The Financial Benefits of Rectifying an Energy Loss Situation

S. George, M. Maphaka
Energy Trading Eskom and EON Consulting
South Africa
E-mail: sonia.george@eon.co.za

Abstract:
For any utility, rectifying energy loss situations is central to bringing down the total energy losses and increasing the organization's revenue. This paper takes a look at the financial benefits of correcting energy loss problems. There are dual benefits to this monetary aspect. The first part looks at the revenue that has been prevented from loss due to the fix, from the date the problem was rectified and going forward for a given period of time. The second part deals with Revenue Recovery for the duration of the energy loss problem. This paper will also briefly look at the key resources and processes that need to be in place.

Key Words: Revenue Recovery, Audit, Fix, Revenue Prevented from Loss, Energy Loss, Consumption Profile

Background

Curbing energy losses has been a key focus area for utilities worldwide as it has a direct impact on the organization's bottom line. The budget constraints arising from the recent global recession as well as the growing importance of reducing carbon footprints to combat global warming and climate change have only served to heighten this focus. While the search for economically feasible methods to utilize alternative eco-friendly sources of energy continues, it is also paramount that the current supply of energy produced is used and accounted for effectively. The measurement of energy losses is a direct reflection of this.

Energy losses can be categorized into non-technical and technical energy loss. Technical losses occur due to the physical properties of the power generation and delivery system. The key types of technical losses are the copper losses (I^2R) and the iron losses that arise due to the core magnetization in transformers. Technical losses can be reduced by optimizing the load flows and strengthening the network. However, they cannot be eliminated completely. Losses arising due to other external reasons not dependent on the physical properties of the system are termed non-technical losses. These can arise due to inefficiencies or deficiencies in process, faulty equipment and malicious intent.

Process inefficiencies within the utility may give rise to a number of missing customers. These are customers that are legally connected to the network and consuming energy, yet are unknown to the utility. Metering equipment can become faulty or stuck due to insufficient maintenance and environmental factors. This causes the meters to either stop measuring energy use or to measure the use incorrectly. Electricity theft is also a predominant type of non-technical loss. Consumers may bypass their meters, illegally connect to the network or tamper with their meters. All of these causes lead to an imbalance in the energy supplied and the energy accounted for by the utility.

Curbing Non-Technical Energy Loss

Utilities invest a considerable amount of resources, materials and funds in the effort to reduce non-technical losses. A fair amount of planning is required to ensure that the utility can detect and rectify occurrences of this nature. Energy balancing plays a key role in the ability to detect possible problems by identifying areas of unaccounted energy. It is therefore crucial that the network is metered sufficiently. Additionally, tracking consumption patterns of the larger customers and estimation methodologies can be employed to also identify anomalies that may need to be investigated. Once problem areas are determined, strategies and plans are put into place to audit these areas. Problematic meters, suspicious cases of electricity theft and customers are identified and reported. The utility will then possibly need to fix, test and replace the meter.

The detection and rectification of energy loss problems requires the utility to pull together a large number of employees, contractors, vehicles, testing equipment and meters within the available funds. It therefore is of value to measure the monetary benefit of fixing a problem.

Benefits of Rectifying an Energy Loss Situation

Fixing an energy loss problem has dual benefits for the utility. It allows the utility to measure the energy lost (unaccounted for) prior to the fix for the duration the problem existed. Additionally by fixing a problem as soon as possible, further loss of energy is prevented. These two components can be seen in the simplified model shown in Figure 1.

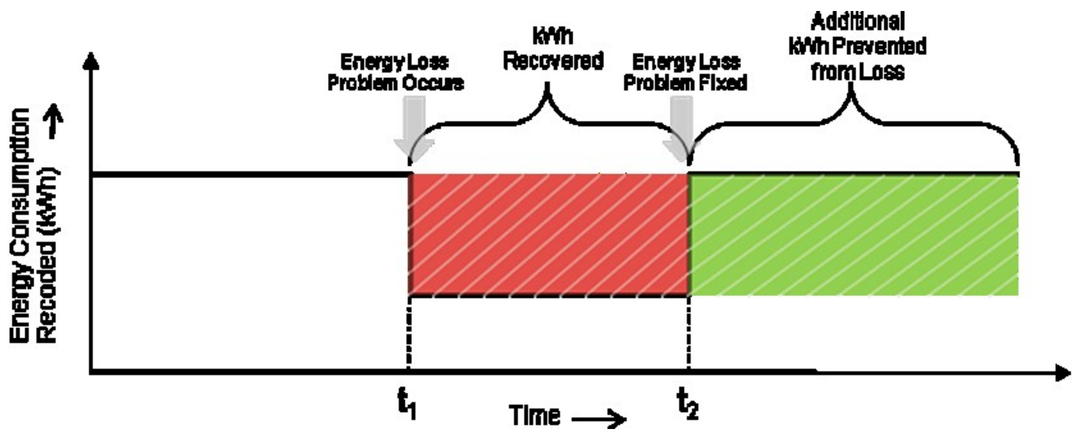

Fig 1: Dual Components to Fixing an Energy Loss Problem

The historical energy that is now accounted for can be translated into revenue that is to be recovered through the utility's collection procedures. Similarly, the energy that is prevented from loss also directly translates into future revenue that is prevented from loss.
This simplified model provides the basis for calculating the components of revenue loss to follow.

In addition to the financial benefits, a host of other benefits arise from fixing an energy loss problem. Revenue recovery leads to better reconciliation of energy purchased and sold by the utility, thereby driving down losses. Also, the process of revenue recovery will help build an awareness of the consequences and costs involved in electricity theft, which may deter customers from subsequent attempts to steal electricity.

Calculating the Revenue Prevented From Loss

In order to measure the future revenue prevented from loss, the duration of the energy loss problem needs to be assessed. This is done by analyzing the consumption profile of the customer for any dips corresponding to the beginning of the period. Statistical tools may need to be employed to model the customer's regular consumption. This model can then be projected forwards against the actual profile to detect major discrepancies which may indicate the occurrence of an energy loss problem.

Once the duration of the problem is determined, the average recorded consumption (kWh and corresponding billed amount) during this period is to be calculated. This forms the baseline (reference consumption) for all future gains that are to be measured. A possible complexity that may arise is when the customer is of a seasonal nature. In this case, if the problem duration is more than 12 months, using 12 months to come up with the baseline will suffice. However, if the duration is less than 12 months, then the seasonality component needs to be dealt with by ensuring different baselines for each season. Future consumption will then be compared with the corresponding baseline to measure the revenue prevented from loss.

When dealing with a large number of customers, it is acceptable to define the energy loss problem duration as 12 months. This accounts for seasonality and in the case where the duration was actually less than 12 months, will only understate the monetary benefit of a fix.

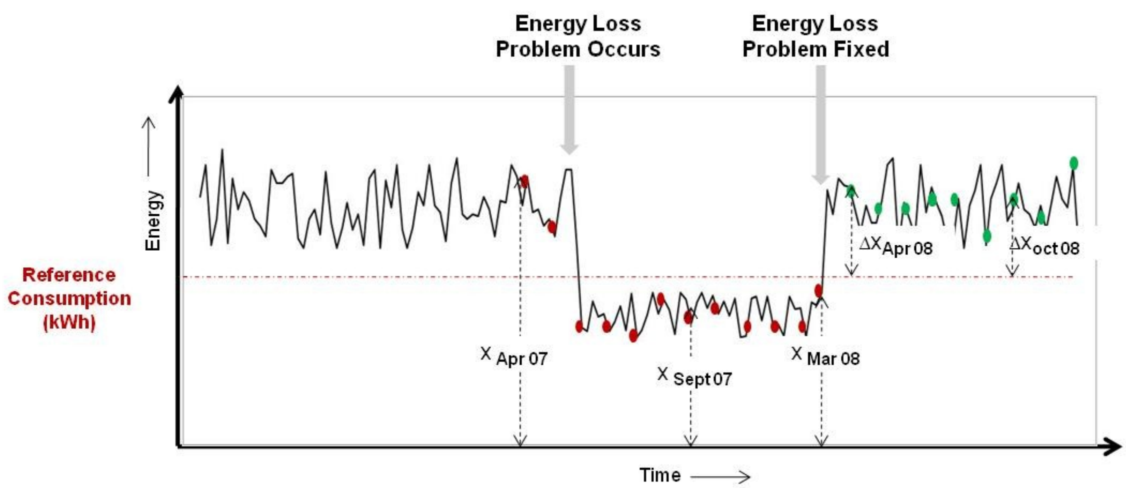

Fig 2: Calculating Revenue Prevented From Loss

The above figure depicts the energy consumption profile a typical customer that experienced an energy loss problem which was rectified in March 2008. Using the principles outlined above,

$$Reference\ Consumption = \frac{x_{Apr\ 07} + x_{May\ 07} + \cdots + x_{Mar\ 08}}{12}$$

Where $x_{month\ i}$ is the kWh reading in month i

The energy consumption prevented from loss in each month going forward is then the difference between the recorded readings in each month and the reference consumption, denoted in Fig 2 as $\Delta x_{month\ i}$. To smoothen out the misalignment of billing dates and calendar dates, it is then recommended to average out the gains for each month. As an example,

$$Average\ Energy\ Prevented\ from\ Loss\ in\ Oct\ 08 = \frac{\Delta x_{Apr\ 08} + \Delta x_{May\ 08} + \cdots + \Delta x_{Oct\ 08}}{7}$$

The energy prevented from loss can then be translated into revenue prevented from loss by applying the utility's corresponding tariffs.

Calculating the Historical Revenue Lost

The other benefit of rectifying an energy loss problem is the possible recovery of revenue for the corresponding unaccounted energy that was used during the period by the customer. The quantification of this however is more complex as it involves various factors that usually require that each customer be dealt with specifically.

The initial step towards this is to reconstruct the customer's consumption profile as though the energy loss problem never occurred. Various factors need to be assessed and applied here. Of crucial importance are the nature of the energy loss problem and the availability of historical consumption data before the problem occurred. These define the methodology to be employed to reconstruct the profile. For example, if the nature of the problem is of a three-phase meter that had one phase disabled, the calculation methodology would entail reconstructing that phase by using the readings of the other two phases and apportioning accordingly. If on testing the meter, it was determined that the meter had slowed down by a certain percentage, the methodology would be to re-apply that lost percentage. If the meter failed to record any consumption at all, historical consumption data would be required. Statistical tools can then be employed to model the profile and project onto the energy loss duration. Where no history is available, the utility may have to wait at least six months in order to build sufficient history that will enable a backward consumption profile projection.

The difference in the reconstructed profile and the actual profile that contains the effects of the energy loss problem provides the utility with the probable measure of energy that was unaccounted for yet used. This can then be translated into revenue that the customer owes the utility.

Recovering the Revenue

Once the historical revenue loss has been determined, the utility now needs to recover this amount from the customer. It is important to note that in most cases, the calculated amount is never completely recovered. In some cases, the costs involved in recovering the revenue may be exorbitant. If the energy loss was caused due to an error on the utility's part, the Prescription Act 68 of 1969 only allows the utility to recover revenue for a maximum of three years. Also, customer agreement has to be obtained before the utility can bill the customer. This may entail negotiations with the customer to finally arrive at a mutually acceptable amount.

Resources Required

In order to carry out the tasks for measuring the benefit of an energy loss problem, the utility must be equipped with sufficient resources. All personnel employed must have adequate domain knowledge about metering, metering errors and fraud and energy losses. First and foremost, management personnel and process personnel will have to take up the responsibility of driving the definition of standards and processes to be followed. Revenue Protection resources must be able to investigate an energy loss problem thoroughly in order to identify the root cause of the problem. They must also gather sufficient evidence which will later be used when negotiating with the customer. Extensive quantitative skills are required in order to track the future benefit of rectifying an energy loss problem. A revenue recovery team may have to be formed to assess each case and apply the quantitative and statistical methodologies to determine the amount of revenue the customer owes the utility. Resources that are well-versed with negotiations and the collections process are required to carry out the last phase of the revenue recovery process. Additionally, billing personnel will need to be trained to address the billing of revenue to be recovered. To support the process, information systems must be developed that have the capability to address the relevant issues at each stage.

Final Thoughts and Recommendations

While the costs involved of setting up the necessary processes and structures along with the training requirements may be high, the quantification of the benefit of rectifying an energy loss problem is an exercise every utility should undertake. Measuring the financial benefit will reinforce the importance of Revenue Protection functions of auditing and fixing. It will also highlight the necessity of fixing problems as soon as they are found, since prolonging fixes results in greater revenue to be recovered, which by its nature cannot be recovered completely. Additionally, by studying the root causes and the energy consumption profiles, the utility can gather greater insight into the type of fixes that need to be prioritized in order to maximize the reduction in revenue loss to the utility.

Until non-technical energy losses are at an acceptable level, it is important to measure the financial benefits as it provides the utility with a sense of the return on investment of key Revenue Protection functionalities.

For additional information, please contact vishnu.moodley@eon.co.za.