18.07.2017

Comments related to: Consultation Reports on Input Values for PPR2

Issues for comment:

1. ***Report on WACC***
2. ***Report on assets lifespan***
3. ***Report on transmission losses***

Commentary:

1. Report on WACC

As set out in the Consultation Report, the cost of equity should be estimated using the much-used Capital Asset Pricing Model (CAPM). Accordingly, the cost of pre-tax equity is calculated as:

$rEi = rf + \beta i * ERPm$

where:

rf	*risk-free rate*
ERPm	*equity risk premium applicable to the market as a whole*
βi	*covariance between the returns on the individual equity asset and those of the market as a whole (the equity beta)*

KOSTT agrees with this approach; however we would like to point out several aspects regarding the CAPM parameters.

Risk-free rate

- "Risk-free rate" represents the required return for an investor under the assumption of zero risk connected with a particular investment. Risk free rate is commonly estimated as the yield to maturity of treasury bonds. The specific bonds used for derivation of the "risk free rate" should be selected by the following criteria::

- The time to maturity should correspond to the duration of expected cash flows of the project. Yield curves are typically upward trending – longer time to maturity implies higher required return;
- Treasury bills with long-term maturity should be used during project evaluation on the with "going concern" assumption, which KOSTT certainly is. Limitation of bonds with longer maturity often results in low liquidity;
- It should be decided whether to use the spot risk-free rate or to calculate the average yield of treasury bills for a certain historical period. While spot rates reflect current market conditions for investment opportunities, the average value of risk free rate over an appropriately selected period eliminates short-term fluctuations in the financial markets and contributes to higher consistency over a longer period. It should be noted that current economic condition within Eurozone reflect short-term fluctuations due to quantitative easing and it has translated into very low yield to maturities of respective bonds.

- Risk free rate and equity risk premium are closely linked to each other for computation of cost of equity purposes (see further). **Thus it is necessary to maintain consistency between maturity of treasury bills used for derivation of risk free rate and bonds used for the measurement of equity risk premium.**
- As a reference to one reputable source, we would like to refer to consulting company Duff & Phelps, which represents a reputable institution for the purposes of assessing CAPM input parameters for estimating WACC. Duff & Phelps in its Valuation Handbook measures equity risk premium based on a ten year average yield to maturity (YTM) of securities with 20-years maturity. **Hence, in this case, the most appropriate equivalent of risk free rate should be based on 10Y average YTM of 20-year treasury bills**.

Equity risk premium (ERP)

- **For preservation of consistency of individual parameters, while calculating the cost of equity, ERP should be determined such that it complies with performed risk free rate.**
- This estimate is based on various academic studies. In particular, we present here the steps for estimation of cost of equity on Duff & Phelps publications to keep consistency with risk-free rate.
- Duff & Phelps studies arrive at a market risk premium of 5.5% using the long-term average difference between return on market index and yield of treasury bills with long maturity (20Y in particular). This market risk premium is recommended to be applied together with a long-term average yield of government treasury bills of similar maturity (normalized risk free rate).
- Hence, it is suggested here to estimate risk-free rate as a 10Y average YTM of securities with 20-years maturity when applying ERP of 5.5%.

Regarding the suggestions of report towards CAPM parameters, we note the following:

Risk-free rate

- The propose rate of between 1.1% and 3.0% is significantly lower than that use for the existing calculation of maximum allowed revenue. The lower limit of 1.1% represents the level of interest for Kosovo's long-term treasury bonds while the upper limit of 3.0% represents the 10-year average of interest rates from Hungary's treasury bonds - which according to the consultation paper represents the most risky long-term debt traded among regional comparators.
- We are aware of the fact that Kosovo has begun to issue long-term debts (up to 5 years) with real interest rate up to 1.1%. As is stated above, the risk-free rate ought to represent the bonds with long maturity when evaluating a project with a 'going concern' assumption (as is the case for KOSTT). We are therefore of the opinion that using debt issued by Kosovo with maturity up to only 5 years is not a relevant indicator (for example, even for a developed economy like Germany or USA, the difference between YTM of 1Y bond and 20Y bond is currently approximately 2%). There is also a question of liquidity of these bonds, as there is no clear indication that these would be continuously trading on capital markets which even further undermines their representativeness of risk-free rate for the purpose of estimation the return on stock.
- We also think that the Republic of Kosovo cannot be compared directly with Hungary because of the following reasons:
  - As part of the European Union (EU), Hungary is subject to EU regulation for its capital markets; investors therefore perceive it as a lower risk when compared to Kosovo.
  - Credit trustworthiness (even though credit rating of Hungary is kept rather in speculative zone) is also supported by the fact that Hungary is a member of EU.
  - Moreover, Hungary has an assigned credit rating by all major credit rating companies (inter alia, Standard & Poor's and Moody's) which means that they are under watch of these companies and investors can to some extent rely on monitoring by these companies. Conversely, Kosovo does not yet have an assigned rating by a major rating agency which increases the overall risk profile of the country, taking into account its recent establishment.
  - Due to this reason, we suggest not taking a Hungary as a reference when estimating risk-free rate of Kosovo.
- As an alternative, we would suggest estimating the risk-free rate based on a risk-free rate from a developed market with highest possible rating (i.e., USA or Germany) and increase it by estimated credit spread taking into account the overall higher riskiness of Kosovo.

Using this approach and based on the recently published data from prof. Damodaran (who represent one of the most reputable persona in valuation field worldwide)[1], we would arrive at a risk-free rate of 8.81% in nominal terms, or 6.78% in real terms (assumed credit rating of Kosovo to be B2 – Moody's or B – S&P scale and inflation rate of 1.9%) calculated as follows:

- Long Term US Treasury bond rate = 2.45%
- Default spread for B2 rating = 6.36%
- Nominal risk-free rate = 8.81%
- Real risk-free rate (by applying Fisher formula[2]) = 6.78%

Hence, we think that the risk-free rate suggested in the consultation paper should be in line with the inputs for PRR 1, i.e., 6.5%, or slightly lower. A decrease from 6.5% to 1.1-3.0% seems to be too large considering the assumed economic development of Kosovo and capital markets worldwide.

Equity risk premium

- ERO proposes to reduce the ERP used to calculate WACC at 4.5% in line with recent EU regulators' decisions.
- As stated above, it is important to ensure consistency between the risk-free rate and equity risk premium. These two components cannot be estimated independently as the ERP, as per its definition, represents the return on the overall market over the risk-free rate. Hence, we would suggest using the ERP estimated by prof. Damodaran, which currently represents the value of 5.7% for US market[3]. This estimation is also in line with Duff&Phelps which calculated ERP to be 5.5%.
- For comparison, the regulatory body in Czech Republic has estimated ERP to be 5% and risk-free rate was estimated using 10Y average YTM of 10-year government bonds which yielded 3.82% in nominal terms, although this was in a period with zero inflation conditions in the Czech economy. We further note that Czech Republic has AA credit rating.

Equity Beta

- We agree that overall beta of 1 can be decreased. However, the decrease to 0.7% is too low in our opinion. Rather, we suggest that equity beta is estimated from relevant

[1] Damodaran, A. (2017). Useful Data Sets: *Costs of Capital by Industry Sector - Europe*. Stern Business School - NYU. Retrieved 14 July 2017, from http://www.stern.nyu.edu/~adamodar/pc/datasets/waccEurope.xls (Long term treasury rate + Risk Premiums for Other Markets)
[2] RFR real = (1+ RFR nominal)/(1+ inflation) - 1
[3] Damodaran, A. (2017). Useful Data Sets: *Costs of Capital by Industry Sector - Europe*. Stern Business School - NYU. Retrieved 14 July 2017, from http://pages.stern.nyu.edu/~adamodar/New_Home_Page/datafile/implpr.html

sources, i.e., from Damodaran research4. Based on the data provided in the Damodaran website, equity beta in the power sector is 0.82. If we would base the beta estimation on unlevered beta (0.62 as stated in Damodaran data) we would arrive at equity Beta (taking into account the gearing as proposed of 0.4) of 0.95. Hence, we would consider a lowering of beta to somewhere in the range 0.82-0.95 not to be unreasonable.

Cost of Debt

- We generally agree with the approach towards cost of debt calculation. We also suggest taking into account the risk-free rate suggestion as mentioned above.
- Regarding interest rates, KOSTT estimates that adjusting the allowed cost of debt by applying current credit rates is not appropriate for this period and does not represent the real cost of the credit market in Kosovo and beyond.

Overall approach

We understand that WACC for KOSTT represents the Government's guidance to ERO that, as KOSTT owner, it was intended to aim for a lower return on equity than a private owner would require, aiming at benefiting the electricity customers. As stated in the consultation paper, the proposed WACC value shown for KOSTT represents what is assumed if a real pre-tax return on equity of 2%, as determined by the Government for PRR 1, applies also to the second regulatory period (PRR 2). **ERO is seeking guidance from the Government regarding the appropriate principle to be applied for PRR 2.**

We are of the opinion that it is no longer appropriate to apply a regulated return on equity of 2.0% and it is now appropriate for KOSTT to be permitted to earn a commercial return on equity. The commercial return on equity should be set with reference to that established by KEDS.

2. Report on assets life

KOSTT has analyzed the proposals derived in the Asset Life Consultation Report and estimates that they are almost the same as the proposals made by KOSTT in this regard.

Due to clarity we can state that the poles fall under category two of amortization assets and not to the category three, hence this is the only comment we have on this report.

[4] Damodaran, A. (2017). Useful Data Sets: *Levered and Unlevered Betas by Industry - Europe*. Stern Business School NYU. Retrieved 14 July 2017, from http://www.stern.nyu.edu/~adamodar/pc/datasets/betaEurope.xls (Beta; Unlevered Beta)

Table 1: Transmission asset categories and life proposed for KOSTT

	Asset	Asset life (years)
I	Buildings, roads, sewerage networks, water supply, wells, lifts	50
II	HV network, poles	40
III	Low voltage network, substations, transformers, etc.	30
IV	Trucks, cherry pickers and working machinery	10
V	Control and Telecommunication, various equipment, fire protection	8
VI	Furniture, office equipment	7
VII	IT equipment, software, licenses, cars etc.	5

3. Report on transmission losses

KOSTT's comments regarding ERO's proposal for the allowed level of losses in the transmission network for the period 2018-2023

3.1 Examination of previous losses and current trend

The development of losses in the transmission network has been characterized by a continuous decrease from 2007 to 2012 as a result of the reinforcement of the network throughout the territory of the Republic of Kosovo. After 2012, the development of network losses is introduced into the saturated zone, as shown in Figure 1.

After the displacement of the technical and commercial boundary between KOSTT and OSSH since April 2012, within the losses on the transmission network are added the losses caused in the distribution transformers 220/35/10 kV and 110/35/10 kV.

Based on conducted theoretical analyzes and measurements it is estimated that from 18 GWh to 20 GWh is attributed to the losses caused in these transformers. The estimation of such losses is explained in the analysis provided in Annex B of this document.

While in 2016 losses amounted to about 10.44 GWh higher than in 2015.

From the analysis presented in Annex A it can be concluded that the increase of 10.44 GWh of losses in 2016 compared to 2015 is attributed to:

- 6,552 GWh projects Peja 1-Peja3 double line and other implemented projects
- 3.888 GWh losses caused by no load work of 400 kV NS Kosovo B-NS Tirana 2 line and the inadequate level of measurement accuracy of previous KEDS measuring groups in noncompliance with the metering code.

Figure 2 presents the dependence of transmission losses from power flows to the transmission network. Despite the fact that the input energy in the transmission network has not changed much during 2013-2016, there is a significant increase in losses during 2016 as explained by the above conclusion that unfavourable operating conditions are caused during the implementation of specific projects as a consequence of the opening of 110 kV rings which directly affects the increase of losses in the network.

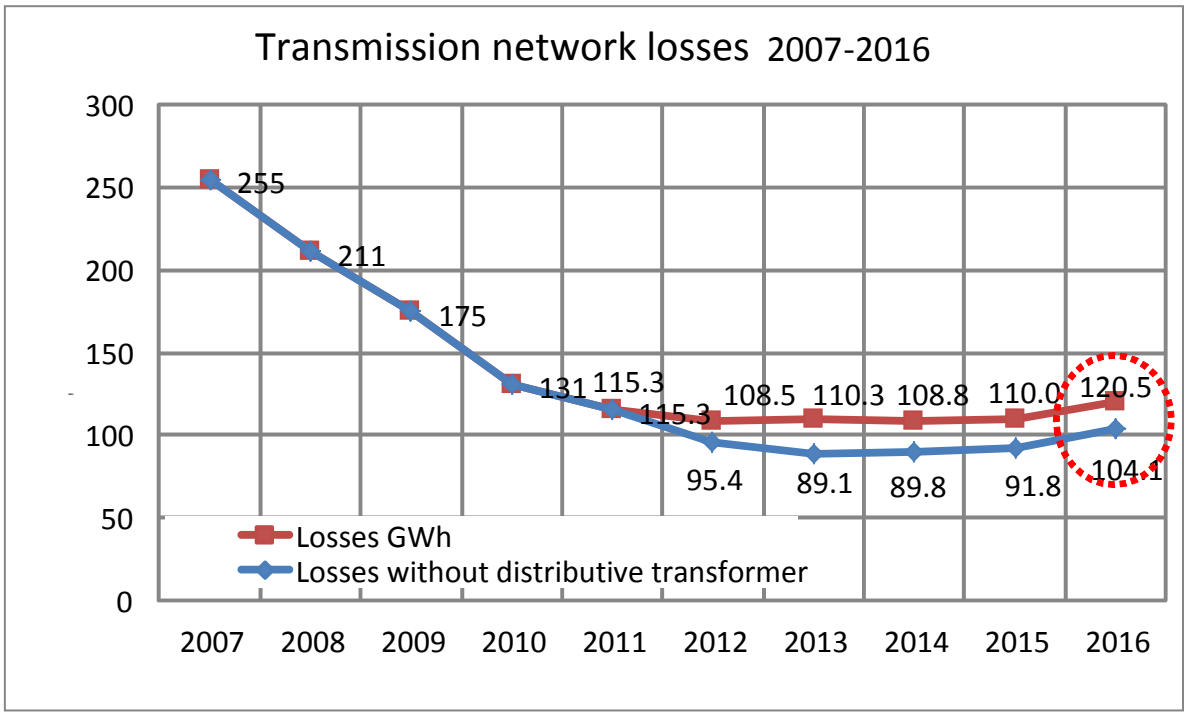

Figure 1. Losses of active energy in the transmission network 2007-2015

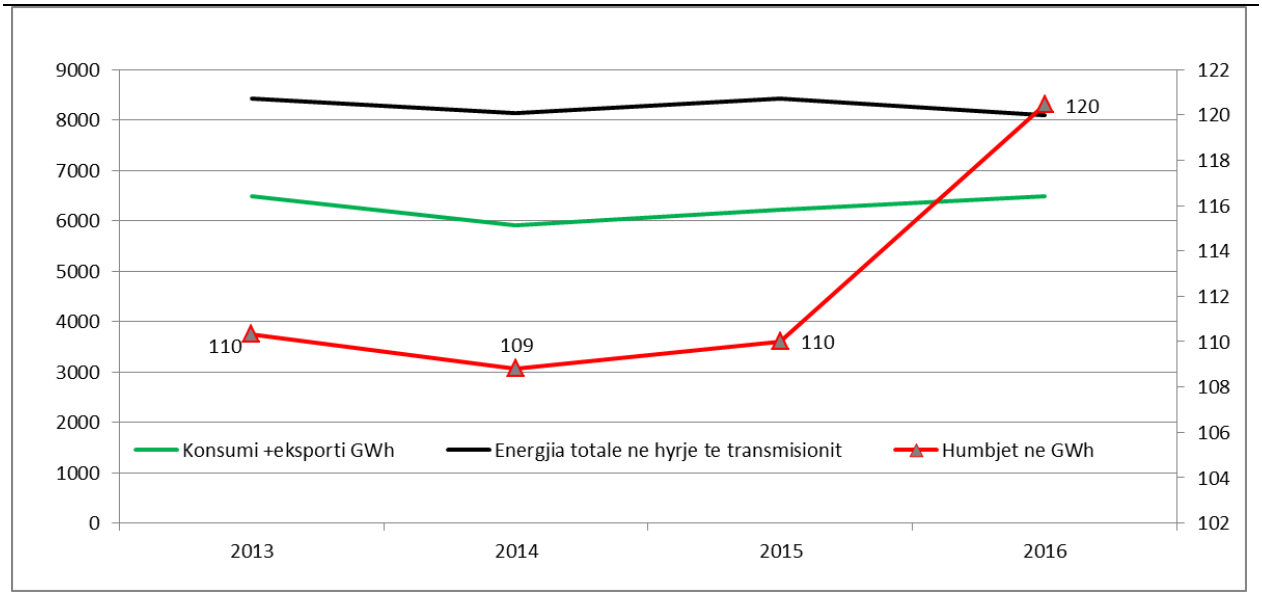

Figure 2. Dependence of transmission losses 2013-2016 from power flows in the network

3.2 Trend of losses for the current year 2017

Due to the complexity of the implementation of the project double line Peja 1 - Peja 3, GIS substation in SS Peja 3 and the 110kV line revitalization project SS Deçan-SS Peja 2, 110 kV ring has remained open almost until May of this year. Table 1 shows the trend of losses for the realized period. From the metered data it can be noticed that by the end of June 2017 total losses are 2.3 GWh higher than losses in 2016 for the same period. These additional losses are also affected by the network configuration, no load work of the 400 kV Kosovo Albania line and the inaccuracy of the metering from the remainder of the metering groups that are incompatible with the Metering Code. Since May, the network operates with mostly normal conditions with optimum configuration, it is expected that the remaining losses will be lower than in the same period of 2016, but the trend shows that they will be higher than 1.8%.

Putting into operation of two 300 MVA transformers in SS Peja 3 and SS Ferizaj 2 will affect the increase of losses caused mainly by losses in iron.

Table 1. The current trend of the development of losses in transmission and comparison with 2016

2017	Energy Available (Generation + Import)	Realized energy (Export +Consumption	Losses in 2017	Losses in 2016	Difference in Losses 2017-2016
Month	kWh	kWh	kWh	kWh	kWh
January	804,064,108	787,156,933	16,907,175	11,831,051	5,076,124
February	646,027,608	634,369,719	11,657,889	9,879,777	1,778,112
March	724,920,555	715,968,867	8,951,688	11,216,186	-2,264,498
April	635,222,038	627,883,402	7,338,636	6,404,808	933,828
May	674,951,220	667,054,728	7,896,492	9,358,811	-1,462,319
June			6,474,188	8,232,592	-1,758,404
July				8,625,409	
August				8,612,794	
September				8,209,191	
October				10,196,211	
November				11,740,330	
December				16,150,536	
Realized			**59,226,068**	**120,457,696**	**2,302,843**

3.3 Impact of 2018-2023 transmission projects on development of network loss

Within the framework of projects of the 5 year plan with impact on the losses in the transmission network we distinguish projects of categories:

- Network reinforcement
- Load support

If projects are analyzed in the next 5 years, load support projects dominate mainly:

a. Third transformer in SS Lipjan (2017)
b. SS Prishtina 6, 2x 40 MVA (2018)
c. SS Fushe Kosova 2x 40 MVA(2018)
d. SS Mitrovica 2 2x 40 MVA (2018)
e. SS Drenasi 2x 40 MVA (2019)
f. SS Dragashi 2x 40 MVA (2019)
g. SS Malisheva 2x 40 MVA (2020)
h. Second transformer in SS Klina (2020)
i. Second transformer in SS Gjilani 5 (2020)

While network reinforcement projects will be:

j. New line Rahovec- Therandë
k. New line Prizren 2- Prizren 1

l. Revitalization of Prizren 1-Prizreni 3

The impact of the reduction of losses from new substation projects will mainly be noticed in the distribution network, while in the transmission network the losses are expected to increase mainly by the increase of power transformers, although there will be a reduction of losses in the 110 kV lines due to the re-distribution of power flows but significantly smaller than the additional losses on the transformer.

Based on the analysis of the power flows according to the foreseen consumption 2018-2023, as well as the sequence of putting into operation of the aforementioned projects the impact of the addition of new transformers to the losses in the network will be as follows:

New transformers:

- In **/2017** 2 transformers 300 MVA, **Additional losses 1.2 GWh**
- In **/2018** 1 transformer 40MVA in Lipjan, **Additional losses 0.2 GWh**
- In **/2019** 6 transformers 40MVA, **Additional losses 1.8 GWh**
- In **/2020** 8 transformers 40MVA, **Additional losses 2.4 GWh**

New projects with impact on reduction of losses:

- In **/2019** Theranda-Rahoveci Line Prizren1- Prizren 2 Line and revitalization of Prizren1-Prizren 3 Prishtina 6 and Fushe Kosova, **Annual saving 1.2GWh**
- In **/2020** SS Malisheve 2 affects reallocation of flows and a reduction of 330MWh annually Dragash=450 MWh, **Annual saving 0.78GWh**

So in 2017, additional losses of 1.2 GWh are expected
In 2018, an increase of losses by 1.2 + 0.2 = 1.4 GWh is expected in reference to 2017
In 2019, an increase of losses by 1.2 + 0.2 + (1.8-1.2) = 2 GWh is expected in reference to 2017
In 2020, an increase of losses by 1.2 + 0.2 + (1.8-1.2) + (2.4-0.78) = 3.62 GWh is expected in reference to 2017.

On this occasion it is assumed that the 400 kV Kosova B-Tirana 2 line will be in operation in 2018.

Considering the increase of electricity demand on the basis of the prediction from the 10-year Balance then the projection of losses by 2023 is predicted to be:

Table 2. Prediction of losses in the transmission network 2018-2023

Year	2018	2019	2020	2021	2022	2023
Losses GWh	115	117	118	119	120	122

3.4 KOSTT's comments on ERO's proposal for losses in transmission for PPR 2.

3.4.1 Allowed losses according to ERO's proposal for MYT 2

According to ERO's proposal we cite:

> "ERO proposes that the allowed level of transmission losses for MYT 2 be set at **1.7%,** the current value achieved at the beginning of PRR 1. This is a level that KOSTT has demonstrated that it can achieve. This also does not reward KOSTT for increasing losses from this level as it was seen during the PRR1 period".

KOSTT has analyzed the prediction from the long-term power balance and ERO's proposal of 1.7% of the allowed losses for the next 5 years. Thus, the losses in units denominated in GWh are estimated as in the table below:

Table 3. Prediction of losses as proposed by ERO 1.7%

	2018	2019	2020	2021	2022	2023
Losses proposed by ERO for PRR 2	1.70%	1.70%	1.70%	1.70%	1.70%	1.70%
Losses in GWh	105.2	108.7	109.5	110.7	111.7	112.9
Net national consumption GWh	5585	5785	5837	5905	5964	6034
Exports GWh	606	606	606	606	606	606
Consumption + export GWh	6191	6391	6443	6512	6570	6640
Total energy at transmission input	8400	8602	8655	8724	8784	8856

Based on the estimation of the losses realized in the previous years, the identification of the influencing factors, the current trend and the prediction of consumption and exports, allowed losses in relative terms 1.7% in reference to Net National Consumption + Exports are not significantly below the value of losses predicted.

3.4.2 Comments of KOSTT

The relative value of 1.7% proposed by ERO for the allowed level of losses in the transmission network for the next 5 year period cannot be made considering the following factors:

- New substation projects (SS Prishtina 6, F Kosova, Mitrovica, Drenas, Dragash, additional transformers in SS Gjilani 5, SS Klina and SS Lipjan) affect the reduction of losses in the distribution network but due to the increase of transformers to a certain extent impact on the increase of losses in the transmission network.
- The continuation of new projects that will affect network configuration during implementation (2018/2020) and consequently increase network losses.

Losses in GWh resulting from allowed losses in relative units (percentage), will vary depending on the amount of net national consumption plus export. The component of the export will have an impact on the allowed value if reflected in GWh. In this regard, there may be an additional risk of non-realization of losses in GWh reflected in the 1.7% proposal which is significantly dependent on the export component, since the export is mainly made through a horizontal network which is more efficient than the vertical network.

Table 3 indicates the estimation of losses based on KOSTT's analysis of losses.

Table 3. Prediction of losses for MYT 2 according to KOSTT

	2018	2019	2020	2021	2022	2023	Average value
Losses assessed by KOSTT for MYT 2	**1.86%**	**1.83%**	**1.83%**	**1.83%**	**1.83%**	**1.84%**	**1.84%**
Losses in GWh	**115.0**	**117.0**	**118.0**	**119.0**	**120.0**	**122.0**	
Net national consumption GWh	5585	5785	5837	5905	5964	6034	
Exports GWh	606	606	606	606	606	606	
Consumption +export GWh	**6191**	**6391**	**6443**	**6512**	**6570**	**6640**	
Total energy at transmission input	8400	8602	8655	8724	8784	8856	

Based on the estimation of losses made in the previous years, the identification of influencing factors, the current trend and the prediction of consumption and exports, KOSTT proposes that allowed losses in relative terms should be about 1.84%.

ANNEX A:

Calculation of annual losses in distributive transformers

Losses caused in energy transformers are:

- Losses without load (iron loss)
- Losses on load (Copper losses)

In fact, iron losses are dependent to tension according to the formula: $P_{fe} = G \cdot U_n^2$

These types of losses have a significant participation in total transformer losses as they continue to occur as long as the transformer is energized. Considering that the voltage during the maximum load falls below the nominal value while during the minimum load increases above the nominal value it therefore can be assumed that these losses are constant.

Losses caused by loads (fluxes) are determined by the expression: $P_{cu} = P_{cun} \left(\frac{S}{S_n} \right)^2$

Meaning that they depend on the level of transformer's load.

Based on measurements on the meter system and the SCADA/EMS system, it is noted that depending on the substation's level of load, there are cases where iron losses dominate copper losses and vice versa. The accurate calculation of losses incurred by distributive transformers was made possible after placing the metering points at above 60% at the new commercial boundary between KOSTT and KEDS (35 kV and 10 kV) and processing data from two metering groups with 0.2s accuracy, in both primary and secondary transformer. Table B-2 shows the measurements for substations that already have new metering units on the medium-voltage side. Losses vary depending on the type, year, transformer capacity, ranging from 0.2% to 0.7% of electricity flowing through the transformer.

Using the median of all transformers, it results that about **0.44%** of electricity required from the distribution is comprised by total losses in distributive transformers that connect KOSTT to KEDS.

Table A-1 Estimated annual energy losses in KOSTT/KEDS distributive transformers

Year	**2013**	**2014**	**2015**	**2016**
Consumption distribution [GWh]	**4606.5**	**4505**	**4496.7**	**4582.5**
Transformer losses [GWh]	**21.7**	**19.8**	**19.8**	**18.3**

Table A-2 Annual measured energy losses in distributive transformers KOSTT/KEDS

REPORT ON ENERGY COMPARISON: Primary - Secondary

FROM: 20/07/2016 08:21 **TO:** 20/06/2017 08:21

Substation	Field	110 kV	10/35 kV	Losses	Difference %
		kWh	kWh	kWh	
		a	b	c = a-b	d = c/a
SS Berivojca	TR-1				
	TR-2	49,125,956	48,864,350	261,606	0.53%
SS Deçani	TR-1				
	TR-2				
	TR-3	66,991,551	67,248,776	257,225	0.38%
SS Podujeva	TR-1				
	TR-2	76,818,324	76,358,415	459,909	0.60%
SS Prishtina 2	TR-1	0	0	0	NaN
	TR-2	0	0	0	NaN
	TR-3	44,819,632	44,605,200	214,432	0.48%
SS Prishtina 3	TR-1				
	TR-2	89,869,780	89,308,406	561,374	0.62%
SS Prishtina 5	TR-1	84,948,864	84,451,238	497,627	0.59%
	TR-2	51,530,160	51,285,518	244,643	0.47%
SS Prishtina 7	TR-1				
	TR-2	81,745,686	81,270,420	475,266	0.58%
SS Prizreni 1	TR-1				
	TR-2	94,649,984	94,341,618	308,366	0.33%
	TR-3	0	0	0	NaN
SS Prizreni 3	TR-1	89,705,506	89,433,829	271,677	0.30%
	TR-2	85,936,114	85,631,044	305,070	0.35%
SS Gjakova 1	TR-1	56,856,294	56,471,373	384,921	0.68%
	TR-2	63,760,092	63,422,268	337,824	0.53%
SS Gjakova 2	TR-1	57,823,700	57,596,569	227,131	0.39%
	TR-2	56,285,152	56,065,564	219,588	0.39%
SS Gjilani	TR-1	94,908,858	94,511,256	397,602	0.42%
	TR-2				
SS Vushtrria 1	TR-1				
SS Vushtrria 2	TR-1	85,880,740	85,622,591	258,149	0.30%
	TR-2	65,018,646	64,803,191	215,455	0.33%
SS Peja 1	TR-1	40,873,712	40,677,693	196,019	0.48%
	TR-2				
SS Peja 2	TR-1	68,059,530	67,902,214	157,316	0.23%
	TR-2	55,866,558	55,758,911	107,647	0.19%
SS Vitia	TR-1	63,110,850	62,844,474	266,376	0.42%
	TR-2	42,473,420	42,307,146	166,274	0.39%
SS Palaj	TR-1	121,473	120,624	849	0.70%
	TR-2	6,992,832	6,946,800	46,032	0.66%
	TR-3	106,781,697	106,083,852	697,845	0.65%
Total		**1,680,955,111**	**1,673,933,339**	**7,536,222**	**0.448%**

ANNEX B

Impact of project implementation - 2016 on increasing Losses in the Transmission Network

1. Summary

The change to configuration in certain parts of the network such as opening of lines, radial supply etc. which occurs for a relatively long time, results in increased losses in the transmission network. This occurs due to change of active and reactive power flows on the lines and the transformers, which then affects the voltage profile at certain system nodes and consequently increases losses in the network. Network losses are in a function of the power supply quadrant, meaning a quadratic dependence of losses in the function of increasing power flows in elements affected by the change in configuration.

Configuration changes in the Power System of Kosovo are mainly applied during project implementation period, whereby some elements such as lines and transformers due to project implementation remain out of operation for a certain time, depending on the process of installing new equipment. In the process of implementing projects related to transmission capacity building and revitalization of substations, during 2016 a considerable number of projects have been conducted, whereby their implementation required the disconnection of lines and transformers. Project implementation**: double line 110 kV Peja 1 - Peja 3**, was initially conducted with the dismantling of existing lines and construction of a completely new double line. This resulted with the opening of the 110 kV ring Peja 3 – Peja1 - Peja2 - Deqan_Gjakova1, starting from 09.04.2016 and continued until 22.12.2016.

The consumption of substations SS Peja 1, SS Peja 2, SS Deçan was covered by radial supply from SS Gjakova 1, resulting in an increase of losses in the transmission network. Computer simulations show that during the maximum load, the open ring operation resulted with an increase of losses by **3.5 MW** compared to closed ring operation. By applying the standard methodology of calculating electricity losses, based on the country's overall load duration curve, as well as its characteristics, and by comparing open and closed ring operation, the analysis show an increase in losses of around **10.44 GW** due to the change in network configuration caused by project implementation in 2016.

The losses metered during 2016 resulted to be **120.45 GWh**, while in 2015 losses were **110 GWh**, which means there was an increase of 8.4 GWh in losses caused mainly due to demolition of 110 kV line Peja 1 – Peja 3, and a loss of 2 GWh due to implementation of other projects conducted during 2016, such as:

- Revitalization of SS Vitia
- Second transformer 300 MVA in SS Peja 3
- Second transformer 300 MVA in SS Ferizaj 2
- Installation of transformer 40 MVA, 110/10(20) kV in SS Skenderaj
- Revitalization of equipment of TM in SS Prizreni 3
- Revitalization of equipment of TM in SS Gjakova 2
- Installation of the third transformer 40 MVA, 110/10(20) kV in SS Prishtina 2

2. Analysis of losses during 2016

Below have been calculated losses to transmission network using the standard methodology for calculating losses.

First of all, losses to the transmission network have been calculated with all the elements at work, while the same calculations have been conducted taking into account the opening of some elements during the project implementation process and which have an impact on the loss.

Table 1 shows comparative data from the electricity balance realized for the previous two years, namely 2015 and 2016.

Tab.1 Comparison of Power Balance for the two previous years 2016 and 2015

	Generation [GWh]	Transit [GWh]	Net domestic consumption [GWh]	Losses [GWh]	Losses from transit [GWh]	Losses from consumption [GWh]
YEAR 2015	5,595.347	2,136.123	5,552.847	110.012	14.953	95.059
YEAR 2016	5,919.109	1,700.767	5,305.920	120.458	11.905	105.458
DIFFERENCE	**323.762**	**-435.356**	**-246.927**	**10.446**	**-3,047**	**10,44**

Whereas, Figure 1 shows the comparison of monthly losses realized for the previous two years 2015 and 2016.

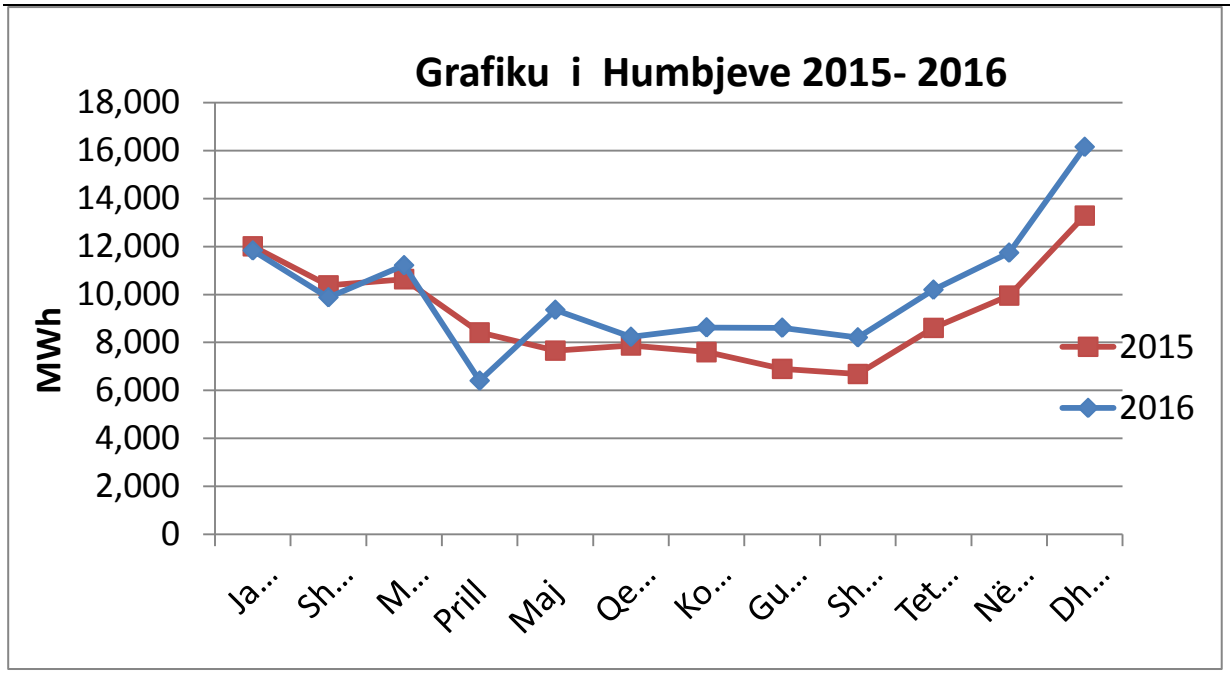

Figure 1. Comparison of monthly losses realized in the previous two years 2015 and 2016.

Despite consumption in 2015 being higher than in 2016, this change was mainly observed in power flows in the 220 kV lines caused by a demand reduction of 374 GWh from Ferronikeli compared to 2015 (585GWh$_{2015}$-211 GWh$_{2016}$ =374 GWh).

Hence, there was actually a relatively small increase in the rest of the consumption for 374-247 = 127GWh and mainly this consumption is covered through substations 110/X kV.

2.1.1 Calculation of loss increment

Through computer simulation in PSS/E, the loss increment of 3.5 MW is gained as a result of construction of the double line Peja 1 - Peja 3.

$$INCREMENT \quad (\Delta P) = \Delta P_{open\_ring} - \Delta P_{closed\_ring} = 3.5\,MW$$

Therefore, system power losses are analyzed under the same generation and load conditions, comparing the case with the open ring and the closed ring at the Dukagjini area network.

Knowing the annual diagram of loads for each hour of 2016 (from the dispatch diary) and from 09.04.2016 until 22.12.2016, when the line Peja 1- Peja 3 was not in operation, then the calculation of total hours of annual energy loss T_{Δ} results to be:

$$T_{\Delta} = \frac{\sum_{j=2352}^{8544} P_j^2 \cdot (t_j - t_{j-1})}{P_{max}^2} = 1872 \text{ hours}$$

The increment of losses is related to system operation hours with the open ring, so based on project implementation period, resulted that ring operated open for **6192** hours during 2016. Therefore, the reduced curve of load duration shown in Figure 2 was considered in the analysis.

Therefore the calculated increment of energy losses is:

$$INCREMENT \quad (\Delta W) = T_{\Delta} \cdot INCREMENT \quad (\Delta P) = 1872 \ h \cdot 3.5 \, MW = 8424 \ MWh = 6.552 \ GWh$$

Based on results obtained, it results that implementation of project: **The double line 110 kV Peja 1 - Peja 3**, resulted in a loss of **6.552 GWh**

By comparing previous balances of 2014, 2015 and 2016, and network configuration for the years in question, we can consider that the increase of **10.44 GWh** in losses in 2016 compared to 2015 can be attributed to:

- 6.552 GWh project Peja 1-Peja 3 double line and other projects implemented
- 3.888 GWh losses caused by load-free work of the 400 kV line SS Kosovo B - SS Tirana 2, and inadequate level of metering accuracy of previous KEDS' metering groups in non-compliance with the metering code.

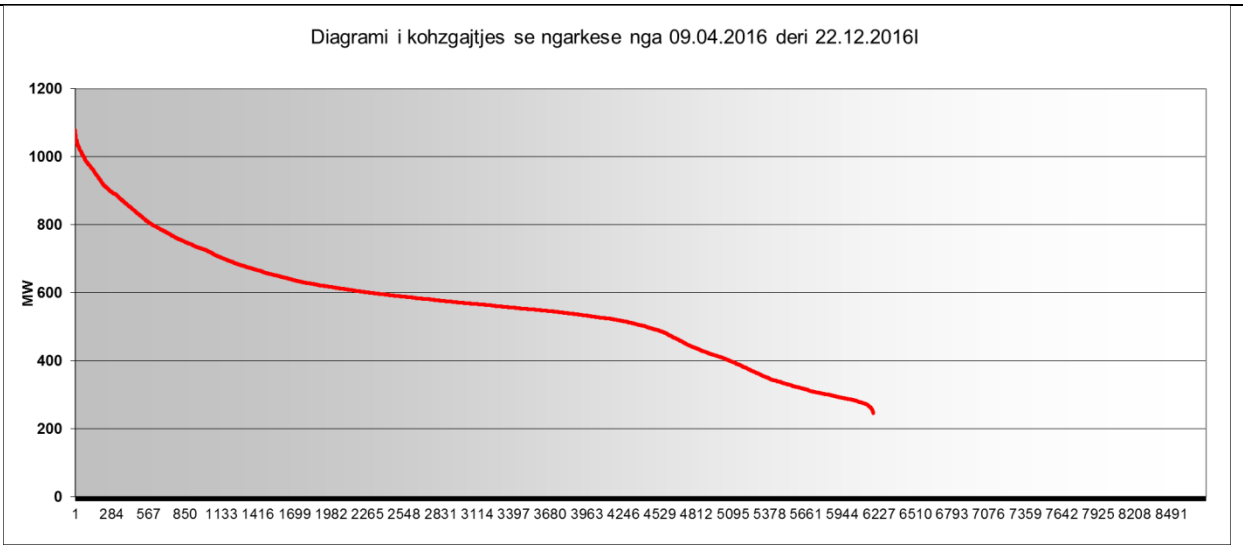

Figure 2. The curve considered in the calculation of energy losses during 2016

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