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# Minimizing non-technical losses with point-to-point measurement of voltage drop between "SMART" meters

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**Abstract:** Detection of unauthorized consumption in the context of non-technical losses through installation of the smart meters, as a part of electricity Transmission and Distribution, became a challenge for every engineer to give their contribution in this direction. Distribution systems losses can be attributed to technical and non-technical losses. The percentages of Transmission and Distribution losses have been quite high and they affect the economy and the Utilities of every country. This paper processed to utilize smart meters in order to decrease non-technical losses in the distribution network and contribute on economy development and well-being of population. The paper shows how the significant voltage drop in the distribution lines can be used for the detection of unauthorized consumption in the context of non-technical losses. Suggestions are practically illustrated in example.



*Keywords:* Smart Grids, Transmission and Distribution, Smart Meters, Non-Technical losses, Voltage drop, Cost Oriented Automation

## 1. INTRODUCTION

Energy losses are an unavoidable part of energy networks around the world. A major impact on reducing non-technical losses is the development of smart grid and smart meters. Technical losses are inherent in the nature and can be reduced by means of enhanced technology and infrastructure. Despite these losses, there are non-technical losses which in some cases exceed the technical.

Therefore one of the main tasks of the distribution companies is to reduce non-technical losses (theft is the most common but not the only cause), which usually is caused by the unauthorized spending–via unauthorized connection to the meter. However problem that remains is to do with the illegal absorption of energy in front of the electric meter. (Soma Shekara Sreenadh Reddy Depuru, November 2010)

This paper deals with precisely this issue which is proposed to identify illegal consumption by means of the voltage drop on the medium -low voltage lines of transformer cell, to the end consumer at a low voltage.

The second chapter deals with explanation of technical and non-technical loses. Third chapter deals with the issue of unauthorized consumption of electricity. Fourth chapter deals with the impact of smart grid and smart meter to those losses. The fifth chapter contains basic explanations and definitions related to the voltage drop in cables and transformers and how it can be exploited to detect unauthorized spending hundreds which is the main topic of this work.

It also provides an example of calculations of the voltage drop on the lines of the distribution network, as well as changes this voltage drop due to an increase in electricity consumption. Sixth and seventh chapter focuses on the conclusion and literature use.

## 2. LOSES IN THE POWER SYSTEM

The percentage of transmission and distribution losses has been quite high and they affect the economy of the Utility. The amount of losses in electrical distribution system is one of the key measures of distribution performance as it has a direct impact on the utility. Distribution losses, refers to the difference between the amount of energy delivered to the distribution system and the amount of energy customers is billed.

Distribution losses are comprised of two types:

- Technical and
- Non-technical losses (Hamed EMARA KASSEM, 2013)

These energy losses are defined in terms of the following equation:

$$\sum \text{EnergyLosses} = \sum \text{IncomingEnergy} - \sum \text{EnergySold}$$

Where:

$\sum \text{EnergyLosses}$ -In the amount of energy lost

$\sum \text{IncomingEnergy}$ -Represents the amount of energy delivered


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$\sum EnergySold$ -Represents the amount of energy recorded or sold *(C.C.B.Oliveira, 2001) (Hoda El Halabi, 2012)* (1)

In general, system losses increase the operating costs of electric utilities and typically result in higher cost of electricity. By default, the electrical energy generated should be equal to the energy registered as consumed. In reality, the situation is different because losses occur as an integral result of energy transmission and distribution.

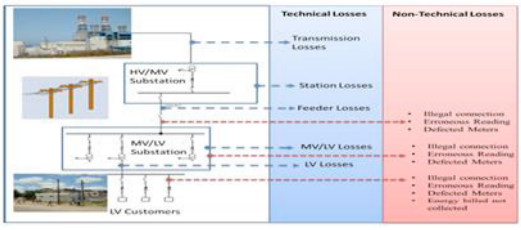


Fig 2.1 Power System Losses (Hoda El Halabi, 2012)

The analysis of power and energy losses imposes a series of tasks which need to be sorted out on basis of:

- Accuracy in determining overall losses;
- Separation of non-technical losses;
- Distribution losses by network elements;
- Locating places that are hot spots for losses
- Analysis of sample loss;
- Choice of measures to reduce losses

### *2.1 Technical losses*

Technical losses, according to Davidson et al. are due to the current flowing in a conductor generating heat and affecting resistance, causing electricity loss. In all conductors at least one of the following losses occurs: Copper losses, Dielectric losses, Induction/radiation losses. *(Davidson I.E., April 2002)*

The main factors impacting technical losses according to Neetling et al. are: Substations, Circuits, Voltage levels, Type of circuits (air, underground, mixed, i.e. location of cattle), Type of load (residential, commercial, industrial, mixed), Transformation points, Installed capacity, Predicted demand, and Length of the circuits. *(Deepak Madan, 2012)*

Technical losses represent 6-8 % of the cost of generated electricity and 25% of the cost to deliver the electricity to the customer. *(Davidson I.E., April 2002)*

A reduction in technical losses will originate two important savings:

- A decrease in energy required to be generated, and
- A decrease in the maximum demand.

Also, during the analyses of Technical losses in the components of the power system, they can be more simply divided into losses which depend on the voltage, and losses that are dependent on current. Losses depend on the voltage are perpetual losses, they come from the effects of the maintenance of power systems live or on the perpetual drive mode for electricity supply. This group includes losses in the transformer core, the dielectric losses of cable and capacitor banks. Losses are dependent on the current result of the moving of the current through the components of energy systems and depend on the degree of use of the network i.e. Quantity of the transmitted energy that is dependent on the square of the current.

Dealing with this two type of losses always has to take in consideration that technical losses in transmission it is possible to determine more exactly than in the distribution.

### *2.2 Non-technical losses*

An ideal electrical energy distribution network will generate electrical power X and distribute the electrical power to the network equal to X. Due to losses in the transmission and distribution sections of the electrical energy network less than X electrical energy is distributed to the network. This loss in electrical energy is the system losses of the electrical distribution network. It is given by:

$$\sum P_{Generated} = \sum P_{Distributed} + \sum P_{Systemlosses} \quad (2)$$

Non-technical losses represent electricity that is delivered to customers, but not paid. Mainly those losses caused by consumption of the owner and operator networks, energy lost in fault (short circuit), stealing electricity, unchecked consumption (public lighting), and errors in the measured, the collection and processing of data when reading. Also a mistake can come from the time difference between meter reading and billing of electricity. *(Fourie, 2004)*

Measures to reduce non-technical losses are:

- Editing customer database,
- The formation of the required number of assembling a team to control,
- Installation of smart electricity meters and replace existing measurement infrastructure,
- Displacement of measurements stations,
- Improvement of reading electricity expenditure,
- Legalization of customers who illegally have connected their facilities to the distribution network,
- Installation of meters for their own consumption,
- Check measurement for public lighting,
- Reducing the number of failures in the networks, Illegal line tapping's
- Meter tamper
- Damage to cables and other electrical apparatus, and
- Media support for education and prevention of electricity abuse

A reduction in non-technical losses will have a direct economic benefit in reducing electricity prices paid by the customer and it will increase the income of electrical distribution supply