IMPROVE STABILITY OPERATIONS IN KOSOVO’S ELECTRICAL ENERGY DISTRIBUTION NETWORK;

A CASE STUDY OF NORTHERN PRISHTINA

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<th>Description</th>
</tr>
</thead>
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<tr>
<td>ABC</td>
<td>Software for calculating energy balance of 10kV, energy losses and other data taken from CCP software, mostly used for feeder reductions</td>
</tr>
<tr>
<td>AlFe</td>
<td>Overhead conductor material made from Aluminum and Iron</td>
</tr>
<tr>
<td>Cu</td>
<td>Overhead or underground conductor material made from copper</td>
</tr>
<tr>
<td>CCP</td>
<td>Software used in KEK which holds for all the customer data’s</td>
</tr>
<tr>
<td>DIN</td>
<td>the German Institute for Standardization</td>
</tr>
<tr>
<td>DNO</td>
<td>Distribution Network Operator</td>
</tr>
<tr>
<td>DSO</td>
<td>Distribution System Operation</td>
</tr>
<tr>
<td>dW</td>
<td>Technical energy losses in DSO</td>
</tr>
<tr>
<td>EN</td>
<td>European Standard</td>
</tr>
<tr>
<td>ERO</td>
<td>Energy Regulatory Office</td>
</tr>
<tr>
<td>ESTAP</td>
<td>Energy Sector Technical Assistance Project, Master Plan prepared for KEK</td>
</tr>
<tr>
<td>GIS</td>
<td>Geographic Information System</td>
</tr>
<tr>
<td>GREDOS</td>
<td>Software used for calculating energy flow for middle voltage level</td>
</tr>
<tr>
<td>GWh</td>
<td>Giga Watt hour</td>
</tr>
<tr>
<td>IEC</td>
<td>International Electro technical Commission</td>
</tr>
<tr>
<td>IPKO</td>
<td>Private Operator that provides telecommunication services in Kosovo</td>
</tr>
<tr>
<td>IPO</td>
<td>Underground cable with oil</td>
</tr>
<tr>
<td>ISO</td>
<td>International Organization for Standardization</td>
</tr>
<tr>
<td>IRR</td>
<td>Intern Rate of Return</td>
</tr>
<tr>
<td>KEK</td>
<td>Kosovo Energy Corporation (Korporata Energjetike e Kosovës)</td>
</tr>
<tr>
<td>KK</td>
<td>Municipal Assembly (Kuvendi Komunal)</td>
</tr>
<tr>
<td>KOSTT</td>
<td>Transmission System and Market Operation in Kosovo</td>
</tr>
<tr>
<td>KV</td>
<td>Kilovolt – measure unit for voltage</td>
</tr>
<tr>
<td>KVA</td>
<td>Kilo Volt Ampere – is the amount of apparent power expressed in kilo</td>
</tr>
<tr>
<td>LV</td>
<td>Low Voltage whose upper limit of nominal value is 1kV</td>
</tr>
<tr>
<td>LVN</td>
<td>Low Voltage Network (0.4kV network)</td>
</tr>
<tr>
<td>MEM</td>
<td>Ministry of Energy and Mines of Kosovo</td>
</tr>
<tr>
<td>MV</td>
<td>Middle Voltage, whose nominal value of voltage is from 1kV to 35kV</td>
</tr>
<tr>
<td>MVN</td>
<td>Middle Voltage Network (35kV and 10(20) kV network)</td>
</tr>
<tr>
<td>MVA</td>
<td>Mega Volt Ampere – is the amount of apparent power expressed in Mega</td>
</tr>
<tr>
<td>MW</td>
<td>Mega Watt – It is unit of power in the International System Unit. Usually in generation, transmission and distribution, MW is used for measuring</td>
</tr>
<tr>
<td>NPV</td>
<td>Net Present Value</td>
</tr>
<tr>
<td>OHL</td>
<td>Overhead lines</td>
</tr>
<tr>
<td>Sins</td>
<td>Nominal (installation power) which is apparent power expressed in MVA. It is expressed as Pins for active power installation</td>
</tr>
<tr>
<td>PMO</td>
<td>Project Management Office</td>
</tr>
<tr>
<td>PP 41</td>
<td>Type of cable</td>
</tr>
<tr>
<td>PTK</td>
<td>Operator of Post and Telecom in Kosovo which provides: mobile telephony, fix telephony, internet and post services</td>
</tr>
<tr>
<td>Pmax</td>
<td>Peak power expressed in MW</td>
</tr>
<tr>
<td>R&amp;D</td>
<td>Research and Development</td>
</tr>
<tr>
<td>r.m.s</td>
<td>Root mean square, known as the quadratic mean, useful when variants are positive and negative sinusoids</td>
</tr>
<tr>
<td>SWOT</td>
<td>Strategic planning method used to evaluate strengths, weakness, and opportunities and threats during a project</td>
</tr>
<tr>
<td>SS</td>
<td>Substation building in which electric equipments such TR, circuit, breakers, bus bars, cubicles, current, voltage regulators etc. are located.</td>
</tr>
<tr>
<td>TR</td>
<td>Energetic Transformer transfers voltage from higher level to lower level.</td>
</tr>
<tr>
<td>Uc</td>
<td>Declared supply voltage, if by agreement between DNO and the network user a voltage different from the nominal is applied to the terminal, then this voltage is declared supply voltage</td>
</tr>
<tr>
<td>W</td>
<td>Electric Energy (MWh)</td>
</tr>
</tbody>
</table>
1. ABSTRACT

This Capstone Project addresses an important problem regarding the power quality which is very common in Kosovo. It describes the context of power quality in distribution systems and deals more specifically with the corresponding diagnostics and implementation. It develops a precise and effective technique and method for the analysis how to improve a quality of electrical energy in Kosovo. The challenge of this project was to upgrade the existing design of network, and bring and build a new design of distribution system electric energy in Prishtina, saving energy which is being lost in distribution networks and improve the stability of particularly the electrical energy in Prishtina area.

This project involves technical and managerial prospects for solving the problems which are facing KEK employees and the customers in northern Prishtina. Moreover, the project provides experiences from other countries for making comparison with those in Kosovo.

This project based on the very latest studies, on increasing the reliability of quality of power energy supply up to the last customer. This project also considers the reduction of technical losses. The main goals of this project concerns the need for increasing the high level of voltage, necessary number of lines, substations and improve low voltage networks.

If it is possible to establish a scale of human needs, giving importance to the achievements of modern time and the way of living of modern human being, then for sure the electrical energy would take one of the top positions.
2. NETWORK OVERVIEW

The distribution network situation during 90’s in Kosovo was as a status quo. Due to the political situation there was no interest to invest in Kosovo. This resulted in gradual deterioration of the distribution network area.

In 1999, after the war in Kosovo, new developments took place affecting the electrical infrastructure, the same as other infrastructures in Kosovo. Households began to concentrate in the city and its suburb areas. This situation led to an increased demand for electric energy supply. On the other hand, the existing network was not designed to respond to such a flux of increased of customers.

It can be calculated that this old network cannot endure the current demand on electrical energy. The middle low voltage network in Kosovo is shown in figure.2.1 where each district is represented by a different color.

Figure.2.1 Middle voltage network of Kosovo

Source; Estap, 2002

As consequence to this, KEK faces with the problems presented in box 1.
Box.1 Problems leading to poor quality of energy supply which both KEK and customers are facing with

- **Old Network Equipments.** The electrical energy distribution network is very old. Most of the equipment is older than forty years. E.g. old cables are mostly copper oil-filled which need several interventions during the winter season. Towers are mostly installed from impregnated wood and decay is a present risk for the environment because of their age in some areas.

- **Small cross section** The network on 10kV level is mainly constructed with Al/Fe conductors of 25 mm\(^2\) and 35 mm\(^2\). This cross-section technically cannot endure higher loads in long lines

- **Radial Design.** 10kV feeders from main substations are usually very long in rural areas, thus giving rise to high voltage drops (up to 40% of the nominal voltage) and considerable technical losses.

- **No reserve supplies** due to the radial structure of the 10kV network (particularly in the rural areas); it is not possible to have reserved supply from SS during outages of feeders. As a result of the delicate 10 kV network, it is sometimes necessary to disconnect individual feeders due to the operations in them. Figure 2.4 shows middle voltage network with feeders in Prishtina.

- **Bottlenecks:** When the loads are higher and the capacity of network to endure such loads is lower, bottlenecks are experienced through the network.

- **Employees are facing with a lot of network problems,** due to the problems mention above. The majority of their works in the field are under risk circumstances. In some cases towers are over weighted with conductors (annex 1)

- **Lack of Business investments** due to the quality of voltage. Businessmen, who want to perform their activities, often cannot accomplish their daily activities due to interruptions and quality of voltage. New investors hesitate to invest in such places where there is lack of electrical energy, because it is impossible to use uninterrupted, stable and qualitative electrical energy.

- **No electrical energy for 24 hours/day.** Customers cannot use their equipment in some areas in Kosovo because of the lack of electrical energy.

The length of network state in Kosovo shown in numbers is highlighted in Table 2.1. Based on this table, 11,411km belong to the low voltage network 0.4kV and 674 km to the level 35km. 411 km can work as a 20kV, but for the moment they work as 10kV and 5,783km belong to 10kV. Both 10kV and 20kV are currently working as 10kV which means 6,974km in 10kV. The level of voltage 6kV is mainly used by the industry.

Table 2.1 highlights that 1,407km are cables, which mean that only 7.7% of distribution network in Kosovo is cable. The rest, 92.3% of network, is over head lines.
Table 2.1 Length of distribution network in Kosovo

<table>
<thead>
<tr>
<th>Network by level of voltage</th>
<th>Wood poles (km)</th>
<th>Steel and concrete poles (km)</th>
<th>Total OHL (km)</th>
<th>Cables (km)</th>
<th>Total (km)</th>
</tr>
</thead>
<tbody>
<tr>
<td>35kV</td>
<td>0</td>
<td>372</td>
<td>648</td>
<td>26</td>
<td>674</td>
</tr>
<tr>
<td>20kV</td>
<td>34</td>
<td>250</td>
<td>299</td>
<td>113</td>
<td>411</td>
</tr>
<tr>
<td>10kV</td>
<td>2,733</td>
<td>694</td>
<td>4,991</td>
<td>792</td>
<td>5,783</td>
</tr>
<tr>
<td>6kV</td>
<td>34</td>
<td>10</td>
<td>44</td>
<td>2</td>
<td>46</td>
</tr>
<tr>
<td>0.4kV</td>
<td>7,160</td>
<td>658</td>
<td>10,940</td>
<td>474</td>
<td>11,414</td>
</tr>
<tr>
<td>Total</td>
<td>9,961</td>
<td>1,985</td>
<td>16,922</td>
<td>1,407</td>
<td>18,329</td>
</tr>
</tbody>
</table>

Source: Development Department KEK, 2009

Table 2.2 Number of SS in network distribution and their installed power

<table>
<thead>
<tr>
<th>Voltage level (kV/kV)</th>
<th>SS number</th>
<th>TR number</th>
<th>Si (MVA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>220/35/10(20)</td>
<td>1</td>
<td>2</td>
<td>80.00</td>
</tr>
<tr>
<td>110/35</td>
<td>4</td>
<td>7</td>
<td>186.00</td>
</tr>
<tr>
<td>110/35/10(20)</td>
<td>7</td>
<td>14</td>
<td>564.00</td>
</tr>
<tr>
<td>110/20/0.4</td>
<td>2</td>
<td>3</td>
<td>111.50</td>
</tr>
<tr>
<td>110/20/0.4</td>
<td>9</td>
<td>15</td>
<td>346.50</td>
</tr>
<tr>
<td>35/10(20)</td>
<td>53</td>
<td>102</td>
<td>658.80</td>
</tr>
<tr>
<td>35/0.4</td>
<td>1</td>
<td>1</td>
<td>0.63</td>
</tr>
<tr>
<td>20/0.4</td>
<td>890</td>
<td>895</td>
<td>171.55</td>
</tr>
<tr>
<td>10/0.4</td>
<td>5,098</td>
<td>5,258</td>
<td>1,500.81</td>
</tr>
<tr>
<td>6/0.4</td>
<td>35</td>
<td>35</td>
<td>6.68</td>
</tr>
<tr>
<td>Total</td>
<td>6,100</td>
<td>6,332</td>
<td>3,626.46</td>
</tr>
</tbody>
</table>

Source: Development Department KEK, 2009

2.1. Energy Technical Losses in KEK

Technical losses in Kosovo were 17% last year. These losses are due to resistance in lines, transformers etc. Those are the losses in general in all network districts, but in Prishtina separately they are around 14%. Table 2.3 shows technical energy losses in Kosovo per each district. Based on this table, the highest energy received in Prishtina was 1,302GWh or about
28% of all consumption goes to Prishtina \[(1,302/4,681)*100=28\%\]. The technical losses expressed in MWh (184,799MWh) were the highest in Prishtina, but in percentage these were the lowest compared to other districts (14.19\%)

Drop voltages at the ending points are more than 40% in some regions around Kosovo. It means that the voltage reaching the customer is not 220V but often it is below - 140V. In northern Prishtina during the peak load the value of drop voltages is from 0.5% to 30%. An analysis taken from Section of Analysis and technical losses is shown in Annex 2. It shows the drop voltages in some areas in a 10kV feeder for the highest loads.

As the result of technical issues mention above, KEK technical losses expressed in energy were 800,445MWh in 2009. Having in mind that the average costs per MWh was 57 euro last year, the results shows that KEK, due to these technical losses, lost about 45.6 million € last year.

Table 2.3 Annual reports of technical losses 2009

<table>
<thead>
<tr>
<th>Districts</th>
<th>Energy received (MWh)</th>
<th>Total technical losses (MWh)</th>
<th>Technical losses in MV (MWh)</th>
<th>Technical losses in LV (MWh)</th>
<th>Technical losses %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prishtina</td>
<td>1,302,725.236</td>
<td>184,799.931</td>
<td>68,148.680</td>
<td>116,651.251</td>
<td>14.19</td>
</tr>
<tr>
<td>Prizreni</td>
<td>733,736.303</td>
<td>159,803.451</td>
<td>85,193.331</td>
<td>74,610.120</td>
<td>21.78</td>
</tr>
<tr>
<td>Mitrovica</td>
<td>649,062.936</td>
<td>136,687.336</td>
<td>75,310.796</td>
<td>61,376.539</td>
<td>21.06</td>
</tr>
<tr>
<td>Peja+HE-at</td>
<td>507,930.004</td>
<td>97,938.190</td>
<td>42,503.075</td>
<td>55,435.115</td>
<td>19.28</td>
</tr>
<tr>
<td>Gjilani</td>
<td>391,691.185</td>
<td>62,045.338</td>
<td>21,517.827</td>
<td>40,527.511</td>
<td>15.84</td>
</tr>
<tr>
<td>Gjakova</td>
<td>280,173.913</td>
<td>48,555.652</td>
<td>19,944.476</td>
<td>28,611.175</td>
<td>17.33</td>
</tr>
<tr>
<td>Lomag</td>
<td>252,867.141</td>
<td>1,308.269</td>
<td>788.913</td>
<td>-</td>
<td>0.52</td>
</tr>
<tr>
<td><strong>Total (MWh)</strong></td>
<td><strong>4,680,919.977</strong></td>
<td><strong>800,445.285</strong></td>
<td><strong>367,136.454</strong></td>
<td><strong>432,789.475</strong></td>
<td><strong>17.10</strong></td>
</tr>
</tbody>
</table>

Source: Section for Technical Losses and Analysis, Development Department, Network Division, 2009

Figure 2.2 shows technical losses in 2009 graphically. During summer, technical losses are smaller compared to losses in winter. They are depended on the loads which always get higher in the winter season, due to the use of electric energy for heating.
Improve Stability Operations in Kosovo’s Electricity Distribution Network;  
A case study of northern Prishtina

Figure 2.2 Technical energy losses diagram

![Technical Losses 2009 (MWh)](image)

Source: Sector for Technical Loss Calculations

2.2. Energy Technical Losses in Europe

Technical losses in Albania are 22.74%, in Armenia in transmission and distribution they are 10.2%, in Georgia 7.3% in Serbia in 2008 (10.5-11.5)% assumed, Croatia 6%, Austria 5.44%, Belgium 4.79%, Finland 3.5%, Greece 8.34%, France 7%, Spain 5.71%, Italy 6.65, Netherland 4.14%, Germany 5.4% Slovenia 6.42. These technical losses are shown in figure 2.3.

Figure 2.3 Technical losses around Europe

![Technical losses (%)](image)

2.3. Northern Prishtina as a study case

In this research, northern Prishtina has been used as a case for analysis. The reasons why northern Prishtina has been chosen as a study case are:

- There is no need to invest in the main supply or substation 110/10(20) kV, because this substation exists. Existing SS has the possibility of transformation from 110/10kV and 110/20kV which is needed for the project.

- The main idea of this research is to promote the transition from level 10kV into 20kV. In Prishtina 5, about 50% of the existing equipment in middle voltage network can work as 20kV.

- The structure for studying is more interesting because of its urban and rural areas.

- The network in this part of Prishtina looks like ‘a spider network’, due to many air conductors through the roads.

- The technical losses in this part of Prishtina are the highest compared to the other areas in Prishtina.

The region of northern Prishtina is supplied by substation SS 110/10(20) kV Prishtina 5. This substation supplies about twelve thousands customers. It has sixteen feeders 10kV with 111 SS 10/0.4kV. The northern Prishtina is shown in figure 2.4.

Figure 2.4. The view of middle voltage network and the 10kV feeders in northern Prishtina.

Source: District of Prishtina, Engineering Section, taken from Gredos software
The feeders which supply the city are not visible in this figure, but the feeders in rural areas are. Therefore, feeders Barshoshi and Rezervoaret are shown in the figure while substations in the city are shown with small circles (like points).

2.3.1. **Middle voltage network in SS 110/10(20)kV Prishtina 5**

The main substation with transformation of voltage from 110kV to 10kV with the possibilities to transform to 20kV was built in 2003 in northern Prishtina to supply that area. The 10kV feeders are lines which come from 10kV bus bars in 110/10kV and they supply the substations SS 10/0.4kV. The table 2.4 shows the name of each feeder in Prishtina 5, number of cubicles, nominal power of SS 10/0.4kV, the number of SS 10/0.4kV and 20/0.4kV.

Some of the customers use the entire line just for their needs, for example pumps. The table below shows includes three feeders which belong to SS Besia 35/10kV needed for further studies below.

Table 2.4 Data of 10kV feeders in northern Prishtina

<table>
<thead>
<tr>
<th>Code</th>
<th>Feeder Name</th>
<th>Cubicle no</th>
<th>No. SS 10/0.4kV</th>
<th>No. SS 20/0.4kV</th>
<th>Pinst [kVA]</th>
</tr>
</thead>
<tbody>
<tr>
<td>13000001</td>
<td>Bardhosh J5</td>
<td>13</td>
<td>5</td>
<td></td>
<td>2710</td>
</tr>
<tr>
<td>13000002</td>
<td>Rezervoaret KFOR J6</td>
<td>13</td>
<td>1</td>
<td></td>
<td>4890</td>
</tr>
<tr>
<td>13000003</td>
<td>Baci Petrol J7</td>
<td>0</td>
<td>3</td>
<td></td>
<td>1430</td>
</tr>
<tr>
<td>13000004</td>
<td>Llukar J9</td>
<td>9</td>
<td>2</td>
<td></td>
<td>2000</td>
</tr>
<tr>
<td>13000005</td>
<td>Kodra e Trimave 11 J12</td>
<td>1</td>
<td>2</td>
<td></td>
<td>2260</td>
</tr>
<tr>
<td>13000006</td>
<td>Kodra e Trimave 7 J17</td>
<td>3</td>
<td>3</td>
<td></td>
<td>3390</td>
</tr>
<tr>
<td>13000007</td>
<td>Kodra e Trimave 9 J18</td>
<td>0</td>
<td>1</td>
<td></td>
<td>1000</td>
</tr>
<tr>
<td>13000008</td>
<td>Kodra e Trimave 8 J20</td>
<td>2</td>
<td>0</td>
<td></td>
<td>1260</td>
</tr>
<tr>
<td>13000009</td>
<td>Pompa u ujesjellesit J21</td>
<td>2</td>
<td>0</td>
<td></td>
<td>1260</td>
</tr>
<tr>
<td>130000010</td>
<td>Kodra e Trimave 21 J21</td>
<td>2</td>
<td>2</td>
<td></td>
<td>2520</td>
</tr>
<tr>
<td>130000011</td>
<td>Pumps J13</td>
<td>1</td>
<td>0</td>
<td></td>
<td>630</td>
</tr>
<tr>
<td>130000012</td>
<td>Kodra e Trimave 4 J22</td>
<td>2</td>
<td>2</td>
<td></td>
<td>3630</td>
</tr>
<tr>
<td>130000013</td>
<td>Xhamia e Llapit 1 J25</td>
<td>2</td>
<td>2</td>
<td></td>
<td>1260</td>
</tr>
<tr>
<td>130000014</td>
<td>Xhamia e Llapit 2 J24</td>
<td>2</td>
<td>3</td>
<td></td>
<td>3890</td>
</tr>
<tr>
<td>130000015</td>
<td>Kodra e Trimave 5 J27</td>
<td>1</td>
<td>1</td>
<td></td>
<td>1260</td>
</tr>
<tr>
<td>130000016</td>
<td>Kodra e Trimave 8-1 J19</td>
<td>1</td>
<td>1</td>
<td></td>
<td>1260</td>
</tr>
</tbody>
</table>

Total Prishtina 5: 4 28 34650

<table>
<thead>
<tr>
<th>Code</th>
<th>Feeder Name</th>
<th>Cubicle no</th>
<th>No. SS 10/0.4kV</th>
<th>No. SS 20/0.4kV</th>
<th>Pinst [kVA]</th>
</tr>
</thead>
<tbody>
<tr>
<td>130000017</td>
<td>Lluzhan 1.00</td>
<td>13</td>
<td>1</td>
<td></td>
<td>3530</td>
</tr>
<tr>
<td>130000018</td>
<td>Prugovc 2.00</td>
<td>14</td>
<td>0</td>
<td></td>
<td>2630</td>
</tr>
<tr>
<td>130000019</td>
<td>Besi pumps 3.00</td>
<td>1</td>
<td>0</td>
<td></td>
<td>630</td>
</tr>
</tbody>
</table>

Total Besia: 28 1 6790

Total Northern Prishtina: 82 29 41440

*Source: District of Prishtina, Engineering Section, Maintenance Section, CCP software, 2009*

20 kV lines that still function as 10 kV after the war have been mainly used as 10 kV lines, until they are transferred to level 20 kV.

630kVA and 1000kVA transformers are mainly installed in the city; the others are mainly installed in rural area. Some businesses have their own substation to cover their needs, for example sawmill, plastic factories, college, drink factories, hotel, cantonment, Medical Ministry, gas pumps etc.
2.3.2. Low Voltage Network in northern Prishtina

Low voltage network or 0.4kV network, supplies customers from substation 10/0.4kV through conductors and other LVN elements. Here the lines have a cross section of 4x25 mm$^2$ Al, 4x35 mm$^2$ Al and in rare cases cables of PP-41 4x150 Al. There are cases with extreme asymmetries in certain locations.

Figure 2.5 Low Voltage Network in SS 10/0.4kV Kodra e Trimave

Source: Section for Analysis, Development Department, 2007

Figure 2.5 shows a LVN in SS 10/0.4kV in the so-called Kodra e Trimave 9 with installed power 1000kVA. There are five feeders of 0.4kV which emerge from this SS and proceed to supply the customers through lines and poles (shown in small circles).

2.3.3. SS 35/10kV Besia

Substation SS 35/10kV Besia has two 10kV feeders which supply the villages near Prishtina but the supply comes from Mazgit. Besia transformer with voltage rating 35/10kV located in Water System substation in Besia. KEK in the future should abandon its transformer in SS Besia and should find other ways to supply its customers. For the moment Prishtina 5 is the best solution for short-term supply of Besia’s customers. Besia is currently supplying the villages of Progovc, Raskove, Bakshi and Barileve. As shown in table 2.4, it has 29 substations with installed power of 6790kVA. During the analysis it should be considered to find the best solution for these feeders.
3. QUALITY STANDARDS

The quality of electrical energy is regulated with different standards. The standards prescribe the norms of electrical stability or electrical quality that would be approved in the countries. Usually the quality of electrical energy is indicated by the quality of voltage and frequency. The power of electrical energy depends on voltage, therefore technical losses depend on power; it could be said that when talking about electric energy quality depending from voltage, this standard is comprehensible for technical losses too.

Quality standards are defined by:

- The quality of voltage
- The continuity of supply (interruptions) and
- Service quality

The aim of this project is focused on quality voltage which is one of quality areas. Furthermore, this study case does not draw attention to frequency variation since they are monitored and managed by interconnected power system operators. Due to the voltage quality in Europe, the most important norm regarding voltage characteristics of electrical energy supply is the Cenelec norm and EN 50160.

Standard EN 50160:2008 “Voltage characteristics of electrical energy supplied by public distribution networks”, describes the limits or values within which the voltage characteristics can be expected to remain over the whole of the public distribution network’. ‘Under normal operating conditions excluding voltage interruptions, during each period of one week, 95% of the 10min. mean r.m.s value of the supply voltage shall be within the range of $U_c=\pm10\%$’. EN 50160 provides recommended levels for different power quality parameters, including a time-based percentage during which the levels should be kept.

3.1. Voltage quality regulation in Europe

Countries such as Albania, Bosnia, Croatia, Serbia and Romania, have regulated the stability of electrical energy based on standard EN 50160. These countries and some other countries are using the standard RS EN 50160 and Grid Code approved by regulatory bodies.

This norm, issued in 2003, is the most important norm regarding standardized methods for measurement of voltage quality. EN 50160 defines that 95% of the 10-minutes average values of the voltage measured during a week should be within the range of $\pm 10\%$ of the nominal voltage and that all 10-minutes average values should be within the range of $+10\%/-15\%$ of the nominal voltage.

Based on the table 3.1 it is easy to notice a different percentage of voltage applied in different countries where this voltage is accepted as declared voltage from the regulation office in each country.

Table 3.1 highlights nominal deviation of voltage taken from EN 50160 and declared deviation of voltage from some countries.
Table 3.1 Standard quality voltage and declared voltage in European countries

<table>
<thead>
<tr>
<th>Nominal Voltage</th>
<th>230V</th>
<th>380V</th>
<th>10kV</th>
<th>20kV</th>
<th>35kV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard³</td>
<td>(-10%; +10%)</td>
<td>(-10%; +10%)</td>
<td>(-10%; +10%)</td>
<td>(-10%; +10%)</td>
<td>(-10%; +10%)</td>
</tr>
<tr>
<td>Kosovo³</td>
<td>(-15%; +10%)</td>
<td>(-15%; +10%)</td>
<td>(-10%; +11%)</td>
<td>(-10%; +10.5%)</td>
<td>(-15%; +10%)</td>
</tr>
<tr>
<td>Albania¹¹</td>
<td>(-15%; +10%)</td>
<td>(-15%; +10%)</td>
<td>(n/a; 10.75%)</td>
<td>(n/a; 20%)</td>
<td>(-11%; 11%)</td>
</tr>
<tr>
<td>Serbia¹²</td>
<td>(-5%; +5%)</td>
<td>(-10%; +10%)</td>
<td>(-10%; +10%)</td>
<td>(-10%; +10%)</td>
<td>(-10%; +10%)</td>
</tr>
<tr>
<td>Croatia¹³</td>
<td>(-10%; +6%)</td>
<td>(-10%; +6%)</td>
<td>(-10%; +10%)</td>
<td>(-10%; +10%)</td>
<td>(-10%; +10%)</td>
</tr>
<tr>
<td>Bosnia¹⁴</td>
<td>(-5%; +10%)</td>
<td>(-5%; +10%)</td>
<td>(-10%; +10%)</td>
<td>(-10%; +10%)</td>
<td>(-10%; +10%)</td>
</tr>
<tr>
<td>Romania¹⁵</td>
<td>(-5%; +5%)</td>
<td>(-5%; +5%)</td>
<td>(-5%; +5%)</td>
<td>(-5%; +5%)</td>
<td>(-5%; +5%)</td>
</tr>
<tr>
<td>Norway¹⁶</td>
<td>(-10%; +10%)</td>
<td>(-10%; +10%)</td>
<td>(-5%; +8%)</td>
<td>(-5%; +8%)</td>
<td>(-5%; +8%)</td>
</tr>
<tr>
<td>Hungary¹⁰</td>
<td>(-10%; +15%)</td>
<td>(-10%; +15%)</td>
<td>(-10%; +15%)</td>
<td>(-10%; +15%)</td>
<td>(-10%; +15%)</td>
</tr>
<tr>
<td>Spain¹⁰</td>
<td>(-7%; +7%)</td>
<td>(-7%; +7%)</td>
<td>(-7%; +7%)</td>
<td>(-7%; +7%)</td>
<td>(-7%; +7%)</td>
</tr>
</tbody>
</table>

3.2. Voltage quality regulation in Kosovo


Network Code and Measurement Code have been approved by ERO and they are ready for implementation, while Standard Code of Electric Energy is under preparation by the Regulatory Office in KEK, to be approved later by ERO. For the moment KEK is working with European standards as used by regional countries. ²⁴

Currently there are no financial penalties applicable from the regulatory on voltage quality.

The rated voltage for the low voltage level consumption is 220V and the permissible deviation is between + 10% and -15%. The permissible deviations for the 10 kV and 20 kV level consumption in Kosovo are between +11% and -10%.

---

³ Based on table 3.1
¹ Variable according to operating conditions
² Information on particular location upon request by interested user
⁴ By researching this case, there was a need to have some of the standards mention above. KEK bought for the first time some standards from Ministry of Trade and Industry of Kosovo needed for this capstone.
According to the Distribution Code of KEK, table 3.2 the tolerance of voltage for LVN (230V) is +10%; -15%, which is -5% more than the toleration as per European standards, but it is accepted by ERO as declared voltage based on the standards.

Table 3.2 Nominal voltage and the tolerance of voltage

<table>
<thead>
<tr>
<th>Nominal voltage</th>
<th>Lower Voltage</th>
<th>Higher Voltage</th>
</tr>
</thead>
<tbody>
<tr>
<td>230 V</td>
<td>253 V</td>
<td>255.5 V</td>
</tr>
<tr>
<td>400 V</td>
<td>440 V</td>
<td>440.5 V</td>
</tr>
<tr>
<td>6.3 kV</td>
<td>6.9 kV</td>
<td>6.6 kV</td>
</tr>
<tr>
<td>10 kV</td>
<td>11.1 kV</td>
<td>11.9 kV</td>
</tr>
<tr>
<td>20 kV</td>
<td>22.1 kV</td>
<td>22.9 kV</td>
</tr>
<tr>
<td>35 kV</td>
<td>38.5 kV</td>
<td>39.25 kV</td>
</tr>
</tbody>
</table>

Source: KOSTT and DSO Distribution code, version 1.0, July 2008, section 4.6.2 Voltage

Under states of contingency, it is exceptionally allowed that the voltage may be 15% lower than the rated one.18

3.3. Technical losses and drop voltages in Northern Prishtina as a study case

The parameters such as drop voltages, technical losses, the load of transformers and lines, load shedding, etc. help to define the quality of electrical energy. The 10kV feeder in Prishtina 5 called ‘Rezervoaret’ has the lowest values of voltage drops of 33.1%. Energy technical losses are the highest in this 10kV feeder with annual losses of 19.42%; if expressed in energy it means that 2,076MWh is lost. Table 3.3 highlights the calculated parameters for each 10kV feeder.

The price for average cost of MWh last year was 57 Euro. If this price is used to calculate the losses in feeder Rezervaori, the result is 118,341 Euro. The total technical losses in northern Prishtina were 917,233 Euro or 2% of the total losses in Kosovo for 2009.

The higher peak load Pmax was in the feeder called Kodra e Trimave 7 with 4.02MW. Most energy was spent by the feeder called Xhamia e LLapit 1 with 12,656MWh. Technical losses in the feeder Pompa were zero because their meters were set in the SS Prishtina 5 and the losses were billed to the pumps.
Table 3.3 Energy flow parameters for each 10kV feeder in Prishtina 5 and Besia

<table>
<thead>
<tr>
<th>FEEDER 10KV</th>
<th>Energy (MWh)</th>
<th>Technical losses (%)</th>
<th>Technical losses (MWh)</th>
<th>Losses (euro)</th>
<th>Voltage drops(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>j5 Bardhosh</td>
<td>7,179</td>
<td>16.56</td>
<td>1,189</td>
<td>67,764</td>
<td>22.00</td>
</tr>
<tr>
<td>j6 Rezervaret-KFOR</td>
<td>10,691</td>
<td>19.42</td>
<td>2,076</td>
<td>118,341</td>
<td>33.10</td>
</tr>
<tr>
<td>j7 Baci Petroll</td>
<td>4,331</td>
<td>13.00</td>
<td>563</td>
<td>32,089</td>
<td>15.80</td>
</tr>
<tr>
<td>j9 Llukar</td>
<td>5,506</td>
<td>16.60</td>
<td>914</td>
<td>52,100</td>
<td>21.20</td>
</tr>
<tr>
<td>j11 Kodra e Trimave 11</td>
<td>7,731</td>
<td>13.42</td>
<td>1,037</td>
<td>59,135</td>
<td>16.30</td>
</tr>
<tr>
<td>j12 Kodra e Trimave 7</td>
<td>13,126</td>
<td>13.73</td>
<td>1,802</td>
<td>102,722</td>
<td>16.80</td>
</tr>
<tr>
<td>j17 Kodra e Trimave 9</td>
<td>5,489</td>
<td>12.97</td>
<td>712</td>
<td>40,583</td>
<td>15.00</td>
</tr>
<tr>
<td>j18 Kodra e Trimave 8</td>
<td>12,425</td>
<td>14.36</td>
<td>1,784</td>
<td>101,704</td>
<td>15.30</td>
</tr>
<tr>
<td>j20 Pompat e ujesjellit</td>
<td>394</td>
<td>0.00</td>
<td>0</td>
<td>0</td>
<td>0.50</td>
</tr>
<tr>
<td>j21 Kodra e Trimave 21</td>
<td>6,818</td>
<td>13.18</td>
<td>899</td>
<td>51,222</td>
<td>18.50</td>
</tr>
<tr>
<td>j13 Pompat</td>
<td>4,714</td>
<td>0.00</td>
<td>0</td>
<td>0</td>
<td>0.57</td>
</tr>
<tr>
<td>j22 Kodra e trimave 4</td>
<td>9,781</td>
<td>15.88</td>
<td>1,553</td>
<td>88,534</td>
<td>20.30</td>
</tr>
<tr>
<td>j25 Xhamia e Llapit I</td>
<td>12,657</td>
<td>13.42</td>
<td>1,699</td>
<td>96,816</td>
<td>17.50</td>
</tr>
<tr>
<td>j24 Xhamia e Llapit II</td>
<td>2,485</td>
<td>13.10</td>
<td>326</td>
<td>18,555</td>
<td>18.90</td>
</tr>
<tr>
<td>j27 Kodra e trimave 5</td>
<td>4,476</td>
<td>13.06</td>
<td>585</td>
<td>33,322</td>
<td>19.60</td>
</tr>
<tr>
<td>j19(e re) Kodra e Trimave 8</td>
<td>5,070</td>
<td>13.24</td>
<td>671</td>
<td>38,262</td>
<td>21.10</td>
</tr>
<tr>
<td></td>
<td>112872.00</td>
<td>14.01</td>
<td>15810</td>
<td>901,149</td>
<td></td>
</tr>
</tbody>
</table>

Losses in transformer 110/10kV 282.18 16,084
Technical losses in total for 2009 in Prishtina 5 are: 16092 917,233

Source: Energy flow parameters taken from ABC software, Balance Section. Drop voltages taken from Gredos software and Power Factory, Measure Department, 2009

Table 3.4 Energy flow parameters for each 10kV feeder in Besia, which is part of northern Prishtina but not supplied from Prishtina 5

<table>
<thead>
<tr>
<th>FEEDER 10KV</th>
<th>Energy (MWh)</th>
<th>Technical losses (%)</th>
<th>Technical losses (MWh)</th>
<th>Losses (euro)</th>
<th>Voltage drops(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Luzhan</td>
<td>4,789</td>
<td>15.23</td>
<td>729.38</td>
<td>41,575</td>
<td>23.50</td>
</tr>
<tr>
<td>Prugovc</td>
<td>3,843</td>
<td>16.30</td>
<td>626.46</td>
<td>35,708</td>
<td>22.60</td>
</tr>
<tr>
<td></td>
<td>8,632.30</td>
<td>15.71</td>
<td>1,355.84</td>
<td>77,283</td>
<td></td>
</tr>
</tbody>
</table>

Losses in transformer 35/10kV 21.58 1,230
Technical losses in total for 2009 in Besia are: 1377.42 78,513

Source: Energy flow parameters taken from ABC software, Balance Section. Drop voltages taken from Gredos software and Power Factory, Measure Department, 2009
4. PREPARATION OF PROJECT AND CONTRACTS

4.1. Simulations with Gredos and Power Factory software

Once the network parameters have been entered into the computer database, the analysis allows the engineer to study the performance of the network under a variety of outage conditions. Currently, all the data related to high voltage and middle voltage network exist in the software. For the moment DSO employees are doing a sketching project and are collecting some of these data in the field. This project is expected to be completed this year. Then the data will be entered in the new software called Power Factory.

Other softwares in Network Division were very useful to help this research with the collection of data. Gredos is power flow software which calculates all the parameters related to middle voltage network, technical losses, power flow, information about lines, TR etc. But there is a weakness that it does not include the data on low voltage network.

The new software Power Factory was installed last year and is still in the phase of implementation. It is more sophisticated and it calculates all the data including LVN. These softwares are being used in KEK to calculate the losses, the drop voltages, the power flowing etc. Another software, the so-called ABC, is used to calculate the energy losses per each 10kV feeder and make different comparison. Other CCP and ABC softwares needed for this project have been used to extract data’s on each customer, each feeder and SS 110/35/10kV.

4.2. Gathering data from field

To make this project livable and applicable technical, economic, and human resources data are needed. Being aware that some technical equipment is new, knowledge is needed to operate with it.

The usual practice was that KEK had donors to help with the investments. Today the investments should be done by KEK itself. KEK has its departments which can help to manage the project. Development Department helps with analysis and projects while Engineering Department help to implement the project under the supervision of the Implementation Department. Sometimes there is lack of communication among these departments. The district of Prishtina provides always the new technical data from the field.
4.3. Contractual arrangements

The process before starting the project requires the involvement of procurement to choose the best and most responsible bid. There are some important criteria: which should be set to identify the best bidder:

- technical capability on technical skills and capabilities to do the job
- if there is any risk, how they could be mitigated
- does the supplier use equipment based in the technical specification
- does the supplier work based on the set standards and offer warranty time
- can the supplier be expected to obtain the necessary financial resources
- what is the past experience of the supplier and verification of references they have provided

Procurement is conducted actively to select the supplier having in mind the warranty, product support, penalties, etc. The process is called closed after inspections and commissioning and upon the agreement of both parties.

If KEK cannot accomplish all the works by itself, a contractor from outside should be involved. Agreement with contractor can be reached when the parties have the necessary capacity to contract; the contract must not be trifling, indeterminate, impossible or illegal. Important agreement between KEK and other operators require permissions from Municipality, water supply system and post telephony called PTK, before the project starts. These permissions are needed before the implementation, because works are related to other infrastructures (water tubes, heating tubes, telecommunication cables). The municipality could help in finding the proper locations.

KEK-PTK and KEK-Batllava have agreements on how to help each other and to avoid the problems that they might suddenly come across. E.g. Before starting the works, PTK informs KEK about its cables so KEK could avoid any possible damage. PTK, Ipko and Kujtesa operators are using KEK network to distribute their services to their customers. It is necessary to involve these operators when changing some part of network in northern Prishtina. Before making the plans, KEK should make agreements with these customers so that they could participate in the infrastructure of KEK network based in the agreements.

During the project, problems might occur in finding the proper location for new SS or poles, especially in private properties. A major challenge for the municipality and KEK is to convince the customers for the land.

The land does not introduce a problem in repairing existing equipment, but this project involves the establishment of a new SS 10/0.4kV and new lines. In this case, the municipality should play a mediator role between KEK and third parties (citizens), in finding solutions for the locations of the lines and SS. Land expropriation should be envisioned, that’s why during the budgeting projection, KEK should foresee land expropriation funding.
5. POTENTIAL TECHNICAL DESIGN OPTIONS

Below are proposed and described the best solutions. At the end of this chapter the reasons why it is important to invest will be described.

The proposals will be given based on the analysis and calculations made last year from some sections in Network Division.

5.1. Improve stability in middle voltage network – provide the transition from level 10kV to level 20kV of voltage

The transition from low level of voltage into the higher one is the best solution to improve the quality of electrical energy in MVN and to provide better electrical energy supplied by the substations 10(20)/0.4kV then LVN. Until now a few SS 35/10kV into SS 110/10(20) kV are upgraded in KEK, but no 10kV network is converted into 20kV. Even though this transition is not physically realized, all equipment installed in the last 10 years has been intended to work as 20kV voltage. It is easy to say that some of it is already ready to be used for this project.

Up-to-date Kosovo has 2.2% of its network in 20kV level while 4.7% of transformers are 20/0,4kV. Compared to other states, Croatia has more than 20% of equipment in 20kV, Albania 4.4% and Serbia 22%. Slovenia already has converted into 20kV.

5.1.1. Upgrade the cross section of the conductors and built lines for reserve supply

The following actions should be undertaken in this study case in northern Prishtina in order to have the cross section of the 10kV feeders upgraded:

1) The length of the feeders which are overloaded and have small conductor cross section should be upgraded due to the overloads occurring in them

   - About 6 km length of over head lines are overloaded in the northern Prishtina. They should be upgrade urgently
   - About 20km of conductors, mostly in rural areas should be upgraded

2) On the other hand, the target of reserve supply evaluation is satisfying the general supply continuity criterion, (N-1). It means that for single network outages, the reserve customer supply is satisfied. This criterion is addressed mostly to urban areas and industrial customers. It is also allowed in rural areas, but the conductors with small cross section cannot play the reserve role. In that case the aim is to build these lines and to connect radial feeders:
• First reserve lines supplies should be build in the city between the 10kV feeders of
the so-called K. Trimave 21 and Arberia 5 (SS Prishtina 3 110/10) kV at a length of
about 0.7km and second line between K. Trimave 9 and Baci Petroll at a length of
about 0.3km.

• Another two lines should be built between feeders Bardhoshi and Rezervoaret-Kfor
at a length of 0.8km and between Bardhoshi and Llukar at a length of about 1.8km.
These lines connect two radial feeders with long lengths. It is recommended that
these lines are build, after the cross section is upgraded. These lines are shown in
figure 5.1 (circle)

Figure 5.1 Line reserve suppliers for the feeders 10kV

Table 5.1 shows two proposals for the first activity. The value of $P_{max}$ and electrical energy
received $W$ (MWh) have been taken from 2009 reports, the technical losses (MWh) have been
estimated while technical losses in euro have been calculated based on the mentioned price
above 57euro/MWh.

Table 3.3 serves as a reference to make comparisons of its technical losses 16,092MWh or
917,233Euro. In table 5.1, technical losses in % have been calculated
as($15,826/112,872$)$/100=14.02%.

Energy saved in MWh has been calculated as (16,092-15,826)=266, and energy saved in
money has been calculated as 266*$57=15,162euro$

The reserve supply activity does not show a high reduction of technical losses, but it calms
the situation down by eliminating bottlenecks in the overload feeders and by offering an
alternative supply to the customers during the failures.
Table 5.1 First activities how to improve the quality and continuity supply in northern Prishtina

<table>
<thead>
<tr>
<th>Activities I</th>
<th>Energy received (MWh)</th>
<th>Technical losses before (MWh)</th>
<th>Technical losses after (MWh)</th>
<th>Technical losses (%)</th>
<th>Energy saved (MWh)</th>
<th>Energy saved (€)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upgrade cross section</td>
<td>112,872</td>
<td>16,092</td>
<td>15,826</td>
<td>14.02</td>
<td>266</td>
<td>15,162</td>
</tr>
<tr>
<td>Reserve supplies</td>
<td>112,872</td>
<td>16,092</td>
<td>16,092</td>
<td>14.01</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

5.1.2. Transition from voltage level 10kV into 20kV.

The transition from 10kV to 20kV is the best solution to greatly reduce the losses and voltage drops. The following recommendations should be considered during the transition to 20kV:

- The main supplier must have transformation 110/10(20) kV. In our case Prishtina 5 has two transformers with rating 110/10kV or with possibility of 110/20kV.
- All SS MV/LV 10(20)/0.4kV must be of reconnectable type. The old model transformers should be replaced with new models.
- All new SS 10(20)/0.4kV equipment must comply with 20kV.
- Some of the overhead lines located in the city should be replaced with cables.

The upgrade of the middle level of voltage network, will correspond to the transition of 20kV. The activities should be done with the aim to improve supply and to offer a better view to the city of Prishtina. There are some activities that should be undertaken in order to start this phase of the project.

1) In the northern Prishtina there are copper oil cables installed, which cannot function as 20kV. Taking into account the most important aim of this project - the transition from 10kV level of voltage into 20kV - the oil cables should be changed. Based in the Gredos software there are about 15km that should be changed, while 27km of new cables which currently work as 10kV have the possibility to function as 20kV and therefore should not be changed.

2) On the other side, overhead lines should be upgraded to work as 20kV. It includes the change and upgrade of the section of conductors followed by other equipment such as poles,
consoles, insulators etc. Another important issue that should be considered in this case is the **replacement of overhead lines conductors with cables**. It will improve the network which passes in main roads and looks like a ‘spider network’; it gives an unpleasant view to the city. It is not necessary to replace all the air conductors with cables.

3) **Change 10/0.4kV transformers** with 20(10)/0.4kV transformers. In northern Prishtina, 28 substations with both transformation 10(20) kV are reconnectable type. The process should start with replacing 10/0.4kV transformers with 20/0.4kV transformers and accompanying equipment. 54 TR with transformation of 10/0.4kV should be changed in Prishtina 5 with new 20/0.4kV rating transformers because of the transition in higher level of voltage. The latest news from DSO is that this region in northern Prishtina will have another 4 new substations this month with the possibility of 20/10kV transformation.

The table 5.2 presents these activities that bring solutions and shows how much technical losses will be reduced, having in mind as a reference that the losses were 14% (see table 3.3). It also presents how much electrical energy is saved by undertaking these activities.

### Table 5.2 The second solution to improve quality in northern Prishtina

<table>
<thead>
<tr>
<th>Activities II</th>
<th>Energy received (MWh)</th>
<th>Technical losses before</th>
<th>Technical losses after</th>
<th>Technical losses (%)</th>
<th>Energy saved (MWh)</th>
<th>Energy saved (euro)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Change cables</td>
<td>112,872</td>
<td>16,092</td>
<td>15,598</td>
<td>13.82</td>
<td>494</td>
<td>28,158</td>
</tr>
<tr>
<td>Upgrade OHL</td>
<td>112,872</td>
<td>16,092</td>
<td>13,556</td>
<td>12.01</td>
<td>2,536</td>
<td>144,552</td>
</tr>
<tr>
<td>Upgrade TR</td>
<td>112,872</td>
<td>16,092</td>
<td>15,256</td>
<td>13.52</td>
<td>836</td>
<td>47,652</td>
</tr>
</tbody>
</table>

This activity is the most important in this study. There have been a lot of attempts to initiate a transition from low to higher level in MVN, but they have not been successful. This study will help KEK to initiate this process again. Based on the table, it brings the best estimated reductions from 14% into 9.7%. The third activity which has to do with transformers is dependent on the first and second one.

### 5.2. Improve stability in LVN

Based in the data shown in the tables, there are about 12 thousands customers in northern Prishtina. The peak load based on the feeders during the winter time is 39.36MW, which means around 3kW per customer. During the winter time, the electrical energy is used to heat the houses, to warm the boilers for bathrooms etc.

This year software has been put into use to make easy calculations of technical losses and power flow in network. This Power Factory software is not yet fully operational, because it needs a lot of data from the field. Based on the distribution sections, the calculations are being done manually for some SS in LVN; then this average is used for the others.
5.2.1. Establishing phase symmetry

Additional losses in phases occur due to the lack of symmetries between phases. KEK has faced with asymmetry problems between phases, because the whole LVN system is uncontrolled, which causes the asymmetries in the system. The use of software helps to avoid asymmetries between 0.4kV feeders and between the phases. The new Power Factory software enables to set all the data of LVN and to control them. In this case, the software helps to increase chances in avoiding asymmetry and to minimize the losses caused by asymmetries.

5.2.2. Rehabilitation of LVN

As mentioned above, after the war, the expansion of network distribution was as a ‘boom’ in Kosovo. Seen from the aspect of regional points, it happened mostly in the cities, but seen from the aspect of the level of voltage it happened mostly in LVN. Some of the new lines worked according to KEK permission but most of them worked without any permission from KEK or municipality. It could be said that for new lines there is no need for reinforcement it is proposed above that MVN overhead lines located in the main roads in the city to be replaced by cables. The same should be done with LVN. It will bring a better view to the city and avoid the danger from OHL.

5.2.3. New SS 20/0.4kV

The increase of population creates new demands on the use of electrical energy, so new 20/0.4kV transformers should be placed where demands are higher. In absence of software for LVN, these substations can be placed more easily with the help of Maintenance Departments of municipalities.

Software would enable to see where the longest lines of 0.4kV are and which should be shortened by doing investments in the future. The use of software makes it easy to identify overloaded SS 10(20) kV and where to put new ones.

Another way to identify the overloaded substations is dispatch center. They statistically know on a daily basis where interventions due to different faults are mostly done; i.e. which substations are frequented most by maintenance employees. Based on the methodologies above for identifying the needs for new SS 10(20) kV, approximately ten new SS are needed in northern Prishtina.

5.2.4. The compensation of reactive energy

When the power factory is lower than 0.95, the battery capacitors would set to compensate the reactive energy. Based on the last year analysis, power factory is 0.92<0.95. The batteries should be set to the customers who have lower value of the power factory; this should be the case mostly with those who use equipment with motors for their businesses.
Table 5.3 The third solution to improve quality in northern Prishtina

<table>
<thead>
<tr>
<th>Activities</th>
<th>Energy received (MWh)</th>
<th>Technical losses before (MWh)</th>
<th>Technical losses after (MWh)</th>
<th>Technical losses (%)</th>
<th>Energy saved (MWh)</th>
<th>Energy saved (euro)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>(4/2)*100</td>
<td>(3-4)</td>
<td>(6)*57€</td>
</tr>
<tr>
<td>Establish asymmetry</td>
<td>112,872</td>
<td>16,092</td>
<td>15,550</td>
<td>13.78</td>
<td>542</td>
<td>30,894</td>
</tr>
<tr>
<td>Rehabilitation LVN</td>
<td>112,872</td>
<td>16,092</td>
<td>13,666</td>
<td>12.11</td>
<td>2,426</td>
<td>138,282</td>
</tr>
<tr>
<td>New SS</td>
<td>112,872</td>
<td>16,092</td>
<td>15,587</td>
<td>13.81</td>
<td>505</td>
<td>28,785</td>
</tr>
<tr>
<td>Compensate reactive en.</td>
<td>112,872</td>
<td>16,092</td>
<td>15,840</td>
<td>14.03</td>
<td>252</td>
<td>14,364</td>
</tr>
</tbody>
</table>

5.3. Besia SS 35/10kV

This project foresees to supply two feeders from Besia in Prishtina 5 as the nearest location. The investments include: 20kV lines from Prishtina 5, upgrade of cross section of 20kV conductors, change of 28 TR because they cannot function as 20kV (the activities 5.1 and 5.2)

Technical losses in table 3.3 and 3.4 are 17,469MWh or expressed in euro 995,746Euro. The parameters calculated in table 5.4 are calculated: technical losses in %

\[(15,942/121,504)/100=13.12\%\]

Technical losses in euro are calculated: \((17,469-15,942)=1,527\). Energy saved in money \(1,527*57=87,039\) euro

Table 5.4 Fourth solution for northern Prishtina with two more feeders from Besia

<table>
<thead>
<tr>
<th>Activity IV</th>
<th>Energy received (MWh)</th>
<th>Technical losses before (MWh)</th>
<th>Technical losses after (MWh)</th>
<th>Technical losses (%)</th>
<th>Technical losses (Euro)</th>
<th>Energy saved (euro)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Besia in Prishtina</td>
<td>121,504</td>
<td>17,469</td>
<td>15,942</td>
<td>13.12</td>
<td>1,527</td>
<td>87,039</td>
</tr>
</tbody>
</table>
5.4 Summary of chapter 5 - priorities

A summary of this chapter is given in the table below and the activities above have been briefly described.

Table 5.5 Summary of the activities from the tables 5.1-5.4

<table>
<thead>
<tr>
<th>Activity</th>
<th>Energy received (MWh)</th>
<th>Reduce of technical losses (MWh)</th>
<th>Reduce of technical losses (%)</th>
<th>Reduce of technical losses (euro)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1 Activities I</td>
<td>112,872</td>
<td>266</td>
<td>0.24</td>
<td>15,162</td>
</tr>
<tr>
<td>A2 Activities II</td>
<td>112,872</td>
<td>3,866</td>
<td>3.43</td>
<td>220,362</td>
</tr>
<tr>
<td>A3 Activities III</td>
<td>112,872</td>
<td>3,725</td>
<td>3.30</td>
<td>212,325</td>
</tr>
<tr>
<td>A4 Activities IV</td>
<td>121,504</td>
<td>1,527</td>
<td>1.26</td>
<td>87,039</td>
</tr>
<tr>
<td>TOTAL</td>
<td>121,504</td>
<td>9,384</td>
<td>7.72</td>
<td>534,888</td>
</tr>
</tbody>
</table>

There are some activities to be undertaken during this project.

A1: Activity I is important to provide better supply to the customer during network failures due to damages, because the cross-section of the conductors needs to be upgraded. Usually this activity is undertaken in emergency situation until a better solution is applied (found).

A2: Activity II is related to middle level of voltage which is the best solution to eliminate 10kV level of voltage and to reduce losses in a large amount. The best results of this activity are expected in the rural areas compared to urban areas, where the 10kV lines are longer (e.g. feeders Bardhoshi, Rezervoaret Kfori and Llukari)

A3: Activity III improves the stability and quality of voltage in the low voltage network.

A4: In the current situation, activity IV is necessary to improve supply to the villages near Prishtina. It is also important to find a solution for the transformer located in the Besia Pump property.

The first activity has its importance in cases of emergency. Activity II and III are both very important, but if priorities should be set between these two, activity II is more important. It realizes the aim of the project by fulfilling:

- The quality of voltage in middle voltage network
- Is the first project in Kosovo which improves the transition from lower voltage into the higher (10kV to 20kV)
- Creates a stability voltage in the 20/0.4kV transformation
- Based on table 5.5, it saves more money compared to other activities
Then third activity should be done and the latest activity IV can be performed.
6. DISTRIBUTION MANAGEMENT RESOURCES

6.1. Project supports

This project can be considered as a complex one, because it involves investments, some infrastructures and a commitment of resources. The project requires integrating the activities, dispelling disruptive conflicts and maintaining customer strong relation. It is necessary for the project to be supported from executives, senior engineers and senior managers. They should appoint the best project manager; give him/her power, authority and continuous support during the project lifetime. They should help the project manager to establish the objectives of the project.

The project manager will be responsible to identify modalities that would avoid destructive factors from influencing the execution of the project. The role of the supporters is in policies, monitoring execution, priority settings and conflict resolution. The commitment of senior management gives importance to the projects. The interaction of project activities with other activities in other departments in DSO and KEK establish interdependence between projects.

6.2. Managerial approaches

There are several approaches that can be taken to managing project activities including agile, interactive, incremental, and phased approaches.

- Project initiation stage;
- Project planning, design stage;
- Project execution stage;
- Project monitoring and controlling systems;
- Project completion stage.

Each of these stages requires particular knowledge, skills and resources, whereas the project manager should have acquired staff for that. The project manager works to accomplish the goals of the KEK organization.

The project manager should apply the tools and techniques which are generally recognized as good practices, understand and use the knowledge and skills; and at last apply standards and regulations.

When recruiting and building an effective team, the manager must consider not only the technical skills of each person, but also the critical roles and relations between workers.

Project manager attempts to reduce risk significantly, often by adhering to a policy of open communication, ensuring that project participants can voice their opinions and concerns.

6.3. Human Resources Management Plan and Team Selection

Human resources management plan in this project includes the organization of management and personal administration to help the project.

Organizational management is a correlation between all organization’s effectiveness to implement strategy. Organizational Management is fundamental to creating an environment...
that supports continuous improvement of individuals and their organizations to better provide for the communities they serve.\(^{23}\)

Employees should be given security, safe working conditions, motivation and payment for overtime works.

Using the new technology or new equipment is not always easy. The employees should be trained to gain more knowledge on how to use the equipment, how to install them, how to be safe during the works etc.

The best person in the Network Division should be assigned to work with the project team and on the tasks that need to be completed. He/she should be experienced in the field of project management. The project leader should be empowered and given authority from the leadership to implement the project. He must know how the project fits into the organization, handles budget, timetables, criteria, expectations, diverse resources, deadlines etc.

Key project management responsibilities include creating clear and attainable project objectives, building the project requirements, and managing the triple constraints for projects, which are cost, time, and quality.\(^{24}\)

After appointing a capable and credible leader, it is important to select team members to meet the needs of the project. Most of the team members could be from DSO, additional ones can be hired to fill capability gaps.

### 6.4. Training needs and security procedures

It is important to identify staffing requirements, education and professional development, and to administer their work-related needs, find organization's personnel resources where and when they are needed, training and skills required by the work.

There is a Training Center inside KEK in Obiliq, which offers training possibilities to employees. Project manager will introduce the needs to the human resources and support the employees on the capacity building processes. If new employees are hired to help the project, KEK will take care to train them first.

The training should not be limited only to the nature of the profession; it must fulfill the other needs such as: security, risks, environment etc.

Employees should be secure during their works in the field and in each work place. Their clothes would be suitable for every occasion.

A sector for security of employees exists inside each district of KEK; the sector was created a year ago and is tasked to implement KEK rules on security during works, health and working environment, approved in 2005 by Executive Board of KEK, based on the Law no.2003/19.

The aim of security is to prevent the employees from the lesions and other damages during the works, to protect people around the works and to protect the environment.\(^{25}\)
6.5. Communication with Internal and External stakeholders

The project determines the needs of stakeholder information and defines a communication approach. Preparatory meetings are necessary between Finance Division and DSO, with the purpose to establish communication and monitoring process.

Internal stakeholders, use their responsibilities to help the project go forward. Internal stakeholders belong to KEK divisions and departments. These departments include: Department of Procurement, Department of Development, Department of Implementation, Department of Engineering, Division of Finance, Division of Audit, Department of Maintenance, and Department of Operation.

They gather and analyze quantitative and qualitative information to determine whose interests should be taken into account.

External stakeholders play an important role on this project. Energy Regulatory Office applies the standards based on which KEK has to implement the projects. In that case ERO helps KEK to implement standards or otherwise applies penalties e.g. if the percentage of technical losses and voltage drops are higher than allowed in the network. In order to maintain these standards, KEK has to invest in the network.

KEK has a department which is responsible to implement projects every year, but in case this department is not able to fulfill their obligation, a contractor from outside would help to implement the project.

The communication between Municipality of Prishtina and KEK is very important. Permission from the municipality is required for new equipment that need to be installed in Prishtina. It is difficult for KEK to find locations to install new equipments such as: substations, poles or cables. Also there are property requirements (section 4.4.2) for which the municipality could help a lot.

Water supply systems like ‘Batllava’, ‘Iber Lepenci’ etc. have their water pipelines network underground for which KEK has no information. During the performance of underground works, KEK communicates with them in order to take care of not damaging their network or vise versa. Also KEK takes care not to damage PTK underground cables and Central Heating pipes. An old agreement permitted PTK to use some of KEK poles to deliver their services to end customers.

Last year KEK made an agreement to help two operators to provide their services through KEK network. These are IPKO - operator in Kosovo which provides mobile telephony, fixed telephony, internet and cable TV services: the main shareholder of which is from Slovenia and Kujtesa - mobile and cable system operator. They are using KEK underground network and overhead lines - poles. Cooperation and coordination with them should continue in this project.

Project impacts all entities: schools, universities, cultural institutions, small and large businesses, hospitals, health stations, families with low incomes, all ethnical groups and entities etc.

7. RISK MANAGEMENT PLAN AND BUDGETING ESTIMATES
7.1. Identify and mitigate risks

A risk management plan should be prepared by the project manager which identifies the activities that can harm the project and creates plans on how to mitigate the risks.

**SWOT** analysis is a strategic planning method used to evaluate the **Strengths**, **Weaknesses**, **Opportunities**, and **Threats** involved in a project or in a business venture. It involves specifying the objective of the business venture or project and identifying the internal and external factors that are favorable and unfavorable to achieving that objective.

Identification of SWOTs is essential because subsequent steps in the process of planning for achievement of the selected objective may be derived from the SWOTs.  

Table 7.1 SWOT Analysis

<table>
<thead>
<tr>
<th>Strengths</th>
<th>Weaknesses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Using existent capacity of SS 110/10kV</td>
<td>Self financing difficulties</td>
</tr>
<tr>
<td>Existing staff commitment</td>
<td>The delay of project</td>
</tr>
<tr>
<td>Projects done by DSO</td>
<td>Changes to investments direction</td>
</tr>
<tr>
<td>‘Bottlenecks’ finding</td>
<td>Low quality of equipment and work</td>
</tr>
<tr>
<td>Previous experiences for similar projects</td>
<td>Inability to deal with multidisciplinary assignments</td>
</tr>
<tr>
<td>Supervising the projects</td>
<td>Risk managing of projects</td>
</tr>
<tr>
<td></td>
<td>Spontaneous damages</td>
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<tr>
<td></td>
<td>Corruption within organization</td>
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<td></td>
<td>Non-technical executive influences</td>
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<table>
<thead>
<tr>
<th>Opportunities (Future)</th>
<th>Threats (Future)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bussines development</td>
<td>Lack of investment when privatized</td>
</tr>
<tr>
<td>Use of Europian Standards</td>
<td>Property issues</td>
</tr>
<tr>
<td>Better environment security</td>
<td>Out of ERO legislation</td>
</tr>
<tr>
<td>Advanced technology</td>
<td>Social impacts</td>
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</table>

<table>
<thead>
<tr>
<th>POSITIVE</th>
<th>NEGATIVE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>
7.1.1. Strengths

a) Using existing capacity of 110/10kV. In a lot of areas the project involves the building of main SS supplier of 110/20(10) kV. This substation was built in 2003 to supply the region of northern Prishtina. So, there is no need to build another SS.

b) Existing staff commitment. KEK can save spending the budget on extra employees due to existing staff who can do a lot of works in the field. There are employees from Engineering Departments whose job description is related to the implementation of new SS and lines in Network Division. The Implementation Department will supervise the works and maintenances employees from district can help in the works.

c) Project plans done by DSO. There is a section in the Network Division which implements all the projects in Network Division.

d) Identification of ‘Bottlenecks’ in the middle level of voltage is usually done by KEK each month during the analysis and calculation of technical losses. In low voltage of network bottlenecks are detected by maintenance department and by dispatch center based on the interventions in network due to failures.

e) Previous experiences in designing and implementation of projects are needed for further projects. These experiences are related to implementing new SS, changing transformers, building new feeders, changing equipments, making projects, supervising projects etc.

f) Supervising the projects. All the projects until now are supervised by senior and experienced engineers then accepted by a professional commission inside the KEK.

7.1.2. Weaknesses

a) Self-financing difficulties. KEK has experienced unpleasant situations with financing and investments. About 40% of energy is being lost in the network due to technical losses mentioned above and due to thefts by customers. If KEK could manage to control the losses due to thefts, the money saved could be spent in investments in the network. KEK needs to build a specific strategy on how to reduce commercial losses in the nearest future. Other ways of financing are: loans from banks or use of particular self financing investments.

b) The delays of projects. Delays in one project cause delays to the other projects. This should be mitigated during the designing stage.

c) Changes to investments direction. When budget reconciles and is allocated to other projects, which seems more important or emergent.

d) Low quality of equipment and work. If the equipment needed to implement the project are not quality ones, this can be categorized as a risk which needs to be mitigated. This risk can be mitigated by designing the right specifications before the bid and by supervising them during the implementation.

e) Unable to deal with multidisciplinary assignments. Employers and employees find it difficult to adapt themselves to the new multidisciplinary assignments. This is
mainly reflected in elderly employees who have difficulties to adapt with the changes and new trends

f) **Risk in managing projects.** If the project manager and the team who are responsible for the project do not show willingness to engage themselves sufficiently in the project or do not have sufficient knowledge to managing the projects this presents a risk for the project.

g) **Spontaneous damage and security.** Any unwarned or spontaneous failure during the works could happen in the field, which presents a risk for the workers and environment.

a) **Corruption** is a weakness in KEK. There is a division in KEK which fights the corruption and protects the customers. Corruption in some sections of KEK, which might be related to this project, could lead to the failure of the project.

h) **Non-technical executive influences,** who gives themselves the right to interfere in the project but are not professionally competent, could be a risk for the project.

### 7.1.3. Opportunities

a) **Businesses development;** Implementing such a project will help the society and will attract interested investors to invest in their businesses. Businesses from Llapi region are mostly concentrated in the northern Prishtina so they could develop their businesses and activities there.

b) **The use of European Standards;** The use of European standards of electrical quality, their implementation and monitoring by ERO is a step forward to European standards of quality.

c) **Better environmental security.** By improving the electrical network, people will be more secure as the possible risks due to different dangerous faults will be avoided.

d) **Advanced technology.** KEK will have new equipment and technology to serve to the customers and employees. KEK will be part of Europe by using the new modern technology and by updating it.

### 7.1.4. Threats

b) **Lack of investments when privatized.** It might be a risk that after privatization new investors would not be willing to invest in the DSO. Therefore it is important to include investments in the contractual arrangements of the privatization process. ERO should be empowered to implement the legislation which foresees ERO as a regulatory body.

c) **Property issues** should be solved before the implementation of the project, so that the project would not be extended. The municipality should support this process by acting as a mediator on making arrangements. This process needs governmental support too.
d) **ERO legislation.** If the laws from ERO are not applied or there are gaps in laws, the future investments during the privatization in DSO could be missed.

e) **Social impacts.** 26.7% of energy in KEK was lost because of thefts last years. If the customers continue not to pay back their debts of the electrical energy or continue to steal it, KEK will have less money in its funds and it will make fewer investments on KEK (DSO). An urgent regulation from KEK (Supply Division) supported by the government should be applied.

### 7.2. Budgeting and cost estimation

Based on table 5.5 the technical loss reductions for each year would be approximately 535 thousands euro. The investments needed in northern Prishtina are over 6 million euro. Based on the energy saved from technical losses, return on investments in total will be achieved in 11 years.

<table>
<thead>
<tr>
<th>Activities</th>
<th>Activities I</th>
<th>Activities II</th>
<th>Activities III</th>
<th>Activities IV</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy saved from losses (euro)</td>
<td>15,162</td>
<td>220,362</td>
<td>212,325</td>
<td>87,039</td>
<td>534,888</td>
</tr>
<tr>
<td>Investments (euro)</td>
<td>200,000</td>
<td>3,200,000</td>
<td>1,700,000</td>
<td>1,000,000</td>
<td>6,100,000</td>
</tr>
<tr>
<td>Return on investment (yr)</td>
<td>13</td>
<td>15</td>
<td>8</td>
<td>11</td>
<td>11</td>
</tr>
</tbody>
</table>

The money saved from losses, can be used to finance other similar projects across Kosovo, that is, 535 thousands euro which will be saved from northern Prishtina each year, can be used to invest in other projects. The maintenance and operation costs are not as a concern of this project. By reducing the non-technical energy losses and by improving collections sufficiently, KEK should be able to generate considerable funds for investments in a few years.27

There are some proposed ways how to invest in the project:

a) Loans from Banks

b) Help from government

c) Find a donor

d) Use self investments if t progress is made in collecting money from customers bills
8. THE EVALUATION OF THE PROJECT

This capstone project is intending to accomplish the results which will:
   a) improve voltage quality;
   b) promote energy savings; and
   c) improve stability across Kosovo.

Developing the network by repairing the existing one, investing in new ones and upgrading it through transition, will develop KEK, will provide secure, reliable and better services. KEK will be environmentally-responsive, transparent and a commercially orientated organization that is responsive to all customer needs.

8.1. Determining cost benefit

This project recommends and reviews cost benefit analysis, methods and techniques used to estimate values, supply side estimates, NPV and final cost-benefit outcomes.

In this study there will be a direct cost benefit by saving the energy of 535 thousand Euros per year through the reduction of technical losses. The other determined cost benefits are:

1. Enhance reliability and quality of electric supply;
2. Rehabilitate and modernize network capabilities;
3. Comply with operations and performance standards;
4. Increase the security in the building and surroundings;
5. Increase reliability in supply with qualitative electric energy for customers;
6. Eliminate bottleneck effects; and
7. Reduce load shedding customers.

8.2. Social benefits

By increasing the quality of electrical energy, business interests will increase. More businesses means more people employed in their processes by reducing the poverty in these regions.

Stability of electrical energy would not be an obstacle for pupils to learn in their schools and for teacher who teach them, for doctors in hospitals etc. Work would not be interrupted in different institutions due to the poor quality of electrical energy.

The new network will give a better view to the city. The lines will be replaced with cables enabling people to walk freely and safely as there will be fewer slopes in the towers. If there are less air conductors in the roads, the customers’ concern from occasional demolition of conductors which could fall, will be reduced.

It is assumed that more interested investors will come and invest in Kosovo if the quality of electrical energy is guaranteed.
8.3. Environmental Protection

The project should be focused its planning and development based on laws on environment and nature protection approved by Ministry of Environment and Spatial Planning. KEK would cooperate closely with Kosovo’s Assembly, Ministry for Environment and Spatial Planning, Ministry of Transport and Telecommunications, and all other authorities that deal with environment protection during planning and project implementation.

Rotten poles, present a risk for the workers who have to climb up these poles and for people or the environment around them. By implementing the activities mentioned above, these poles will be removed and replaced with new ones or by cables.

8.4. Growing interests of businesses

As a consequence of improper supply with qualitative electrical energy, additional load shedding is often used in a lot of districts around Kosovo. Currently there are many businesses that are not able to develop their activities because of the lack of electric energy.

By constructing the new SS and enabling better electrical energy supply, there will be better development opportunities for businesses in this region, enabling economic growth and indirectly improving social welfare and the quality of life. The increase of these capacities would partially facilitate economic development and attract small businesses.
9. DISCUSSIONS, FUTURE WORKS AND RECOMMENDATIONS

The methodology used for establishing this project is built in three directions: collecting energy parameters, economic and based on the technical European standards.

In order to improve the stability in the future, the voltage and technical losses must be considered. The improvement of the situation in the distribution network also helps to improve the electrical energy that must be provided to the customer.

To better summarize, the following six sentences should be considered together with technical requirements, the financial aspects and appropriate standards approved by ERO.

To finally clarify the work of this project, below are listed six sections:

- Technical future works
- Finance future considerations
- Northern Prishtina recommendations
- Activities in the long term plan
- Future project selection criteria
- Recommendations having highest priorities – Northern Prishtina

9.1. Technical Future Works

a) Development of electro energetic system in computerized model, in order to control this level of voltage (it is on way in network)

b) Avoid overhead lines in urban area. Replace overhead lines with cables in area which are used frequently by customers, to avoid the risks and to give a better view to the city

c) Invest more in the regions where technical losses are higher, paying special attention to the rural areas where these losses are higher

d) The transition from low voltage networks to higher voltage is the best way to minimize technical losses in MVN

e) The separation of a feeder into two means creating two feeders from a long one

f) Change equipment that has exceeded its life time

g) Increase the number of the supply sources (the 110 kV/MV substations)

h) Abolition of the 35 kV voltage level and adoption of the direct 110/(20)10 kV

i) Reinforce the MV network (upgrading the conductor cross-sections)

j) Minimize the length of long line by making two lines from it in MVN
Improve Stability Operations in Kosovo’s Electricity Distribution Network; A case study of northern Prishtina

k) Improve quality in low voltage network by
   - Implement new substation with transformation 10(20)/0.4kV
   - Distribute symmetrically to customers in the LVN
   - Compensate reactive energy
   - Rehabilitate the LVN network

9.2. Financial Future Consideration

a) Make agreements with telecommunication operators to invest together in the future in the new underground cable lines or overhead lines.
b) Find the best ways how to invest in DSO: use own KEK investments, loans from Banks, helps from government, donations etc.
c) Calculate net present value NPV or IRR for each project
d) Invest in new similar projects, using funds generated by savings due to reduction of technical losses in northern Prishtina.

9.3. Northern Prishtina Recommendations

a) First find the budget to implement this project
b) Built strong relationships with municipalities and all institutions that can help northern Prishtina in project activities.
c) Take into account the technical recommendations from 9.1 a), b), c), d), g), i) and financial recommendations from 9.2 a), b), c)
d) Based in chapter 5.5, start project with activities A1, then A2, then A3 and at the end activity A4.
e) Spent more time in developing the project, so the implementation would be more successful
f) Use own human resource capacities to implement the project, but if it is necessary engage external contractors.

9.4. Activities in the Long Term Plans

- Define least-cost investments program for rehabilitation and expansion of network infrastructure.
- Built strong relationship with municipalities, Ministry of Transport and Telecommunication and all institutions that are involved in construction and
infrastructure activities. Based in their infrastructure plans; KEK should adapt its plans so it will easy to develop the network or vice versa.

- Based on the results of the first project which will be used as a pilot project (northern Prishtina), KEK could develop a strategy on how to reduce technical losses in all areas in Kosovo, then determine priorities to invest in other projects.

- The reduction of commercial losses and increase of debt collection would help KEK to increase its budget.

- Develop a project management office to manage all the processes distributed in different departments and help in:
  - identifying the project standards
  - identifying best practices
  - developing management methodology
  - capacity planning and development
  - preparing stakeholders participation and involvement plan/strategy

- Develop a strategy to reduce commercial losses. The reduction of commercial losses will increase KEK funds, so more money will be available for investments.

- Offer special supply (own feeders, substations) to industrial businesses development. Some industries require a special supply.

### 9.5. Future Project Selection Criteria

In order to determine where the priority areas for projects are, it is necessary to analyse the network. Some priorities related to implementation of new main SS 110/20kV should be undertaken together with KOSTT.

The primary objectives of the Network Development Plan for investments are to address the following issues in order of priority:

- Based on the areas where technical losses and drop voltages are higher
- Based on customer complaints about voltage quality
- Based on the increase of energy foresight by demands of electrical energy
- Based on demography: areas showing an increase in population have higher demands for electrical energy
- Based on audit statistics of maintenance that collect data from the situation in the field; they present the needs for electrical equipment changes
- In substations where load shedding is unavoidable due to bottlenecks
• in areas where cost benefit is higher and return from projects is acceptable, mainly having in mind money saved from technical losses

• In ranking other projects, take into account: NPV, IRR and ROI

9.6. Recommendations Having Highest Priorities

- Gradual transition from the level of voltage 10kV to the level of voltage 20kV, because as compared with other methods it brings better results to reduce the technical losses

- LVN investments as a second priority

- Replacement of air conductors with underground cables, especially in the main roads and in the places frequented by people. This replacement of conductors includes MVN (10kV) and LVN

- Agreement with telecommunication operators to invest together in the new network and in the rehabilitation of new network.

- Synchronization of DSO development plans with the municipal plans, telecommunication’s operators plans, KOSTT plans, central heating plans etc.

9.7. Summary

In preparation of this project, the current state of electro-energetic system, investors, donor agencies, stakeholders etc and other analytic factors have been taken into consideration.

Implementation of this project will advance the distribution system to a comparable level with European standards. It would also make possible the integration of Kosovo’s distribution system in other regional electro-energetic systems.

Increase of these capacities would partially facilitate economic development and attract small businesses, while needs for capital loads will be addressed at the moment of their emergence by adapting to the system of required conditions.

This project comes at a stage when the network distribution system has very high technical losses and shows poor quality in the supply system. Currently, the quality of electrical energy provided to the customers, does not meet the standards established by European norms. The main idea of this project is to improve the quality of electrical energy to the customers by promoting the best methods.

To improve the quality of electrical energy, there is a need to invest in the low level voltage and middle level voltage networks. Based on network analysis using software, it is worth to mention that the transition from level of voltage 10kV into 20kV brings the best results of technical loss reductions.
The implementation of sets of activities described in this project would enable an increase of the quality of electric energy and the quality of services in Kosovo (northern Prishtina as a study case.) Northern Prishtina is taken as a study case because it has better chances to be converted from 10kV into 20kV. It means that half of the middle voltage network can work as 20kV, so the investments will be fewer in that case. The transition from low level of voltage into higher is taken into consideration and is assessed as a first priority compared to the other activities.

This study describes the analysis which refers to the management resources, risks, budget etc. Among others, the implementation of this project brings a better view to Prishtina city, offers greater security to the workers, increases environment security and brings other benefits to the society.

General and technical recommendations are taken into considerations which are necessary for other projects in the future.
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1. Annexes

Foto.1 Kodra e Trimave Prishtine

Source: Lutfije Dervishi 2009

Foto.2 Bregu I Diellit, Prishtine

Source: Lutfije Dervishi
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Source: Faruk Gjukaj, 2007
Source: Bashkim Shabani, 2010
Annex.2

**Feeder 10kV Turiqevci**

This feeder supplies 44 SS 10/0.4kV, with a length of the 10kV feeder of about 60km and conductor AlFe 35/6mm² and AlFe 25mm². The analysis shows that:

<table>
<thead>
<tr>
<th>Sinst (MVA)</th>
<th>Pmax (MW)</th>
<th>S/Smax (%)</th>
<th>Overloaded (km)</th>
<th>dP (MW)</th>
<th>dP (%)</th>
<th>dV Izbice (%)</th>
<th>dV Aqareve (%)</th>
<th>dW (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.07</td>
<td>3.2</td>
<td>136</td>
<td>6</td>
<td>1.02</td>
<td>31.87</td>
<td>41.87</td>
<td>45.13</td>
<td>27.5</td>
</tr>
</tbody>
</table>

Sinst- Installed power
Pmax – Peak load
S/Smax- shows how much is a feeder overloaded, in this case it is 136%, which means that more than 6km are overloaded by 36%
dP-Technical power losses in MW
dP(%)-Technical power losses in %
dv are voltage drops in the ends points