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Electric Losses and Ways to Reduce Losses

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Abstract:- Losses of electrical power are considered one of the major problems that lead to financial losses as well as pay to build new electricity generating stations to compensate for the lost capacity.

I. INTRODUCTION

System that provide consumers with electricity are contains three main sectors, generation, transmission lines and distribution networks.

Power that produced in power plants transmitted and reaches the end users after passing through complex parts. According to studies and comparisons realized that the unit of electric energy produced in Power plants does not match with the units consumption by consumers, this difference is known as losses. This difference in the produced and consumption power by users is known as Transmission and Distribution loss (T&D losses).

Losses are estimated (17%) in transmission lines while (50 %) in Distribution sector, due to high range of loss in distribution Sector, considered as the weakest part in the electric power system .

T&D Losses = (Energy Input to feeder (Kwh) – Billed Energy to Consumer (Kwh)) / Energy Input kwh x 100.

Losses in transmission and distribution networks In Europe, estimated between 4 and 10% of electricity generated.

Energ loss "It is difference between energy generated in power house and billed on the basis of consumption by the consumer connected to that particular power system."

Mathematically,
Energy .Loss= Energy .production-Energy Billed.

The normal average losses in the electric power system is 8.8% and cannot be reduced to zero but it can be reduced to minimum level. However, this amount is different among countries, somewhere the losses are high , in order to estimate amount of losses , need to collect dependable data about electric system .

Table below shows Energy Consumption and demand in 2014 (GWh) in one Governorate in Iraq

Category	Total
Energy Consumption (metered)	4319
Energy Demand from substation	7,956

Table 1 , energy demand and consumption Iraq/ 2104 / one governorate

To calculate energy losses :

Energy Losses % = Energy Dispatch –Energy Consumed x100

Energy Dispatch

= 7,956 – 4,319 x 100 % = 45.7 %
7,956

As calculated above if we remove 4 % as errors in data
Overall Energy Loss Estimate (2014) = 41.7%

Money losses (if we take average tariff 20 ID) in 2014 = 72,740,000,000 ID.

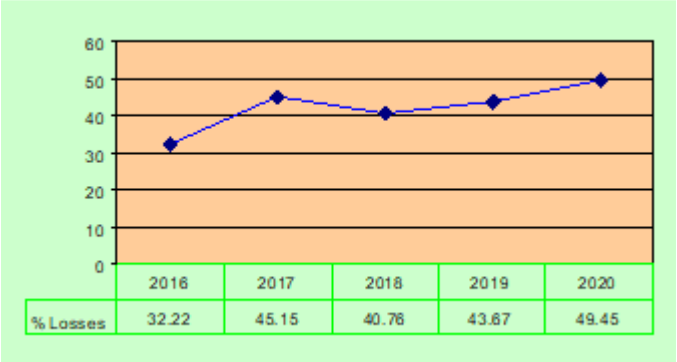

Table 2 losses in one distirct in Iraq

Types of Transmission and Distribution Losses:
1. Technical Losses
2. Non Technical Losses

1. Technical Losses

This kind of losses defined as energy lost in the conductors, all equipment used in transmission line, distribution lines and magnetic losses in transformers.

Technical losses amount depend on the whole electric system characteristics, quality and the mode of operation.
The unexpected load increase in power use above the normal level was reflected in the increase of technical losses. Losses are inherent to the distribution of electricity and cannot be eliminated.

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Below shows maximum permissible technical losses in distribution system;

Description	Line Losses
H.T lines	2.5%
Distribution trandformers	3.5%
L.T lines	2.5%
Servise	0.5%

Table 3 permissible technical losses in distribution system

There are two Type of Technical Losses.

1. Permanent / Fixed Technical losses

This kind of losses do not vary with change in amount of current, that means un dependable on the load on the power system. These losses take the form of or produce heat and noise, it is occur as long as the system is energized.

Between 1/4 and 1/3 of technical losses appears in distribution networks are fixed losses. Fixed losses on a network can be defined as below:

- Corona Losses is a phenomenon caused by the partial discharging caused by high electrical stress.
- Leakage Current Losses is the current that flows through the protective ground conductor to ground.
- Dielectric Losses is the energy that goes into heating For example, a capacitor incorporated in an alternating-current circuit is alternately charged and discharged each half cycle. Dielectric losses varies with frequency and the dielectric material
- Open-circuit Losses.
- Losses in continuous load of measuring and control elements which are part of the system.

2. Variable Technical losses

This type of losses vary with the amount of electricity consumption, its proportional to the square of the current. Consequently, a 1% increase in current leads to an increase in losses of more than 1%.

- Variable technical losses covers 2/3 and 3/4 of whole technical losses in distribution grid.
- Joule losses in lines in each voltage level
- Impedance losses
- Losses caused by contact resistance.

Main Reasons for Technical Losses

1. Lengthy Distribution lines

Provide consumers in rural areas without pay attention to line length In practically 11 KV and 416 volts lines**,** such as in villages and private projects outside of cities, because installing new substation for small loads is not economic.

This mistake lead to high I^2R losses in the line due to resistance increase.

2. Samll Size of Conductors of Distribution lines

The conductors cross section are not selected according to standards , with caring of applying the rule of KVA x KM to avoid high losses.

3. Location of distribution transformers

Locating transformers away from load center caused long electric lines ,drop voltage and consumption raise.

Consequently, the farthest consumers provided with low voltage even though a good voltage levels maintained at the transformers secondary.

This again leads to higher line losses and more consumption.

4. Power Factor

Low Power Factor contributes towards high distribution losses , due to raising current consumption as losses proportional to square of the current, according to data obtained, power factor is between 0.65 to 0.75 in most low tension distribution system.

5. Bad Workmanship

Bad electrician and technical workers contributes significantly role towards increasing distribution losses, because any electric connect and daily repair if applied wrong causes lost in power.

6. Feeder Phase Current and Load Balancing

Feeder unbalancing tends to unbalance in voltage among phases which cause drop voltage in more loaded phases and over voltage in other phases it lead to losses.

Feeder phase

Unbalancing also appear in non similar conductor resistance among phases, and lack of switches between feeders to allow for appropriate load transfer.

7. Load Factor Effect on Losses

By raising the load factor, losses are reduced. Power consumption by consumers is no stable it varies throughout the day and over seasons this variation is Called load factor and It varies from 0 to 1.

Load Factor = Average load in a specified time period / peak load during that time period.

Residential customers generally reach peak demand in the evening hours due to using most electric equipments when all family members are at home. Same commercial customers load generally goes to peak in the early afternoon. keeping power consumption will lower peak get less power loss and overall energy losses.

For example, for 30 days month (720 hours) peak Load of the feeder is 10 MW. If the feeder supplied a total energy of 5,000 MWH, the load factor for that month is (5,000 MWh)/ (10MW x 720) =0.69.

8. Transformer Sizing and Selection

Transformers have both load losses and no-load core losses.

Transformer copper losses vary with load based on the resistive power loss equation (P loss = I^2R). To obtain acceptable loss its best to choose transformers capacity that suitable for required load.

However, if transformer over reached peak load ,loss will increase , it is better to use higher capacity of transformer to avoid it.

Transformer no-load excitation loss is constant. Iron loss depends on transformer core design and steel lamination molecular structure. Improved manufacturing of steel cores and introducing amorphous metals *(*such as metallic glass*)* have reduced core losses.

9. Balancing 3 phase loads

Un balancing 3-phase loads network can increase losses significantly because it is cause unbalance voltage and it goes to more consumption.

10. Switching off transformers

Switch off transformers in periods of low demand in order to avoid transformer losses by reducing number of energizing transformers.

11. Other Reasons for Technical Losses

- High neutral currents because of unequal load distribution on phases in R.S.T in L.T system.
- Leaking and loss of power in weak points.
- Over loading of lines.
- Abnormal operating conditions at which power and distribution transformers are operated.
- Low voltages at consumer terminals causing higher drawl of currents by inductive loads for example using Automatic voltage regulator raises current consumption proportional to the amount of voltage drop.
- Inefficient and Poor quality of equipment used by consumers such cooler air-conditioners, motors and industrial machines.

NON TECHNICAL LOSSES(ADMINISTRATIVE LOSSES)

These losses are caused by lack of administration, financial constraints, pilferage, theft, defective meter, error in meter reading and un metered supply of energy."

CAUSES OF ADMINISTRATIVE LOSSES

1- Electric companies of offices
2- Customers
3- External factors

1-Electric companies or offices

A/ Metering equipment

1- Energy meters not meet with standards
2- Defective energy meters
3- Non replacement / calibration of energy meters in time and in right ways.
4- Un-secured energy meters that lead to inaccurate data
5- Supply power to customer without meters.

B/ Meter reading and billing

For example bring false reading such as make mistake in meter factor and number of digits of meter.

C/ Lack of administration and unlawful

1- Heavy work load that lead to lack of follow problems and checking mistakes in sub divisions and divisions.
2- Lack of standard equipments for testing meters and current transformers.
3- Untrained manpower and inefficient staff in meter connecting and other technical daily work.
4- Labor problem
5- Involvement of staff in un legal efforts that cause incorrect data and problem to progress.

D/ Financial constraints

1- Low pay-outs cause not sufficient work.
2- Shortage of staff that make the work not move as the requirements need.

E/ Un-realistic tariff, if high encourage consumers to cheat if low cause to increases in electricity use which move toward more losses.

2-CUSTOMERS

1- Living standards
2- Socio-economic conditions which make controlling customers very hard.
3- Pilferage of energy
4- Status symbolism
5- Immorality

3-EXTERNAL FACTOR

1- In-effective laws and lack of support to apply laws that lead to more and more break rules of electricity instructions.
2- Un-even implementation of law
3- Political reasons , can classified as major reason in several countries and lack of intend to resolve.
4- Geo graphical reasons
5- In-efficient judicial system and lack of steps to help authorities in electric sector to control illegal customers.
6- Less budget grant to offices that un sufficient to cover all jobs requirements.
7- Stealing by administrative offices and law enforcing agencies causes to increase illegal works.

Ways to reduce TECHNICAL LOSSES A/

One of the most urgent problems that need to be fixed is to focus on the 33KV line for distribution purposes. Because of the high losses in 11KV lines losses as known using 33K reduce conductor losses 89% of 11KV .

Also as know using 33KV feeders have other benefits like Greater load carrying capacity and System voltage drop improvement.

The biggest problem that prevent more using of 33KV line for distribution is because its coast by laying underground 33KV line so the solution for this problem is by using covered wire 33KV for overhead purposes some of the benefits of using this type is in below;

1- Less coast compare with underground cable
2- More than a feeder can be carried on the same pole
3- Easier and faster for installation
4- Solve the problem of feeder path
5- Safety
6- less effected by corrosion
7- Easier for maintenance
8- Easier for solving the problems by using thermo detector

B/

Installing substations directly to transmission lines such us 132//33/11 KV to pass the stage 33/11 KV , so can use both voltages with lower cost and lower losses .

C/

1- Raising- cross sectional area of lines and cables for a given load, losses will fall due to decreasing of impedance of lines.
2- Bifurcation of feeders in order to get stable system and less distance
3- Installation of shunt capacitors to improve power factor, Shunt capacitors can be connected either in secondary side (11 KV side) of the 33/11 KV power transformers or at various point of Distribution Line..

A more appropriate manner of improving this PF of the distribution system and thereby reduce the line losses is to connect capacitors across the terminals of the consumers having inductive loads like motors, water pumps and welding machine, it will be better using automatic PF regulator to inset variable number of capacitors according to amount of fall of PF.

By inserting required capacitors across individual loads, the line loss is reduced from 4 to 9% depending upon the extent of PF improvement.
4- Addition of new grid stations and area planning according to standards by using all possible ways to reduce weak points that causes high losses.
5- Extensive energy loss reduction program by collecting data and implementing program step by step.
6- Changing L.T line into 11 kV line through locate transformers closer to customers to keep voltage drop within permissible limits and to reduce line resistance.
7-Transformer takes about 30% of distribution system losses So using the best type of transformer make very good result and its important to insert 1PH transformers to the system because of below benefit:
a- No- load losses is 74% less
b- Less coast
c- no need for H-pole it mounted on existing one pole .
d-Easier for installing
e- Easier for maintenance
f-more safe because it can be Installed on higher pole than H-pole
g- more efficient for small consumers
h- For small consumers rural areas you don't need to take 3 lines 2 lines needed.
8- Continuous preventive maintenance that lead to less expected losses in weak points of network.
9- Improvement of workmanship, to overcome all points that cause raising of losses, such us proper jointing techniques should be used to ensure firm connections, transformer bushing-stem, drop out fuse, isolator, and LT switch etc. should be periodically inspected and proper pressure maintained to avoid sparking and heating of contacts. This mean it is better to keep number of joints as less as possible.

Also replacement of deteriorated wires and services should be made timely to avoid leaking..

10- Standard repair of transformers to prevent raising losses after abnormal repair.
11- Voltage regulation in MV and LV.
12- Mapping of distribution system that give easy way to study the system and update requirements.

Ways to control administrative losses

1- Metering equipment by using best quality and test meters with digital tester.
2- Meter reading and billing by using trained staff and watch their work through strong and confidential supervisor.
3- Administrative improvements.
4- Realistic tariff.
5- Monitoring of consumption
6- Increase load factor by offering customers "time-of-use" if they avoid using electricity in peak load times . Companies use pricing power to influence consumers to shift electric-intensive activities during off-peak times (such as, space heaters and boilers, air conditioning, irrigating, and pool filter pumping).

The second way to increase load factor by giving financial incentives, some electric customers are also allowing utilities to interrupt large electric loads remotely through radio frequency or power line carrier during periods of peak use, through dividing them to groups and operate each groups in different times till passing peak load time.

Other way is by try to design to get higher load factors by running the same feeders through residential and commercial areas.

6 / Focus on checking of energy meters
7- Detection bills / penal action to minimize cases.
8- Judicial powers to implement rules to stop cheating.
9- Mass media campaign to encourage to prevent break rules and show this action as a very shameful.
10- Integrity of staff
11-VIP culture discouragement.
12- Incentive to honest employees and give them power to lead.
13- Shift to pre-paid card system or smart meters.

II. CONCLUSION

1-Not all losses are controllable and not every loss reduction is justifiable. If the power lines loaded higher, then variable losses increased too. This means that should be take into account the level between load and losses. In order to get reduced cost of losses, in the other hand should raise capacity The appropriate way for such an investment decision is Life Cycle Costing (LCC). It has been suggested that the optimal average utilization rate of distribution network cables should be as low as 30% if the cost of losses is taken into account because by this way cost of losses reduced which compensate the cost of raising capacity.

Loss-optimized network design also lead to reduce network impedance, and hence has a positive impact on supply quality and avoiding cost of losses.

In several countries there is a price cap on the network tariff, without including the term for network losses. This means that the cost of network losses can be entirely charged through to the customer. This tariff system produces a strong disincentive for investing in network efficiency and helps the authorities in electric power system to reach the lower losses. The price cap prevents authorities to obtain sufficient cash for efficiency investments and to improve all weak points that cause losses due to that the perfect work is to reduce losses to lower level not just prevent increases, while the lack of a price cap on network losses makes such investments completely useless – the network operator does not have to pay for the losses anyway.

2-Reducing the number of transformation steps and using high efficiency distribution transformers , as detailed that transformers contain 50 % of network losses.
3- Fixing Accountability by declaring Feeder Managers. Accordingly go down up to linemen level to ensure implementing instructions.
4- Consumer data to monitor power use and to find doubt consumers.
5- Distribution Transformer (DTR) Metering by this way all consumers that connected to this transformer are monitored if any cheat occurred it can be found.
6- Move to use smart grid system and smart meters that give all facilities to control consumers and view about available network condition.
8- Implementing plan to reduce technical losses by using good quality of electric equipments in electric network and change all weak points of network according to standards.

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