Study of Electricity Theft Impact on the Economy of a Regulated Electricity Company

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Abstract

The Electricity theft is an economic issue for the electricity company due to unbilled revenue of consumers who commit such action. In a regulated scenario the company needs to fit within the laws of a regulatory agency (ANEEL in Brazil) and the loss of revenue is a problem that can compromise the compliance with regulatory targets and business efficiency. The objective of this article is to analyze how the energy theft impacts on the economy of the regulated company, consumers and society as a whole.

Keywords: Electricity theft, Regulated Electricity Company, Economic Impact, Tarot, Operational Optimal Point.

1. General Idea

The sale of electricity is the main form of revenue for a power distribution utility. However, not all purchased energy from generators is sold to energy consumers. Part of the purchased energy is lost due to the electrical losses from the conditions and characteristics of the network and another part is lost in form of technical and commercial losses. The sum of technical losses with non-technical losses represents the global system losses. Non-technical

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losses on distribution represent a major impact on company revenue because of the energy that is not billed.
When the amounts of these losses begin to get too high the electricity utility should worry because its billed revenue become lower. An economic analysis will be done in this paper in order to demonstrate how these losses growth exclusively from electricity theft impact on the financial diagram of the company. Moreover, an analysis of how the electricity theft affects the social indicators such as the consumer surplus and the social welfare will be carried out.
A study of the company in the regulated scenario with and without electricity theft will also be conducted in order to determine one or more optimized tariffs in order to obtain the economic added value of the electric utility equal to zero, which is a regulatory requirement imposed by ANEEL (the Brazilian electrical energy regulatory agency).
Other non-technical losses such as fraud, billing errors and measurement, among others, will not be considered in this article, which initially focuses exclusively on electricity theft Penin [1] Smith [2] Amin et al. [3].
For countries in which electricity theft is not a problem, the economic model of this paper has also its importance. Thinking that electricity theft causes an unbilled revenue to the company, for other not billed revenues it can also be used as for example in frauds, government facilities which does not pay for electricity and so on.
Figure 1 represents the global energy losses on a subsystem segregated into technical and commercial losses and their subdivisions:

The electricity theft represents the deviated energy, or the energy that is not registered by the meter. Figure 2 illustrates this phenomenon:
The energy that leaves the transformer is lost in form of electrical losses and the energy that feeds the consumers is called required energy.
Where:

T1: Transformer.
M: Electrical Energy Meter.
E_1: Total energy supplied to consumers after technical losses.
Ceq: Equivalent Energy Consumer.

The calculation of the optimal tariff will occur in order to verify which tariff

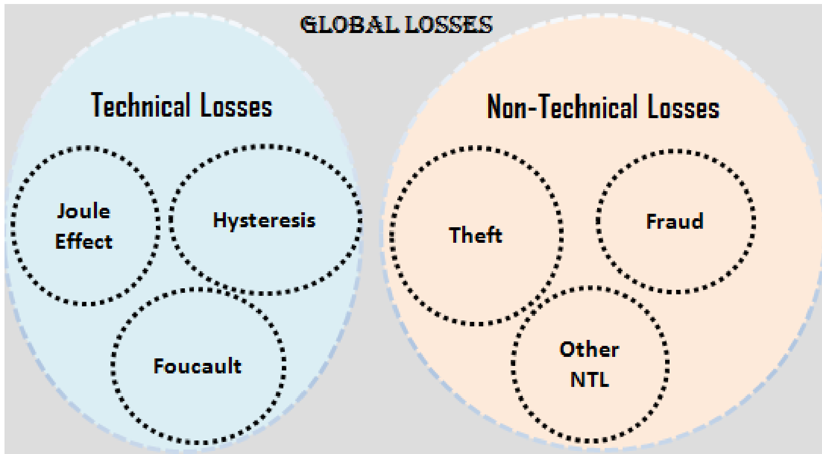

Figure 1: Losses Representation of a Power System

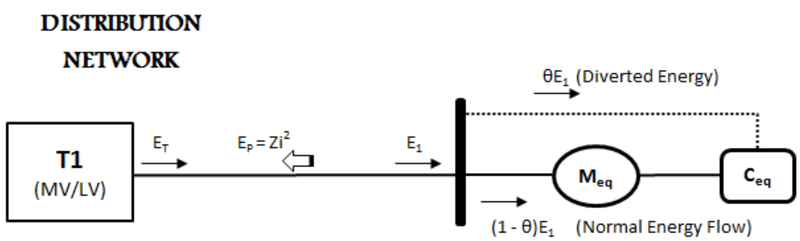

Figure 2: Energy Theft Schematic in Distribution Network

2. Conclusions

Through the proposed economic market model it was possible to verify that a regulated electricity company can operate in two distinct points of optimal tariff. Looking to the consumer's perspective the higher optimal tariff causes a decrease in surplus, due to a higher payoff, reason by it becomes preferable the T_2^*.
The increase of energy theft in a regulated electric company (V = 0), caused a variation on optimized tariffs (T_1^*) e (T_2^*), leading to convergence as the theft reaches its threshold.
Through the parameters of the consumers and of the electricity utility, it is possible to determine the percent of theft threshold. That is, as consumers and utilities have different parameters, the theft threshold will be distinct.

Therefore, it will not be appropriated if the regulator set the same theft goal to all electric utilities.
The electricity theft despite of reducing the economic value added of the company (V), increases the socioeconomic welfare (W). This can be explained by the fact that consumers are increasing their utility (consumed energy increase) and reducing its payoff (R), because they are not paying for energy. Thus, the consumer surplus (S) increases more than the reduction of the economic value added (V). Although the theft causes an increase in socioeconomic welfare (W), this act is considered illegal and regulators should in the first instance act in favour of what is ethically correct.

3. Appendix

TAROT (acronym for Optimized Tariff) is a model based on demonstration of the company's value. It combines the EVA calculation methodology, worldwide popularized by the company STERN and STEWART with $ANEEL$ regulatory procedure for tariff revision. TAROT is based on a structure of expenditures (G), appropriate to electrical distribution system, which relates the costs in proportion to sales, technical losses and depreciation on investment. Starting from the revenue (R), results taxable gains (EBIT = R - G) and taxes (X = t.EBIT). Finally, capital remuneration is subtracted ($Y = r_w.B$) where (B) is the investment and (r_w) the cost of capital (WACC - Weighted Average Capital Cost).

4. References

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