Technical Losses Ratio: Analysis of Electric Power Transmission and Distribution Network

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Summary
The electricity deliver to power consumer has amount of power losses due to some potential reasons with the passage of time, the losses are reflected as sever energy losses. From the power distribution system points of view, the losses cannot be isolated from electric power load distribution and power generation networks. Theses power losses are called as technical losses which leads to many other problems as un-balancing power load distribution, high transmission line power losses, decreases power generation stations efficiencies while increases the capital expenditures, production cost and power shortage. This paper indicates occurrences of the overall technical losses and ratio of technical losses which leads net-deficits among power demand and power supply. The methodology identify ratio of technical losses incurred during power generation station to power distribution sub-station through transmission lines and power transformer modules.

Key words:
Technical Losses, Analysis, Types of technical losses, Technical Losses Ratio

1. Introduction

The technical losses (TL) are arisen in power networks due to sub-standard conductor materials, equipment of power transmission devices, transformers, transformers magnetic losses, high transmission and power distribution lines, [1]. The TL are normally 25.95% and 22.42% which directly relational to the power distribution system features and the method of power set-up. A massive quantity of technical fatalities on energy networks are owing to primary and secondary power dissemination grid wires whereas conduction and sub conductions wires fatalities has nearby 30% power losses from total power generation. Other reasons of technical losses includes unpredicted power load increases contrary to the normal power load, congenital harms with power supply system. There are two types of technical losses: transmissions losses and distribution losses. 17% transmission losses are occurs during the power transmission from generation station to delivery grid and 50% supply losses are causes from distribution setup to distribution points respectively [2].

The rest of the paper is structured into five sections. The introduction about technical losses has been discuss in section one. Background of technical losses demonstrated in section two. The section three have been comprised types of technical losses and section four represents the measurement of technical losses. Finally, a conclusion has been drawn in section five

2. Related Work

Furthermore, the TLs are divided in two categories as fixed and variable technical losses. Fixed losses are not alter rendering to existing transmission links. The losses take place due to noise, heat and power transformer energizing. The power dissemination system has share of 1.4% and 1.3% fixed losses worldwide. Fixed losses include, open circuit losses, continues power load measuring devices, continues power load control devices, current leakage issues and dielectric power losses. These losses are also called as Technical Losses or natural losses. Which occurs during electric power generation and transmission from one point to another point. Technical losses are further categories in two categories as fixed and variable losses.

2.1 Fixed Losses: occurs due to many reasons mentioned as following:

- TLs occurs due to heat and noise and increases when transformer is energized
- On electric power dissemination grid 1:3 to 1:4 losses reflected as eternal harms.
- Some losses occurs due to ionization of air molecules near to the high conduction line conductors called as corona fatalities[3].
- Regular energy losses from the exciting capacitors. These losses are due to micro electronics devices connected with capacitor is called leakage current losses.
- TLs occurs owing to insulation substantial which causes fluctuating electric pitches and losses some quantity of energy called dielectric losses[4].

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- Open-circuit Losses.
- TLs occurs due to constant power loads quantifying components
- TLs occurs due to constant loads of controlling components, [5].

2.2 Variable Technical losses: The losses fluctuate by quantity of electric power circulation and were relational of tetragonal to the current, [6]. subsequently, one percent of current increase leads to increase the proportion of power losses more than 1%. When these fatalities have in between 2:3 and 3:4 ratio during electric power dissemination respectively considered as variable losses. Variable losses are causes due to following factors.

- Cross sectional power area conduction links
- Power load set on transmission lines
- Voltage level and joule fatalities in control lines
- Impedance fatalities

3. Types of Technical Losses

Technical losses cause massive disruption in the power transmission between power generation stations to power dissemination points. These losses damage the performance of power distribution equipment is mainly used in power generation, transmission and distribution. There are many types of technical losses mentioned as in figure 1.

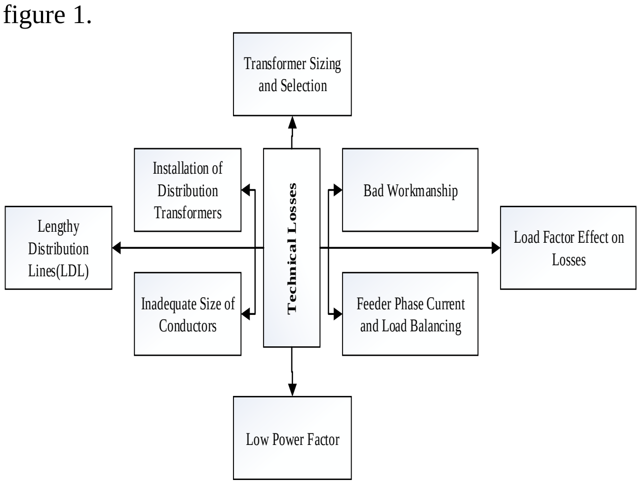

Fig 1. Technical Losses

3.1 Lengthy Distribution Power Lines

Fundamentally, 11Kilovolts and 415 volts conduction power wires remain prolonged through extensive spaces to feedstuff power load distribution above huge ranges, [7]. Subsequently the primary and secondary supply lines in rural zones are mainly spread-out. The resulted extraordinary lines conflict thus big I2R fatalities for power lines [8]. (1) Arbitrary expansions of substitute standard power conduction & supply lines for newly establish region. (2)Gigantic stability in rustic electrification over- lengthy 11kV and communication lines as shown in figure 2.

Fig 2. Lengthy Power Wires

3.2 Insufficient Size of Conductor of distribution power lines

The size of delivery lines must be nominate on the base of Equation 1: (KvA X Km) capability to regular conductors of an indispensable power parameter however, spherical power lines frequently disseminate rustic power load. The conductor line latitude of the feeder line must remain suitable as shown in figure 3.

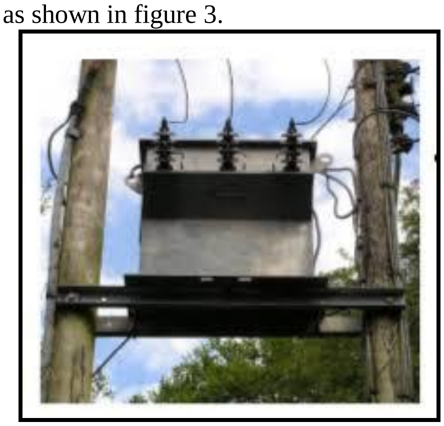

Fig 3.Conductor Size

3.3 Installation of distribution transformer left since power load cores

The supply transformer were not situate at center load on subordinate supply grids,[9]. Moreover, the distributions transformer were not situate at center by respect to customers. Subsequently, utmost customers acquire extreme small amount of voltage from the normal voltage level sustained by transformer. The situation again indicates of sophisticated link fatalities. The reasons of the link fatalities accumulative and the outcome is voltage declined on customer's sites, [10]. Thus, to decrease the voltage descent on customer's sites, the supply transformers can be situate near to power load centers for maintaining the voltage descent in allowable parameters. The figure 4 shown transformer position from the power generation station.

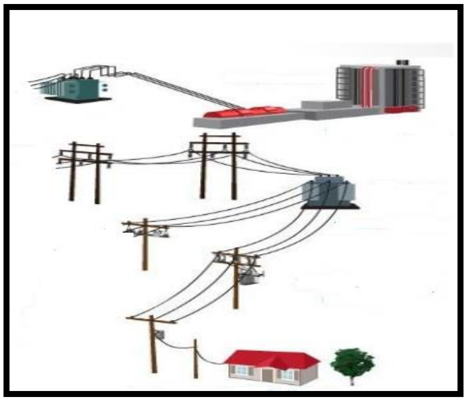

Fig 4. Transformer Distance between Power Generation Stations

3.4 Low Power Factor of Primary and secondary distribution system

In most LT supply circuits, usually the power factor sorts from 0.65 to 0.75. A low power factor adds towards high supply fatalities. When factor of power will be low, current will be strained in great hence power fatalities relational to tetragonal of the current. Consequently, lines fatalities remaining to deprived power factor and be able to compact through improve the PF, [11].

- By-pass capacitor can be coupled either one in subordinate adjacent 11 Kv site of 33/11 Kv transformer.
- Optimal grade of capacitor sets in delivery structure will 2/3rd of regular KVAR constraint, [12].
- A more suitable method of refining this power factor (PF) of the delivery structure and thus decrease lines fatalities for joining capacitor through workstations of the customers taking inductive power load, [13].
- Joining the capacitor through discrete power load, lines losses is concentrated since 4 to 9% contingent of the magnitude of power factor enhancement.

3.5 Bad-Work-man ship

This adds expressively part near to swelling supply fatalities .Joins are a cause of power losses. Hence, the number of links should be retained to a least, [14]. Appropriate joints methods can be used to safeguard secure links, links to transformers bush-stem, drop out fuses, isolator, etc. shown by figure 5. Can be intermittently examined and suitable compression upheld to shun flickering and reheating of links, [15]. Auxiliary of worsened lines and facilities can also be made sensible to shun any root of dripping and losses of power.

Fig 5. Transformer Destruction

3.6 Transformers Selection and Size

The supply transformer usage the copper electrode winding to bring an irresistible arena in the grain-oriented silicon steel core. Thus, transformer has equally losses of load and no-load essential losses. Transformers copper loss differ with load based on the resistive power loss equation (P loss = I2R). For some utilities, economic transformer load means loading supply transformers to capability or marginally overhead capability for a small time in an exertion to reduce investment cost and quiet conserve extended transformer lifetime, [17].

Transformer no-load excitation losses happens in shifting irresistible arena into transformers fundamental when the transformer is eager, [18]. The fundamental losses differs marginally through voltage however principally measured continuous. Fixed iron losses be contingent of transformers core intention and steel lamination molecular arrangement, [19, 20, 21].The figure 6 shows transformer sizing and selection.

Fig 6. Transformer Selection and Size

4. Technical Losses Measurements Results and Analysis

The technical losses were measure on bases of Equation-I1.

Equation-1I:

T&D Losses: (Energy Input to Feeder (Kwh) - Billed Energy to Consumer (Kwh) % Energy Input (Kwh) x 100)

Ratio-I: The ratio 1 is based on the following technical losses by the years of 2011 to 2017. Two electrical power distribution companies has been select to calculate the technical losses such as Hyderabad Electric Power Supply Company (HESCO) and Water & Power Division Gilgit-Baltistan (PWD). The losses are following as Lengthy Distribution lines (LDL), Inadequate Size of Conductors of Distribution lines (ISDL), Installation of Distribution transformers away from load centers (IDTLC), Low Power Factor of Primary and secondary distribution system (LPFPSDS). The table 1 comprises the technical losses in percentage by the years of 2011 to 2017.

Table-1. Technical Losses of LDL, ISDL, IDTLC, LPFPSDS

	2011	2012	2013	2014	2015	2016	2017
LPF(PSDS)	0.86%	0.98%	1.10%	0.88%	0.88%	0.90%	0.78%
IDT(LC)	7.00%	8.00%	6.62%	9.00%	6.00%	7.10%	6.00%
IS(DL)	9.00%	10.00%	8.88%	5.61%	8.61%	6.00%	5.21%
LDL	5.50%	6.25%	8.50%	10.50%	11.60%	12.00%	11.00%

The figure 7 shows the graphical representation of table-1.which shows the various technical losses of different calendar years.

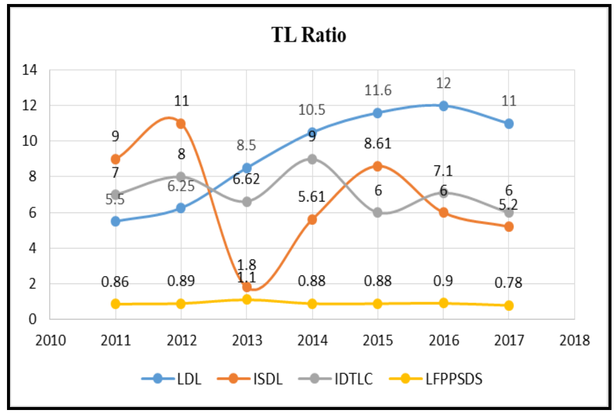

Fig 7. Graphical representation of table-1

Ratio-II: The TLs are mentioned as , Bad Man-Work ship (MW), Feeder Phase Current and Load Balancing (FCLB), Transformer Sizing and Selection (TSS), Load Factor Effect on Losses (LFEL)

Table-2. Technical Losses of BMW, FCLB, TSS, TFEL

	2011	2012	2013	2014	2015	2016	2017
TFEL	1.10%	0.86%	0.98%	0.78%	0.88%	0.88%	0.90%
TSS	6.62%	7.00%	8.00%	6.00%	6.00%	9.00%	7.10%
FCLB	8.88%	9.00%	10.00%	5.21%	8.61%	5.61%	6.00%
BMW	8.50%	5.50%	6.25%	11.00%	11.60%	10.50%	12.00%

The figure 8 shows the graphical presentation of table-2 where different technical losses ratio have been occurred by year of 2011 to 2017.

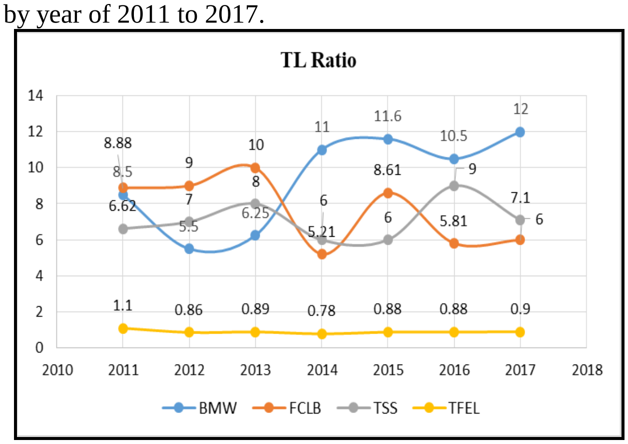

Fig 8. . Graphical representation of table-2

Ratio-III: TLs were Balancing 3 Phase Loads (BPL), Switching off transformers (SOT), leaking and loss of power (LLP), over loading of lines (OLL)

Table-3. Table 1. Technical Losses of BPL, SOT, LLP, OLL

Year	BPL	SOT	LLP	OLL
2011	8.50%	8.00%	6.62%	1.98%
2012	5.00%	9.00%	7.00%	1.36%
2013	6.25%	10.00%	8.00%	0.98%
2014	11.00%	5.21%	6.00%	0.78%
2015	11.00%	8.61%	6.00%	1.54%
2016	10.50%	5.00%	9.00%	1.49%
2017	12.00%	6.00%	7.10%	1.90%

The figure 9 depicts the graphical results of technical losses ratio as shown in table-3.

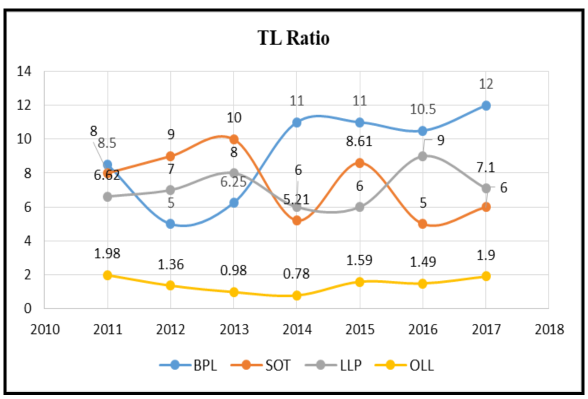

Fig 9.Graphical representation of table-3

Ratio-IV: TLS were, Poor quality of equipment (PQE), Unequal load distribution (ULD), Low voltages at consumer terminals (LVCT), Abnormal operating conditions (AOC)

Table-4. Technical Losses of PQE, ULD, LVCT, AOC

Year	PQE	ULD	LVCT	AOC
2011	9.50%	7.00%	5.62%	2.98%
2012	4.00%	8.00%	6.00%	3.36%
2013	7.25%	11.00%	6.00%	4.98%
2014	9.00%	4.21%	6.00%	3.78%
2015	9.00%	6.61%	5.00%	5.54%
2016	8.50%	4.00%	7.00%	6.49%
2017	10.00%	1.00%	5.10%	3.90%

The figure 10 presents ratio of technical losses shown by tabl-4 by the different calendar years.

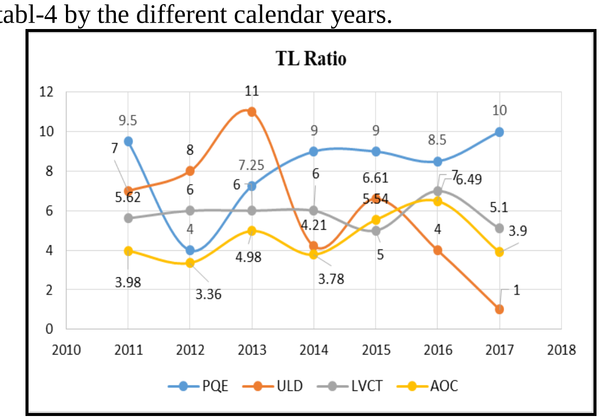

Fig 10.Graphical representation of table-3

5. Conclusion

The article explain the systemic measurement of technical losses ratio encounter by different electrical power supply companies in different regions of Pakistan. The electrical power supply companies does not have proper and sophisticated mechanism to overcome the technical losses as well as non-technical losses among the power generation stations, transformers and power grid stations. Moreover, Technical losses has significant contribution of energy crises in Pakistan due to timeworn electrical power transmission and distribution network.

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