STRATEGIES TO FIGHT NON-REVENUE LOSSES IN UTILITY DISTRIBUTION

There has been a persistent increase in fraud and theft in utilities, both energy and water, around the world, becoming a major problem in an increasing number of countries. Direct costs of fraud in electricity utilities worldwide amount to US$89.3 billion annually. Society in general pays the cost of non-metered consumption via subsidies or taxes, or by increased tariffs that embed all or a major part of the value delivered and not billed.

The problem of non-technical losses is essentially seen as a social issue, reflecting a problem of poverty aggravated by cultural issues by disregarding utility theft as illicit. This explains one of the components of the problem, but not all of its complexity.

Sophisticated frauds committed by commercial and industrial consumers as well as high-consumption residential show that this criminal practice may be increasingly used as a strategy to reduce expenses and/or increase the competitiveness of businesses.

Strategies to reduce non-revenue energy and water

There are basically two strategies to reduce losses. The first is a preventive strategy which consists of implementing networks with 'smart' elements that would thus become more 'protected'; ie making grid and meters more difficult to manipulate using appropriate technologies such as smart electronic meters with two-way communication (telemetry, remote disconnection). This strategy benefits from the technological evolution of smart grids and, in some cases, may also be employed to shield grid devices.

The cost of technology is still a serious limiting factor, halting a faster adoption of these new technologies. The return on investment is usually obtained by the gains in reduction of losses (more relevant in countries with serious loss problems) and by the gains in reduction of operational costs and improvement of the quality of energy (predominant in the most developed countries with higher cost of manpower and small percentage losses). Because of the relatively high cost of solutions, payback will generally come in a scale of several years. Companies are adopting smart grid technologies in a progressive way, initially for the high-end consumption customers (industrial and then commercial). In general, this is a long term, multi-year programme.

The second is a corrective strategy that consists of detecting and correcting anomalies. These anomalies could be caused by external or in-house issues. On the external causes, grid offenders should be identified and penalised by detecting anomalies and pre-selecting most probable (and of most value) fraudsters, followed by inspection and repair of the physical installation, and collection of the un-metered and unbilled value.

Furthermore, anomalies caused by internal (in-house) errors or faults should not be disregarded. An additional factor of non-billed energy (and water) comes from problems in a utility's key processes like error in registers, billing, meter readings or calculations that can occur on the grid (meter faults) and also as part of an internal process (IT, human processes, etc).

This second strategy is applied almost universally by all utilities, with more or less the same level of technological sophistication. Many companies still use internally developed applications to analyse customer consumption behaviour and identify possible billing anomalies, or sometimes simple spreadsheets, a method that is highly inefficient due to the huge amount of data to be processed and the immense effort of feeding new data and updating investigation patterns. The main challenges of anomalies detection are to increase assertiveness (finding more anomalies and generating fewer unsubstantiated actions/inspections) and especially increasing productivity (more energy or water recovered, per action/inspection). The detection and selection of targets for inspection has been greatly improved by the development and availability of modern professional data analytics software tools, especially those specifically developed for utility theft detection.

The inspection strategy is universally adopted, on the one hand because there will always be anomalies – being errors or individuals (and businesses) willing to do whatever it takes, even to commit fraud, to reduce the metered consumption and their bills, causing some level of losses on the other hand because it is a relatively low cost strategy for the utility. The return of the investment is generally significant due to the collection generated by the billing of unmetered consumption and the reduction of losses (therefore operational costs), with short payback times, usually in less than a year.

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The importance of software and specific experience

Using state-of-the-art data analytics and big data technologies supported by computational intelligence techniques and machine learning algorithms increases the effectiveness of pre-selection and extraordinarily boosts productivity per action; ie more energy or water recovered, by selecting targets of greater probability of anomaly and more utility recovery potential (higher value).

Utility data is rich but usually stored in silos, with no connection. The data is correlated and analysed by powerful algorithms that scale the possibility of an anomaly and the amount of energy (and water) involved. Natural language processing algorithms can analyse non-structured data and geospatial techniques help visualise issues in a geographical context and include heat maps. Clustering techniques help to build a client's profiles to generate new insights and strategies.

A visual interface makes the management of the data analysis process user friendly, not requiring programming skills to be efficiently operated.

An extremely important factor is the specialisation. Utility distribution is a technological process involving several stages and teams in a complex process. The intricacies of such processes (and of human behaviour) should be considered, patterns developed and the processes modelled and followed. So, a knowledge base built on the results of extensive field experience and knowledge of utility processes are both key assets. This knowledge base should be constantly enhanced and updated by machine learning algorithms that will keep the whole system and process adapted to the field changes as new issues and new forms of fraud will eventually appear.

In companies that have started implementing smart meters, the quantity and quality of data that is received from the field is largely enhanced, allowing an even broader understanding of consumer behaviours and bringing additional data (such as detailed consumption curves, additional electrical measurements and various alarms) that allow an even more comprehensive computational treatment with the use of signal processing techniques. On the other hand, valuable information that the conventional measurement process provides, generated by the observation of the installation and the meter from the visit of the reader and the visual reading operation, will be lost. In general, with electronic meters there is an expressive occurrence of alarms, often undue and that need to be treated and discarded to avoid unnecessary costly inspection visits. Thus, the adequate computational treatment of these data obtained by telemetry continues to be of fundamental importance.

The generation of a consumer database with a focus on consumption-related behaviour has an additional benefit, to be explored in future applications. It will help us to understand client behaviour and to be able to develop and offer new solutions and benefits for the customer as well as new revenue sources for the utility, as future regulations are expected to enable innovative business models.

Distribution utility cases

In a Brazilian energy distribution company, revenue intelligence technology has brought unprecedented insight into the behaviour of its four million consumers, especially that of network offenders. As a result, company loss analysts were able to discover patterns of fraudulent behaviour by associating a scientific research methodology based on computational intelligence techniques using fuzzy logic, neural networks, evolutionary systems, genetic algorithms and machine learning algorithms together with their human perceptions. With the implementation of a loss control intelligence centre, the company has doubled energy recovery in the first year; and since then has consistently improved energy recovery rates, eight years later reaching an amazing 400% increase on energy recovered per inspection. The first month's operation brought $40 million a year additional revenue – high enough to change the stock market perception of the company and increase the value of its shares.

Another recent case involved a Colombian multi-utility, multi-country distribution company with 7.5 million electricity, water and gas consumers. Here the combined use of consumption data and other info from all these services led to the discovery of previously unsuspected patterns of fraud/theft and an impressive increase in the effectiveness of the pre-selection and consequent assertiveness of the inspections. The results after a few months of operation have already led to productivity increase of 134% and 126% in assertiveness.

These two companies are in initial stages of smart meter implementation and have a large majority of conventional meters, with little consumption data available (only one measured value per month). This makes analysis even more difficult and tracking the right anomaly indications requires extensive knowledge, experience and specialisation.

Conclusions

There is no single solution to the complex problem of losses. The two strategies are complementary and should be applied, with emphasis and budgets appropriate to each different region and situation.

Combating losses is a war without an end in sight, but not necessarily a war without winners. Reducing non-technical losses to a manageable value is a primary objective of utilities to better serve the population with quality services at a fair price. This objective can be achieved with the use of modern intelligent software technologies and processes generating significant results to support tariff modality, bringing an impressive return on investments with adequately short payback periods. **MI**

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