES into the grid, as the need for regulatory reserves will be reduced, while the possibility of creating a market for auxiliary services and expanding it will increase.

Another very important dimension is efficient use of energy, which will help the energy sector in reducing energy demand.

The dimension of de-carbonation is related to the previous dimensions, and the main factor that enables this is the creation of conditions for the energy and electricity system for gradual integration of renewable sources and the improvement of energy efficiency use.
All can be achieved if the country provides favourable conditions for young researchers, innovation and genuine competition. Human resources are the key to success.

5. KOSOVO's TRANSMISSION NETWORK DEVELOPMENT PROJECTS (2023-2032)

5.1 The incentive factors of the development of transmission network

Kosovo's electrical industry and its development are based on the objectives of the National Energy Strategy, as well as essential or strategic objectives of the European Union. This focus sets out the context of capital investment carried out in Kosovo's transmission system and can be summarized as follows:

- *Security of supply*
- *Ensuring competitiveness and development of the national economy*
- *Ensure the long-term sustainability terms of national electricity supply.*

To achieve these strategic objectives, it is necessary to ensure continued investments in the development and maintenance of the transmission system. Specific factors conducive to investment in the transmission network infrastructure have been identified and can be described as follows:

- *Ensure adequate supply of the transmission network*
- *Promotion of market integration and transparency*
- *Promotion of renewable resources, and*
- *Decarbonisation of electricity sector.*

To achieve adequate electricity supply security; integration and further development of the market, integration of new generation capacities, is related to proper planning of the transmission system. As the demand for energy and the generation changes, namely since the regional transmission network becomes even more interconnected, or as new generation connects to the network, electric power flows on the transmission network also change. To accommodate these changes in the power flows it is often necessary to strengthen the transmission network, to maintain the level of safety, performance and efficiency of the transmission system.

5.2 Implemented projects 2007-2021

During 2007-2021, 246 M€ capital investments have been made in KSOTT. Total investments since after the war until now (October 2022) in the transmission network are around 300 M€. Essential investments have been made in strengthening the transmission and transforming capacities of the network, which constitute 49% of total investments. Investments have been made even in other categories of projects, as shown in Figure 5-1.
Based on all measurable performance indicators recorded in the last decade, continued investments in transmission system infrastructure; modernization of support systems; human resource development, have enabled in a higher continuous security and performance of the transmission system operation.

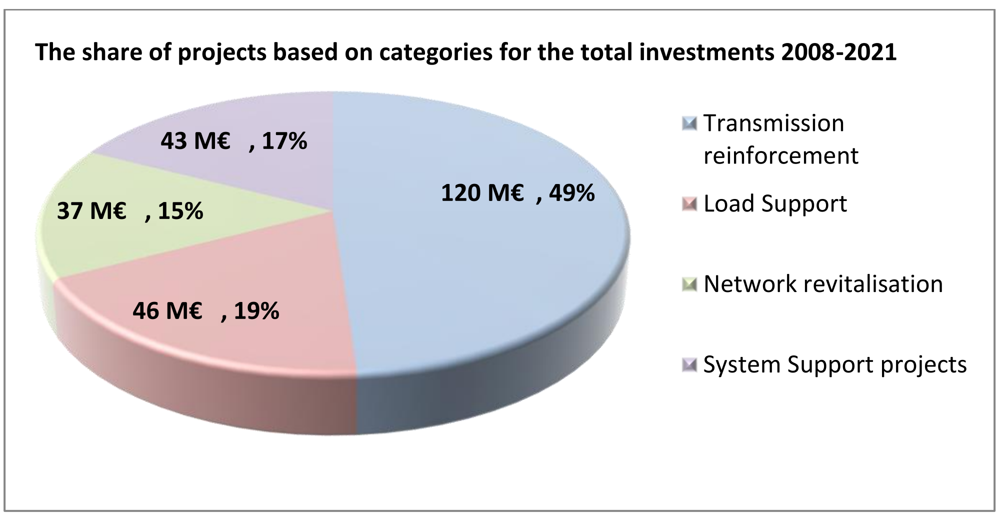


Figure 5-1

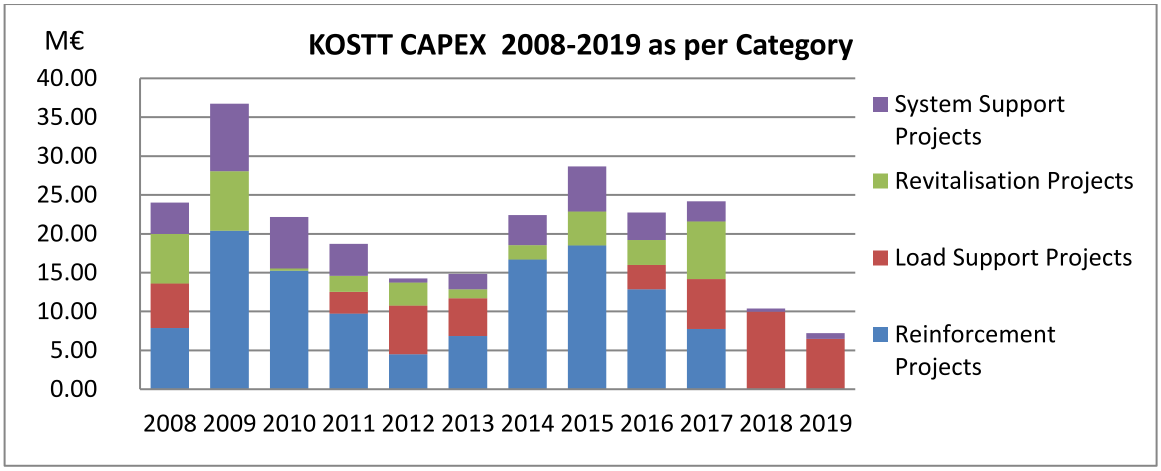


Figure 5-2. Distribution of investments through the years according to projects category

A complete list of realized projects from 2007 until now is presented in Table 5-1.

Table 5-1. List of realized projects in KOSTT from 2007 until Q4 2022.

No	LIST OF IMPLEMENTED PROJECTS 2007-2020 Project title	Year
1	Conductor replacement in the 110 kV line No. 125, SS Kosovo A - SS Vushtrri 1&2	2007
2	Conductor replacement in the 110 kV line No. 164/3, SS Prizreni 1 - SS Prizreni 2	2007
3	Replacement of 110 kV power switches in SS Prishtina 1 and SS Prishtina 2	2008
4	New 110 kV line - SS Prizren 2 - SS Rahoveci and SS Rahoveci	2008
5	Conductor replacement in the 110 kV line SS Deçan - SS Gjakova 1	2009
6	AT1 in SS Kosova A, 220/110 kV	2009
7	Revitalization of SS Kosovo A	2009
8	Revitalization of SS Prishtina 1	2009
9	Package project PEJA 3	2009
10	Replacement of relay protection facilities in SS Kosova B and SS Prishtina 4	2009
11	ITSMO meters (in borders)	2010
12	Adaptation of the L212 line as a 110 kV line SS Kosovo A - SS Ferizaj 1	2010
13	New 110 kV line SS Peja 3 - SS Klina, under the Peja 3 package project	2010
14	Connection of SS Skenderaj, with a dual 110 kV line, to the Vallaq - Peja 3 line	2010
15	AT3 in SS Prishtina 4, 220/110 kV	2010
16	Replacement of the conductor in the 110 kV line, L 126/5, SS Peja 1 - SS Peja 2	2010
17	Revitalization of SS Kosovo B	2011
18	Package Project FERIZAJ 2	2011
19	SCADA/EMS	2011
20	Package project SS Palaj with 110 kV lines	2011

21	Revitalization of SS Prizreni 2, 220/110 kV & AT3=150MVA	2012
22	Package project SS Gjilani 5 with transmission lines	2012
23	IT system supporting market operation	2012
24	Replacement of relay protection facilities in SS Prishtina 2 and SS Prishtina 3	2012
25	400 kV switches for generation fields in SS Kosova B	2012
26	Division of bus bars in two sections in SS Gjilani 1 and SS Theranda	2012
27	Rehabilitation of equipment for own-use in SS Kosova B	2012
28	General overhaul of 110 kV equipment in SS Prishtina 3 (GIS system)	2012
29	Rehabilitation of HV facilities in SS Ferizaji 1 and Gjilani 1	2013
30	Interconnection of SS Lipjan in the 110 kV L112 line	2013
31	Installation of two fields for 110 kV lines in SS Prizreni 2	2013
32	Replacement of conductors and izololatorëve. at 110 kV lines L125 / 2 and 125/3	2013
33	OPGW in 400 kV lines, SS Peja 3- SS Ribarevina, SS Ferizaj 2- SS Shkupi 5	2014
34	OPGW in 220 kV lines, SS Podujeva- SS Krushevci,	2014
35	Line allocation L1806 from SS Gjakova 2 to SS Gjakova 1 and ri-vitalization of SS Gjakova 2	2015
36	Transformer installation 40 MVA, 110/10(20) kV in Skenderaj and Burimi	2016
37	Re-vitalization of HV equipments in SS Prizreni 3	2016
38	Re-vitalization of HV equipments in SS Gjakova 2	2016
39	LFC – Secondary Regulation	2016
40	Installation of 31.5 MVA transformers, in Berivojce and Viti	2016
41	Interconnection lines 400 kV SS Kosova B – SS Tirana 2 (242 km)	2016
42	Re-vitalization of MV (35kV) in SS gjakova 1	2016
43	Installation of third transformer 40 MVA, 110/10(20) kV in SS Prishtina 2	2016
44	Second transformer 300 MVA in SS Ferizaj 2 and Peja 3	2016
45	New 110 kV line SS Peja 3 - SS Peja 1 and revitalization of SS Peja 1	2016
46	Re-vitalization of SS Peja 1 (New GIS System)	2016
47	Revitalization of the 110 kV line: L126 / 2 SS Peja 2- SS Deçan	2017
48	Re-vitalization of TM (35 kV) equipment in NS SS Gjilani 1 and SS Ferizaj 1	2017
49	Revitalization of line fields and transf. 110 kV in: SS Lipjan and NS Viti	2017
50	INTER-OST Meters - Installation of metering points in cross-border lines	2017
51	Replacement of circuit breakers and separators in SS Prishtina 4	2017
52	Third transformer 40 MVA in SS Lipjan	2017
53	New Independent and Self Redundant AC/DC Supply System of SS/HV	2017
54	Re-vitalization of SCMS / SCADA in SS Kosovo B, SS Podujeva, SS Prishtina 5	2017
55	Implementation of changes in SCADA / EMS (Observation Area)	2017
56	Re-vitalization of HV equipment in SS Theranda	2018
57	Installation of metering groups at the new boundary between KOSTT and KEDS/DSO	2018
58	SS Ilirida, 2x40 MVA, 110/10(20) kV	2019

59	SS Drenasi, 2x40 MVA, 220/10(20) kV	2019
60	SS Dardania, 2x40 MVA, 110/10(20) kV	2019
61	New Line 110 kV SS Rahoveci – SS Theranda	2020
62	New Line 110 kV SS Vushtrri 1 – PE SELAC (Deep connection)	2021
63	Re-alocation of tranformer from SS Burimi, SS Peja 2 in Prishtina 2 and 3 (Conversion of 20 kV)	2021

5.3 Transmission network infrastructure development 2023-2032

5.3.1 Introduction

This chapter presents and examines transmission network development projects in the period 2023-2032. These projects were also presented in the previous 2020-2029 plan, with the inclusion of changes that belongs mainly in implementation times, but also design change and priority. Considering that the planning process of the transmission network is an extremely complex process, greatly dependent on many factors, the ten-year period that defines this document is divided into two periods:

The first period of five years 2023-2027, which is considered relevant and influential in the long term development of the network, with high probability of implementation. Projects included in this period of time are analyzed in detail. This timeline of the plan is linked to the 5 year investment plan 2023 – 2027 which is approved by the ERO.

The second five years period, 2028-2032, includes optional (indicative) projects of internal or regional character for which KOSTT considers their importance and their contribution in achieving the technical standards for operation of the transmission system in order to support the electricity market. This category of projects may be subject to change depending on processes that take place in the energy sector in Kosovo and the region. Generally, this relates to the development of generation and load as well as power flows expected to occur in the next decade in the regional network.

Transmission network development projects are divided into five categories:

- ***Transmission network reinforcements***
- ***Load support/New 110/10(20) kV nodes***
- ***Revitalization of the transmission network***
- ***Supporting projects of the transmission system (management, monitoring, measurement and control),***
- ***Generation support (Connection application)***

Because of considerable complex dependence on the various factors for the implementation of the projects, the time and manner of such implementation can be considered as subject to possible changes and as such in the annual updates will be revised with te-freshed input datanext document will revise the data and update them.
Tables contain the project identification codes (ID), a general description of the project, the expected completion time and reasons and effects of project implementation.

5.3.2 List of new development projects planned for the period 2023-2032

The following is a list of planned projects broken down by categories, which are the result of optimal selection of different scenarios to strengthen the network during the planning process. These projects include the time period 2022-2026. Lists of projects are presented in tables categorized according to the respective specifications. Factors considered influential in the redesign of some previously planned projects, in the change of timelines of their implementation and selection of certain new projects, are processes that are not dependent on KOSTT, such as:

- *Requests for new connections of load or generation*
- *Provision of funding*
- *Issues with of expropriation of property, substations and line routes etc.*
- *Unforeseen problems during the procurement process*

For the reasons above, the planning process and selected projects for development are adjusted to new changes that occurred in the meantime.

5.3.2.1 List of new projects in the category of transmission network reinforcement

The table 5-2 provides a list of projects planned for the next 10 years, which are considered to be influential on increasing network capacities, pursuant to technical requirements obliged from the Grid Code. Projects are ranked according to their planned implementation period.

Tab. 5-2 List of planned projects for reinforcement of the transmission network 2023-2032

PROJECT CATEGORY: TRANSMISSION NETWORK REINFORCEMENT - (2023-2032)					
No	**ID**	**Project title**	**Technical description**	**Reason for implementation**	**Year**
1	004	**Variable reactor 100MVAr, 400 kV in SS Ferizaj 2**	- Installation of variable reactor 100MVAr in the free field 400 kV C05 in SS Ferizaj 2 - Reactor field 400 kV	Reducing overvoltage level in the transmission network. Regionally coordinated project	Q4-2024
2	006/1	**Second 40 MVA transformer in SS 110/10(20) - Klina**	TR2 Transformer 110/10(20) kV, 40 MVA - One transformation field 110 kV and 10(20) kV completed	Security of supply consumption of Klina, maintenance and optimization of SS. Increase of transformation capacities	Q2-2026
3	006/3	**The second transformer 40 MVA in SS 220/35/10(20) kV Malisheva**	- transformer 40 MVA, 220/10(20) kV - a transformer field 220 kV and a 10(20) kV.	- Completing the N-1 criterion and increasing the security of Malisheva's consumption supply	Q2-2026
4	006/4	**The second transformer 110/10(20) kV Gjilani 5**	- Transformer TR2 110/10(20) kV, 40 MVA - A 110 kV and 10(20) kV transformer field completed	- Security of Gjilan's consumption supply; - Criterion N-1 - maintenance optimization of SS. -Increasing the transformative capacities	Q2-2026

5	007/1	**The second transformer 40 MVA in SS 110/10(20) kV Fushë Kosova**	- transformer 40 MVA, 110//10(20) kV	- Completing the N-1 criterion and increasing the security of the supply of the consumption of Fushe Kosova	Q2-2026
6	007/2	**The second transformer 40 MVA in SS 110/35/10(20)kV Kastriot**	- The second transformer 40 MVA, 110/35/10(20) kV	- Security of Ferizaj's consumption supply; optimization maintenance of SS. - Increasing transformative capacities	Q2-2026
7	007/3	**Replacement of the transformer in SS 110/10kV Gjakova 1 (40MVA)**	- Transformer TR2, 20MVA, 110/35 kV (v1965) is replaced by 40/40/40MVA, 110/35/10(20) kV (in coordination with KEDS) - A 10(20) kV transformer field	- Security of Gjakova's consumption supply; - Reduction of losses in distribution.	Q2-2026
8	007/4	**Replacement of the transformer in SS 110/10kV Therande (40MVA)**	- New transformer 40 MVA, 110/10(20) kV replaces transformer TR2:31.5 MVA, 110/10 kV (year 1985)	- Security of Theranda's consumption supply; Completion of criterion N-1 in Transformation. - Reduction of losses in the distribution.	Q2-2026
9	007/5 dhe 007/6	**Transformer replacement in SS Prizreni 1 and Peja 1 (40 MVA)**	- In Prizren 1, TR1 31.5MVA (year 1975), 110/35kV is replaced by a 40/40/40MVA, 110/35/10(20)kV transformer - In Peja 1, TR1 31.5MVA (year 1985), 110/35kV is replaced by 40/40/40MVA, 110/35/10(20)kV - Two 10(20) kV transformer fields	- The project avoids eventual breakdowns with a high probability of old transformers and enables the fulfillment of the N-1 criterion in transformation even at the 10 kV level.	Q2-2026
10	007/7	**Transformer replacement in SS Ferizaj 1, (40MVA)**	- Replacement of TR2 31.5MVA (year 1969), 110/35kV with new three-phase transformer 40/40/40MVA, 110/35/10(20)kV - A 10(20) kV transformer field	The project avoids eventual breakdowns with a high probability of the old transformer and enables the fulfilment of the N-1 criterion in transformation at the 10 kV level	Q2-2026
11	007/8	**Replacement of the transformer in SS 110/10kV Deçani (40MVA)**	- New transformer 40 MVA, 110/10(20) kV replaces transformer TR1:20 MVA 110/10 kV (year 1977),	- The security of supply of consumption of Deçan; - Reduction of losses in distribution.	Q2-2026
12	008/4	**New double overhead / cable line and dismantling of the existing line between SS Prizreni 1 and SS Prizreni 2**	- 4.81 km, double overhead/cable AlSt 240 mm^2 /1000mm^2, (dismantling of the existing one and utilization of the route. Also, the current conductor HW 170mm^2 is used to reinforce the capacity of the line Prizren1-Prizren 3 - A field of 110 kV line in SS Prizren 1	- The construction of the new transmission line enables the fulfillment of the N-1 criterion as well as reduces losses in the network	Q4-2026

13	008/5	**New cable line 110 kV SS Prishtina 2- SS Prishtina 4**	- Two fields of 110 kV lines - Cable line 1000mm^2, with a length of about 4.85 km	- The project enables the fulfillment of criterion N-1 for the part of the 110 kV network connecting SS Prishtina 2&3 and SS Kosova A	Q4-2026
14	008/6	**Revitalization of the 110 kV line: SS Prizreni 1 - SS Prizreni 3**	-Replacement of the conductor from 150/25mm^2 to HW 170mm^2 in the length of 4.69 km from SS Prizren 1 to SS Prizren 3. The conductor is taken from the Prizren 1-Prizren 2 Line which is dismantled and converted into a double line.	- Increasing the transmission capacity of the line from 83 MVA to 114 MVA in order to increase the transmission capacity and meet the N-1 criterion.	Q4-2026
15	011	**Revitalization and reinforcement of the 110 kV line segment SS Kosova A - SS Bardhi - SS Ilirida**	- Dismantling of the existing line with a section of 150mm^2, 30.5 km from SS Kosova A to SS Ilirida (segment with a section of 150mm^2, year 1958); - Construction of the new double line 29.2 km ALSt, 240 mm^2 and connection with SS Vushtrri 1 - double cable 2.24 km, 1000 mm2 from Kosovo A Single cable 2.4 km from the end of the overhead line to SS Ilirida. -4 fields of 110 kV lines (Kosova A, Vushtrri 1 and bypass)	- Increasing the transmission capacity of the line from 83 MVA to 2x114 MVA, reducing power losses, meeting the N-1 safety criterion for the 110 kV network - Increasing security for the storage battery in SS Palaj	Q1- 2027
16	012	**Transformer replacement in SS Gjakova 1 Gjilani 1 and SS Vitia (40MVA)**	- In SS Gjakova 1, TR1 20MVA (year 1974) is replaced with a 40MVA, 110/10(20) kV transformer - In SS Gjilani 1, TR1 31.5MVA (year 1974), 110/35kV is replaced by 40/40/40MVA, 110/35/10(20)kV - In SS Vitia, TR1 20MVA (year 1974) is replaced with a 40MVA, 110/35/10(20) kV transformer - Two 10(20) kV transformer fields	- Increasing the security of supply to consumers in Gjakovë, Gjilan and Viti	Q4-2027
17	054	**The new interconnection line 110 kV SS Deçani-SS Bajram Curri**	19 km of single line 110 kV, 240mm2 to the border A 110 kV line field in SS Deçan	Increasing the interconnecting capacities between KOSTT and TSO Optimizing the operation of the AK Control Block	Q4-2028
18	055	**Revitalization of the 110 kV line: L127 SS Bibaj - SS Kastriot**	-Dismantling the part of the existing line with a section of 150mm^2 from SS Bibaj (Ferizaj 1) to the connection point of SS Kastrioti (Ferizaj 3) with a length of 6.7 km -Construction of a new 6.7 km ALSt line, 240mm^2	- Increasing the transmission capacity of the line from 83 MVA to 114 MVA, reducing power losses in the 110 kV network	Q4-2028

19	056	**Revitalization of the 110 kV line: L106 SS Ferizaj 2-SS Sharr**	-Dismantling the existing line with a section of 150mm2, 28.7 km from SS Ferizaj 2 to SS Sharr (section with a section of 150mm2, year 1953); - Construction of the new 28.7 km ALÇe line, 240 mm2	- Increasing the transmission capacity of the line from 83 MVA to 114 MVA, reducing power losses in the 110 kV network	Q4-2029
20	057	**Revitalization of the 110 kV line: L110 SS Trepça-SS Vallaq**	- Revitalization of the 110 kV line with a length of 11.4 km, replacement of the conductor from 150 mm2 to 240 mm2	- Reduction of losses in the 110 kV network Increasing the transmission capacity of the line from 83 MVA to 114 MVA	Q4-2030
21	058	**Revitalization of the 110 kV line: L116 (155/2) Vallaq- border**	- Replacement of phase and protective conductors up to the border (18.78 km), year 1958 - Reinforcement of poles and replacement of insulators.	- Reinforcement of transmission capacities and support of the load in the northern part of Kosovo	Q4-2031
22	059	**SS NASHEC, 400/220/110 kV with interconnection line 400 kV**	- Construction of SS Nashec, 400/110 kV, 1x300MVA, as a continuation of SS Prizreni 2, which comprises two 400 kV line fields and one 400 kV connection field, one 400 kV TR field and one 110 kV TR field. - Expansion of the 110 kV busbar system - Construction of the 400 kV double line, 26 km in length from the cutting point of the 400 kV SS Kosova B-SS Koman	Configuration of the 400 kV and 110 kV grid and optimize of active and reactive power flows, reduction of losses, and support of new generation and load. Creating conditions for the second 400 kV interconnection with Albania	Q4-2032

Note: ID (Numbers) in green are projects beyond the Investment Plan 2022-2027

5.3.2.2 List of new projects in the category: Load support

The inclusion in the plan of investments in 110/TM substations will be confirmed when companies, KOSTT and KEDS, harmonize their respective development plans. Main signals that would initiate the construction of a new SS 110/TM come from KEDS and are based on demand development data in the long-term domain. Also, another initiating signal could be the level of transformer loads in existing substations managed by KOSTT. Whenever security of supply is put in danger and there are no possibilities to install additional transformers, the development of a new substation for that area will be initiated, in a harmonized effort with KEDS. In such circumstances, KEDS, after harmonizing the project, commits to the provision of investments in distribution network infrastructure 35 kV, 10(20) kV which will be installed in the 110/TM substation.

Table 5-3 shows load support projects (new substations) envisaged for the forthcoming ten years:

Table 5-3 List of projects planned for load support 2023 – 2032

PROJECT CATEGORY: LOAD SUPPORT - - (2023-2032)					
Nr	**ID**	**Project title**	**Technical description**	**Reason for implementation**	**Year**
1	001	**SS 110/10(20) kV Kastrioti (Ferizaj 3) with 110 kV transmission lines**	- 3.1 km double 110 kV line, Al.Çe 240 mm2 and 0.3 km double 1000 mm2 cable from SS Kastrioti (Ferizaj 3) to the connection point on the 110 kV line SS Theranda-SS Bibaj (Ferizaj 1) - Transformer 1x40 MVA, 110/35/10(20) kV - A field trans. 110 kV and 35 kV, 10(20) kV, two-line fields and a 110 kV connecting field. - Command facility with accompanying equipment	- Increasing the security and quality of Ferizaj's consumption supply - The discharge of transformers in SS Bibaj and the completion of Criterion N-1 in transformation	Q3-2023
2	002	**SS 110/35/10(20) kV - Fushë Kosova**[1]	- GIS type substation110/35/10(20)kV 2x40 MVA with two 110 kV transformer fields and 35 kV, 10 (20) kV, with two 110 kV line fields, with a 110 kV connection field - Command centre with ancillary equipment	Increased security of supply, reduction of losses in the distribution network, optimum distribution of power flows in the 110 kV lines and transformers.	Q3-2024
3	003	**SS Malisheva 220/10(20) kV with 220 kV transmission lines**	- 250 m dual line 220 kV, Al/St 490 mm^2 from SS Malisheva to the connection point in the line 220 kV SS Drenasi - SS Prizreni 2 - Transformer 1x40 MVA, one with 220/35/10(20) kV and the other 220/10(20) kV - One 220 kV and 35 kV, 10(20) kV transformation - fields, two line fields and one 220 kV, 1 bay field of 220 kV - Command facility with ancillary equipment	Increasing security and quality of consumer supply to the Malisheva region. Reducing of power flows in SS Rahovec	Q1-2025
4	005	**SS 110/10(20) kV Dragash with 110kV transmission lines**	- SS Dragashi, 2 110 kV transformation fields, one 10(20) kV and one 35 kV, two line fields and one 110 kV connection field. - 2x40 MVA transformer, 110/35/10(20) kV - Single lines, 8 km, AlSt240 mm^2 from SS Prizreni 2 to Zhur (double poles)). - Double lines, 13 km, AlSt2x240 mm^2 - From Zhuri to SS Dragash - Single line, 26 km, AlSt240 mm^2 from Zhuri to Kukës (from Zhuri to the border, 9 km)	Qualitative and reliable supply of the Dragash region. Reduction of power flows in SS Prizren 1. Optimization of operation of systems of Kosovo and Albania	Q1-2026

5.3.2.3 Projects planned for the category: Re-vitalization of KOSTT substations

The following table contains a list of projects related to the process of revitalization of substations managed by KOSTT.

[1] Supply lines / cables of SS Fushë Kosova are built in the framework of EBRD projects.

Table. 5-4. List of projects of the category of re-vitalization of substations 2023-2032

PROJECTS OF CATEGORY: REVITALIZATION OF SS (KOSTT)- (2023-2032)					
Nr	**ID**	**Title of Project**	**Technical Description**	**Reason for development**	**Year**
1	009	**Revitalization of HV equipment in SS Deçani and SS Prishtina 2**	- Replacement of 5 110 kV fields in addition to circuit breakers in SS Deçan - Replacement of the 110 kV fields except for circuit breakers in SS Prishtina 2 - Revitalization of the AC/DC system and monitoring equipment in both substations	- Increasing security and reliability of the Substations operation.	Q4-2025
2	013	**Revitalization of HV 110kV equipment in SS Vushtrri 1**	- Replacement of two 110 kV line fields, replacement of a 110 kV transformer field. - Replacement of the 110 kV busbar system and portals and the construction of a 110 kV connecting field.	- Security and reliability of supply, passing the life cycle of equipment. - Increasing the security of the work of WP Selaci	Q4-2025
3	006/1 dhe 006/2	**Revitalization of HV equipment in SS Klina and SS Burimi**	- Replacement of 3 line fields 110 kV, - Replacement of 2 transformer fields 110 kV (In SS Klina must first be installed the second transformer, and then the field should be changed)	To increase the security and reliability of substation's operation	Q4-2026
4	015	**Support in the conversion of the 10 kV to 20 kV network of the DSO**	- Adaptation of transformer fields for 20 kV voltage - Adaptation of cables for 20 kV voltage - Adaptation of transformer neutral resistors for 20 kV voltage - Re-allocation of 110/10 kV transformers with 110/10(20) kV transformers for substations which are converted from 10 kV to 20 kV	- Reduction of losses in the distribution network - Increasing the distribution capacity -Increasing the reliability and security of supply to customers - Reduction of breakdown currents on the secondary side of transformers	Q2 2021-Q 2031
5	**010**	**Revitalization of HV equipment in SS Vallaqi**	- Replacement of five field lines 110 kV, replacement of two transformer fields 110 kV. - Replacement of busbar systems 110 kV and portals and construction of a new connection field 110 kV.	Safety and reliability of supply, expiry of equipment lifespan. Increasing the work safety of HC Ujmani	Q2-2027

5.3.2.4 Projects planned in the category: Supporting transmission system operation

The following table presents the projects planned in the category of supporting transmission system operation. This list was selected through an identification of transmission system in complying with technical requirements emerging from the Grid Code and technical requirments recommended by ENTSO/E.

Table 5-5. List of projects in the category of support to system operation 2023-2032

PROJECTS OF CATEGORY: Support of the transmission system (2023-2032)					
Nr	**ID**	**Project title**	**Technical description**	**Reason for development**	**Year**
1	**017**	**Supply and installation of signs for signaling lines as requested by Civil Aviation**	Placing visual signs on overhead lines in areas of national interest: -placement of signalling balls -Flashing lights -Painting of the pillars (white-red)	The project fulfils the statutory obligation regarding signalling on specific areas of national interest in terms of aviation flights safety.	Q2-2022-Q2-2027
2	**033**	**Migration to advanced telecommunication systems.**	-Bandwidth capacity increase: - Network segmentation, for different services and applications - Application quality, -Redundancy and network protection - Limitation of loss, delays for time critical applications.	- Modernization of communication systems in line with developments in ENTSO/E and the country's needs for modern systems, and well protected from potential cyber attacks.	Q4-2024
3	**030**	**Replacement of the Existing SCADA/EMS System in NDC and NEDC**	- Establishment of the SCADA/EMS platform in the National Dispatch Center and the emergency dispatch center	- Completion of the new ENTSO-E criteria. - Increasing the performance of command and control of the transmission system	Q4-2025
4	**028**	**Supply and installation of equipment for adoption of Local SCADA (RTU and SCS)**	- Installation of RTU in substations - SCS installation in substations	- Increasing the security of system operation - Increasing the performance of the command and control of the transmission system	Q1-2024-Q4-2027

5.4 Technical description of transmission planned projects for the period 2023 -2032

5.4.1 Introduction

The following is a description of development projects from the list of projects planned for the period 2023-2032. This projection of the transmission network development creates the conditions for the development of new conventional and renewable generation capacities in the next 10 years. This time period includes projects which directly contribute to the strengthening of the transmission network, projects to revitalize substations, load support projects and Transmission System support projects.

5.4.2 Projects of category: Transmission grid strengthening

The following are detailed descriptions of planned projects pertaining to the category of strengthening or capacity increase of transmission network, for the planning period 2023-2032.

- **Projects: Variable-Shunt reactor 100MVAr, 400 kV in SS Ferizaj 2**

In the last three years there is an increase in the level of voltage in the horizontal network, mainly this increase is observed at the level of 400 kV and 220 kV. In some periods of time, especially during the summer system operation mode, the voltage level exceeds the maximum nominal values set by the Grid Code. This high voltage level creates great strain on the insulation of 400 kV voltage equipment, risking dangerous downtime of the busbar system and on the other hand affects in the reduction of the life of the equipment and increases the losses in the transformer cores (iron losses). Figure 5-3 can be seen the frequency of overvoltages (> U_{max}= 420kV) measured in SS Peja 3. Year after year it is observed that the hours of operation of the network in overvoltage conditions are increasing and are quite disturbing. Some drops of lines and busbars have been recorded during the last two years as a result of overvoltages and mainly appear in polluted and high humidity areas. The area around the Termo Power Plants is characterized by the aforementioned conditions.

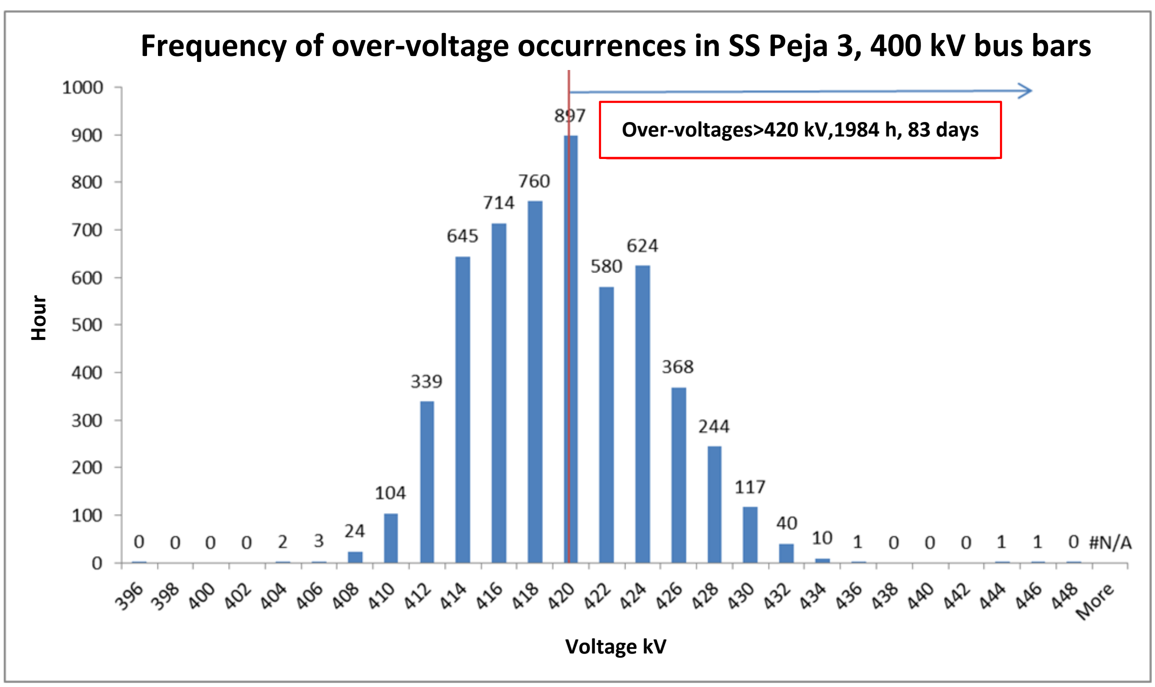


Figure 5-3. Frequency of occurrence of overvoltages in 400 kV busbars in SS Peja 3

This problem cannot be solved isolated, by KOSTT alone, as it is a regional problem as a result of the construction of many 400 kV lines in the region and without reactive power compensation. On the other hand, the level of horizontal network load in the network of Southeast Europe has decreased as a result of the economic recession in the region. This problem appeared a few years ago in the horizontal network of Croatia, Bosnia and Herzegovina, wheras gradually expanded to the part close to our transmission network. The commissioning of new 400 kV lines in the region without adequate compensation, with low loading level has led to the appearance of excess capacitive reactive power which significantly increased the level of voltages. Based on the regional study entitled "Regional Feasibility Study for voltage profiles improvement in the Western Balkans" it has been identified that the regional network from the six countries of the Western Balkans (WB6) has a reactive power surplus of about 800 MVAr. The distribution or contribution of each TSO to this reactive power surplus is presented in the following table:

Table 5.7 Reactive power surpluses for the six TSOs of the region

OST	CGES	KOSTT	NOS/EL.PRENOS	MEPSO	EMS	Total
0	207	75	327	143	42	794

The amount of 800 MVAr is a minimum volume of reactive power compensation to be installed in the "WB6" region to maintain the voltage level below the allowable upper limit (420 kV). The required volume of reactive power compensation for the existing state of the system, based on the optimal power flow results according to the study is about 950 MVAr, respecting the target voltage range at 400 kV in the range from 1.05 pu (420 kV) - 1.03 pu (412 kV). This volume should allow the necessary safety margin for voltage control system services.

According to the study, KOSTT should install reactive power reactors in the range from 120MVAr to 150MVAr, based on data from long-term regional models. Considering the uncertainties of the implementation of these plans and considering that the new generators must meet the technical conditions to support the reactive power system then initially KOSTT will install the 100MVAr variable reactor at the location recommended by the study. According to the information, Albania has installed a 120 MVAr reactor in the 220 kV network and the second 120MVAr reactor is expected to be installed soon in SS Elbasan. Also, in the next two years it is expected that the Montenegro operator CGES will install the 250MVAr reactor in SS Lastva, due to the problems that are being faced by the converter substation in SS Lastva which connects the submarine cable with Italy. These projects will be essential to avoid critical overvoltages over 430 kV, while in order to stabilize the entire network of WB6 countries, 100 MVAr should be installed in SS Vranje (EMS), 220MVAr in SS Tuzla and 120MVAr in SS Mostar (NOS/El.PRENOS) and 150MVAr in SS Dubrova and 100 MVAr in SS Ohrid (MEPSO).

The study recommends the installation of variable-shunt reactors (VSR) as they have advantages over shunt-reactors with fixed power.

Variable-shunt reactors (VSR) allow a continuous compensation of reactive power in the range from 20-100% of nominal capacity, with the application of voltage regulator, similar to power transformers. The adjustment speed is determined by the voltage regulator and can meet relatively slow load variations (seasonal, daily or hourly). Variable reactor control is usually performed by operators, through the SCADA system.

The use of VSR allows the reactive power compensation to be adjusted depending on the current load and to operate the network in an optimal way, thus reducing power losses and increasing the active power capacity of the lines. Other important benefits include:

• Connection of certain degrees of variable reactor capacity is manifested by smaller switching pulses compared to shunt reactors.

• If VSR operates in the low installed power range, losses and noise emissions are reduced,

• By adjusting the reactor inductance within the unit itself, the power switches will have fewer connections and disconnections and will require less maintenance,

• Provide flexibility to adapt to future load changes (in emerging economies with increasing demand, where the load will increase over time).

It should be noted that a VSR is a more cost-effective solution than two fixed reactors; it is less costly, requires less installation space, requires less equipment (only one switch) and allows a better adjustment of seasonal and daily load variations.
The project foresees:

- Installation of variable-shunt reactor, 400 kV with power of 100 MVAr in the free field C03 in SS Ferizaj 2 (figure 5-4)
- Installation of 400 kV reactor field

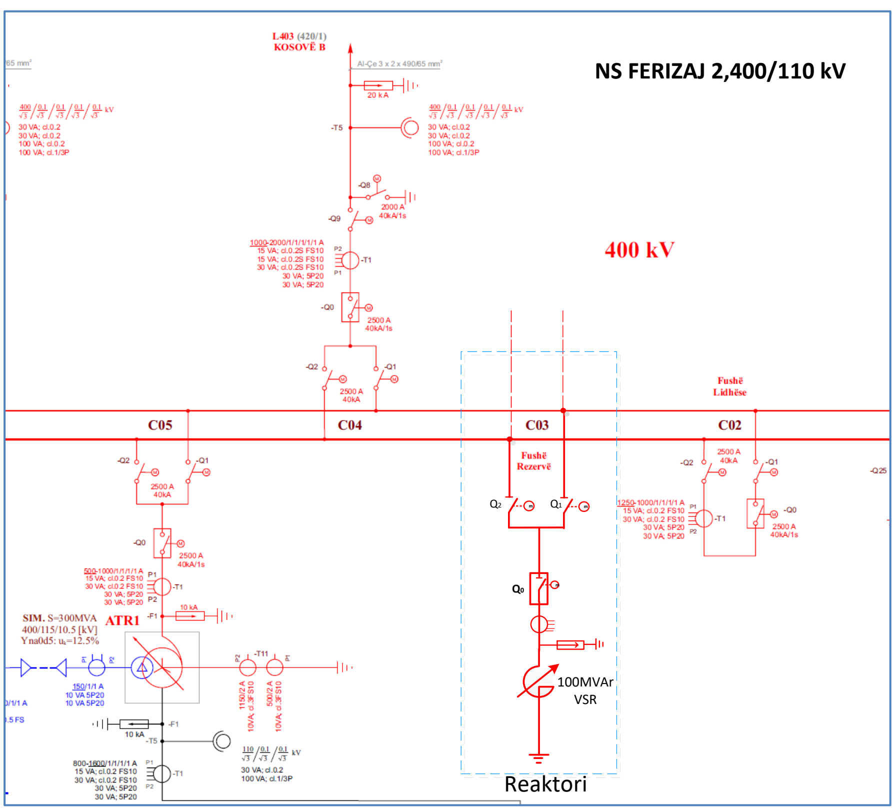


Figure 5-4. Single line scheme of installation of 100 MVAr reactor in SS Ferizaj 2

Expected benefits from the project:

- *Avoidance of overvoltages in the transmission network*
- *Reduction of overvoltages reduces the accelerated aging of high voltage equipment as a result of degradation of insulation in equipment*
- *Short connections in the busbars of the main substations in KOSTT are avoided, where the TPP Kosova B and TPP Kosova A generators are also affected.*
- *The number of short connections in the transmission network is reduced as a result of the blowout of insulation from overvoltages, and with this the energy not sent to the consumer*
- *The operations of TPP Kosova B and TPP Kosova A in the sub-excitation mode (reactive power absorption) are avoided and their stability is maintained.*
- *Reduction the Corona effect and the losses caused by this effect*
- *Reduction of reactive power flows in lines and increase of carrying capacity of lines for active power.*

Due to its high importance, the project is considered a high priority. The project is planned to be energized in 2024.

- **Projects: Additional transformers in SS Klina and SS Gjilani 5**

Substations SS Klina and SS Gjilani 5 currently operate with only one transformer. Operation with only one transformer is a major problem in case of an unplanned outage. There is no backup supply (ring network and the secondary voltage) in the areas where the aforementioned substations are located, which for such cases for a short time would transfer the supply from the failing network to the medium voltage network. Substations operating with only one transformer, hinder the process of periodic maintenance of the transformer and its field (110 kV, 35 kV or 10 kV). On the other hand, substations operating with only one transformer, hinder the important process of periodic maintenance of the transformer and its field (110 kV, 35 kV or 10 kV). The probability of faults in the transformer and its fields is also impacted by age, power flows, and short circuits in the system, and previous level of maintenance. Many facilities or system components, including transformers and switchgear in 110/35 kV substations and 110/10 kV, are faced with severe constraints caused by breakdowns/shorts circuits in the 110 kV network, frequent in the period 1990-2006 when the network had insufficient transmission and transformation capacity. Breakdowns in transformers such as the winding, or voltage regulator are problematic, and their repair requires time and is sometimes not financially viable. The time from the moment of the breakdown occurs to its elimination, or replacement of transformer can take days, thus the damage causes to customers will be greater in the absence of a second transformer, or a reserve capacity to supply from the medium voltage network. The amount of undelivered energy will be very significant, with negative socio-economic effects for consumers. To avoid the risk of not supplying the consumer as a result of losses/disconnection of the transformer it is necessary to install the second transformer in the substations above.

- In SS Klina in **2026** is planned the installation of a second transformer 40 MVA, 110/10 (20) kV in addition to the existing transformer 31.5 MVA, 110/10 kV. Also, will be installed respective 110 kV and 10 (20) kV transformer fields. This project will create conditions for the fulfillment of N-1 transformation. This project should be synchronized with the revitalization project of the 2 existing

110 kV fields, so that the undelivered energy to consumers during the project implementation process is minimized.

- In SS Gjilan 5 in **2026** is planned to install a new transformer 40 MVA, 110/10 (20) kV, in addition to the existing 31.5 MVA, 110/10 (20) kV, and two respective fields 110 kV and 10 (20) kV. This project will create conditions for the fulfillment of N-1 transformation.

Expected benefits from three these projects are:

- *Reduction of undelivered power to consumers of Klina and Gjilan region,*
- *Increased safety and reliability of load supply of distribution consumption*
- *Support for further development of the distribution network 10 (20) kV*
- *Increased of 110/MV kV transformation capacities and fulfillment of the N-1 in transformation*
- *Optimization of maintenance processes.*
- *Support to the development of the economic sector/industrial load.*

- **Projects: Replacement of transformers at SS Decani, SS Gjakova 1**

Second existing transformer 20 MVA in SS 110/10 kV Deçan has been constructed in 1977, which implies current age of 42 years. Maximum lifespan for transformers which on average are loaded above 60% value is considered to be 40 years. This life cycle may be shorter, depending on the number of overloads in transformer and faults in network. The chemical analysis and electrical parameters analysis carried out by the maintenance teams indicate an inadequate transformer state and, as such, it is estimated that this transformer can be operational for the next two years with a more pronounced supervision. To avoid the problem of dangerous damages that may appear later, it is necessary to replace this transformer with a new transformer with higher capacity of 40 MVA, 110/10(20) kV. The project increases the security of supply, substation and staff operating the transformer. The project is expected to be in operation in **2026.**

The first existing transformer in SS Gjakova 1 with a 20 MVA capacity, 110/35 kV was built in 1965, being 54 years old. In principle, its normal life expectancy has been exceeded and, as such, based on the evaluation of maintenance teams, it can be operational for the next two years and in 2025, it should be replaced with a new 110/35/10 (20) kV three-pole transformer with 40/40/40 MVA capacity for all three poles, so that part of the 35 kV network in the distribution network in Gjakova is eliminated in order to reduce the losses and improve the quality of supply. N-1 criterion at 10 kV level can be accomplished through the interconnecting lines and cables between SS Gjakova 1 and SS Gjakova 2. Figure 5-5 shows a one-pole scheme that summarizes the two substations: SS Deçan and SS Gjakova 1.

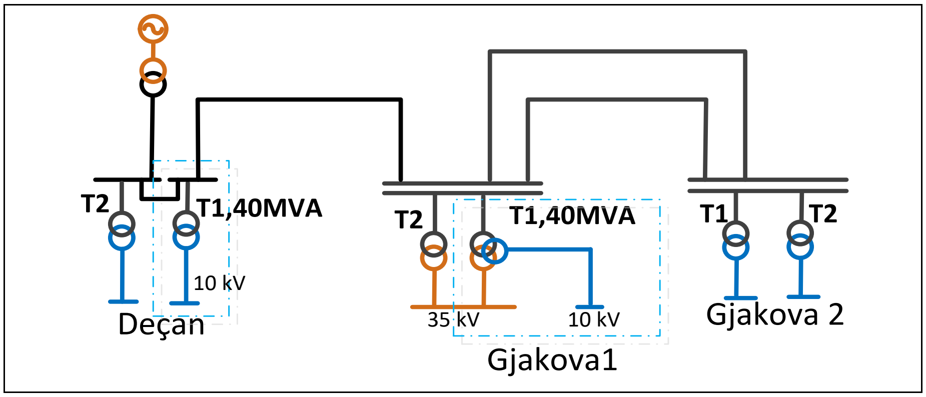


Figure 5-5. Project's single pole scheme for transformer replacement in SS Gjakova 1 and SS Deçani

The expected benefits from the two aforementioned projects are:

- *Reduction of undelivered energy to customers in Deçan and Gjakova area*
- *Increased security and reliability of distribution consumption supply*
- *Support for further development of the distribution network 10 (20) kV*
- *Increased transformation capacities of 110/TM kV and fulfilment of N-1 criterion in transformation*
- *Optimization of maintenance process*
- *Support to the development of economic sector/industrial load.*

- **Projects: New Line 110 kV SS Prizren 1 - SS Prizren 2**

The consistent growth of load in the Prizren region shall put at risk the fulfilment of N-1 criteria for that area of the transmission network. The second 110 kV line from SS Prizren 1 to SS Prizren 2 is necessary since according to the current network configuration, an outage of the line SS Prizren 2- SS Prizren 3 would cause an overload on the Line SS Prizren 2 – SS Prizren 1.
The project foresees:

- Conversion of the existing line SS Prizren 2 - SS Prizren 1 (HW 173mm^2), into a double overhead/cable line (240mm^2 AlSt, 1000mm2XLPE), using the existing route in the non-urbanized part for the overhead line, while in the urbanized part, cable will be made up to SS Prizreni 1. The double overhead line will be about 3.6 km long, while the cable line will be about 1.65 km long, which will extend to public roads. These lengths may vary depending on the situation on the ground.
- The HW 173mm^2 conductor will be used for the revitalization project of the Prizren 1- Prizren 3 line, where the 150 mm^2 conductor with a capacity of 83 MVA will be replaced with HW 173mm^2 with a capacity of 114 MVA.

The geographic scope of the double line SS Prizren 2- SS Prizren 1 is shown in Figure 5-6, while the single line diagram is shown in Figure 5-7.

The project is due to be completed by 2026. This project is important for the realization of 110 kV consumption grouping concept as per main substations.

Expected benefits from the project are:

- *Enhancement of transmission capacities of 110 kV network*
- *Fulfilment of the N-1 criterion in long term period.*
- *Reduction of undelivered energy to consumer*
- *Optimization of power flows and enabling the grouping of 110 kV loads according to independent supply from main transmission system nodes (in this case from SS Prizren 2)*

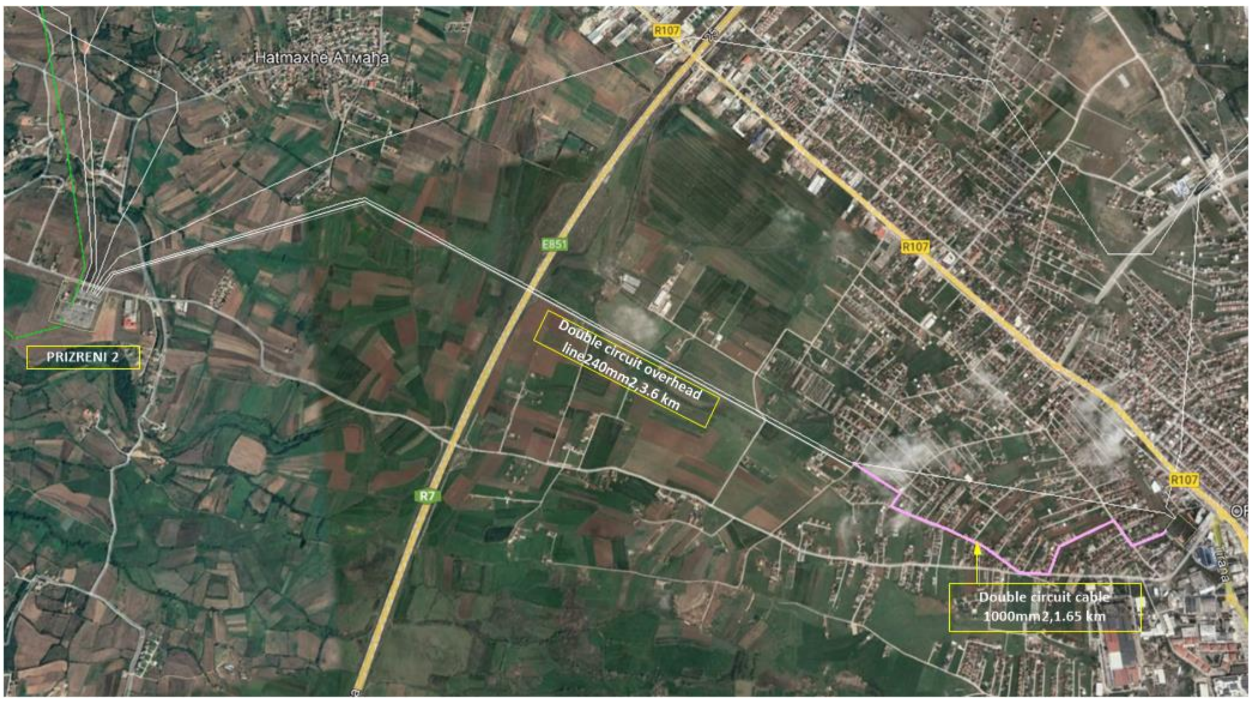


Figure 5-6. Double line project 110 kV line/cable SS Prizren 1- SS Prizren 2

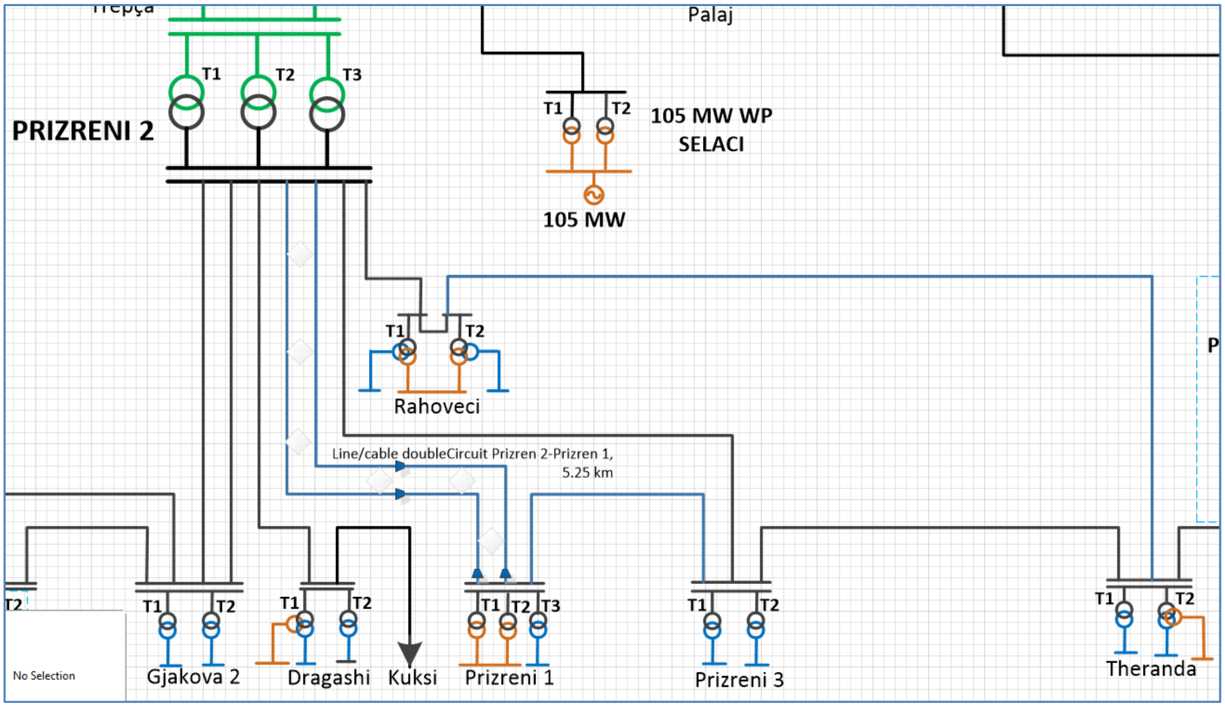


Figure 5-7. 110 kV double line SS Prizren 2- SS Prizren 1 and interconnection with surrounding substations

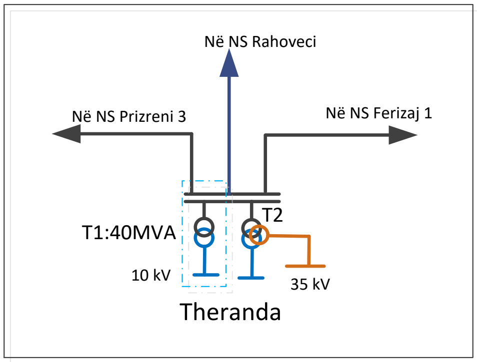
- **Projects: Replacement of transformers in SS Theranda and SS Bibaj (Ferizaj 1)**

The existing 110/10 kV two-pole TR1 transformer at SS Theranda with 31.5 MVA power, due to operations under conditions constrained from overloads or frequent short circuits in that area, has expedited the aging of the transformer. This transformer has been rendered functional in 1985 and is still functional. The transformer will continue operation until expiration of the time period of 40 years, and the state of the transformer will be carefully supervised by operators and the maintenance team. This transformer should be replaced with a new two-pole transformer 110/10 (20) kV with 40 MVA power as shown in Figure 5-8.

The N-1 criterion at 10 kV level is supplemented by transformer capacities at the substation, while at 35 kV level, this criterion is supplemented by the interconnection of SS Theranda with SS Prizreni 1 with a 35 kV line, which can be used as reserve supply in case the three-pole transformer in SS Theranda fails.

The project is expected to become operational in **2026.**

Also the TR2 transformer with 31.5 MVA installed power and 110/35 voltage at SS Bibaj built in 1969 should be replaced with a new three-pole 110/35/10(20) kV transformer with 40/40/40MVA power. In this case, it is possible to fulfil the N-1 criterion for the transformer of 10 kV in the SS Bibaj, which is currently not met. The project is also expected to become operational in **2026.**



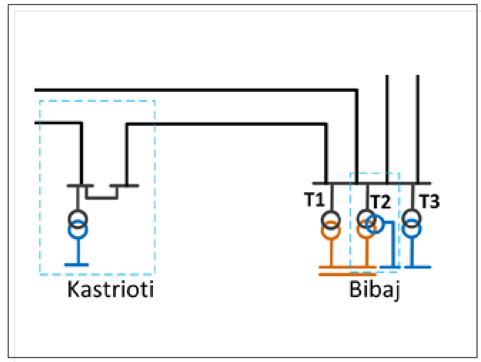


Figure 5-8. Replacement of transformers in SS Theranda and SS Bibaj, with new transformers 110/10 (20) kV, 40 MVA and 110/35/10 (20) kV, 40/40/40 MVA

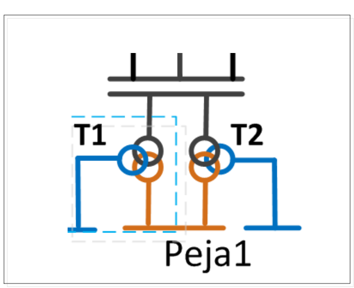
Projects: Replacement of transformers in SS Peja 1, SS Prizreni 1

The main reason for being included in the list of network reinforcement projects is to fulfil the N-1 security criterion at the 10 kV level in both Peja 1 and Prizren 1 substation. Initially both substations had transformers 110/35 kV, while in 2011 the DSO installed a new three-pole 110/35/10 transformer with kV 40 MVA power in both aforementioned substations. In this case the N-1 criterion at the 10 kV level cannot be fulfilled, while the maintenance of these transformers requires total disconnection of customers from to the 10 kV busbars, for as long as there is maintenance of transformer.

In order to avoid this problem and increase security of supply, the project envisages that in 2025 the TR1 two-pole 110/35 kV 31.5MVA transformer is to be replaced in SS 110/35/10(20) kV Peja 1 built in 1985 with the new three-pole 40/40/40 MVA 110/35/10 (20) kV transformer.

Also in the same timeframe, the replacement of the TR1 two-pole 110/35 kV 31.5MVA transformer is planned in SS 110/35/10(20) kV Prizren 1 built in 1975 with the new three-pole 40/40/40 MVA, 110/35/10(20) kV transformer. Figure 5-9 shows the one-pole scheme of two substations with replaced transformers.

In this case, both substations will meet the N-1 criterion for both medium voltage levels: 35 kV and 10(20) kV.



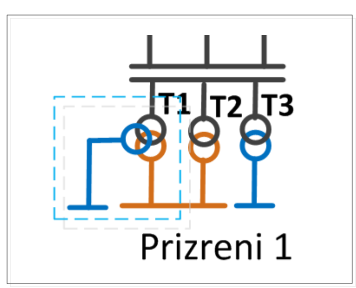


Figure 5-9. Replacement of transformers in SS Peja 1 and SS Prizren 1, with new three-pole 110/35/10 (20) kV 40/40/40MVA transformer

The following are the expected benefits from the two aforementioned projects:
- *Reduction of undelivered energy to customers in Peja and Prizren area*
- *Increased security and reliability of distribution consumption supply*
- *Support for further development of the distribution network 10 (20) kV*
- *Increased transformation capacities of 110/TM kV and fulfilment of N-1 criterion in transformation;*
- *Optimization of maintenance process*
- *Support to the development of economic sector/industrial load.*

- **Project: New 110 kV cable Line SS Prishtina 2- SS Prishtina 4**

This new project, which was not included in the earlier development plans, was initiated as a result of the continuous increase of the load in SS Prishtina 3 and SS Prishtina 2. Computer simulations for the following years result in N-1 criteria not being met in the segment of 110 kV lines SS Kosova A - SS Prishtina 3 - SS Prishtina 2 - SS Prishtina 4. The outage of one of the lines SS Kosova A - SS Prishtina 3, or SS Prishtina 2 - SS Prishtina 4 results with an overload of the line that remained operational.
Two options were analysed for building a new line, i.e. one from SS Prishtina 4 to SS Prishtina 2, and the other from SS Prishtina 3 to SS Kosovo A. The cost-benefit analysis determines the optimum solution in the technical-economic aspect of the construction of the new cable line XLPE AL 1000mm^2 with nominal thermal capacity of 114 MVA from SS Prishtina 4 to SS Prishtina 2.
The construction of this cable line maintains supply security for a large portion of the demand in the capital city. In this case, the N-1 criterion for this part of the network will be met in the long-term period. The cable track is not yet defined as the cable will pass through a significantly urbanized area of the Capital, whereby roads will be used as a potential track from SS Prishtina 4 to SS Prishtina 2, while trying to avoid private properties as much as possible so as to avoid the problem of expropriation. The approximate conceptual assessment of cable length is around 4.85 km. This length may vary depending on the final determination of the cable track.
The project itself contains also the installation of two 110 kV line fields, one in SS Prishtina 4 and the other in SS Prishtina 2. The technology of line fields may be selected as the hybrid “HIS” technology which takes precedence over “AIS” technology in terms of using less space for installation in substation. Figure 5-10 presents the single pole scheme of cable connection between SS Prishtina 4 and SS Prishtina 2.

Project is planned to be completed in **2026.**

Expected benefits from the project:
- *Increased transmission capacities of 110 kV network*
- *Fulfilment of the N-1 security criterion in the long term*
- *Increased security of demand supply and reduction of energy undelivered to consumers in capital city*

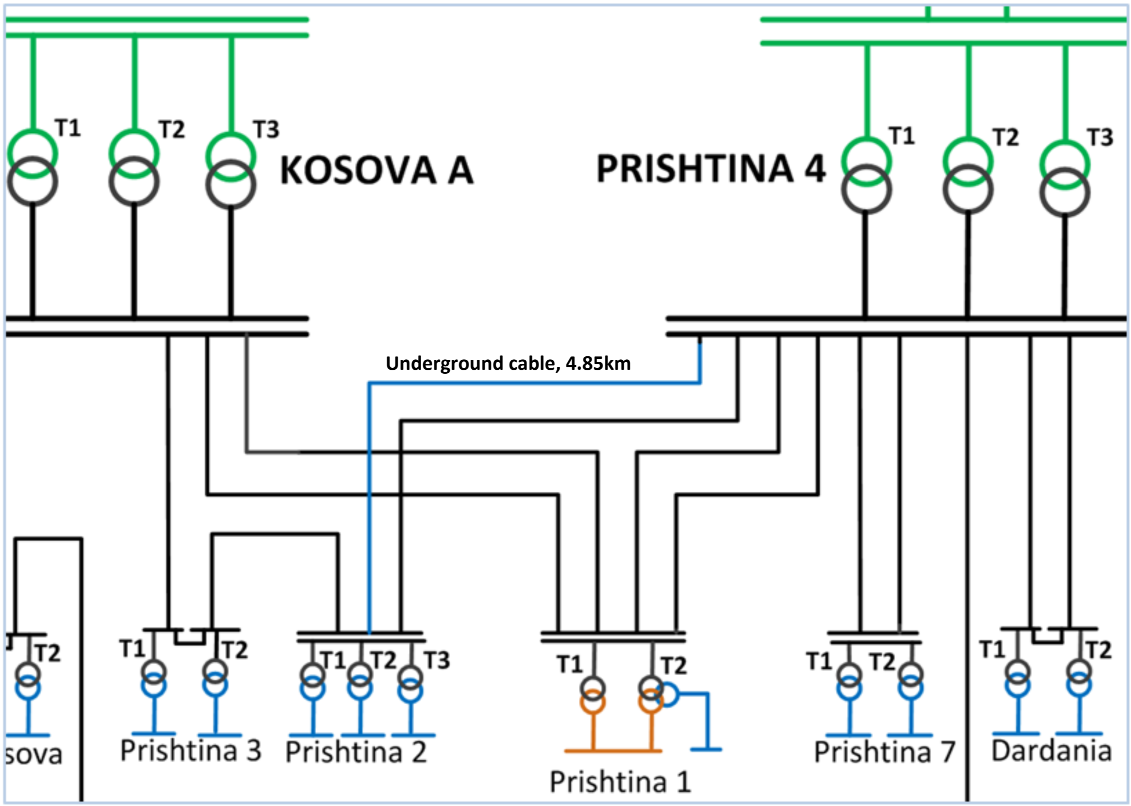


Figura 5-10. Single line scheme connection of new 110 kV cable line SS Prishtina 4-SS Prishtina 2

- **Projects: The second transformer in SS Fushë Kosova, SS Kastrioti and SS Malisheva**

Initially, in the preliminary plans, the two SS Malisheva and Fushë Kosova substations were planned to be built with two transformers, but due to financial limitations, these two projects were initially initiated with one transformer each, while the installation of the second transformer was supposed to be done later. Within the framework of the investments by kFW, phase VII, the installation of the second transformers (criterion N-1) has also been initiated in the three substations: SS Malisheva 220/35/10(20) kV, SS Fushë Kosova 110/35/10(20) kV and SS Kastrioti 110/35/10(20) kV.

The two substations SS Fushë Kosova and SS Kastrioti will be built according to the GIS concept (compact with SF6 gas insulation) due to space limitations, while the substation at SS Malisheva will be conventional AIS (overhead).

- The second 40 MVA transformer, two 110/10(20) kV transformers and a 10(20) kV transformer field will be installed in SS Fushë Kosova. The 110 kV transformer field is provided within the substation.
- The second 40 MVA transformer, two 110/10(20) kV transformers and a 10(20) kV transformer field will be installed in SS Kastriot. The 110 kV transformer field is provided within the substation.

- In SS Malisheva, the second transformer with a power of 40 MVA, two 220/10(20) kV transformers, a 220 kV transformer field and a 10(20) kV transformer field will be installed.

  The project is scheduled to be completed in 2026.

The expected benefits from the three aforementioned projects are as follows:

- Completion of the N-1 criterion in the transformation
- Increasing the security of supply of consumption in Ferizaj, Fushë Kosova and Malisheva
- The creation of transformative reserves in the long-term time domain enabling the locking of the expected industrial and domestic load.
- Optimizing the substation maintenance process by reducing energy not sent to consumption.

- **Projects: Replacing transformers in SS Vitia, SS Gjilani 1 and SS Gjakova 1**

The main reason for inclusion in the list of projects to improve the network is the ageing of transformers and building capacities of transformers in three substations: Vitia, Gjilan 1 and Gjakova 1. The transformer in SS Vitia 20MVA, 110/35 kV built on 1974 will be replaced in **2027** by a three-pole transformer 110/35/10 (20) kV with a capacity of 40/40/40 MVA. In order to maintain the N1 criterion at the 10 kV level, the transformers 35/10 kV in SS Viti should remain installed but not energized. In case of maintenance of the three-pole transformer 110/35/10 (20) kV, the supply of the city of Viti can be transferred from 35 kV to 10 kV level by connecting the two existing transformers 35/10 kV located in SS Viti.
In the same year (2027) is foreseen the replacement of the transformer 31.5 MVA, 110/35 kV in SS Gjilan 1, build in 1974, by a three-pole transformer 110/35/10(20) kV with a capacity of 40/40/40 MVA.
In the same year (2027) is also foreseen that in SS Gjakova 1 the remaining transformer 20MVA, 110/35 kV, build in 1974, will be replaced by the transformer 110/10(20) kV with a capacity of 40 MVA. Thereby, the supply with 10(20) kV for the entire city of Gjakova, consumption is achieved via two substations: Gjakova 1 and 2. The 35 kV network will remain as backup supply which will be necessary for further supply of consumption in Xerxe, which is supplied through 35 kV also by SS Rahoveci. The interconnection of SS Rahoveci with 35 kV lines plays an important role in maintaining network reserves in case of unpredictable breakdowns in both concerned substations.

Figure 5-11 shows the simplified single pole schemes of substations where the transformers will be replaced.

The expected benefits of both abovementioned projects are:

- *Reduction of undelivered energy to customers in Viti, Gjilan, and Gjakova area.*
- *Increased security and reliability of distribution consumption supply*
- *Support for further development of the distribution network 10 (20) kV*
- *Increased transformation capacities of 110/MV kV*
- *Support to the development of economic sector/industrial load*

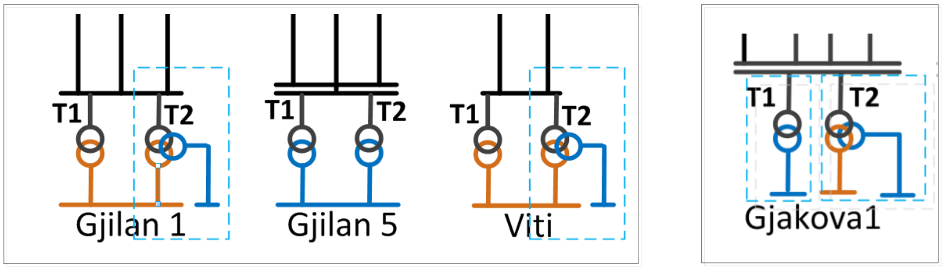


Figure 5-11. Replacement of transformers in SS Vitia, SS Gjilani 1 and SS Gjakova 1 with new transformer

- **Project: Interconnecting Line SS Deçan-SS Bajram Curr**

A joint study of KOSTT and TSO, respectively of the two network planning offices, has been completed to analyze the possibility of connecting SS Bajram Curri (TSO) to the Kosovo transmission network with the aim of increasing the cross-border capacities of the voltage level 110 kV. This study was initiated by TSO (Transmission System Operator of Albania) and KOSTT (System, Transmission and Market Operator of Kosovo) in the wake of the deepening of cooperation and the start of the Operation of TSO and KOSTT in the joint regulatory Block AK.

The main objective of this study was to evaluate the benefits for the second project for the construction of the new 110 kV interconnecting line between TSO and KOSTT and:

- Determination of the optimal configuration of the SS Bajram Curri connection with the KOSTT network;
- Evaluation of the impact of the project in supporting the joint market Albania - Kosovo;

The study has analyzed different variants of SS Bajram Curri connection in the ring form for meeting the N-1 security criterion. The study contains the analysis of power flows for different scenarios of generation and demand of the Regulating Block AK. The study is based on three connection variants of SS Bajram Curri which is currently supplied radially:

- The connection within the territory of Albania, respectively the connection in SS Kukës,
- Connection to SS Deçani,
- Connection to SS Gjakova 2.

All technical and economic indicators favour the option of connecting SS Bajram Curri to SS Deçan.
The 110 kV interconnecting line will have a standard section of 240mm^2, with a total length of approximately 33 km, 14 km in the territory of Albania and 19 km in the territory of Kosovo.

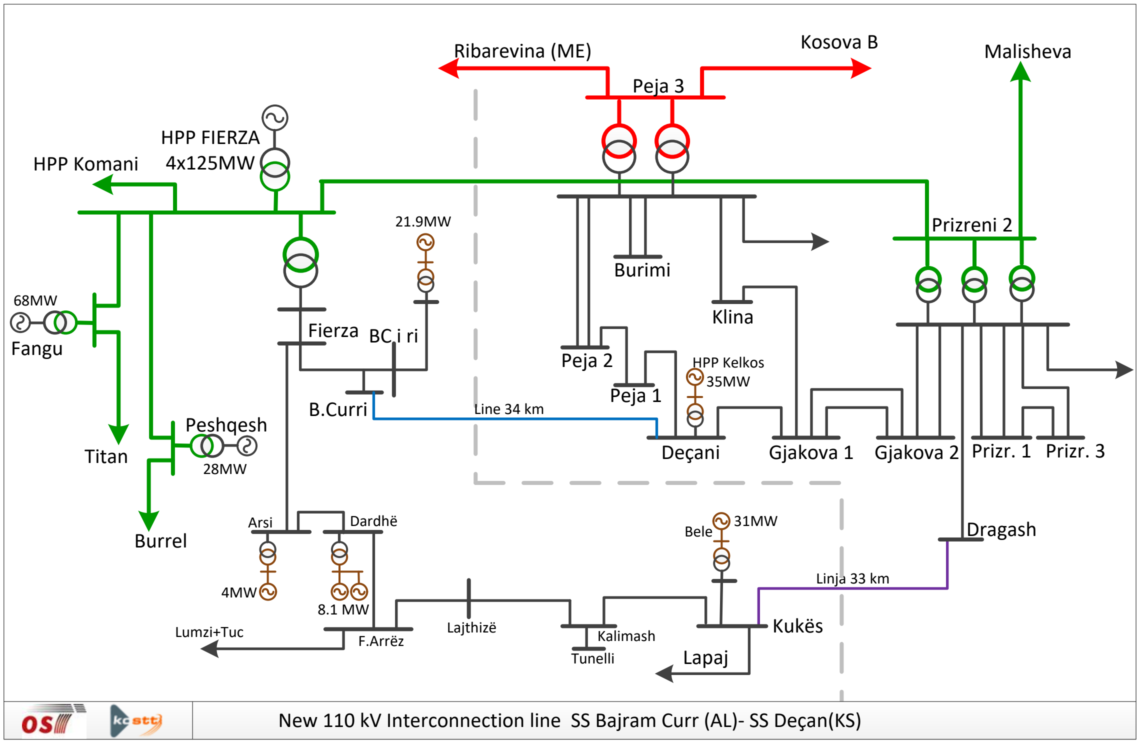


Figure 5-12. Project of second interconnection line SS Bajram Curri- SS Deçani

Expected benefits of the project are as follows:

- *Increasing the interconnecting capacities between Kosovo and Albania*
- *Increase of electricity exchanges in the 110 kV network*
- *Fulfillment of the N-1 criterion for SS Bajram Curri*
- *Support of renewable resources for both countries*
- *Creating additional opportunities for optimizing the work of the Regulatory Block AK*
- *Support for ALPEX (Albanian Power Exchange).*

It enables the re-configuration of the 110 kV network with the aim of optimizing power flows as well as optimizing the operating conditions of the transmission system.

- **Project Packet: SS NASHECI (Prizren 4), 400/220/110 kV with the 400 kV interconnection line**

The development of the 400 kV network was realized in two phases: the first phase was realized in the 1980s and is related to the construction of TPP Kosova B which presented the need for construction of the first substation 400/220 kV and three 400 kV lines. This configuration remained unmodified until 2009 when the second phase of development of the network 400 kV commenced with the construction of the second substation 400 kV SS Peja 3, which had a 400/110 kV transformer. During 2011, was built the third substation SS 400/110 kV Ferizaj 2. Furthermore, in 2016, after 36 years, was built the new interconnection line 400 kV SS Kosova B-SS Tirana 2, which later in 2019 after the extension of SS Komani 400/220 kV is shortened to SS Kosova B – SS Komani line.

If we are to consider the geographical distribution of the system's load, the three areas: Prishtina with the surrounding areas, Dukagjini and South-East Kosovo are now supplied by the 400 kV network. Such configuration has avoided losses caused by transformations 400/220 kV and 220/110 kV, as well as from power transmission in 220 kV lines to distribution substations. Currently only the area of Prizren and its surroundings, including Rahovec, Gjakova and partly Theranda are supplied by the 220 kV network and the supply source is SS Kosova B and the interconnection line SS Prizren 2- SS Fierza.

Computer simulations in complex models undertaken by KOSTT have shown that the network area of the Prizren region will not be compliant to the N-1 criterion after 2026, due to high impedance of two 220 kV supply lines of SS Prizren 2. A larger problem would occur if the 220 kV interconnection line Fierza-Prizren 2 would fail. In this case, voltage collapse may occur, coupled with the disconnection of the load at SS Prizren 2.

Kosovo-Albania market integration after the operation in the Regulation Block AK, establishment of the Albanian Electricity Exchange ALPEX, the operation of two control zones in a common regulation block means intensive exchangesof power between the two countries in different seasonal regimes. Mainly, Albania will use the interconnection network during the summer season for imports from Kosovo TPPs and Solar Parks when hydrologic conditions do not guarantee production by HPP, while Kosovo will provide regulatory reserves throughout the year from Albania's system, including imports to Kosovo power when Albanian's system has surplus. The joint market will impose a change in the maintenance schedule of Kosovo TPPs and will require sufficient interconnection capacities that will be free to exchange regulatory power between the two systems for the needs of the System Operators. Adding the developments in the new generating capacities in Albania and in Kosovo mainly dominated by RES, then conversion of SS Prizreni 2 to substation SS 400/220/110 kV Nashec as well as the eventual connection of Reversiblel HPP Zhuri (250 MW) and HPP Skavica is seen as a real option which would help both countries but also the regional network in the successful integration of small markets in the region of South-Eastern Europe. The project is optional and will largely depend on developments in the Energy sector in both countries and the region in the next 5 years.

The concept of re-establishing SS Prizren 2 in SS Nasheci with 400/220/110 kV transformation will entail the following benefits:

- *Enables the support for new generation capacities (RES, Reversible HPP Drini, TPP with gas)*
- *Increases the 400 kV network's reliability and security.*
- *Facilitates the security of power exchange between Kosovo and Albania and countries in the region, or transits going through horizontal network.*
- *Enables the reconfiguration of the 110 kV network with the aim of optimizing operational conditions of the transmission system*
- *Enhances the quality of consumption supply in the region of Prizren.*
- *Facilitates the 400 kV line maintenance process.*
- *Creates conditions for the construction of a second 400 kV line.*

Project's technical details are as follows:

Upgrading the SS 220/110 kV Prizreni 2 into a three-level substation with 400/220/110 kV, which will be called SS Nasheci based on its existing location. The substation will initially have an auto-transformer of 300 MVA installed. The substation will be located in the open areas at the SS Prizren 2, wherein the 400 kV busbar system will be constructed, which will initially contain two line fields, a connection field and a transformer field, along with the space for a line field and a 400 kV transformer field for future long-term developments. Figure 5-14 shows the configuration of SS Nasheci. The two substations will be in parallel work on the 110 kV side, which means the use of existing 3x150 MVA autotransformers of SS Prizreni 2, by always optimizing their work depending on the demand of the network 110 kV accessed in SS Nashec. Existing 220/110 kV auto-transformers will be utilized until the end of their lifespan, whereby two of them can be decommissioned in 2030, and the third transformer in 2050. They will be replaced by the installation of second auto transformer 400/110 kV after 2032. The existing 110 kV busbar system should be sectionalised in order to optimize the distribution of line fields and transformers and to achieve selectivity in busbar protection.

The dual line 400 kV shall be the supply line of SS Nasheci with a length of approximately 26 km, AlSt 2, 490 mm^2 with a capacity of 1330 MVA will be connected at the crossing point of the existing line SS Kosova B-SS Komani approximately in the 55th kilometre of the line from SS Kosova B. On this occasion, the existing line will establish the lines SS Kosovo B - SS Nashec with length of 81 km and SS Nashec - SS Komani with length of 56 km. After the construction of SS Komani 400/220 kV the line Kosova B-Tirana 2 was cut, where now the interconnection line is significantly shorter (142 km) as shown in Figure 5-13 which represents a part of the regional network. The solid lines in purple represent the lines that are expected to be operational in the next 5 years, while dash-lines belong to the long-term period. This configuration of 400 kV network provides Kosovo's transmission network stability and sustainability in operation, due to a high flexibility of shifting power flows in the event of opening one of the four above mentioned rings.

Figure 5-13 Geographical scope of the SS Nasheci Project in the regjional network (ENTSO-E Map)

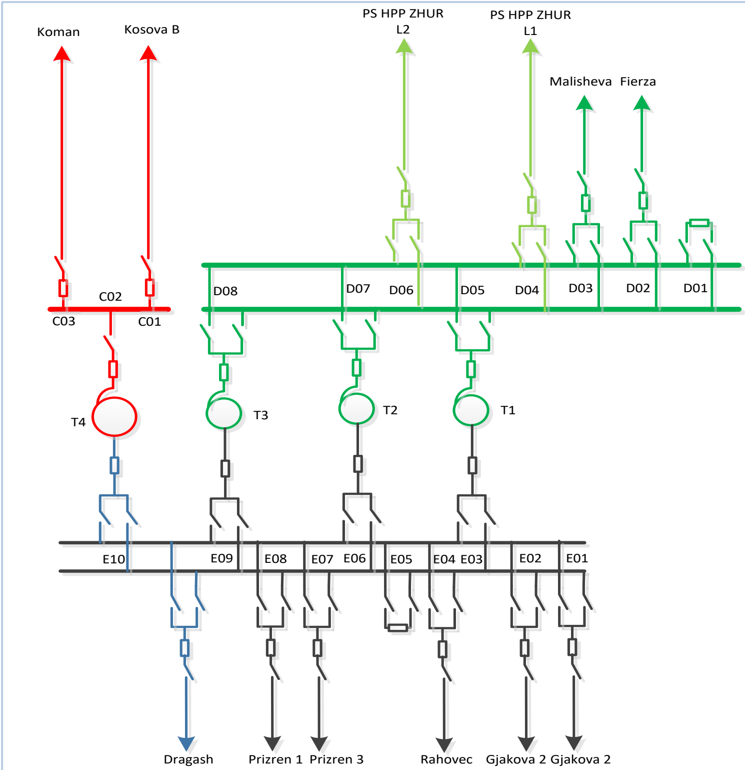


Figura 5-14. Single pole scheme of modified substation SS Prizren 2, 220/110 kV to SS Nashec, 400/220/110 kV

5.4.2.1 Projects: Re-vitalization of 110 kV lines

The important factors that are considered for determining the list of lines which will have the conductors replaced with larger transmission capacity are:

- The age of the lines,
- Line overload frequency (N-1), and
- The level of power losses in the line

The first factor is clearly defined; while the second and third factors are identified by computer analysis, thereby simulating load flows for different transmission system operation conditions, in due consideration of perspective development of projects, which would considerably impact the change of load flows in the transmission network. All 110 kV lines with 150 mm^2 section, in the transmission network, have been analyzed in terms of load losses, thereby pursuing reinforcement at the long term.
Lines that are 40 years old and lines with larger overload frequency and, understandably, higher losses, are listed in the first place.

The main objective of this category of projects is to increase the capacity of 110 kV lines with section conductors of 150 mm^2 (83 MVA), in conductor 240 mm^2 (114 MVA). Some very old lines mainly have concrete towers and replacement of the existing conductors with conductor on greater weight in mechanical and statically terms require reinforcement of towers, with special emphasis on angular towers. In review is considered new technologies ACCC conductors (conductor aluminium, composite core) who have the same weight as 150 mm^2 conductors but the resistance and their carrying capacity is equivalent to 240 mm^2 conductor AlSt. Although the cost of ACCC conductors is two times higher than the equivalent conventional, in lines where considered good technical condition of the towers, it is more reasonable economically to install them. In the 2023-2032 period as in the following are selected 110 kV lines which will be reinforced.

- **Project: Re-vitalization of line 110 kV, SS Prizreni 1 – SS Prizreni 3**

The project in question relates to the project of the dual line 110 kV SS Prizren 2 - SS Prizren 1. The conductor, which is currently located on the line SS Prizren 2- SS Prizren 1, is of type HW 173 mm^2 with a capacity of 114 MVA, during the implementation of the project will be dismantled and the same will be used to replace the 150 mm^2 conductor of the line SS Prizren 1 - SS Prizren 3. This will allow for cost optimization and build the desirable capacity of the lines.

The line represents the connecting segment for supplying SS Prizreni 3 as shown in Figure 5-14. The re-vitalization of this line will significantly affect the enhancement of security and operational reliability of that part of the 110 kV network.

Expected benefits from the project are:

- *Fulfilment of the N-1 criteria for the part of the network 110 kV that connects substations 110 kV in the region of Prizren*
- *Increasing transmission capacity of the line from 83 MVA to 114 MVA*
- *Reduction of unsupplied electricity*

Project is planned to be completed in the third quarter of **2026.**

Figure 5-14 Line 110 kV SS Prizren 1 – SS Prizren 3 with length 4.69 km

- **Project: Re-vitalization of the 110 kV segment line SS Bardhi - SS Ilirida – SS Vallaqi**

After the connection of SS Ilirida to the preliminary line SS Palaj (Bardhi) - SS Vallaq with a section of 150mm2, the power flows on this line have increased, and thus its importance in the security of supply of consumption in the southern part of Mitrovica. Also, the connection of the 105 MW Selaci Wind Park has influenced the increase in power flows. On the other hand, this part of the transmission network has remained undeveloped due to the non-implementation of the reinforcement of the SS Trepça-SS Vallaq line and which remains with significantly reduced power as a result of the 150mm^2 conductor. The enormously increased consumption in the northern part as a result of non-payment of electricity has brought this part of the network to conditions where the N-1 criterion is not met during the winter peak. This line was built in 1958 (61 years). After a detailed examination of the technical condition of the line, it was concluded that the technical condition of the poles is not good. In a large number of Poles, continuous intervention is required due to problems of the statics of the foundations of the Poles. In order to strengthen the 110 kV network in this part of the transmission, based on analyzes carried out, it is necessary, in addition to the revitalization of the line in question, to strengthen the 110 kV transmission capacity. The current proposed project differs from the initial project due to the aforementioned reasons. The project also creates technical conditions for the 45 MW Storage Battery Installation project that is expected to be connected to SS Palaj. The re-designed project of Revitalization and strengthening of the network foresees:

- *Dismantling the segment of the 110 kV line from SS Kosova to the entrance to the city of South Mitrovica. This includes the dismantling of the current 92 portal-type poles.*
- *Construction of a double cable line 1000mm^2, with a length of about 2.24 km (segment 1)*
- *Construction of the double overhead line 110 kV, 240 mm^2 from the end of the double cable to the point where the bypass line is connected as well as the connection of one side of the double line to SS Vushtrri 1. The total length of the double overhead line is about 29.2 km. In this case, the existing route of the line should be used, while the interconnection of SS Vushtrri 1 is made with a new double line. This distance is about 2.7 km and is included in the total length of 29.2 km (segment 2 and 3).*
- *Single overhead line 240mm^2 from the bypass point to the entrance to the urbanized area of South Mitrovica (segment 4)*
- *Due to the highly urbanized area in southern Mitrovica, from the point where the 110 kV bypass line is connected to the SS Ilirida cable, the dismantled part of the line will be replaced with a 1000mm^2 underground cable with a length of about 2.4 km, which will lie mainly along the public roads (segment 5).*
- *From the cable connection point to the SS Ilirida overhead line to the SS Vallaq, the ALSt 150mm^2 conductor is replaced with an ACCC type line with a length of about 7.8 km.*
- *In order to enable the maintenance process in the connection nodes of the former bypass line, the facilities must be built with a switch located in the bypass line at the former location.*
- *The project enables the creation of lines: SS Kosova A-SS Vushtrri 1 24.6 km, SS Vushtrri 1-SS Ilirida 12.8 km, SS Palaj- Bypass node 36 km.*
- *The project must be coordinated with the SS Vushtrri 1 revitalization project.*

The geographical view of the project is presented in figure 5-15. While the unipolar scheme in figure 5-16.

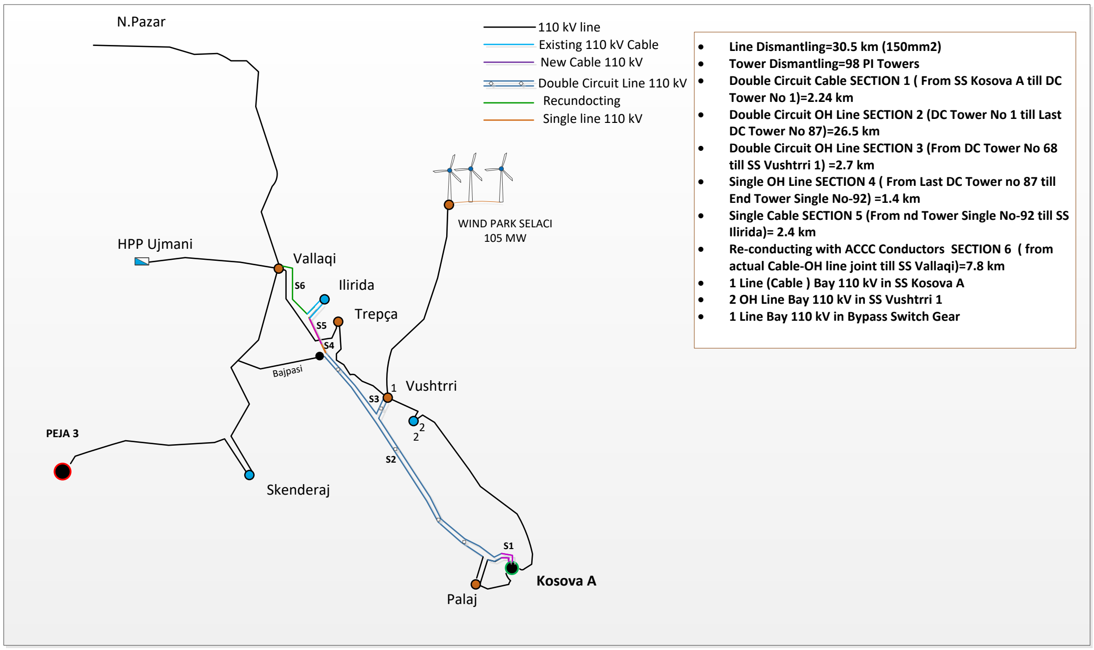


Figure 5-15 Line 110 kV SS Kosova A – SS Palaj – SS Ilirida - SS Vallaq

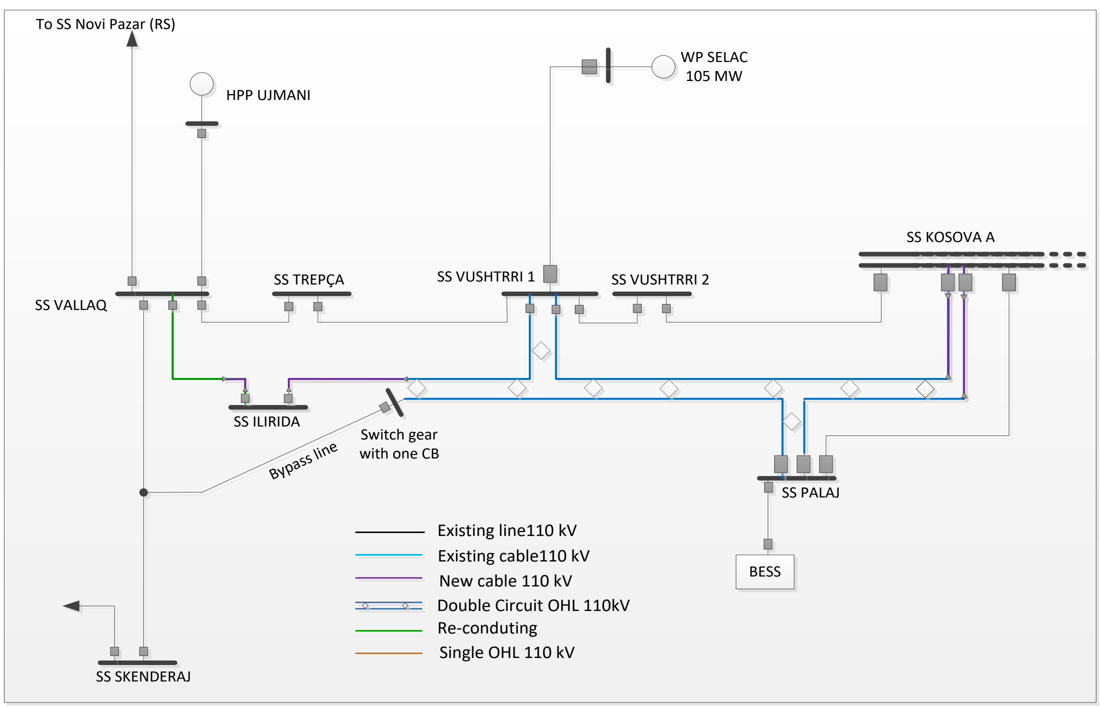


Figure 5 – 16 Skema njepolare e Projektit e Revitalizimit te linjës NS Kosova A- NS Palaj- NS Ilirida

Expected benefits from the project are:

- *Enhancement of line transmission capacity from 83 MVA to 2x114 MVA*

- *Reduction of active and reactive power losses*
- *Fulfilment of the N-1 criterion for the section of the network connecting the ring: SS Kosova A-SS Palaj (Bardhi) – SS Vushtrria 1&2- SS Trepça- SS Ilirida- SS Vallaq*

The project is planned to complete at **2027.**

- **Project: Revitalization of the 110 kV line SS Bibaj- SS Kastriot (L127)**

The connection of the planned SS Kastrioti substation to the current SS Bibaj-SS Theranda line, with a 150mm^2 section, as well as the technical condition of the line built in 1973, are the main factors for the introduction of this project into the development plan of the transmission network. Based on technical assessments, the part of the current line SS Theranda – SS Bibaj, from the connection point of SS Kasrtrioti to SS Bibaj with a length of 6.7 km should be completely dismantled and completely rebuilt using the same route as and the plots of the existing 24 poles, as shown in figure 5-17. The protective conductor containing the optical fibers will be used for the reconstructed line. The project affects the reduction of network losses and increases the capacity of the SS Bibaj-SS Kastrioti line from 83 MVA to 114 MVA. In the phase beyond the period of the development plan, the part of the line segment up to SS Theranda should also be reconstructed.

Expected benefits of the project are as follows:

- *Increasing the transmission capacity of the line from 83 MVA to 114 MVA*
- *Reduction of active and reactive power losses*
- *Utilization of the full capacity of the connecting lines of SS Kastrioti (240mm^2)*

The project is planned to be completed in 2028.

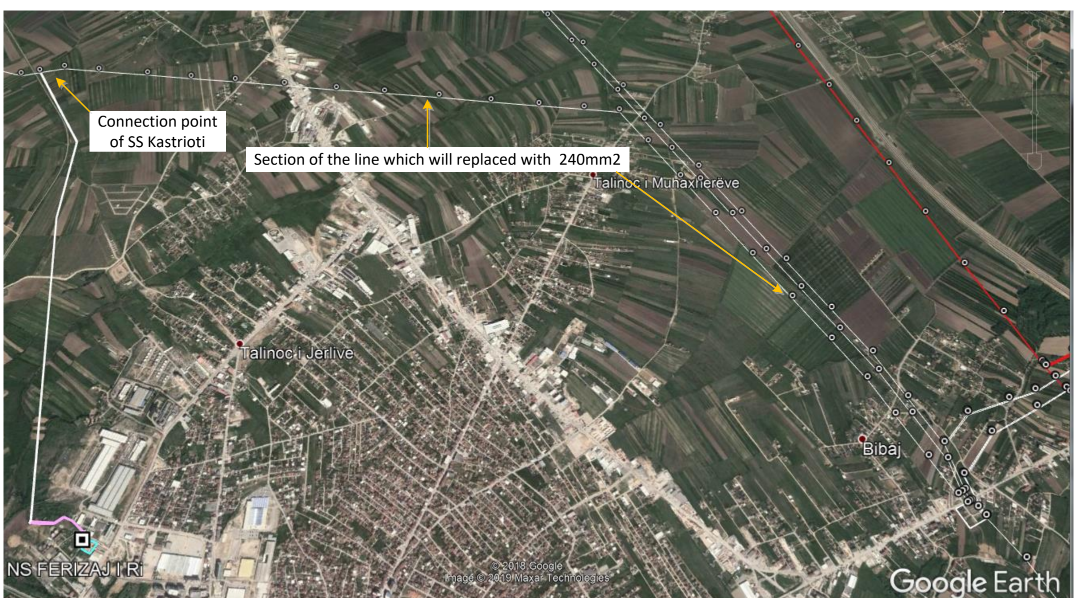


Figure 5-17. The geographical extension of the project for the reconstruction of the SS Kastrioti-SS Bibaj line segment (from the Connection Point to SS Bibaj)

- **Project: Revitalization of the 110 kV line SS Ferizaj 2-SS Sharr (L106)**

The SS Ferizaj 2- SS Sharr line has two conductor sections: the line segment from SS Bibaj to SS Sharr has a section of 150mm^2, while the line segment from SS Bibaj to SS Ferizaj 2 has a section of 240 mm^2 and is part of the larger project SS Ferizaj 2 completed in 2011. The part of the line with a section of 150 mm^2 is among the first 110 kV lines built in Kosovo in 1953. The main factor for the inclusion of this project in the development plan of the transmission network is the age of the line and its technical condition. Based on the technical evaluations, this line with a length of 28.7 km should be completely dismantled and completely rebuilt using the same route as well as the existing pole plots, as shown in figure 5-18. The protective conductor containing the optical fibers will be used for the rebuilt line.

Expected benefits of the project are as follows:

- *Increasing the transmission capacity of the line from 83 MVA to 114 MVA*
- *Reduction of active and reactive power losses*
- *Increasing the reliability of the line.*

The project is planned to be completed in 2029 when the age of the line reaches 76 years from the start of the first operation.

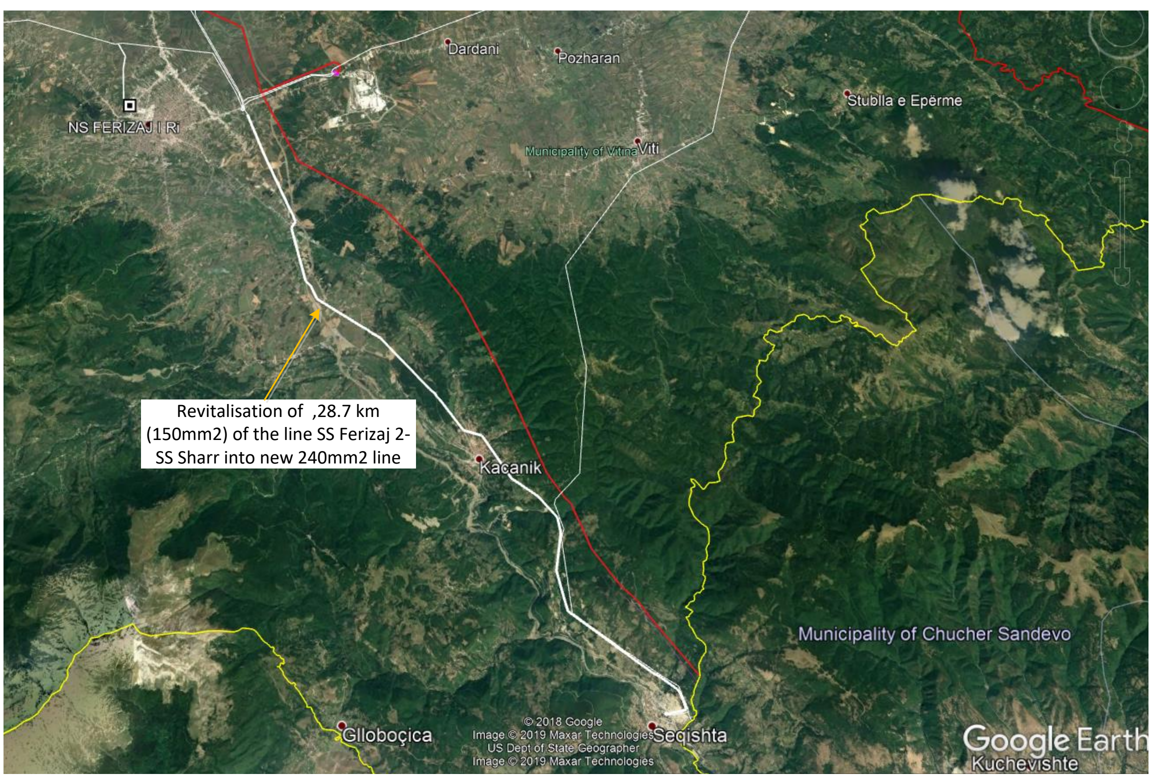


Figure 5-18. Geographical extension of the project: re-construction of the 110 kV line SS Ferizaj 2-SS Sharr starting from SS Bibaj to SS Sharr

- **Revitalization of the 110 kV line: L110 SS Trepça-SS Vallaq**

The segment of the 110 kV network for the northern part of Kosovo that connects SS Trepça with SS Vallaq is a line built in 1959 with a cross section of 150mm^2. The technical condition of the line and the lifespan of the line are the main factors that determine that this line should be revitalized. The 11.4 km long line, with portal type poles, is expected to be reinforced in line with standard dimensions of 240mm^2. In this case, the capacity of the line will increase from 83 MVA to 114 MVA and will affect the reduction of losses on the line and increase the safety of the operation of the 110 kV network in that area. The project will create additional conditions in supporting the RES integration in the 110 kV network as well as in supporting the load.

The following figure shows the geographical extent of the SS Trepça-SS Vallaq line.

Figure 5-19 The Trepça-Vallaq line Revitalization Project

The expected benefits of the project are:

- *Increasing the transmission capacity of the line from 83 MVA to 114 MVA*
- *Reduction of power losses in the line*
- *Increasing the security of the 110 kV network operation*
- *Support for Renewable Resources*
-

The project is planned to be completed in **2030.**

- **Project: Re-vitalization of line: SS Vallaq-border (N. Pazar)**

The line currently does not have sufficient capacity due to its sectional width (150 mm^2). On the other hand, this line is one of the oldest lines of the transmission system of Kosovo, therefore its reinforcement is necessary. Replacement of the conductor is planned for 18.4 km of the line, starting from SS Vallaqi to the the border with Serbia. The project should be previously coordinated with Inter-TSO agreement with neighbour system. The construction of the SS Leposaviqi 110/35/10 kV, which will be connected in the section in the cross-border line SS Vallaq - SS N.Pazar, remains optional. In figure below is shown the geographical position of the project. The project is planned to be complete in **2031.**

Expected benefits from the project are:

- *Enhancement of the line transmission capacity from 83 MVA to 114 MVA*
- *Reduction of active and reactive power losses*
- *Enabling the realization of SS Leposaviq 110/10(20) kV*

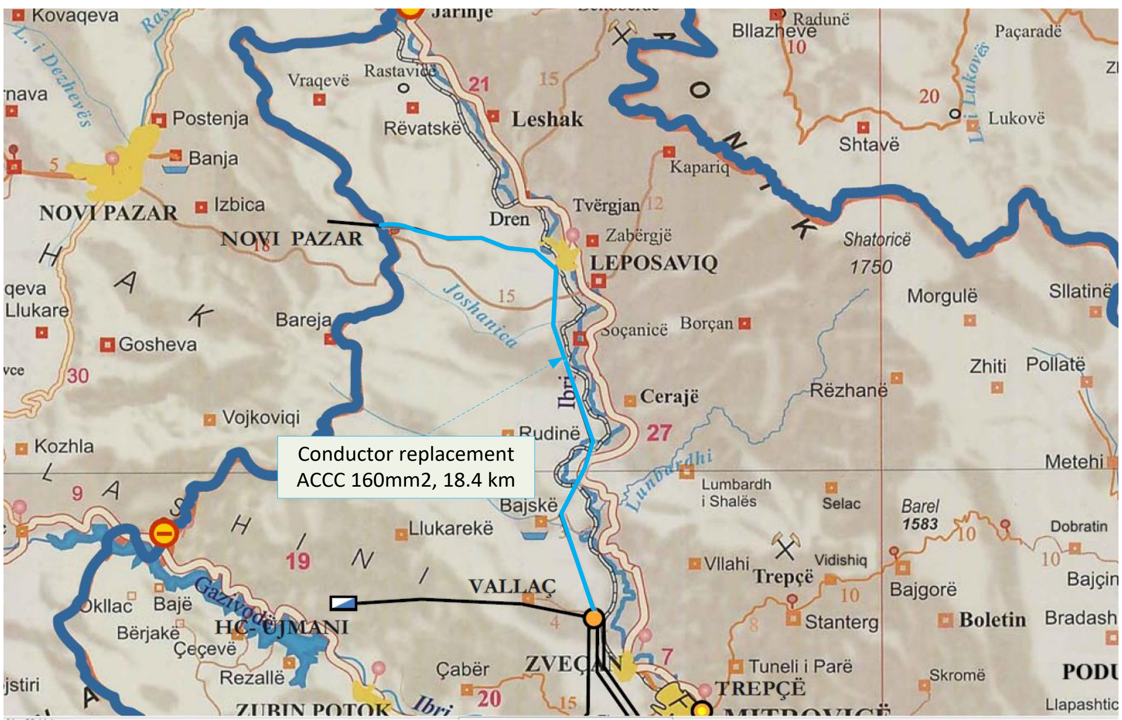


Figure 5-20 Revitalization project for the interconnection line 110 kV SS Vallac – SS N. Pazar

5.4.3 Load support projects

The following are technical descriptions of projects supporting the load and expected benefits from them.

- **Project: SS Kastrioti (Ferizaj 3) 110/35/10(20) kV**

The main factors that have led to initiating the construction of the second 110 kV substations in the Municipality of Ferizaj are the following:

- *High rate increase of demand for electricity as a result of increasing number of businesses and constructions,*
- *Endangering the security supply of customers,*
- *The high level of charge to substation SS Bibaj as a result of the supply of the customers of Kaçanik and Shtërpce,*
- *N-1 non-compliant transformation criteria.*

Ferizaj is considered one of the regions with a rapid growth of small businesses and small industry with a comparatively similar comparison with the regions of Prishtina, Prizren and Peja. The supply of distribution points with only one 110 kV substation does not guarantee supply security and as such creates bottlenecks to the economic development of Ferizaj Municipality and the surrounding area.

The construction of the new substation will have an impact on the distribution of power flows from SS Bibaj to the new substation, thus avoiding the risk of transformers falling and causing large amounts of undelivered power to customers, with negative effects on businesses, industry and citizens.

At KEDS's request, the proposed location is on the exit of the city in the north-western part of the village of Leshkobarë. Based on the proposed location, the most optimal connection point is the existing 110 kV line SS Therandë-SS Bibaj. The intersection of existing line SS Theranda-SS Bibaj will take place at 5.7 km point of the line starting from SS Bibaj.

The supply line of SS Kastrioti will be double line with standard section 240 mm^2, AlSt 3.1 km with a length of 3.1 km near the substation where the switch to a cable line of 1000 mm^2 with a length of 0.3km to substation portals, will take place. Outputs 35 kV and 10(20) kV will be constructed by KEDS and will supply the part of consumption currently covered by SS Ferizaj II 35/10 kV. The main effects on loss reduction will be observed in the distribution network, avoiding losses in 35/10 kV transformers and 35 kV lines. Due to the cost, the substation will initially have only one power transformer with a capacity of 40 MVA, three-pole 110/35/10(20) kV installed. The 10 kV distribution network in a large part of the city can be converted to the 20 kV level by having an impact on the additional reduction of losses in the distribution network.

The 35 kV winding will enable the creation of 35 kV ring reserves using the current, already reinforced 35 kV infrastructure, enabling the interconnection of SS Kastrioti with SS Bibaj (Ferizaj 1) and the transfer of 25 MW from one substation to another if the need arises for any reason during network operation.

The second transformer will be 40MVA two-windings 110/10(20) kV and is expected to be installed in 2025.

The following Figure 5-19 shows the position of the substation and the approximate rout of connection lines, while Figure 5-22 shows the configuration of the connection in the single pole scheme of the transmission system.

Due to dual-line supply, the N-1 criterion is guaranteed for consumption up to 80 MW of new substation.

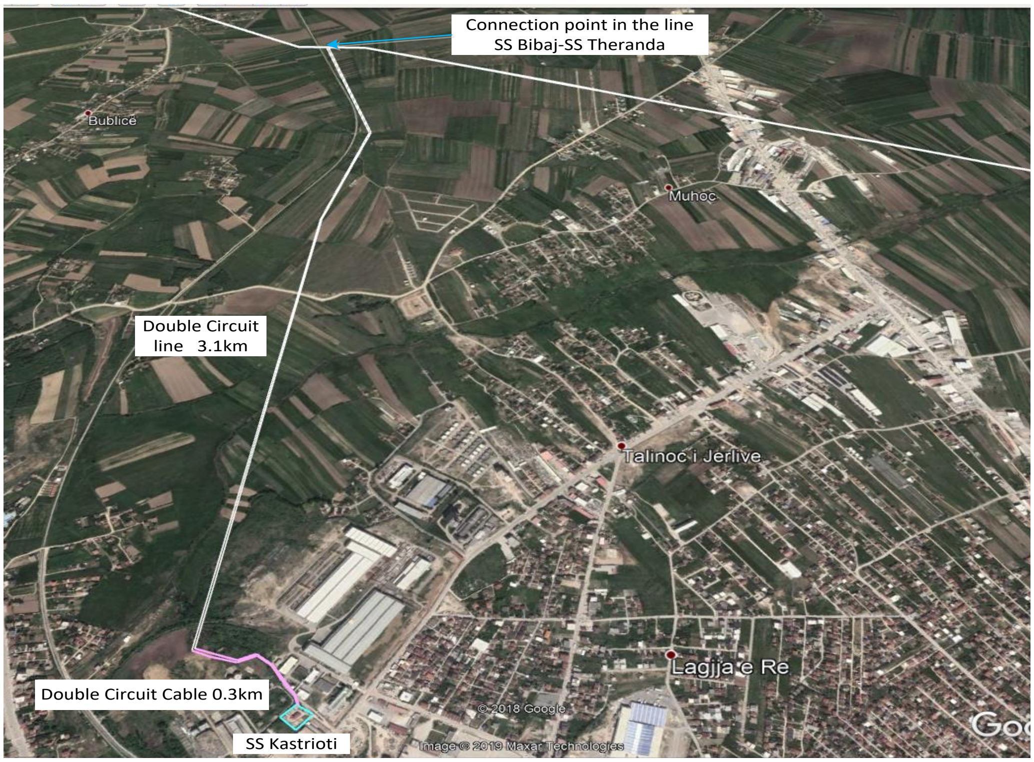


Figure 5-21. Configuration of connection of SS Kastrioti (Ferizaj 3) to the transmision network, approximate route of connection lines

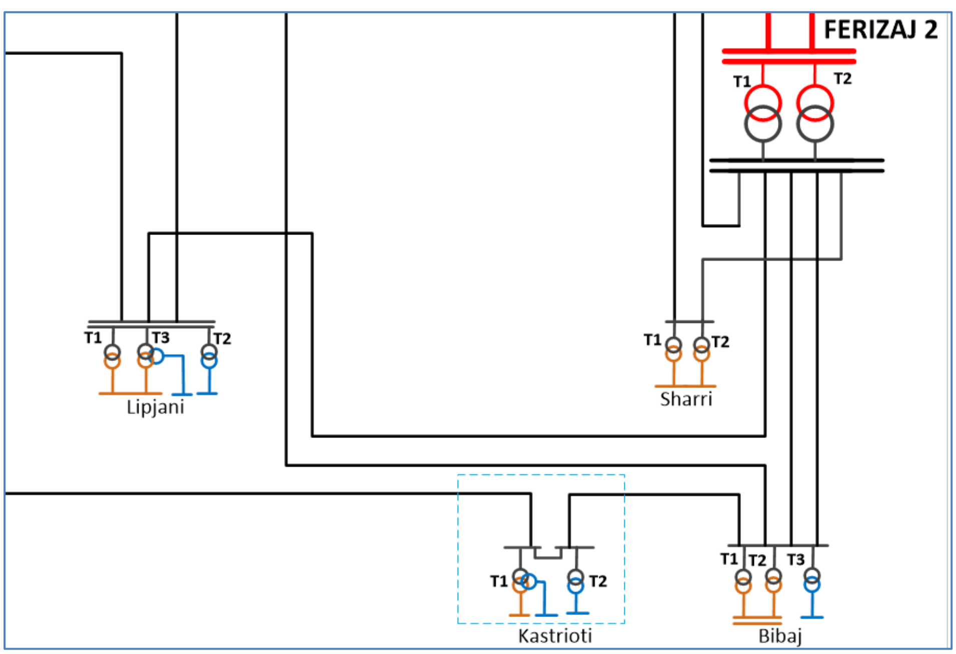


Figura 5-22. Connection configuration of SS Kastriot (Ferizaj 3) in transmission network

Expected benefits of the project include:

- *Reliable and quality supply of Ferizaj consumption*
- *Relief of transformers in SS Bibaj*
- *Reduction of technical losses in the distribution network*
- *Reduction of significant amounts of undelivered energy to consumers as a result of eliminating bottlenecks in the network of distribution*

The substation project with one transformer is in the initial phase of implementation (October 2021) and its energization is planned to be completed in the fourth quarter of **2023.**

- **Project: SS Fushë Kosova 110/10(20) kV**

The list of priority projects from the perspective of KEDS includes the construction of the substation Fushë Kosova 110/10(20) kV, close to the existing substation 35/10 kV. The rapid development in the Municipality of Fushë Kosova, in terms of high constructions after the war, which is also ongoing, has resulted with a continuous increase of electricity consumption. This substation is currently supplied by two 35 kV lines, 95 mm^2 from SS Kosova A and SS Prishtina 1. According to information from KEDS, the 35/10 kV transformation capacities have exceeded the critical limit, while on the other hand the load in the Fushe Kosova region tends to increase steadily.
For this reason, it has been deemed necessary to create a new 110/35/10(20) kV node in Fushë Kosovë, which will contain sufficient transformation capacities, initially a three-windings 110/35/10(20) kV transformer which will be connected to the current 35 kV supply network, creating an important 35 kV ring connected to SS Prishtina 1. The second 40 MVA transformer will be two-windings and will be installed two years later (2025) which will be included in the new credit program from KFW (investment program phase VI and VII). The construction of the substation will affect the discharge of transformers in SS Prishtina 1 and SS Kosova A and the reduction of power flows in the supply lines of SS Prishtina 1.

Within the projects credited by the EBRD, the supply lines infrastructure has been completed and energized, while the substation will be built from KOSTT's investments permitted by the ERO. The substation supply line infrastructure includes 2.91 km long double overhead line (360mm^2-AlSt) and 1.23 km double XLPE Al type cable line, 1000 mm^2.

The geographical position of the connection of SS Fushë Kosova is presented in the figure 5-23, while the connection of SS Fushë Kosova with the transmission network is shown in Figure 5-24.

Secondary side of the two transformers will be linked into the existing SS Fushe Kosova, 35/10 kV, eliminating voltage 35 kV. The dual connection of the substation enables the fulfilment of N-1 security criterion, allowing for sufficient secure supply of Fushe Kosova consumption.

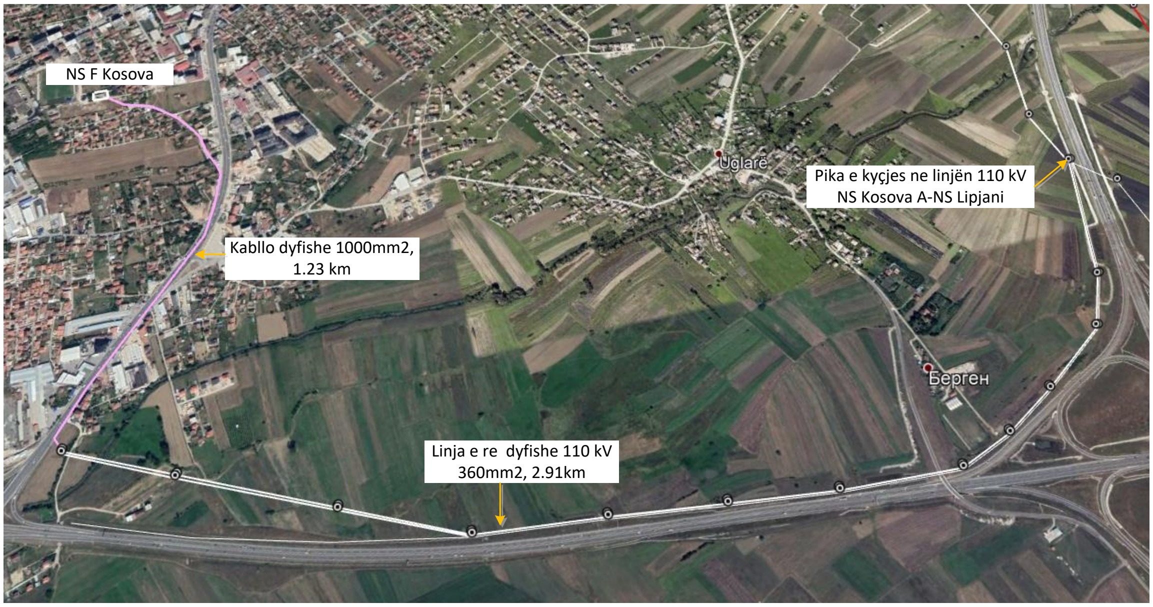


Figure 5-23. Configuration of connection of SS Fushë Kosova in the transmision network (approximetly conceptual route)

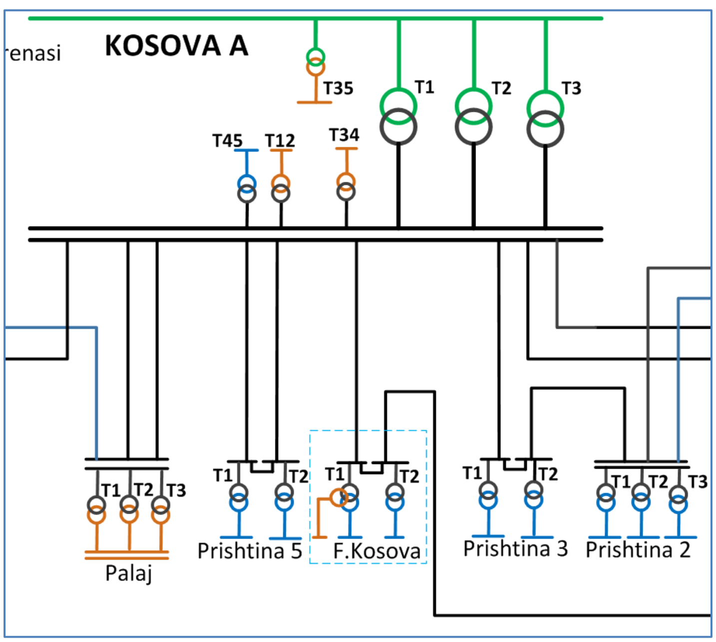


Figura 5-24. Connection configuration of SS Fushë Kosova in transmission network

Expected benefits of the project include:

- *Reliable and quality supply of Fushë Kosova consumption*
- *Discharge of transformers in SS Prishtina 1 and SS Kosovo A*
- *Reduction of technical losses in the distribution network*

- *Optimal use of the converted line (Kosova A - Lipjan – Ferizaj 2)*
- *Optimization of power flows in 110 kV lines supplying substations of Pristina as a result of discharge of the transformers in SS Prishtina 1 and SS Kosovo A*
- *Reduction of significant amounts of undelivered energy to consumers as a result of eliminating bottlenecks in the network of distribution.*

The project is scheduled to conclude in **2023.**

- **Project (ID/009): SS Dragash and 110 kV line SS Kukës-SS Dragash- SS Prizren 2**

Consumption of electricity in the region of Dragash and Zhur is realized through the distribution network 35 kV and 10 kV, extending in the southern part of the territory of Kosovo. The main supply line is 35 kV line connected to SS Prizren 1, 110/35/10 kV which supplies, in a serial connection, Zhuri and Dragash consumption. 35/10 kV substation is operating in Dragash, with two transformers of a total capacity of 8+4=12 MVA. Security of power supply for the areas in question is not satisfactory. During 2018 and 2019, KEDS has made some investments in the 35 kV networks which has significantly improved the highly critical situation, but such a solution does not guarantee continued security of supply for Dragash and operation of RESs connected to the medium-voltage network to that area.

Elimination of the aforementioned problems in the long-term is achieved after the construction of a new substation 110/35/10(20) kV, with a capacity of 2x40 MVA in Dragash and 110 kV lines as shown in the following Figure.

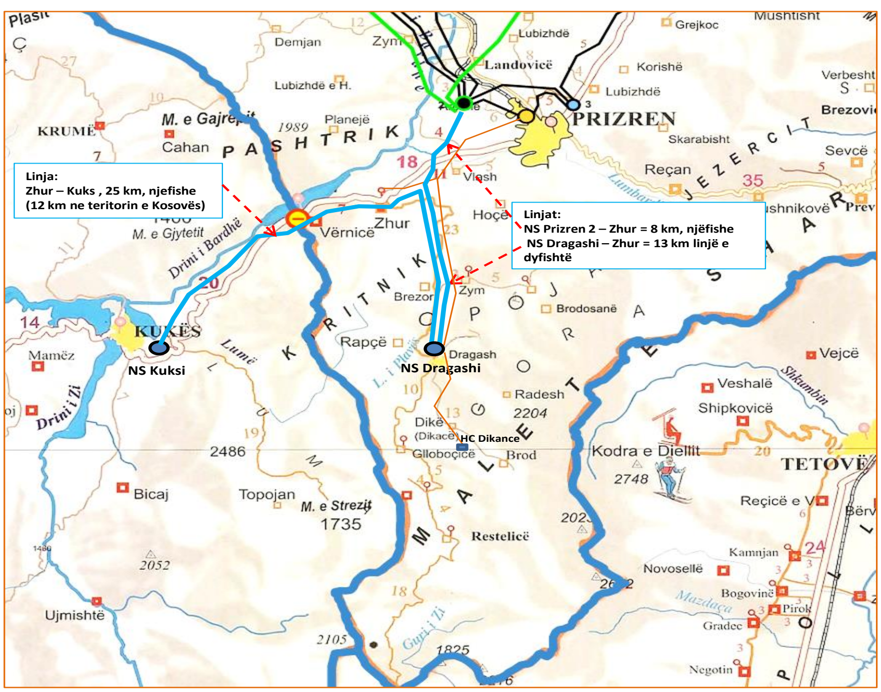


Figure 5-25. Dragash and 110 kV line project with SS Kukes.

Expected benefits from the Project:
Considering the Dragash region as an area with a high potential for development of mountain tourism and light industry, the construction of the new 110 kV substation will create optimal conditions to achieve the security of energy supply.

The network configuration surrounding SS Dragash project and the connection with the current distribution network is shown in Figure 5-26.

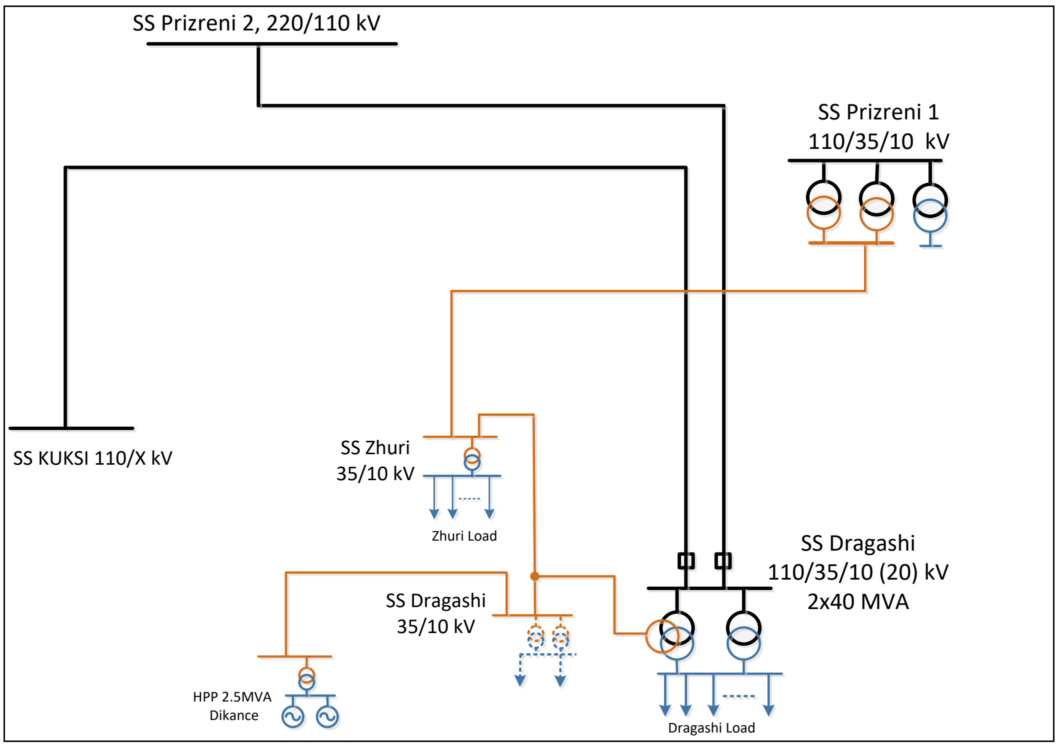


Figure 5-26. Configuration of network project: SS Dragash and 110 kV interconnection lines with SS Kukes

Benefits that Dragash customers will have are presented as follows:

- *Increased security of electricity supply through two 110 kV lines*
- *Quality and reliable supply*
- *Efficient supply reducing technical losses in the distribution network*
- *Relief of power transformers in SS Prizren 1 to a load equivalent to the consumption in the region of Dragash*

The project also includes the construction of the 110kV interconnection line, which will connect, for the first time, the 110 kV transmission networks of Kosovo and Albania. So, in addition to the importance of the project for supporting the load of Dragash, this is considered a project with mutual benefits for both Kosovo and Albania, especially after the start of the operation of KOSTT as a regulatory zone within the regulatory block of the AK (Albania-Kosovo).

Expected benefits for both countries are listed as follows:

- *Optimization of power flow between the two systems Kosovo/Albania which operate in one Regulation Block AK.*
- *Increased of the transmission network cross border capacitities*
- *The mutual exchange of electricity surpluses through radial or parallel operation of the interconnection line.*
- *Increased security and reliability of supply for Dragash and its surroundings, as per the N-1 criterion, through reciprocal supply*
- *Increased quality and efficiency of supply of Kukes*
- *Optimal conditions for maintenance of the 110 kV network for both systems KOSTT/OST*

Project is planned to be in operation in **2026.**

- **Project: Project Malisheva 220/35/10(20) kV**

The Malisheva Project was included in the list of capital projects for load support and strengthening transmission capacities of the network for the following reasons:

a) The situation of supply for the Malisheva region is unsatisfactory, as this region is currently supplied by a 35 kV line from SS Rahovec. The great distance of this line causes significant losses of active and reactive power, thereby adversely influencing the quality of electricity delivered to consumers. The 35 kV voltage level and other distribution levels during the winter load are below minimum allowed values provided in the distribution code. To achieve a sustainable and long-term electricity supply for the Malisheva region, it is necessary to develop a 220/35/10(20) kV substation, with transformation capacities of 2x40 MVA.

b) SS Malisheva will be connected to the 220 kV line SS Drenasi-SS Prizren 2, through a double line AlSt 490 mm^2 with a very short length of about 50 m, as shown in Figure 5-27.

This substation will also initially be built with only one transformer and the three-windings 220/35/10(20) kV transformer. The 35 kV transformer will enable the creation of a ring reserve that will connect SS Rahoveci with SS Malisheva using the current lines. This ring will mainly be used in specific cases (breakdown of transformers, transformer fields) in which case up to 20 MW can be transferred from one substation to another.

Figure 5-25 shows the geographical position of the Project. While the Figure 5-28 shows the unipolar configuration of the SS Malisheva connection in 220 kV network with two transformers.

Figure 5-27 Geographical position of SS Malisheva (approximate conceptual position)

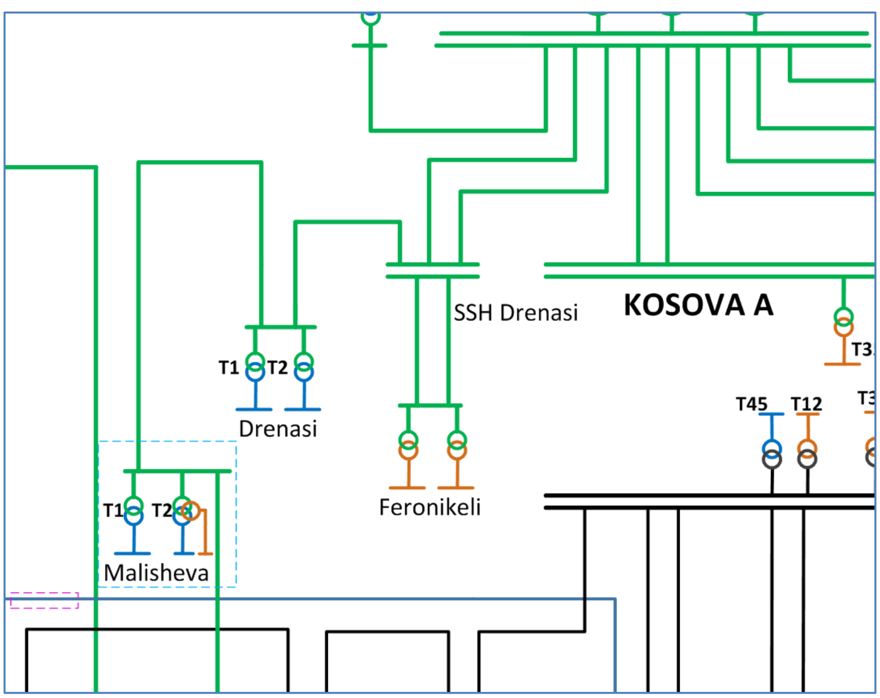


Figure 5-28 Single polar configuration of connection SS Malisheva in 220 kV network

Expected benefits from this project are:

- *Reliable and qualitative supply of Malisheva consum;*
- *Optimization of power flow and discharge of transformers in SS Rahoveci;*
- *Reduction of large amounts of energy not sent to the customer as a result of the elimination of bottlenecks in the distribution network;*
- *Reduction of technical losses in distribution network*
- *Support of economic development of Malisheva.*

Project is planned to be implement in **2025**.

5.4.4 Projects: Substations Re-vitalization

In determining the list of substations that required revitalization the following factors were taken into consideration:

- *Impact of the failure of the substations in the transmission system*
- *The age of the substation*
- *Frequency of the failures and damages in the equipments of the high voltage*
- *The level of the fault currents in the substations*

Probability of failures in high voltage equipment begins to rise with age of equipment, especially equipments that are greatly used. Also, the substations which are characterized by large currents failures considerably influenced in the accelerating the loss of their credibility. Based on data archived in KOSTT related to the above-mentioned factors a list was drafted of substations requiring revitalization in the first five years of the development plan.

- **Project: Support in the conversion of the 10 kV to 20 kV network of DSO**

Within the process of converting the 10 kV to 20 kV network planned by DSO for the next 10-year period, KOSTT and KEDS are harmonizing the synchronization of the two development plans of the two companies so that the implementation cost and technical effects are as optimal as possible. The conversion of the distribution network from 10 kV to 20 kV depends on several factors that involve KOSTT as follows:

- The readiness of transformers at the KOSTT-KEDS technical limit for operation with 20 kV voltage
- The readiness of transformer fields and interconnecting cables for operation with 20 kV voltage

The process has already started and is being implemented in the capital city's network, involving all substations: Prishtina 1, 2, 3, 5, 7 and Dardania (6).

Some of the new substations are ready for operation at 20 kV, while as regards Prishtina 2 and 3 substations, the need for the re-allocation of transformers with the possibility of operating at 20 kV from SS Burimi and SS Peja 2 to SS Prishtina 2 and Prishtina 3 has been raised. On this occasion, installations of elements of the transformer fields were also made which could not operate at the 20 kV level, such as circuit breakers, surge protection, current and voltage transformers, cables, etc.

The conversion project is a long-term project and as such will be harmonized with KEDS so that the implementation continues in areas where substations now have all transformers with the possibility of operating at 20 kV, such as: SS Podujeva, SS Vushtrri 2, SS Gjilani 5, SS Ilirida, SS Drenasi, SS Rahoveci, and projects in implementation or planning SS Kastrioti, SS Fushë Kosova, SS Malisheva and SS Dragashi. In these substations, investments by KOSTT will be very low, mainly the surge protectors must be replaced, which do not have the possibility of operating with two different voltage levels. In other areas, the sequence of conversion by KEDS must be harmonized with KOSTT's Plans for the replacement of transformers which, due to their age, will be replaced in the next 10 years

The summarized expected benefits are as follows:

- *Reduction of losses in the transformer as a result of the reduction of currents in the medium voltage winding*
- *Reduction of breakdown currents in medium voltage busbars*
- *Reduction of losses in the distribution network*
- *Increasing the distribution capacity*
- *Increasing the security of consumer supply*

- **Project: Revitalization of the fields of 110 kV and transformers lines in: SS Deçani and SS Prishtina 2**

The revitalization project of the 110 kV equipment in the aforementioned substations is expected to be completed in **2025**.

Replacing them with modern equipment is important for safe operation of the transmission system. The investment reduces maintenance costs, and increases the operational safety and reliability of the respective substations.

In SS Deçani, the revitalization of 5 110 kV fields must be done, which includes the replacement of all equipment except the circuit breakers which were revitalized earlier.

In this substation, the AC/DC supply system needed to increase the safety of the supply of protective, monitoring, telecommunications and other equipment must be modernized within the substation's own expenses.

Also, in SS Prishtina 2, the revitalization of 5 110 kV fields should be done, in addition to the circuit breakers that were replaced earlier. In this substation, the AC/DC supply system should also be modernized.

The summarized expected benefits are as follows:

- *Increasing the safety and reliability of the operation of the relevant substations*
- *Reduction of energy unsent to the consumer*
- *Increasing the safety of the personnel working in the substation as well as the maintenance personnel*
- *Reduction of maintenance costs.*

- **Project: Revitalization of SS Vushtrri 1**

SS Vushtrri 1 is one of the first substations built in Kosovo with a configuration that does not ensure adequate selectivity of the relay protections. The revitalization of this substation is necessary due to the fact that 3 110 kV lines are connected to its 110 kV busbars, one of which carries the power generated by WP Selaci

105 MW. The technical condition of the substation is not satisfactory and as such endangers the safety of the 110 kV network connecting Vushtrri 2, Trepça, Vallaqi and Ilirida. The current configuration of SS Vushtrri 1 does not ensure proper selectivity in case of breakdowns in one of the lines connected to the substation. The two 110 kV lines operate only through the transverse switch as shown in Figure 5-29. The breakdown in SS Trepça, which is currently connected to the 110 kV network in an unfavorable configuration in terms of network security, has had an impact in the deterioration of the security situation. The revitalization of the substation envisages the replacement of the 110 kV high voltage equipment, the replacement of the busbar system and portals by building a system with double busbars and a connecting field. The project is scheduled to be completed by **2025**.
The project is related to the project: Revitalization of the segment of the 110 kV SS Bardhi - SS Ilirida - SS Vallaqi line, in which case the two free fields of the 110 kV lines will be used for this project.

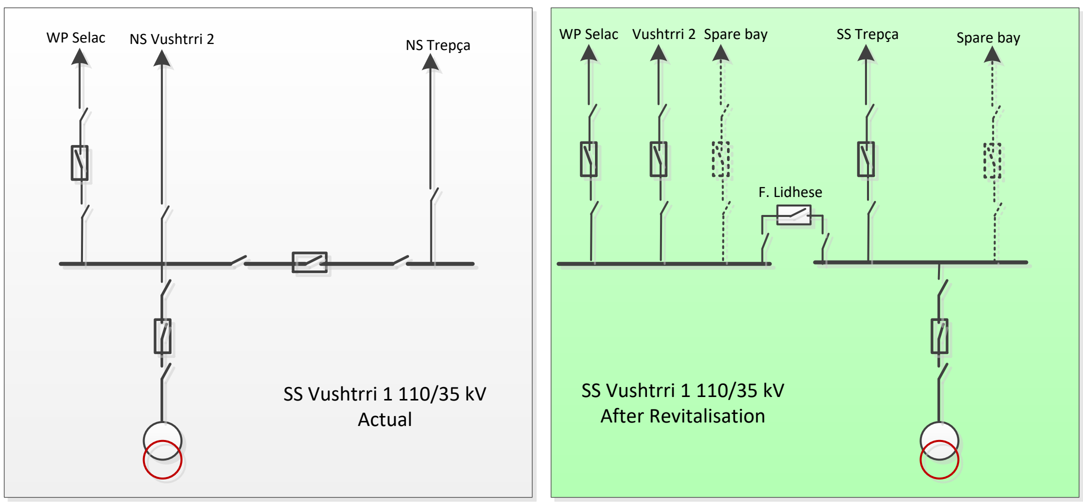


Figure 5-29 The actual diagram of SS Vushtrri 1 and the proposed revitalization diagram

The expected benefits of the project are:

- *Increasing the safety and reliability of the substation operation*
- *Increasing the operation security of WP Selac*
- *Reduction of energy unsent to the consumer*
- *Increasing the safety of the operation of the Trepça metallurgical industry*
- *Increasing the safety of the personnel working in the substation as well as the maintenance personnel*

- **Project: Re-vitalization of line fields and 110kV transformers in SS Klina and SS Burimi**

The re-vitaliziation project of the 110 kV equipment in the afore mentioned substations is expected to be completed in 2026.
Replacing them with modern equipment is important for safe operation of the transmission system. Investment reduces maintenance costs and increases operational safety and reliability of respective

substations. The second transformer should initially be installed in SS Klina in order to enable the installation of the transformer field, without interruption of supply for Klina.

The project includes:

- *Replacement of three line fields - 110 kV, two in Burim and one in Klina*
- *Replacement of second transformer fields - 110 kV, one in Burim and one in Klina*

Expected benefits are summarized as follows:

- *Increased security and reliability of operation of respective substations*
- *Reduction of undelivered energy to customer*
- *Increased security of staff working in substation and maintenance*
- *Reduced maintenance costs.*

▪ **Project: Re-vitalization of the substation SS Vallaq**

SS Vallaqi is one of the first substations built in Kosovo. Revitalization of this substation is necessary because of the fact that its 110 kV busbars are connected with five 110kV lines, one of which transmits electricity generated by HPP Ujmani. The technical condition of the substation is not satisfactory and it threatens the safety and reliability of supply to consumers. Revitalization of the substation envisages the replacement of high voltage 110 kV equipment, replacement of the busbar system and its portals with the development of a double busbar system but with connection field. The project is scheduled to be completed in **2027**.

Expected benefits from the projects are:

- *Enhancement of the security and reliability of the substation operation*
- *Optimization of the operation of the substation after crossing the double busbar system*
- *Reduction of undelivered energy to customers*
- *Enhancement of security of staff working on the substation and maintenance staff*

5.4.5 Projects: Advancement of the monitoring, control and metering system of the Transmission System

The following are TDP projects considered necessary to fulfill the requirements of the Grid Code and ENTSO-E Codes and country regulations.

▪ **Projekti: Marking overhead lines for aviation security**

According to Regulation (CAA - Civil Aviation Authority) no. 03/2019 on Marking of Obstacles, KOSTT is obliged to implement this regulation. This Regulation defines the procedures for marking obstacles with visual signs and lights in the territory of the Republic of Kosovo for the purpose of making them conspicuous to aircraft and helicopters. Pursuant to Article 6 paragraphs 6.1 of the Regulation the following are included:

6.1 Overhead wires, cables, etc., crossing a river, or valley and high voltage lines above 100 kV crossing a highway shall be marked and their supporting towers marked and lighted, except that the marking of the supporting towers may be omitted when they are lighted by high-intensity obstacle lights by day.

The regulation also defines the method of marking the obstacles, namely the towers and other the conductors.
The project has already started and during 2021 the implementation of the 220 kV lines began and will continue in stages until its completion in 2027, since the installation of signaling involves the disconnection of the lines and for this reason it requires time in the implementation as the opening of interconnecting lines which to a large extent pass over motorways and highways is done in a coordinated manner with the regional TSOs.
The project is based on the aforementioned regulation and stipulates that the two towers which connect the lines crossing the main roads, or the valleys and rivers should be coloured white/red, with flashing lights on top. On the other side, the protective conductors should have white/red marking balls at a certain distance so that they could be seen by aircraft and helicopter pilots during day and night.
Throughout the three voltage levels 400/220/110 kV there are a total of 105 intersections with two highways and 4 lane roads that are built in our country. 400 kV lines intersect 14 times, 220 kV lines intersect 13 times, and 110 kV lines intersect 78 times, on four-lane highways and main roads.

Benefits from the project:

- *Increasing the safety of aviation flights in the territory of the Republic of Kosovo*
- *Avoiding fatal airplane and helicopter accidents.*

- **Projekti: Replacement of the Existing SCADA/EMS System in NDC and NEDC, Supply and installation of equipment for adoption of Local SCADA (RTU and SCS)**

Considering that the existing SCADA/EMS system was designed based on the information technology, normative codes, and standards that have been used during 2008-2009 and based on recent technological developments and advancements in SCADA/EMS systems, which are integrated into the ENTSO-E TSO, than our system can operate until 2023 under existing condition, and after that will have to be rebuilt based on the ever-evolving technological developments and requirements stipulated by ENTSO-E.

Below have been provided the facts showing the reason that the existing system should be rebuilt:

The project will include:

- Raising the level of control in the transmission system by fulfilling the technical-technological requirements, the requirements of ENTSO-E as well as the fulfillment of the requirements from the legal and regulatory framework related to the transmission system operation by the National Main and Emergency Dispatch Center;
- The inclusion of all electrical facilities within the infrastructure of SCADA\EMS in accordance with the TDP;
- Completing the creation of technical conditions for mutual monitoring with neighboring TSOs in real time in accordance with "Inter TSO Agreements" with TSOs of neighboring countries;
- Enabling the exchange between TSOs of all post-operational data in normal and incidental situations (critical situations in the case of network incidents and sensitive imbalances);

- Full implementation of the use of the technical infrastructure for access to the EAS (Energy Awareness System) platform within ENTSO-E.
- Instalimi i RTU-ve dhe SCS-ve të reja në nënstacione.

Based on all the facts mentioned, and KOSTT's fundamental and essential duty of secure and reliable operation of the Kosovo Transmission System in real time, the project is necessary at the time for which it is planned.

Expected benefits from the project:

- *Completion of technical requirements required by ENTSO-E in terms of monitoring and control systems*
- *Increased the security of operation of the Relation Block AK (Albania – Kosovo)*
- *Increased security of transmission system operation in terms of network operation in the ENTSO-E synchronous area*
- *Exchange of data with the Security Co-ordination Centres, which are expected to be soon developed in the region of South-eastern Europe, based on new formats and protocols for data exchange.*
- *Adequate protection from possible cyber-attacks that could endanger the country's security of supply.*

The project is planned to be operational in **2023.**

- **Project: Migration to advance telecommunication systems**

Currently, KOSTT has a telecommunication network based on TDM technology that delivers various operating applications used in substations and control and centers for control and monitoring. Most applications are created and adapted to circulate through networks based on IP or Ethernet, such as SCADA, high voltage measurement, etc. Other sensitive remote protection applications still use dedicated transmission lines. However, due to the evolution of smart electrical networks, the ever-increasing need to reduce costs and increase efficiency and flexibility, require even the most critical services to connect to a telecommunications network. Moreover, there is a growing need for increased bandwidth in substations due to increased use of video surveillance and communications such as internet access or intranet across substations and main centers.

During the development and implementation of the projects, the demands for additional services and capacities through the existing telecommunication system have also increased.

With the system network of the existing SDH/PDH telecommunications equipment, it is not possible to fulfill the requests for other services and additional capacities, due to the bottlenecks (maximum utilization of the capacity in the telecommunications links) at the data collection points. It is worth noting that the existing system does not have technical support from the manufacturer. It is also a request from ENTSO-E and from the Manual: "Electronic Highway Technical Reference Manual" (TRM) for the implementation of MPLS-TP technology in the telecommunications system in Transmission System Operators.

Through this project, the telecommunication system equipment will be replaced in substations to enable the normal operation of the telecommunication system.

This project includes the development component of the telecommunications network for the needs of KOSTT, enabling the provision of telecommunication links with greater capacity for KOSTT's internal services, the implementation of requirements for system data exchange with regional TSOs, and the fulfillment of the criteria in relation to the cyber security.

Expected benefits from the project are:

- *Bandwidth: to meet wider bandwidth requirements, respectively communication speeds for applications such as video surveillance etc.*
- *Network segmentation, for various services and applications*
- *The quality of the application, respectively setting the appropriate priority and network performance for individual applications*
- *Redundancy and network protection for highly required and required applications. For most applications, outages for activating the backup path should not last more than 50ms, as is the case with SCADA.*
- *Loss limitation, delays for critical time applications. In some cases, delays should be non-existent, such as applications that still use PDH interfaces inherited as remotely protected.*

The project is expected to be operational in **2024**, which means that the current telecom systems will be exploited for the next 5 years.

5.4.6 Projects of category: Generation support (in implementation)

After the construction of WP Kitka 32.4 MW and WP Selaci 105 MW which are successfully operating in the transmission network, in the current period there are no projects that are in the process of implementation. In the next decade, based on the Energy Strategy 2022-2031, the transmission network should be ready to integrate an additional 600 MW from wind sources and an additional 600 MW from solar parks, including 45MW+125 MW storage batteries for balancing system needs in real time. At this stage of the compilation of the TDP 2023-2032, the new RES locations are not yet known in order to assess the need for strengthening the transmission network.

6. ENVIRONMENTAL IMPACTS

6.1 Environmental protection

Continuous caution for environment will be part of the overall KOSTT Policy and engagement of this police is addressed in the certification of KOSTT with ISO 14001:2004 Standard. KOSTT Development Plan will take measures to prevent and correct any mistake that is referred to the environmental protection in accordance with the internal and external legal bases. Negative impacts mainly include terms of the impact of electromagnetic fields (EMF), noise and visual impact on the environment (more important effects).
It is a primary objective for KOSTT for the future to put particular attention to gaps, which can directly or indirectly affect the health and wellbeing of the KOSTT staff, and certainly the health and wellbeing of parties outside of KOSTT.

6.2 Environmental problems in the transmission system

We can say that the Environmental problems in the transmission system are divided into following:

- Environmental problems caused by the lines, and
- Environmental problems caused by the substations

6.2.1 Environmental problems caused by the lines

Today when there is an imperative need for the energy development of our country, appeared in this Development Plan, we need to adjust the priority of the requirements, being aware of their impact on the environment. Therefore, we can say that the priority is set towards a necessary development of electricity transmission of high voltage (during the above elaboration this need is reflected and justified), not avoiding the need to minimize the possible impacts on the environment.
Most of the lines pass through the agricultural areas, while a little less of those lines that pass on the mountain ecosystems where their impact is not so expressed.
From the aspect of electromagnetic radiation, greater influence has the industrial frequency electromagnetic fields. The research of harmful effects of this type of non-ionizing radiation on man have not yet given the final answer, but it should be noted that nowadays there is a special interest for the possible effects of electromagnetic fields on electrical equipment as well as on the living creatures, especially on people. On the moment of the legal sanction of electromagnetic impact this plan will take into consideration and will be subject to TDP's implementation.
Therefore, KOSTT for this reason has carried out appropriate measurements by independent for the most sensitive aspects of the environmental impact and the results have shown that the level of electromagnetic radiation in the vicinity of the lines does not exceed the recommended values of the World Health Organization.

6.2.2 Environmental problems caused by the substations

Besides occupying the surfaces substations carry the biggest visual changes in their surroundings, but in aesthetic terms do not affect significantly, since under the rules they should be located outside residential areas. The continuous noise caused (transformers work) or the non-continuous work (disconnection equipment/circuits), the most direct impact on the environment of substations, and due to vegetation relief is rarely transferred to the residential areas, but in the substation's location, it is possible to have greater value, but within acceptable limits for professional staff. In modern equipment, breakers/disconnections include inert gas, hazardous for human health of not used properly and sufficiently (timelines are specified and gas releases must be sporadically measured), but have a undesirable impact in the ozone layer and with toxic products in small concentrations, which are caused during the working process in equipment.
Having in mind that there are strict procedures in accordance with international rules, in the use and maintenance of SF_6 circuits, it is proposed that the implementation of SF_6 technology, is ensured after a period of time, when we consider the need to add gas, detectors issuing leaking warning near the switch, followed by measurements of compensated amounts, and also through adequate measurements, so that the risk index will be brought to minimum.
In areas with high urban density, KOSTT is applying the GIS technology of substations, in which case the visual problem is avoided since the high and medium voltage equipment is placed inside the substation facility, except for the power transformers which are built outside the substation. So far, KOSTT has applied this technology to SS Dardania 110/20 kV, SS Drenasi 220/10(20) kV, SS Ilirida 110/10(20) kV which are now in

operation. Also, two new substations are expected to be GIS: SS Kastrioti and SS Fushë Kosova, which will be energized in 2023 and 2024.
Large quantities of synthetic oils found in power transformers, while a little less in the high voltage equipment. Having in mind that oils possess a high potential for environmental pollution, adequate measures are taken, such as the construction of collecting pool and protection for collections of any oil leakage. These pools at the same time are a kind of prevention in cases of large failures likely to occur.

6.2.3 Caution on the other environmental impacts

At a time when the need for more and more energy is growing, the real impact on the environment and aims for qualitative protection of this segment including this TDP that supports the following:

- Reduction of emissions in water, air and land
- Increase of energy efficiency
- Enforcing preventive measures in order to reduce the number of accidents
- Addressing remains, particularly hazardous ones
- Possibility for recycling in many functional forms, including in indirect ways
- Development of systems for data collection and database (electronic forms)
- Reduction of obsolete parts and equipment that are assembled
- Follow-up of gaps in the line system
- Drafting documentation for this transmission segment
- Construction of dual lines, where there are possibilities to rationalize the use of surfaces and corridors
- In general, the improvement of the use for transmission where possible.

All these are implemented in preliminarily planned time frames, such as:

- Reducing the damage done in the past
- The impact reduction of ongoing activity in the relevant sector, and
- Prevention of pollution from activities in the future (e. g. EIA - Environmental Impact Assessment and preventive measures in proper reduction)

6.2.4 Activities and advancements during the period

1. Compilation of numerous documents on environment and protection from corrosion.
2. One of the important KOSTT projects, which was finalized during the period, included the analyses of toxic oil matters (PCB and PCT) in power transformers. The analyses revealed good results, as no PCB or PCT traces are found in any of the transformers possessed by KOSTT. The said analyses were performed in an Italian laboratory licensed for such examinations – in this aspect, the green mark is our protective sign.
3. KOSTT has made measurements of electromagnetic fields (EMF) inside substations and at certain points under and near high voltage lines, as well as measuring physico-chemical parameters and micro-climatic conditions to understand their impact on our employees and external parties. Of course, a Report has

been provided from these impacts with modern instruments, in which case it has been proven that the measured values for EMF are within the limits defined by the International Organization on Non-Ionizing Radiation Protection. All as well as other physico-chemical parameters, such as noise, dust, lighting, temperature, etc., are within the permitted standards and norms. The measurements were carried out by certified institutions for the mentioned measurements.

4. Noise impact in detected and monitored locations, in direct vicinity of our staff's workplaces preventive notification measures have been taken and new protective equipment for our staff was ordered.
5. Regarding waste, we were incorporated in the Municipal Recycling Project, and have drafted the Initial Project for paper and plastic waste recycling.
6. Through the Sector for Safety, Health and Environment, KOSTT has continued with the organization of presentations of programs for information, training and education for safe work and environmental protection.

6.3 Environmental plans

Long-term environmental planning will support the interest and Development Plan of KOSTT as a whole, aiming:

- *Good financial management, leading to better environmental control.*
- *Work on preventive measures to adapt to international standards and legal requirements*

Therefore, KOSTT will include all parts of the operation that have an impact on the environment, but controlling the cost and its impact on the overall budget.

In addition, from all that was mentioned, the following must be adhered to:

- *Domestic legislation (environment, energy)*
- *EU Legislation (environment, energy)*
- *Technical Codes in KOSTT*
- *International standards and norms,*
- *Conventions signed, etc.*

KOSTT values environmental protection in Kosovo and beyond, as a high priority. The application of the environmental management system and the action in accordance with the requirements arising from the certification according to the ISO 14001:2015 norm will affect the continuous progress of the reports towards the environment. Certification with the ISO 14001:2015 standard is an additional opportunity to fulfill the requirements and the continuous advancement of the criteria that emerge from it for a better management of the working environment, in addition to the integrated quality, environment and safety management system. With the activities for the application of the environmental management system, KOSTT has started since 2009. The International Standard ISO 14001:2015 today is the most advanced standard for environmental management, which is applicable in any enterprise that wants to apply, maintain and continuously improve its environmental management system. The implementation of such an approach by the company is a voluntary process. Special attention to the environment is also paid during the implementation of the projects. In the process of project planning, depending on the legal requirements, studies of the environmental impacts of energy facilities are carried out, even though the activity of KOSTT is not considered among the activities that have a high potential for environmental pollution.

The important provision of the International Standard ISO 14001:2015 includes the obligation of the company in the personal environmental management policy, with which the company defines its strategy and goals in relation to the environment, realizing its goals so that they are implemented in practice. With the environmental and safety management system, equal criteria are introduced, within which it is possible to plan, implement, verify and review all possible impacts on the environment and environmental protection measures in all business segments in KOSTT.

The basic principles related to environmental management include the recognition of the aspects and impacts on the environment on the basis of which goals and programs are presented, the measurable results of their implementation are forwarded, therefore, activities for permanent improvement are periodically undertaken.

In order to compensate for the deforestation along the high voltage lines, to maintain the safety and normal operation of the lines, KOSTT plans to support the planting of trees and the greening of the surfaces in cooperation with the central and local institutions.

From the certification with the environmental and safety management system, positive effects are expected, such as: improvements in the state of the environment and personal safety, more rational investments in environmental protection and safety projects, as well as many other similar effects. On the other hand, an advancement in relation to the competent institutions is aimed at, raising the responsibility and awareness of the protection of the environment and safety as a whole, as well as improving the business overview to the general public, which contributes to the fulfillment of the basic business goals.

In addition to the development, rehabilitation and modernization of technology in the Transmission System, the ongoing challenge is also the prevention and management of industrial waste that is mainly caused by the rehabilitation and modernization of technology in substations and the dismantling of electroenergetic appliances and equipment, their temporary storage and care for a healthy environment with special emphasis on substances with the highest risk for people and the environment. KOSTT is committed and will commit to ensure that waste management is in accordance with the legislation in force, the policy for environmental protection and the standard for the environmental management system.

Also, special attention is paid to the monitoring of physico-chemical pollutants and micro-climatic conditions in the workplace

After the completion of the projects for the measurement of EMF (non-ionizing radiation) and the measurement of physico-chemical pollutants and micro-climatic conditions at the workplace in substations and high-voltage power lines, including certain parts in the central directorate facility, the monitoring of pollutants and other parameters continues, as a commitment to a healthy environment and fulfillment of legal requirements according to the Law on Safety and Health at Work, the Law on Environmental Protection, the Law on Noise Protection and the Law on Protection from Non-Ionized, Ionized Radiation and Nuclear Safety.

The realization of the high-capacity battery project for the storage of electricity BESS, from the Compact Project with MCC, represents innovation for KOSTT, apart from the technological aspect, also from the aspect of safety and environmental protection. For this KOSTT will be fully committed to the application of international best standards and practices, in the implementation of procedures for a safe environment.

With this approach, KOSTT as a public enterprise becomes a permanent, aware and responsible member of the environment in which it operates as well as through the system it applies, in order to improve the quality of life in the immediate environment, as well as at the level global.

7. EXPECTED RESULTS FROM TDP 2023-2032 IN THE TRANSMISSION SYSTEM DEVELOPMENT

The Kosovo transmission system must be continuously developed in a manner of allowing for a secure, reliable and quality supply of consumption, pursuant to technical requirements of the Grid Code and the Operation Handbook of ENTSO/E. An adequate and sustainable transmission system development provides for favorable conditions of development of conventional and renewable generation capacities which are expected to be dominant in the next decade. Appropriate long-term planning for transmission system development is essential to meeting the abovementioned requirements. The Transmission Development Plan 2023-2032 has identified medium and long term needs for infrastructure projects, necessary for the enhancement and maintenance of the operational performance of the system, in relation to development in consumption, generation and regional energy markets.

The TDP 2023-2032 sets forth the development priorities broken down by categories and implementation timelines. The full implementation of transmission development plans is challenging even for most developed countries. Difficulties in accessing property, global economic crises, lack of financial resources, and social implications, are some of the factors which may slow or prevent the realization of projects which are necessary to be considered by planning engineers. Positive impacts of completed and ongoing projects have been analyzed in the previous development plan, while the following are general comments on new development projects presented in the TDP 2023-2032.

Developments in the last 5 years in the transmission system have created conditions for KOSTT membership to ENTSO-E. Regarding the fulfillment of the technical requirements of ENTSO-E which are mandatory for each transmission operator operating in the common synchronous area of Europe, with the recent investments both in increasing the transmission capacities, security and reliability of the system as well as development of modern systems for measurement, monitoring and control, KOSTT is in the same, or possibly better position than some of the regional TSO-s which are already members of ENTSO-E. KOSTT will be fully ready for membership. With the start of KOSTT's operation as regulatory zone within the regulatory block AK, the membership process in ENTSO-E shall not have any technical restriction.

7.1 Actual state of the network in 2022

The current transmission system of the Republic of Kosovo operates under optimal conditions as a result of investments made in the last decade. The number of unplanned outages of lines and transformers, the amount of energy not supplied is satisfactory reduced compared with the previous period when the transmission system was not developed in coherence with the development of the system load.

The system under normal condition (N criteria), in all modes of operation with maximum load and minimum are operating optimally. In the last three years, was noted an increase in the horizontal network voltage level; this increase is mainly noticed in 400 and 220 kV level, as presented in figures 7-1 and 7-2. Throughout several periods, particularly during the summer regime of system operation, the voltage level exceeds the nominal maximal values set by the grid code. This high-level voltage creates great constraint to the insulation of 400 kV equipment, risking dangerous failure of busbars system and on the other hand impact the reduction of equipment lifespan and increasing losses in transformer cores (losses in iron). This problem cannot be solved in isolation by KOSTT alone, as this is a regional problem resulting from the construction of numerous 400 kV lines in the region and without the compensation of reactive power. On the other hand, the load level of the horizontal network of South-East Europe Network was reduced due to the economic recession in the region. This problem a few years ago has occurred in the horizontal network of Croatia, Bosnia and Herzegovina, whereas gradually expanded in the areas close to our transmission network.

Operationalization of the new 400 kV lines in the region without adequate compensation with a low load level caused the presence of surplus of reactive power capacity, thus significantly increasing the voltage level. This problem cannot be solved in an isolated manner by the individual TSOs; therefore, a regional study is being carried out currently and will define optimum points for installing inductive reactors, which would have an impact on brining the voltage level within the allowed level. Operation at high voltage is not good for the electro-energetic appliances as it causes high constraints to the isolation and increases losses in the transformers core. KOSTT, by changing the network typology and in cooperation with neighbour TSOs, has tried to manage the voltage levels so they do not exceed critical values. This is mainly achieved with the disconnection of parallel lines and lines with low level of loads, through the coordination of National Dispatch Centres, in compliance with agreements between TSOs.

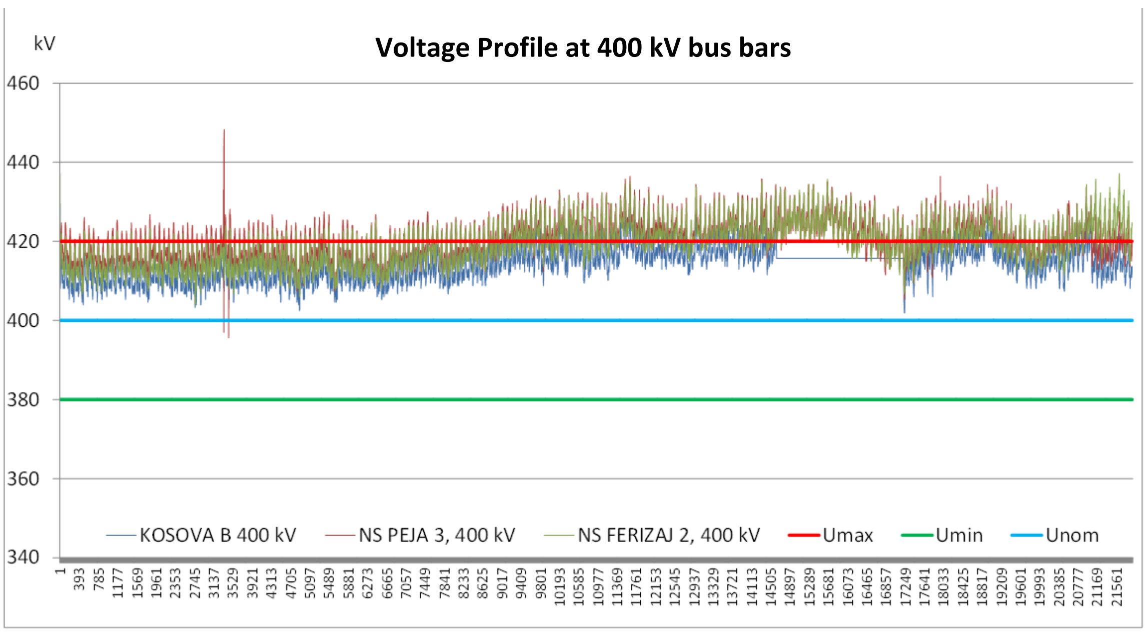


Figure 7-1. 400 kV voltage profile every 15 minutes, recorded from SCADA for 2022 (January-August)

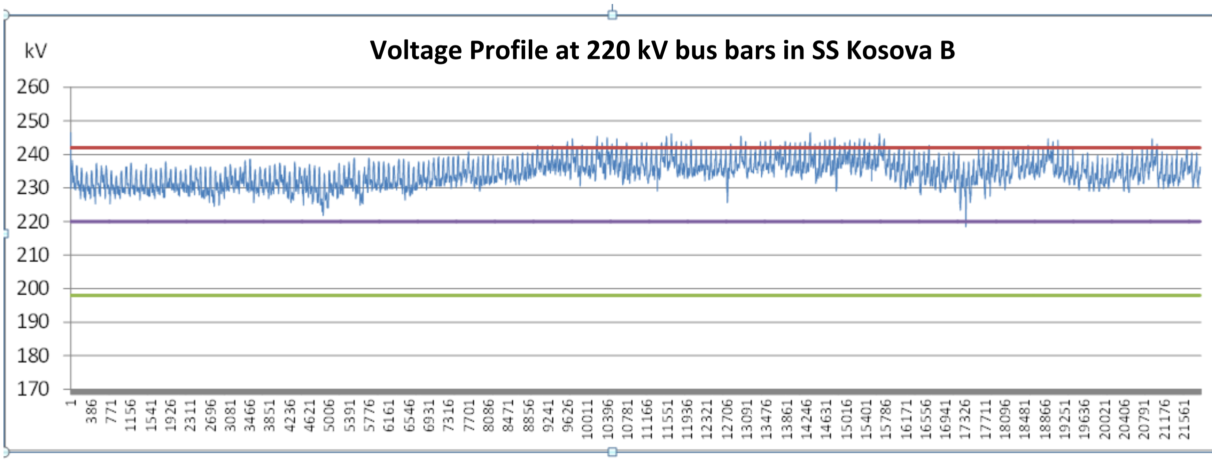


Figure 7-2. 220 kV voltage profile every 15 minutes in SS Kosova B recorded from SCADA for 2022 (January-September)

The level of power losses is included in the saturation zone and almost is the same as with three previous years. The greatest losses are usually caused in 110 kV lines, while the horizontal network losses are dependent on the balance of the system as well as power electric transits flowing in our network. Table 7-1 shows the level of power losses calculated from simulations with PSS/E for the maximum load of the system 1439 MW. Participation in the total losses during the 2021 peak in the transmission network mainly dominates the lines with 70% while the tranformers with 30%. It is noted that transformers in border with KEDS, caused about 20.1 % of total power losses in KOSTT. A large part of losses (around 4 MW) is attributed to losses in iron. These losses depend on the voltage; therefore, they cause a significant loss of active energy, which is around 35 GWh per year. In the general aspect of the reactive power balance of the system, in the vast majority of the year the network is balanced, namely during minimum loads the system is over-compensated, while during maximum loads the system needs around 108.4 MVAr which are obtained from local generators and interconnection.

Table 7-1. Participation of lines and transformers in transmision network losses -2021 during maximum load

Power Losses / Topology Q4- 2022	P(MW)	Q(MVAr)	ΔP(%)
Total losses in 400 kV lines	1.9	-112	6.7%
Total losses in 220 kV lines	3.9	-11.6	13.8%
Total losses in 100 kV lines	14	13.1	49.5%
Total losses on transmission lines	**19.8**	**-110.5**	**70 %**
Total losses in 400/220 kV transformers	0.4	25.5	1.4%
Total losses in 400/110 kV transformers	0.9	25.1	3.2%
Total losses in 220/110 kV transformers	1.5	49.9	5.3%
Total losses in distribution transformers	5.7	118.4	20.1%
Total losses in transformers	**8.5**	**218.9**	**30.0%**
Total losses in the transmission network	**28.3**	**108.4**	**100**

In aspects of N-1 criteria, when an element falls off surprised, in transmission network are still occur constraints relatively small compared with previous years and especially if consumption is higher than 1439 MW. In the following table 7-2 presents the critical failures and critical system elements analyzed through computer simulations in PSS/E.

Tabela 7-2. Lista e rënieve kritike dhe elementeve kritik te sistemit 2021

N-1 nalysis with HPP Ujmani in Operation				
Nr	**Critical Outage Q4-2021**	**Loading of element**	**It[%]**	**Bus with voltage drop > 10%Un**
1	L 110 kV Prizren 2-Prizren 3	L 110 kV Prizren 2-Prizren 1	120	Tensioni mbetet mbrenda kufijve te percaktuar me Kodin e Rrjetit
2	L 110 kV Prizren 2-Prizren 1	L110 Prizren 1-Prizren 3	110	
		L 110 kV Prizren 2-Prizren 3	117	
3	L 110 kV Prishtina 4-Prishtina 2	L 110 kV Kosova A-Prishtina 3	123	
		L 110 kV Prishtina 2 -Prishtina 3	95	
4	L 110 kV Kosova A-Prishtina 3	L 110 kV Prishtina 4-Prishtina 2	124	
5	L 110 kV Vushtrri 1-Vushtrri 2	L 110 kV Trepça-Vallaq	116	WP Selaci maximal output 105 MW
N-1 nalysis without HPP Ujmani in Operation				
6	L 110 kV Vushtrri 1-Vushtrri 2	L 110 kV Trepça-Vallaq	119	WP Selaci maximal output 105 MW
		L 110 kV Trepça - Vushtrri 2	91	
7	L 110 kV Palaj-Ilirida	L 110 kV Trepça-Vallaq	92	

Over the next two years part of the network that connect SS Prizren 2 with SS Prizren 1 and Prizren 3 will continue to remain a critical for larger loads than 1260 MW. However, this problem may be avoided with specific network configuration, namely by opening the line Prizren 3- Theranda. Loads over than 1260 MW has probability about 0.36% (32 hours per year) to happen in the next two years, so the impact on the security of the system will be relatively small. The problem in this part of the network will be solved after the commissioning of the new line 110 kV SS Prizren 2 – SS Prizren 1 and re-vitalization of line Prizren 1 - Prizren 3. Also for national load over 1300 MW, if the 110 kV line Kosova A-Prishtina 3 fails, the overload will appear on the Prishtina 4-Prishtina 2 line. The problem will be solved after the implementation of the construction project of the cable line 110 kV SS Prishtina 4- SS Prishtina 2.

The northern part of the 110 kV transmission network, after the enormous increase in peak and consumption in the northern part, still does not meet the N-1 criterion for certain modes of operation of HP Ujmani and production of WP Selaci. The revitalization and reinforcement project of the Kosova A- Palaj-Ilirida Vallaq ring will solve the security problem in this part of the network in the long term.

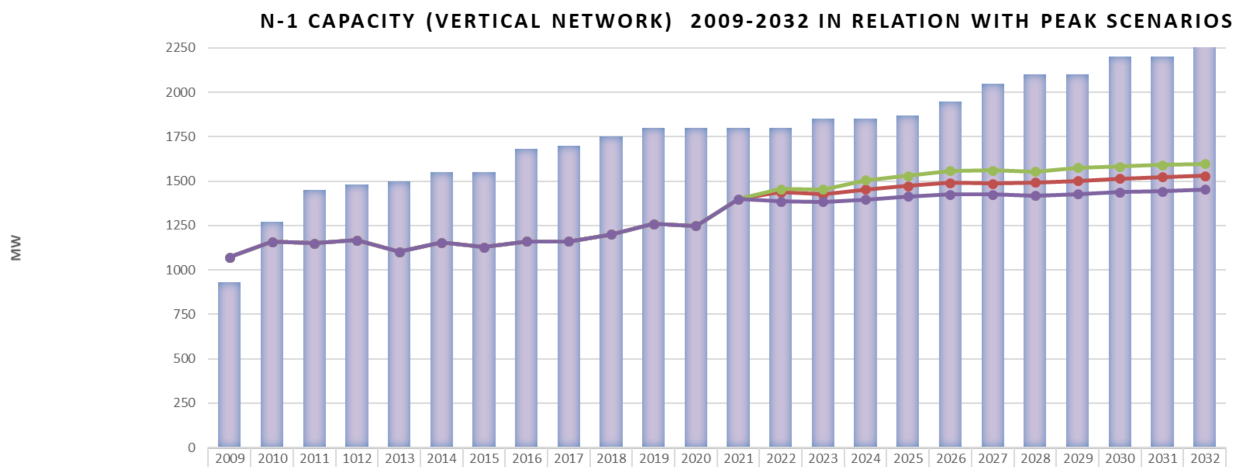
If we refer to the short time when the transmission network does not meet the N-1 criterion, we can say that the transmission network in terms of 400, 220, 110 kV lines and auto-transformers in principle meets the N-1 criterion, since the overcurrents protection systems of the lines during the winter season are adjusted above the nominal thermal value of the lines.

There is no under-voltage problem, as far as the N-1 criterion is concerned, which means that any unplanned drop in a voltage element (line or transformer) at the busbars of the transmission network will remain in the allowed voltage band according to the Network Code. However, during the regime with minimum loads during the summer in the 400 kV and 220 kV network, over-voltages appear temporarily that exceed the maximum values. These overvoltages are caused by the regional grid, so the choice of the problem is the coordinated regional installation of reactors at the points already determined. Such a reactor with a power of 100 MVAr will be installed in SS Ferizaj 2, at the level of 400 kV and its role will be to eliminate over-voltages in the transmission network.

However, in the aspect of transformation, substations 110/35/10 kV still have nodes which do not fulfil the N-1 criterion especially after the enormous peak increase from 2020 onwards. A part of the reserve supply in case of transformer outage may be realized through distribution network 35 kV and 10 kV. From 28 substations supplying the distribution network, 20 substations fulfil the N-1 criterion in terms of transformation, 3 substations fulfil the N-1 criterion through the 35 kV ring network, and 5 substations do not fulfil the N-1 criterion. These substations have a dual voltage system, whereby the 35 kV network fulfils the N-1 criterion, whereas the 10 kV network, upon line failure or during maintenance of transformer 110/35/10 kV, cannot be supplied. Such substations are: SS Prishtina 1, SS Ferizaj 1, SS Prizreni 1 and SS Peja 1, whereas SS Klina has only one transformer 110/10 kV.
The projects of replacing transformers with higher capacity, additional transformers and four new substations will create conditions that the N-1 criterion will be fulfilled even in the transformer at the line with KEDS in a large number of substations.

7.2 Development of the transmission network capacities in the next 10 years

Implementation of planned projects determined from planning process of CBA will enable the continuous development of internal capacity in the network which will create favorable conditions for the safe and efficient supply of consumption, as well as wil create favorable conditions for the generation support. Constructions of new substations, 110 kV lines, and construction of SS Nasheci 400/110 kV, will be key reinforcements that will result in enhancing the capacities of the transmission network.
The figure 7-3 shows the network's internal capacity building diagram in relation to the load for the next 10 years according to three scenarios of peak development. Since 2010, the transmission network has been operating with sufficient transmission reserves and with an increased trend in terms of N security criterion. This means that under the conditions of maximum load system operation, wherein all network elements are operational, no critical values of electricity and voltages are noticed in any of the lines, transformers and transmission system busbars.



	2009	2010	2011	1012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
Internal Capacity-N [MW]	930	1270	1450	1480	1500	1550	1550	1680	1700	1750	1800	1800	1800	1800	1850	1850	1870	1950	2050	2100	2100	2200	2200	2400
Base Peak [MW]	1072	1158	1150	1168	1101	1154	1129	1160	1161	1201	1260	1249	1398	1439	1426	1455	1472	1491	1486	1493	1502	1514	1524	1529
High Peak [MW]	1072	1158	1150	1168	1101	1154	1129	1160	1161	1201	1260	1249	1398	1455	1455	1505	1531	1558	1561	1554	1575	1583	1590	1597
Low Peak [MW]	1072	1158	1150	1168	1101	1154	1129	1160	1161	1201	1260	1249	1398	1385	1383	1396	1413	1424	1425	1419	1427	1438	1442	1453

Figura 7-3 Development of internal (vertical) network capacities in relation to load development for the next ten years

The capacity of the interconnection lines of the transmission network in Kosovo will be much higher than the needs for imports, or opportunities for exports of electricity that our country will have in the next 10 years and considering the volume of significant transit flows (in our network) for the region needs. But on the other hand in the regional network may appear restrictions that are difficult to realize high volume of imports. In most cases the net transmission capacities (NTC) presented by the TSO-s in the region, are significantly lower than they are in reality.

Figure 7-4 shows the indicative values of the simultaneous interconnection capacity (KNTI) for export and import calculated in a regional model and generation adequacy assessment for three generation development scenarios. The calculated capacity takes into consideration the N-1 criteria for all horizontal network of the transmission systems of the countries in the region.

If we refer to the planned generation developments in Kosovo according to the Energy strategy 2022-2031, the horizontal network will be able to accommodate significant generation capacities in full compliance with the technical criteria required by ENTSO-E.
Due to the operation of KOSTT within the AK Regulatory Block, new interconnecting capacities with Albania in the next decade are necessary for the exchange of surpluses and balancing power between the two countries. The installation of flexible units is also needed in Kosovo in the next decade, to accommodate wind and solar RES according to the goals of the Energy Strategy 2022-2031.

Figures 7-7 till 7-12 shows the geographical maps and the single line diagram of the system of Kosovo for three periods: 2022, 2026 and 2031.

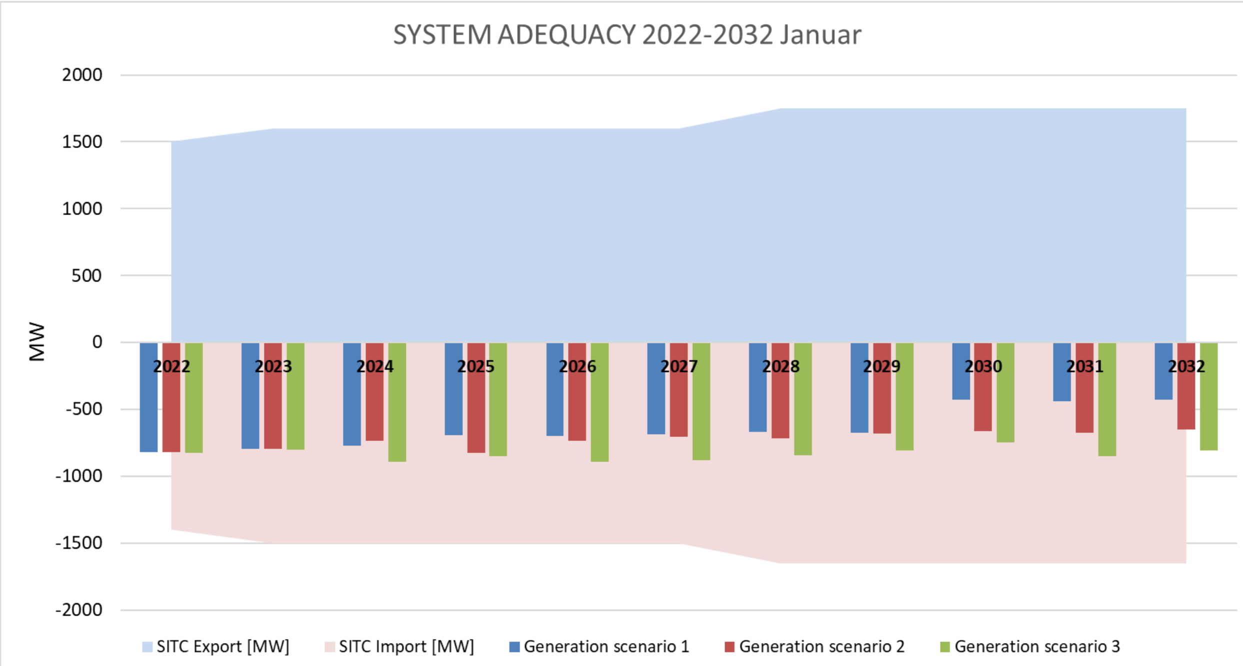
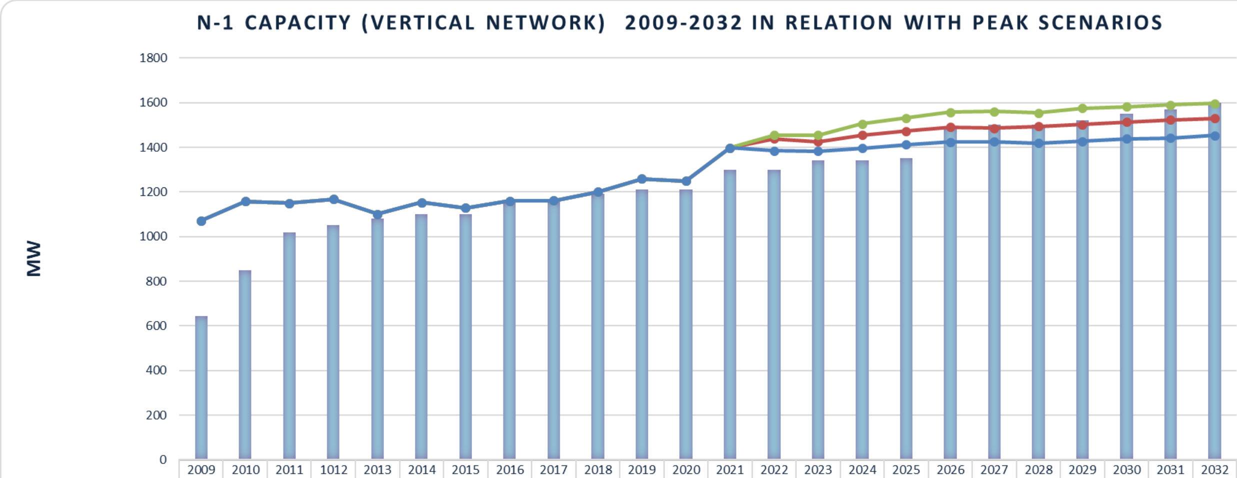


Figure 7-4 Simultaneous development of interconnection capacity in relation to the generation adequacy for the next 10 years

7.3 N-1 security criterion

Looking at the situation in the network before 2009, the N-1 security criterion wasn't met even in summer consumption, while in normal operation conditions, the network would be subject to overloads which were managed by load shedding.
Full implementation of the N-1 security criterion requires considerable investments. If we refer to the development processes planned for the next 10 years, the safety criterion after the implementation of the 110 kV SS Rahoveci-SS Theranda line is almost met in 99% of the hours of the year. The enormous increase in energy demand after 2018 has also influenced the increase of the maximum load beyond the earlier forecast, so there are still a few hours that the network does not meet the N-1 criterion as shown in table 7-2, but in practical terms these hours can be avoided with some specific configurations of the 110 kV network. The N-1 criterion in 220/MV kV and 110/MV kV substations, due to the high cost and tariff implications, will not be completed entirely but, in coordination with KEDS, technical possibilities will be examined to partially complement this from reserves in the distribution network.

Figure 7-5 shows the ability of the network to fulfil the N-1 security criterion, in relation with the maximum load for the next 10 years, for the three load scenarios.



	2009	2010	2011	1012	2013	2014	2015	2016	2017	2018	2019	2020
N-1 Capacity [MW]	645	850	1020	1050	1080	1100	1100	1155	1160	1190	1210	1210
Base Peak [MW]	1072	1158	1150	1168	1101	1154	1129	1160	1161	1201	1260	1249
High Peak [MW]	1072	1158	1150	1168	1101	1154	1129	1160	1161	1201	1260	1249
Low Peak [MW]	1072	1158	1150	1168	1101	1154	1129	1160	1161	1201	1260	1249

	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
N-1 Capacity [MW]	1300	1300	1340	1340	1350	1490	1500	1500	1520	1550	1570	1600
Base Peak [MW]	1398	1439	1426	1455	1472	1491	1486	1493	1502	1514	1524	1529
High Peak [MW]	1398	1455	1455	1505	1531	1558	1561	1554	1575	1583	1590	1597
Low Peak [MW]	1398	1385	1383	1396	1413	1424	1425	1419	1427	1438	1442	1453

Figure 7-5. N-1 capacity development of vertical transmission network 2009-2032

7.4 Quality of supply and efficiency

Figure 7-6 illustrates the impact of investments in the reduction of losses and indirectly confirms the improved the quality of supply of consumtion. The figure shows that the level of losses has entered the saturation area, with a trend of slight increases in absolute values, but in relative terms, they will almost remain at the current level. In 2016 was noticed a significant increase of losses for 10 GWh caused by a long-term operation with open rings of the 110 kV network due to implementation of projects such as: lines 110 kV Peja 1- Peja 3 and Deqan-Peja 2. The no load operation of line 400 kV Kosova B-Tirana 2 had significantly increased the losses of active power during 2016 and 2017. After the rapid increase in the peak and demand for electricity during the previous year 2021 and the current year 2022 the losses in the network have increased significantly.

Reactive power injected in busbars of SS Kosova B reached to 156 MVAr and this power reflected in capacitive electricity creates continuous losses in conductors. After the construction of SS Komani in Albania and shortening of Kosovo-Albania interconnection line from 243 km to 142.2 after cutting the line, the reactive power injection at the SS Kosovo B busbars has been reduced. A part of additional electricity losses is attributed to losses greater than the nominal value in the transformer core due to operation of the transmission system with increased voltage levels. Therefore, in order to reduce the transformer iron losses, KOSTT applies the regulation for optimizing the work of autotransformers, whereby in the period of loads from May to October, they periodically disconnect some autotransformers, always taking care that the N-1 criterion is always met.

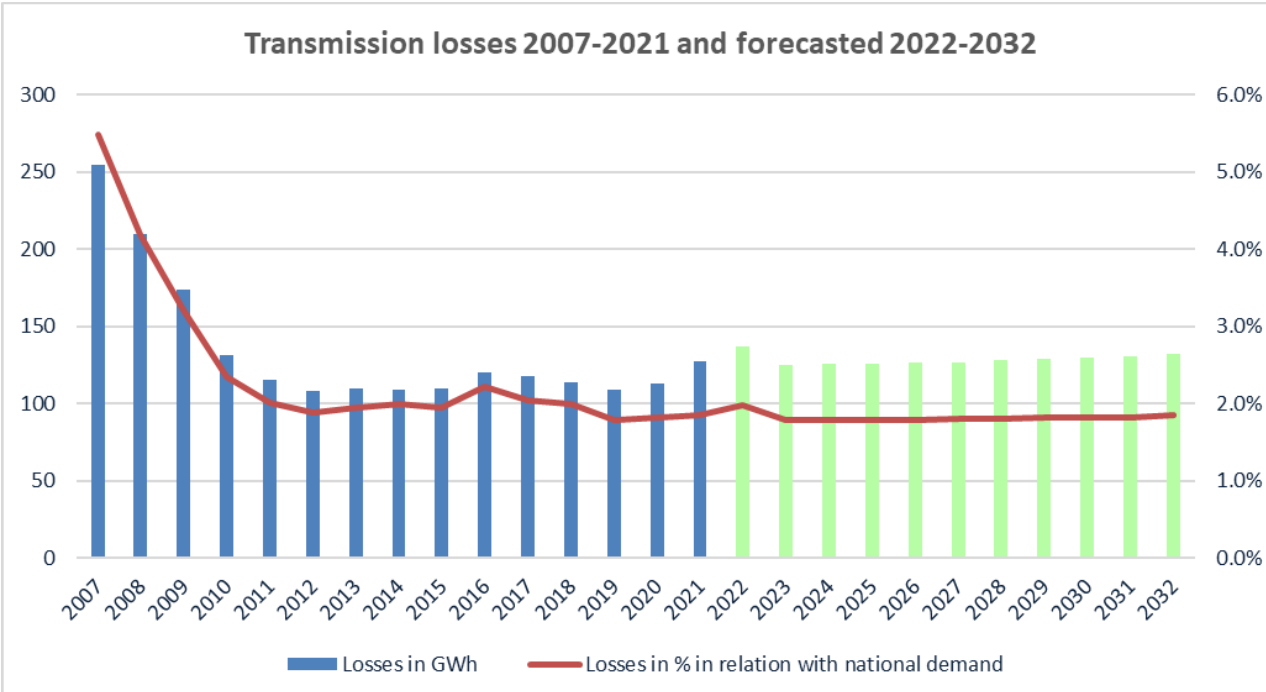


Figure 7-6. Active energy losses in the transmission network 2007-2021 and forecast 2022-2032

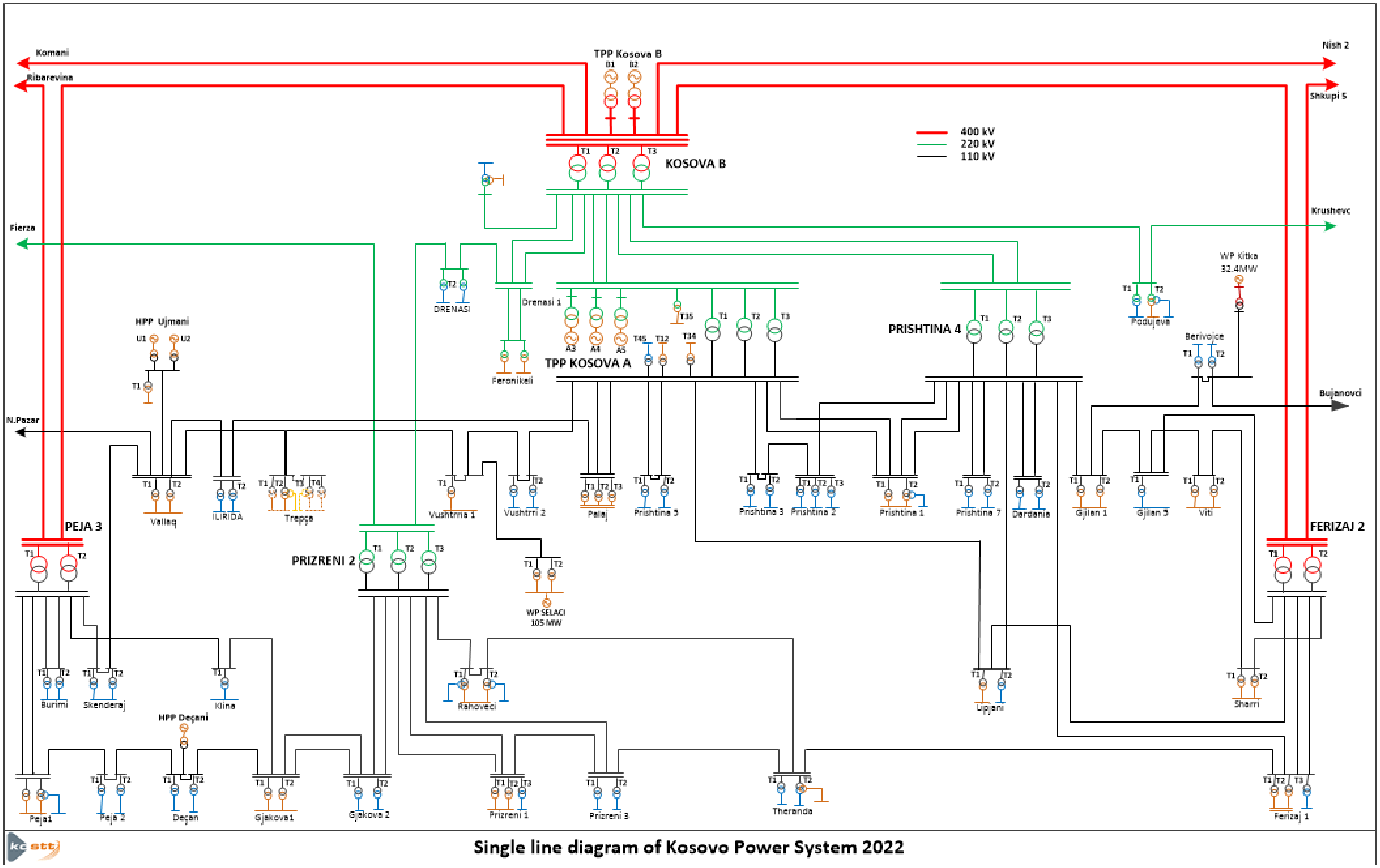


Figure 7-7. Single line diagram of Kosovo EES according to 2022 network topology

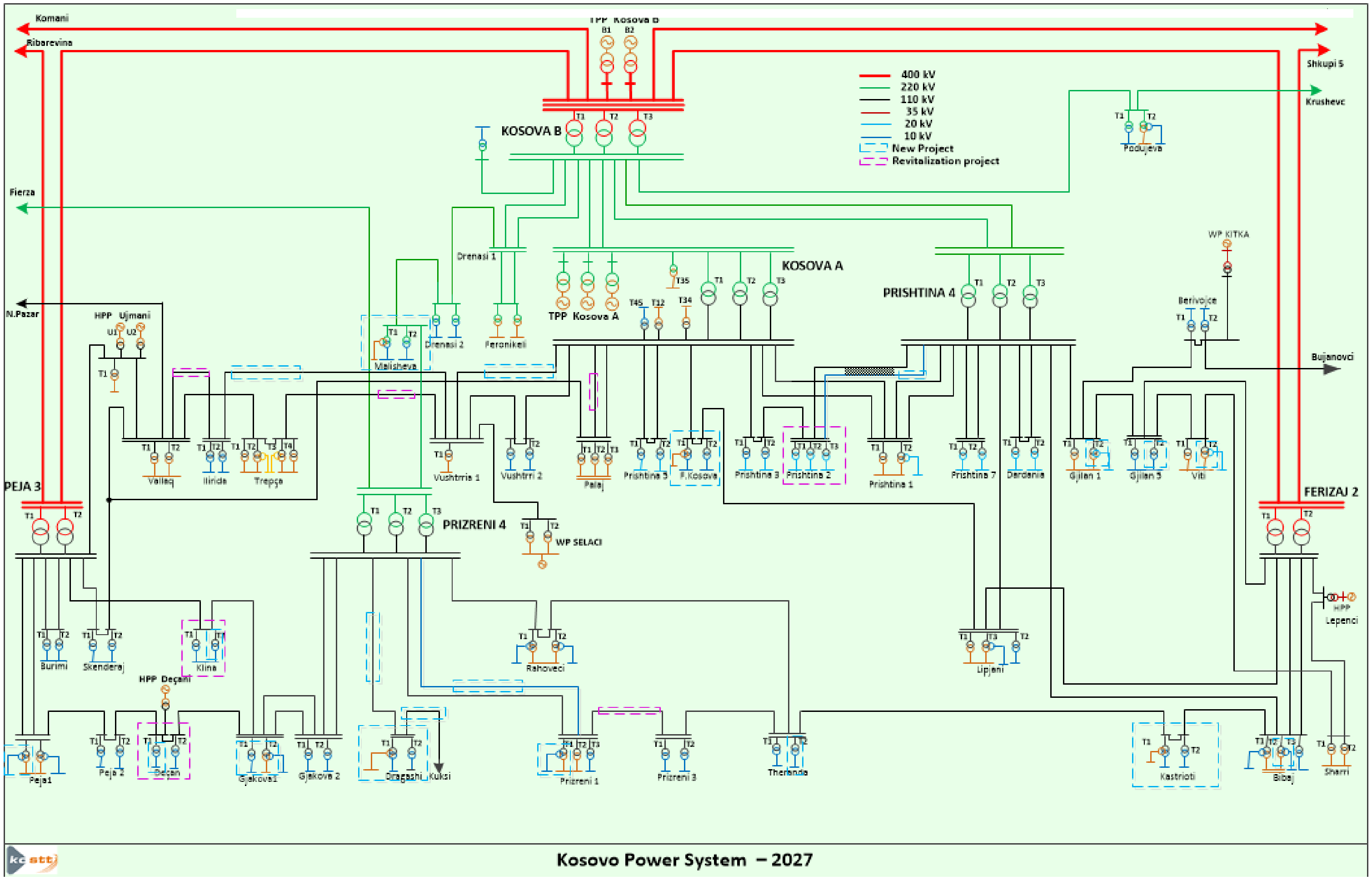


Figure 7-8 Single line diagram of Kosovo EES according to 2027 network topology

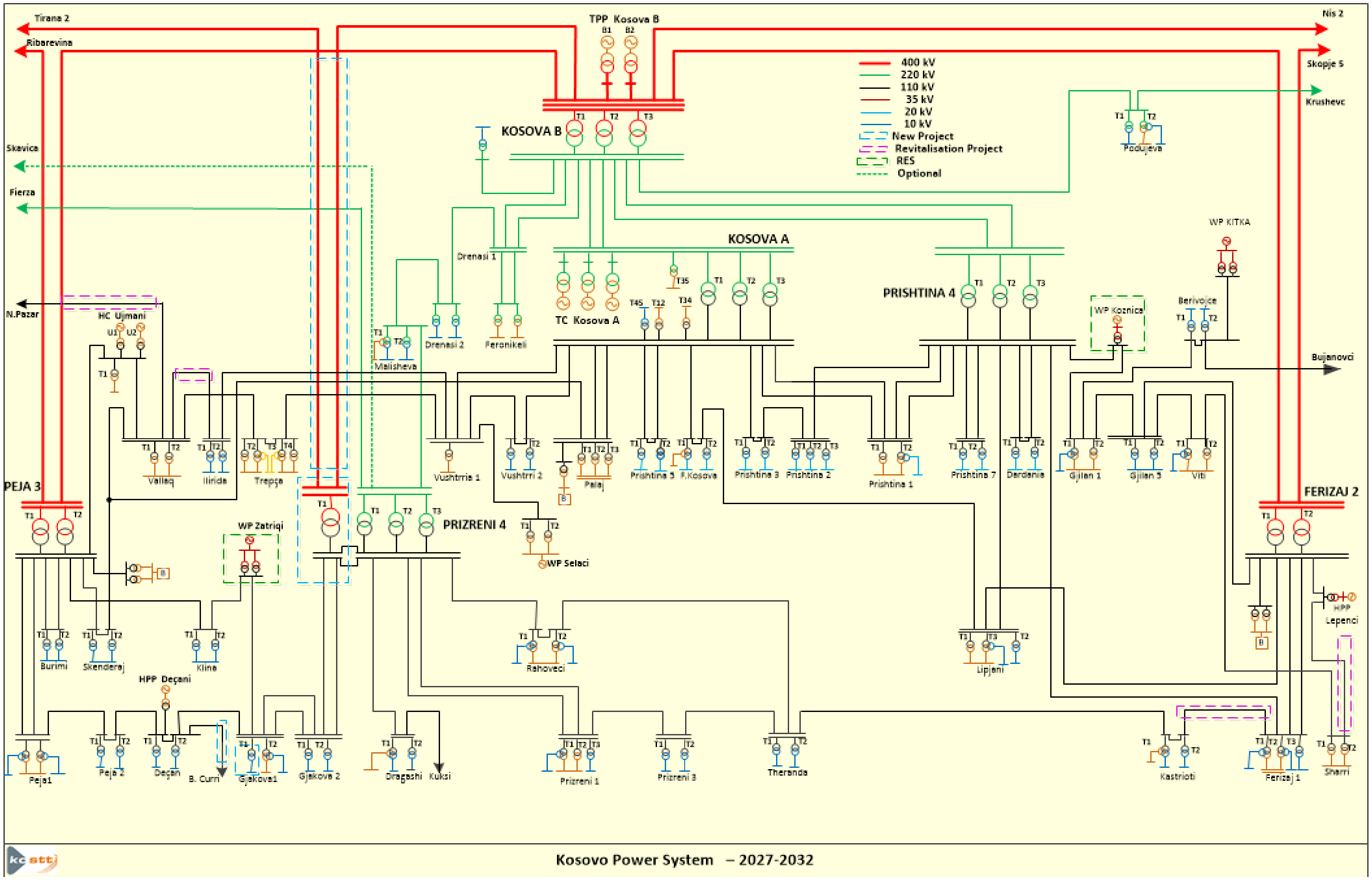


Figure 7-9 Single line diagram of Kosovo EES according to 2032 network topology

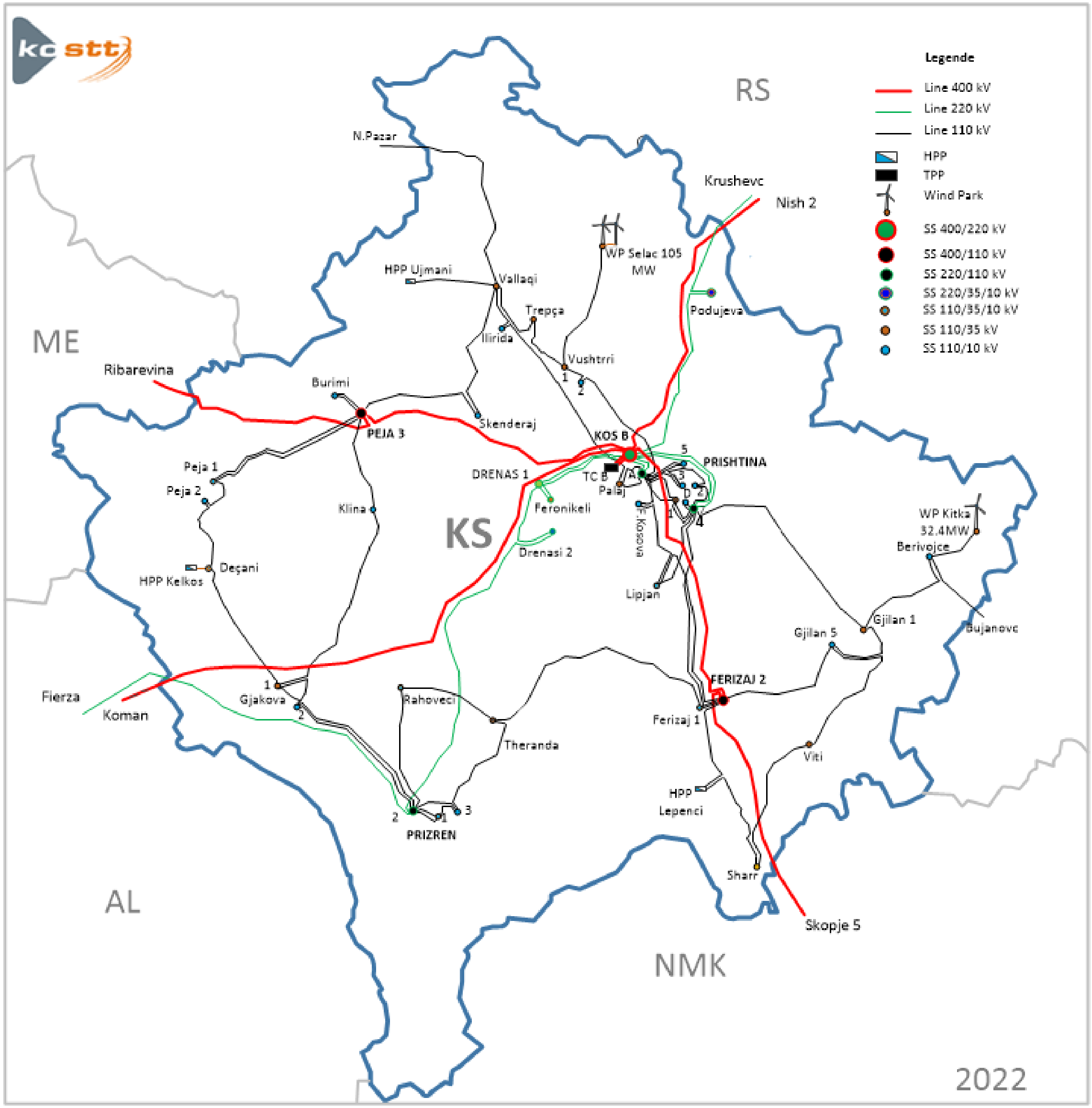


Figure 7-10 Kosovo Power System according to 2022 topology

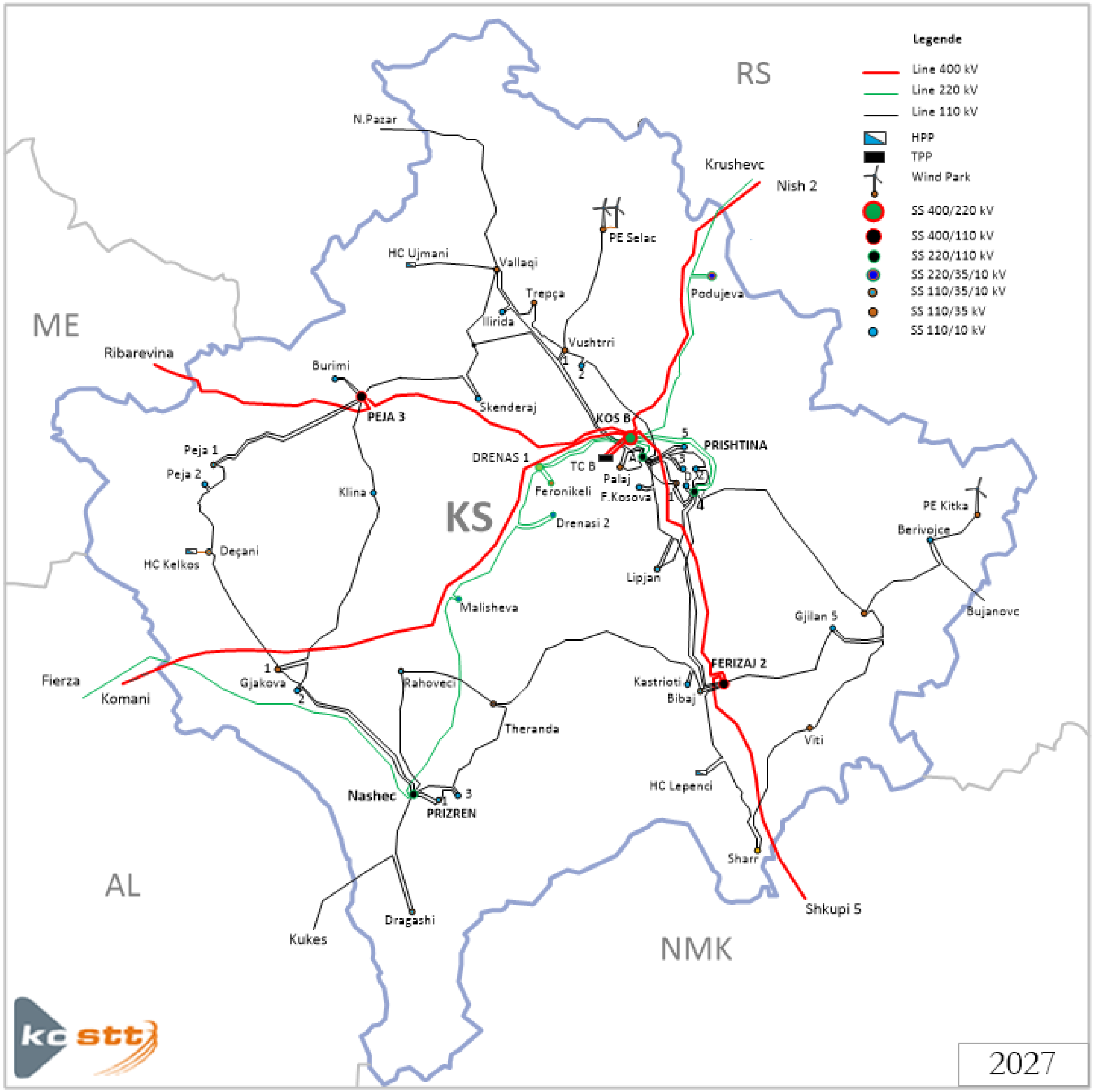


Figure.7-11. Kosovo Power System according to 2027 topology

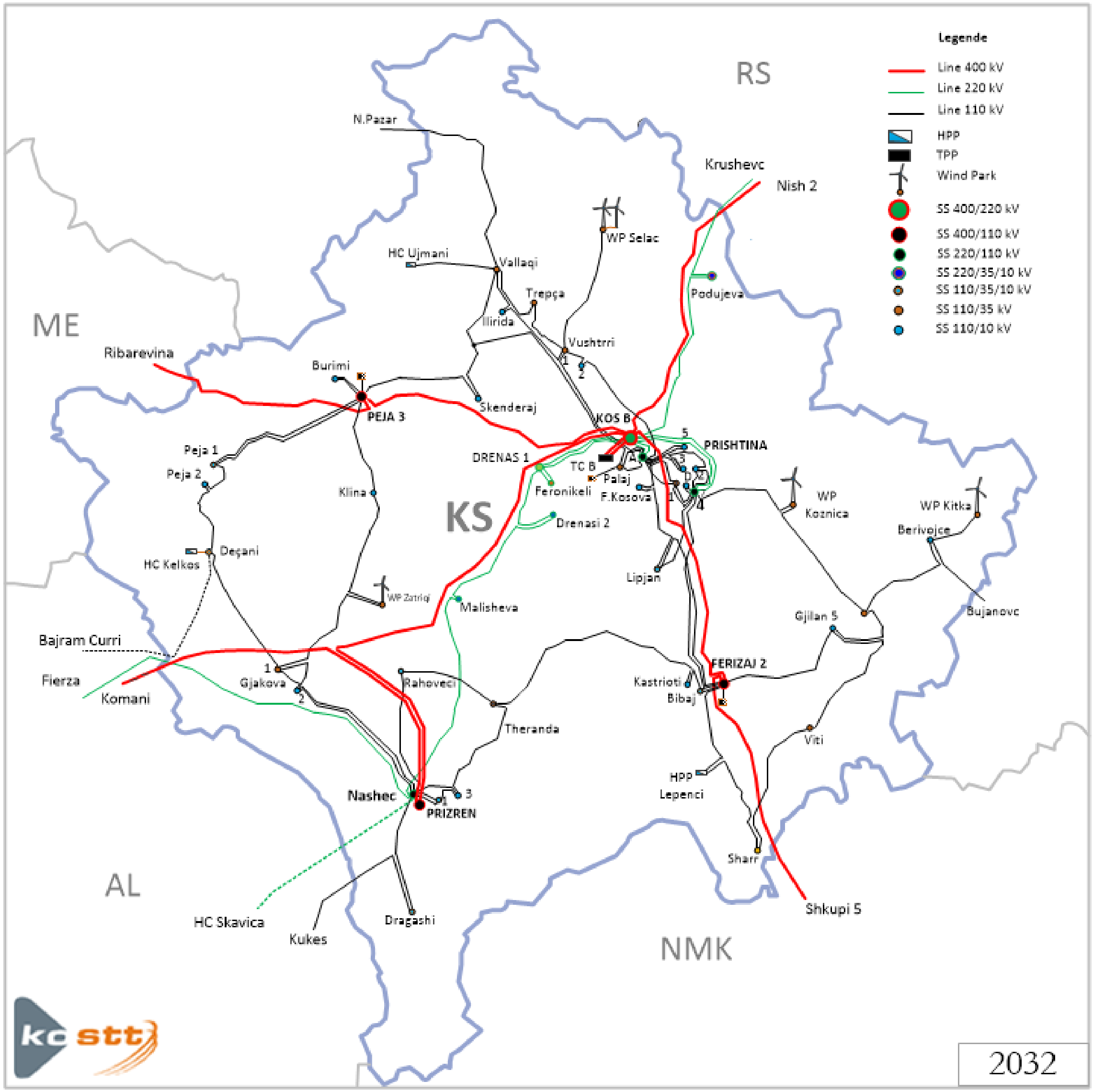


Figure 7-12. Kosovo Power System according to 2032 topology

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