

"Revenue Intelligence by Choice Technologies – an invaluable platform for the utilities' financial health"



Choice Technologies

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# 1. Background and objectives

Brazilian distribution utilities face non-technical losses indices that have been increasing in the last decades, bringing its total losses to approximately US\$ 3 MM /year (non-technical losses ranging from around 1% up to 40% and more in some utilities).

Since 1992 Choice Technologies has been working with leading utilities to improve results and cut losses down. A shift of paradigm was required - a solution whose efficacy should not be restricted to a subset of consumers in one particular concession area but could be utilized in every region of Brazil. Also different issues should be addressed altogether to avoid losses to migrate, for instance from theft to bad-debt, and to optimize ROI.

We have then developed a platform of integrated applications that cover the main aspects related to revenue assurance – fight theft and frauds of energy, non-payment and bad debt management, and selection of alternatives with the objective of maximizing return of investment. Applications are natively integrated to the database level allowing them to share data and metadata (results of analysis and actions). In addition, a R&D program budgeted by regulated funds helps develop new features with the most modern computer intelligence tools in order to keep Choice RI platform the state-of-art technology for Revenue Assurance.

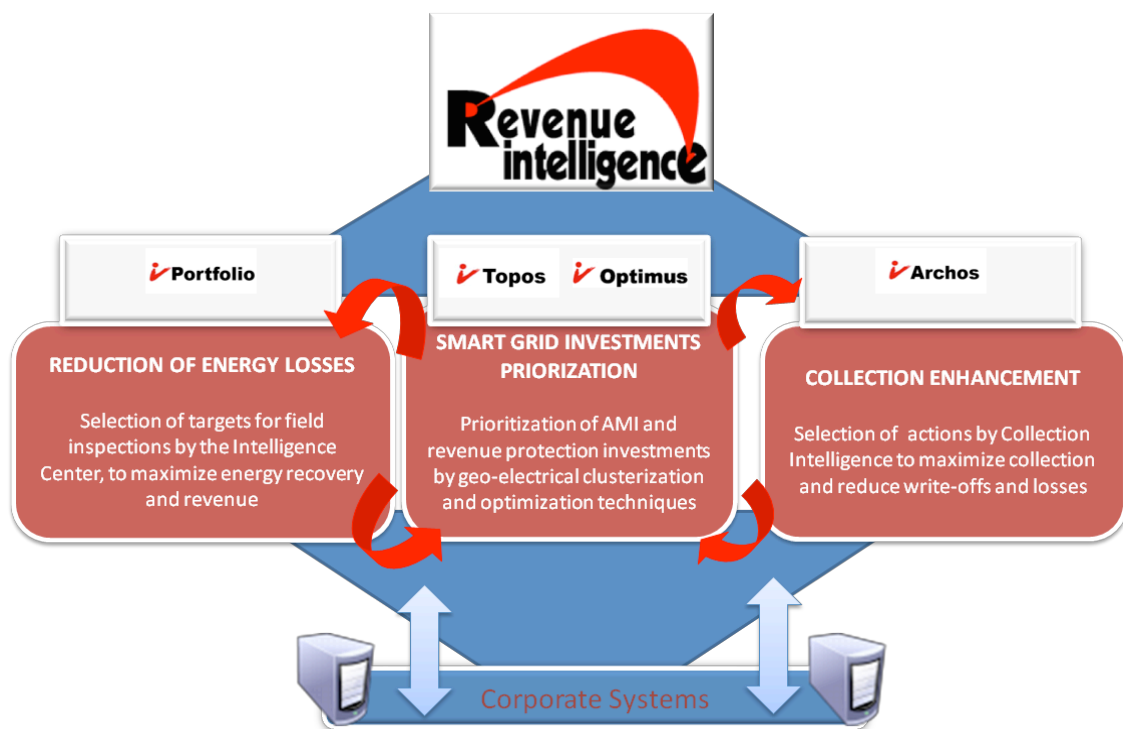


Figure 1 - Choice integrated Revenue Intelligence software platform

But no matter how advanced is the RI software, it is not enough. Experience has demonstrated that the results of our sophisticated tools could be significantly improved by employing a team of skilled specialists that combine computational intelligence technology education with practical experience with our technology and knowledge in revenue assurance / loss recovery processes. Working together with utilities' teams in our Revenue Intelligence Centers, an extensive experience has been accumulated helping improving processes and investigation intelligence, therefore boosting recovery and earnings. It also brings insights to continuously enhance our platform. This unique approach makes Choice Technologies not only a traditional software vendor but a real partner being truly committed with the utility with the goal of improving revenue.

Recognition by leading utilities and prestigious awards due to outstanding results demonstrate the outcomes earned by our clients. World renowned partnerships support our presence worldwide.

## 2. Revenue Intelligence Platform: PORTFOLIO Module

Choice Technologies' Intelligence Center concept is composed by the Revenue Intelligence software platform and best practices in recovery and revenue assurance procedures, as seen below, all operated and managed by a skilled team of trained specialists.

The core concept is a combination of software and procedures supported by both human and computational intelligence and knowledge, to maximize recovery and incorporation of energy in all actions, including investigations and field inspections.

A team of experts from the utility, supported by Choice experts in loss recovery and computational intelligence, form the Intelligence Center team dedicated to increase the productivity of energy recovery in all actions performed by the company.

Choice's Revenue Intelligence software - Portfolio module, through computational intelligence and evolutionary systems techniques such as fuzzy logic, neural network and genetic algorithms aims to identify what consumers are most likely making frauds and stealing energy (an inspection "target"), and simultaneously calculates the energy recovery potential for each target, therefore creating a risk portfolio (the probability) x return – same as a portfolio of investments – to help determine the best actions to reduce losses that could bring the higher financial results.



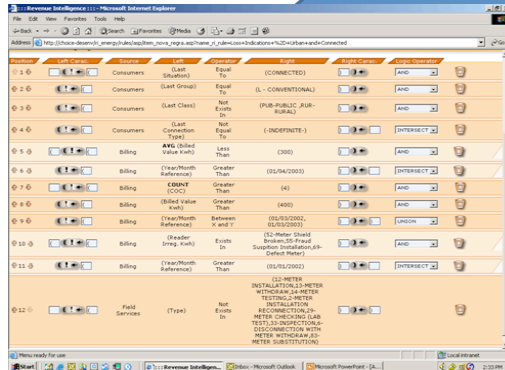
Figure 2 - Intelligence Center

The Portfolio module of Revenue Intelligence software aims to maximize the return on investment given a certain budget and resources to reduce losses. This module allows the experts of the Intelligence Center to elaborate sophisticated investigation rules in a graphical and simple "point-and-click" mode, allowing them to perform complex investigations into data sources from different systems, such as consumers, billing and GIS data bases, thus creating an effective dynamic environment in search of the best results.

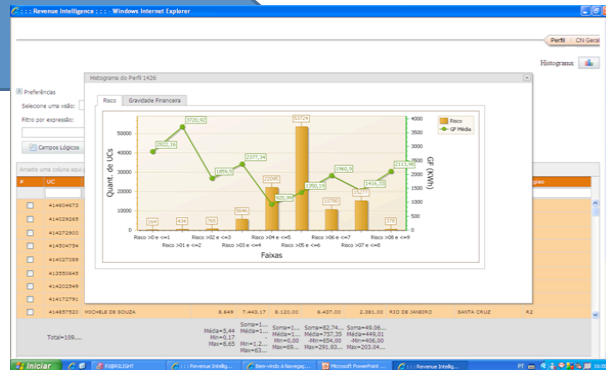


REDUCTION OF ENERGY LOSSES

Selection of targets for field inspections by the Intelligence Center, to maximize energy recovery and revenue



Screenshot: Visual interface for creation of detection rules



Screenshot: Analysis of Results and feedback

Figure 3 - Portfolio module

A key feature that makes this dynamic so important is the principle of evolutionary systems. When a fraudster is discovered, he will usually adapt and try a new method of fraud in order to avoid being flagged again. Thus, a successful investigation rule today may soon turn ineffective. For this reason, a dedicated team of skilled experts in recovery of losses and computational intelligence in the Intelligence Centre is vital for creating new rules for investigation.

The relationship between the area of loss recovery and fraudsters is similar to a predator-prey relationship in nature ecosystems. The evolutionary theory indicates that while the predators build up their skills to hunt preys, the preys will develop new skills to escape the threat of predators, and the one that does best will survive. This continuous cycle creates what is called in the technical literature as an **arms race** or the **Red Queen hypothesis**<sup>1</sup>.

This theory was developed by the American biologist Leigh Van Valen<sup>2</sup>, in analogy with the *Alice in Wonderland* story by Lewis Carroll. Alice was running with the Red Queen, and both did not leave the spot. Alice then stated that at her country, if they ran well, they would move to somewhere else. The Red Queen then said, "What a slow country! Here it takes all the running you can do, to keep in the same spot." The Red Queen Principle can then be stated: "For an evolutionary system, continuing development is needed just in order to maintain its fitness relative to the systems it is co-evolving with." In conclusion, only with computer intelligence it will be possible to increase the productivity, so loss recovery evolves faster than the adaptation of fraudsters, managing to reduce the levels of losses.

<sup>1</sup> Dawkins, Richard – The blind watchmaker, 1986

<sup>2</sup> Van Valen, Leigh – "A new evolutionary law", Evolutionary Theory v.1, 1973

Revenue Intelligence software – Portfolio module includes algorithms based on evolutionary systems that automatically adapt the investigation rules relevance parameters (up to 90,000 combinations in some utilities), to adapt future field actions according to fraud mutations.

## 2.1. Implementation and Results for Portfolio

An outstanding project - the Light project - was initiated in December 2007 and the Intelligence Center started operations in April 2008 when were generated the first field inspections based on the use of Choice intelligence technology.

Considering the complexity inherent in the process of integration with CCS, SAP, and the creation of specific rules for Light, the time schedule below four months to start of operations may be considered one of the relevant achievements of this project. The urgency was justified by the need to reverse the increase in the losses index, where each month would represent millions of dollars of financial losses. At the same time, the responsibility of the project startup was extremely high because the initial actions could not afford any reduction of the on-going performance.

Implementation of the Intelligence Center was a complete success. The trend of increasing the rate of losses was reversed, which was the main goal of the utility. According to the Report to Investors in the 4th quarter of 2008, the increase in energy recovery was 80%, a revenue addition of 57.8 GWh representing a value added (estimated) of approximately US\$ 10 million.

According to the Report to Investors in the 4th quarter of 2009, an additional increase of 16.9% in energy recovery was achieved in 2009, bringing additional revenue of 21.9 GWh, with an increase in incorporated energy of 165.1%, equal to 70.5 GWh. In total the increase in energy billed in 2009 over 2008 was 92.4 GWh – an estimated value added of R\$27.99 million (approximately US\$ 16.5 million) over the 2008 base. The cumulative Intelligence Center financial benefits of the 2008-2009 period is already R\$ 63 million (approximately US\$ 37 million), without considering the benefit of 2010, as can be observed in the increased GWh in energy recovered and incorporated as demonstrated in the chart at the left side.

At CEMAR, during the first year of operation the productivity in energy recovery was 118%, in an amount of 107 GWh / year.

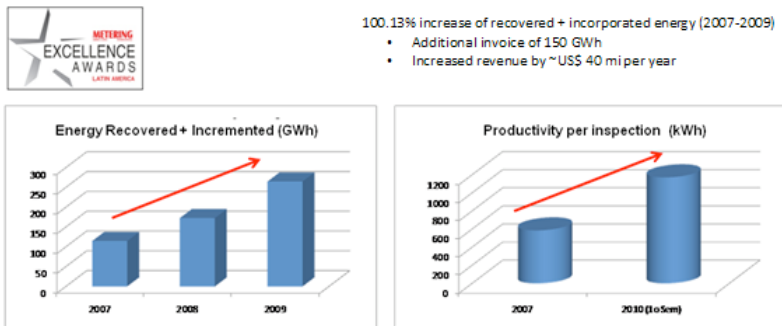


Figure 4 - Energy and Productivity graphs for Intelligence Center

Light Revenue Protection Intelligence Center project was awarded as Best Revenue Protection Project in Latin America, from the Latin America Metering Conference 2010 (Sep 2010).

Not to be overlooked is the impact on energy efficiency. Regularization usually has a significant impact on consumption behavior. Studies show that in some regions there is a consumption reduction of up to 68% after regularization – or, in other words, the consumer who does not pay for the energy is not worried about how much energy he or she uses. So reduction of losses is also a very important driver for energy conservation and the environment.

### 3. Revenue Intelligence Platform: ARCHOS Module

Delays or non-payment, provision for bad debts and write-offs are relevant issues for all utilities. Customers that are uncovered on making a fraud may be strong candidates to default on their increased energy invoice and generate a debt. A successful revenue protection program shall inevitably include a strategy and tools to manage payment and bad debt issues.

Normal utility procedures handle consumer payment delays using dunning rules that are common to all customers in each segment. Of course this method is a simplification as it treats different people equally. Experience shows that the behavior of a defaulted customer will change in reaction to the different ways he/she may be approached by the utility, value and age of debt, and other factors. A simplified course of action – one single strategy serving equally all customers – is certainly a shortcut to increasing debts.

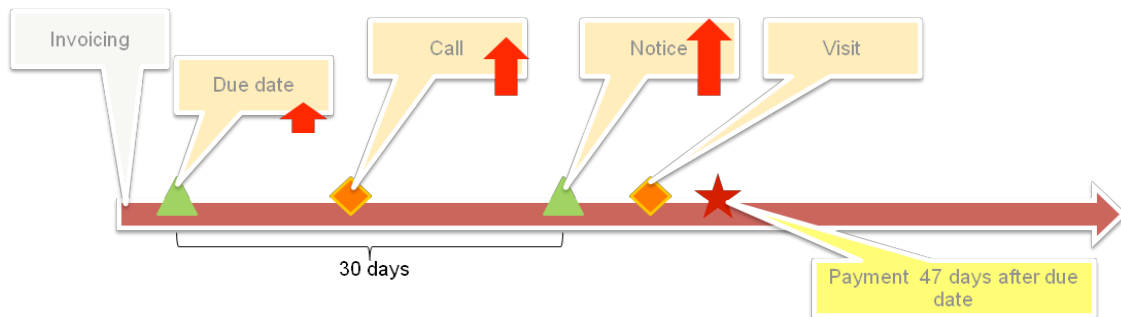


Figure 5 - Collection dunning rule

Choice developed a method applied as software that groups customers in clusters according to several characteristics and helps defining different dunning rules for each cluster. As a consequence, different people will be treated differently according the expected reaction to possible collection actions, based on previous reactions and payment history, value and age of debt, among other factors. The objective is to accelerate the collection process to get maximum revenue in the shortest period and avoid delays to ever become write-offs.

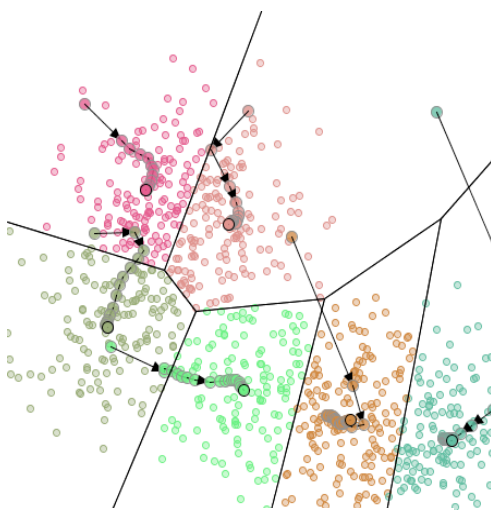


Figure 6 - Use of clustering techniques

Also an important concept is productivity of receivables. Archos includes algorithms that take in consideration several aspects in order to define the priority for the most costly actions – like disconnections. Archos uses clustering algorithms to create segments according to consumer’s response for each combination of collection activities. For each cluster Archos helps creating a unique timeline with specific collection activities, thus optimizing global productivity.

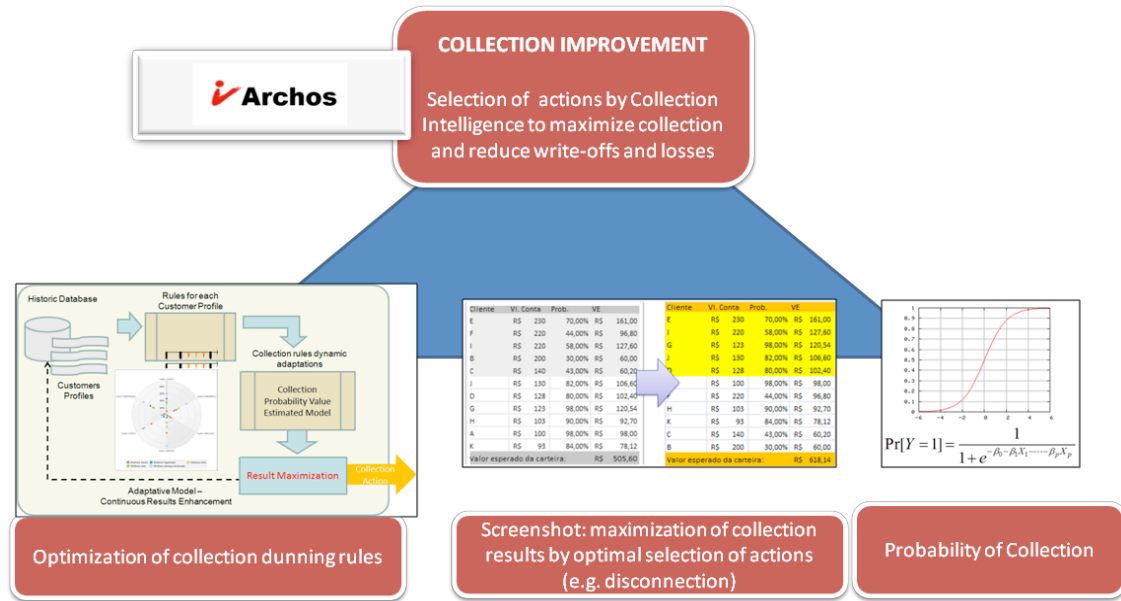


Figure 7 - Archos collection improvement module

### 3.1. Implementation and Results for Archos

Archos was developed for a utility and tested in a pilot project. The results were, in a single two-month test run, an increase of 20% in the receivables compared to previous strategy. During the first year of operation, the Collection Intelligence Center helped improve 90-day Aging from 95.3% to 95.5%.

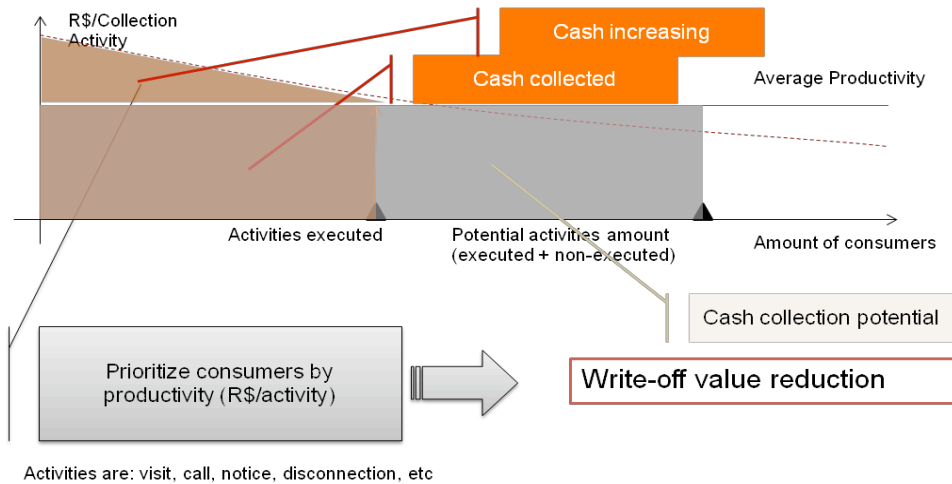


Figure 8 - Archos objectives

## 4. OPTIMUS – Advanced Metering Deployment Accelerator project

As part of its efforts to reduce non-technical losses, a utility has decided to implement new advanced metering technologies combined with grid shielding. Such technologies harden the grid and make energy theft more difficult, as well as provide management of consumption and remote disconnection features.

The cost per consumer unit for this combined solution is high, imposing limits on the annual investment capacity and therefore in the speed of deployment. The challenge is then to find out what areas might offer the best economic return in order that the additional benefits allows a greater number of installations thus accelerating the process, allowing to reach more consumers per year and further reducing the non-technical losses. In other words, we could also say that the project objective is to compare different technologies for each location in a technical and economic standpoint having in consideration complex cost and revenue issues.

To solve this challenge, Light – a 3.9 M consumers utility in Rio de Janeiro, Brazil – hired Choice Technologies via a R&D contract (under the ANEEL Regulator rules) for the research, development and implementation of the OPTIMUS (© Choice Technologies - patent pending) methodology and system to optimize the choice of the best consumer units from the perspective of the return of investment in advanced metering and grid shielding, compared to field inspection procedures performed via the Intelligence Center.

This system develops cost, revenue and return modeling functions. The cost model takes into account acquisition and installation costs for meters, length and range of distribution cables, grid shielding costs per km of LV circuit, as well as consumers' density, electrical characteristics of each consumer, and the cost of implementation and operation of the Meter Center, inspection costs and normalization costs, among others. The revenue model considers the estimation of recovered and incorporated energy, reduction of required energy, avoided costs (meter reading, inspections, remote disconnection and reconnection, etc), load reduction as well as expected decaying of monthly revenue incorporated, and others.

Optimus software includes an optimizer function to define best locations for an investment, given operational and budgetary constraints. This development included a scientific challenge as the decision is binary (to invest or not) per area, so the linear and nonlinear optimization algorithms were not applicable thus requiring the development of non-convex algorithms.

The project also used Choice's geo-electrical intelligence software – Topos – a module of the Revenue Intelligence (© Choice) Platform - as an infrastructure for integrating GIS data like consumer links and electrical metering data for energy balance, with data from commercial systems, and the Portfolio module for inspection intelligence.

This software infrastructure allowed the utility to know not only the losses indices by geographical area as well as the possible causes of loss, so-called “explained loss”. This knowledge was instrumental in the creation of the researched optimization method. It is relevant to mention that we may intuitively believe that the areas of greatest loss will consequently drive the highest economic return, a situation that usually does not occur. In practice, the results of the project demonstrated that areas that were not among the greatest losses may offer a higher economic return, due to aspects relating to grid costs, demography, unexplained losses, and / or historical behavior of frauds.

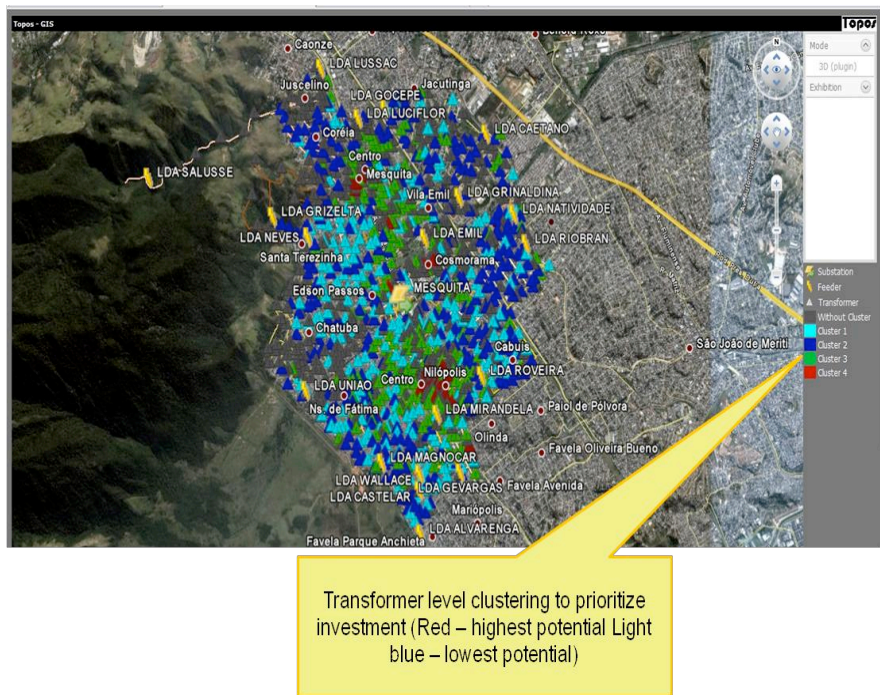


Figure 9 - Clusterization to prioritize investments

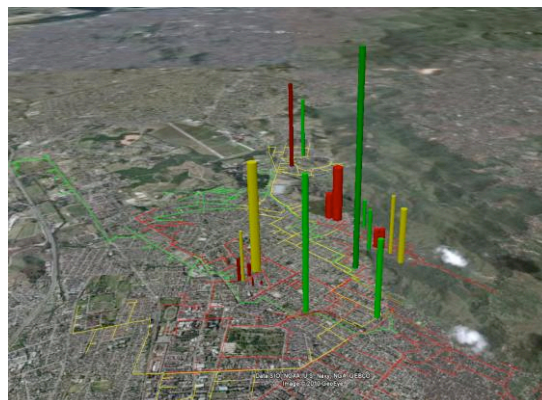


Figure 10 - Prioritization of investments with Optimus / Topos

Optimus© allows automatic execution of scenarios and simulations of investments in regions or in any concession area, and to parameterize budgetary and operational constraints. Additionally, it offers a solid platform for simulation and mathematical optimization to guarantee the completion of the planning process based in a scientific method, as an organized and auditable process, allowing the monitoring of results and data feedback to support the planning for subsequent years.

## 4.1. Implementation and Results for Optimus – doing more with less

To evaluate the results, the investments already made by Light were benchmarked with areas selected by Optimus. For comparison purposes, it was used: (i) the actual cost function, based on actual known data from the grid and the consumers, enabling a more accurate calculation of the deployment costs; (ii) the estimated revenue function used in the business case approved by the Board of Light, with 5 years NPV; and (iii) the same cost constraints (the cost of deploying advanced metering and the grid shield as indicated by Optimus should be the same investment defined by the utility, with a maximum tolerance of plus/minus 2%).

The comparison was made in an area of four substations where Light has deployed shielding and advanced metering to 15,875 consumers, as shown in the table below.

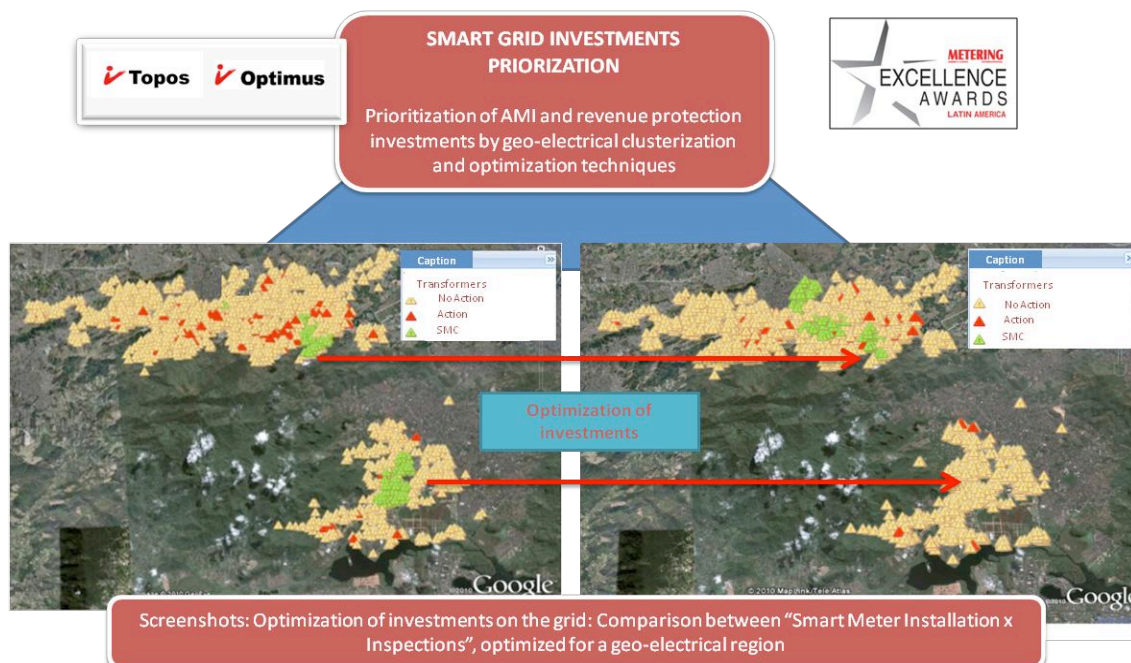


Figure 11 - Comparison on four substations - Analysis of the results – 16,000 consumer units

Smart metering with grid shielding for areas with 4,000 and 8,000 consumer units UCs with a minimum density of 160 UCs/km of LV grid

As a result, with a similar cost, Optimus mostly indicated distinct areas, reaching 48% more consumer units, as can be seen in Figures 11 and 12. As per the economic perspective, the estimated gain was 87% higher, demonstrating the effectiveness of the optimizer. A comparison was also performed for the entire western region, where advanced metering and grid shielding were implemented for 63,392 consumers. Table 1 also shows that with Optimus the amount of consumers would bring 24% more consumers with a 71% increase in profit.

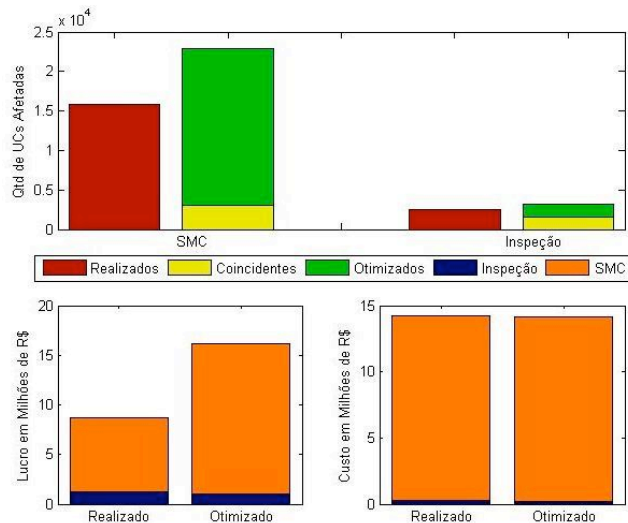


Figure 12 - Comparison on four substations - 16,000 consumer units - Smart metering with grid shielding for areas with 4000 and 8000 consumer units UCs with a minimum density of 160 UCs/km of LV grid

The OPTIMUS project was awarded as Best Advanced Metering Project in Latin America, by the Latin America Metering 2010 (Sep 2010). It was the only invited Latin-American presentation at Smart Grid – i-PCGrid (March 2010) held in San Francisco, CA, USA.

	Performed (SMC)	Optimized (SMC)
Qtd of affected Consumer Units	63,392	78,892
Cost	US\$ 33.5 Mi	US\$ 34 Mi
Revenue	US\$ 57 Mi	US\$ 74.3 Mi
Difference	US\$ 23.5 Mi	US\$ 40,3
<b>Increased Margin</b>		<b>US\$ 16.8 Mi</b>
<b>% Increase</b>		<b>71%</b>



**SUCCESSFUL BUSINESS CASE - LIGHT**  
Result Analysis – Regional: West – 63,000 Consumer Units Light SMC project: AMR system - Smart Meters optimized for protected (“shielded”) grid areas with an average of 6,500 consumer units per cluster

Table 1 - Comparison on the entire western region

## 5. Implementation and Business Models

Choice Revenue Intelligence modules are inherently integrated although each application can be implemented individually. This platform also interfaces with other utility systems like billing, CIS, CRM, GIS, SAP-CCS<sup>1</sup>, MDM, etc by using tools like ETL and message exchange in order to avoid interfering with the performance of these applications. The computational environment for RI platform is then totally separated from other corporate system so the computational intelligence analysis are transparent and do not impose additional load to these systems.

Implementation depends on the utility to supply commercial data about customers' accounts and installations (consumption, payments, service orders, equipment, etc.) and about the grid (GIS and technical data). Utility shall develop ETL (Extraction, Transformation and Loading) tools to gather data from their data bases (typically Customer, Billing and GIS data bases). Consumption data shall be fed into Revenue Intelligence software periodically, according to the periodicity of metering (typically every day for monthly readings and every x minutes for AMR or AMI metering). Other data shall be supplied according to their specific periodicities – daily, in general. Customer data will be processed by Revenue Intelligence software (inspection lists, dunning rules, etc) and returned to the Intelligence Center staff on demand.

The expected time schedule for system implementation is 4 months - counting starts after receiving the ETL files already checked and consisted.

### 5.1. How does it work? The Business Models

Choice business models are designed to offer alternatives to every utility need. Since pilot projects to full implementation of an Intelligence Center for the concession area, by fixed or variable (performance-basis with success fee) pricing or via cloud-based service RAISE (Revenue Assurance Intelligence Services), a pay-as-you-go model, utilities' preferences can be accommodated to better serve their needs.

### 5.2. Intelligence Center Business Model

The Intelligence Center is characterized by the implementation of an Intelligence Center at Utilities office where Utility intelligence team would work together with Choice Intelligence specialists to enhance efficacy and foster recovery results. All processing and analysis will be done in Utility premises by a joint Utility/Choice team and fully controlled by the Utility personnel. Choice specialists would be part of a team effort together with the utilities revenue assurance or collection staff, or would support Engineers to define best investment alternatives. Knowledge accumulated by Choice team in several projects in different technical and social environments will be put to work and transferred for the Utility team allowing faster results and fostering energy recovery.

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<sup>1</sup> SAP and CCS are trademarks of SAP AG.

The offer typically includes software licensing plus implementation, intelligence analysis and support services, as below:

**Software licensing:** includes all Choice (Revenue Intelligence modules) and third-part software (data base, BI, etc) licenses necessary to operate the Intelligence Center. Costs depend on the number of customers served by the Utility.

**Implementation services:** includes support on ETL processes (ETL = Extraction, Transformation and Loading) to extract data from Utilities applications (billing, CRM, GIS etc) databases and support to ETL process optimization, application customization, software installation and put in operation, training of Utility personnel, and creation of initial investigation rules.

**Intelligence Support services:** it may include all professional services by Choice Intelligence specialists team to support Utilities teams on the analysis and recovery processes and optimization of investments – analysis and review of investigation and recovery processes, intelligence knowledge and support, analysis and complementation of the utilities team skills, construction of investigation rules, selection of inspection targets, parameterization of rules, rules review and optimization, analysis of results and fine tuning, creation review and optimization of collection dunning rules, selection of regions/areas to implement AMR/AMI.

**Software support services:** includes software support and updates, development of new reports, and development of customized functionalities.

The cost structure is according to number of customers (clients of the Utility). Utility has the possibility to start small and grow according to results and needs. A pilot project could be designed in order to start by a small are that should cover a region according to available budget.

Choice can also offer a price structure option where investments can be modulated by a Risk Reward scheme. Cost would be composed by a discounted base cost + success-fee based on performance indicators to be negotiated with the Utility.

### 5.3. RAISE Business Model

An alternative business model is the RAISE – Revenue Assurance Intelligence Service. The basic concept is to deliver the results of a Revenue Intelligence Center (based in Choice or third-part premises) in a cloud model where Choice receives data from the Utility in a defined format and returns the analysis results: lists of customers to inspect, lists of collection actions, selections of investments, etc. System and data is housed in secure servers in the cloud and all tuning, rule creation, analysis and processing is done by Choice personnel. Customer, grid and consumption data is transmitted from the utility to the Choice cloud servers. All analysis results will be contained in encrypted files and transmitted by Choice to the Utility.

Choice team will prepare the rules and do all analysis. Knowledge accumulated by Choice team in several projects in different technical and social environments will be put to work for the utility allowing fast results and fostering energy recovery. Utility teams do not participate in the analysis but their knowledge can and should be captured and considered.

This model allows utilities to pilot-test the technology in a services low-budget scheme without making investment in infrastructure – e.g. hardware and software licenses. The Intelligence Center hardware, software and staff are fully provided by Choice, so training, office and operation costs would also be minimized. The initial costs are low then the Utility can develop a practical proof-of-concept before actually investing to buy an intelligence Center and internalize the platform.

The costs are according to number of transactions (number of inspections, disconnections, etc) contracted. It is possible to start small and grow according to results and needs. Initially could cover the complete area of concession but number of transaction (e.g. inspection targets) would be defined according to available budget. A RAISE contract could start as little as 1,000 inspections per month, for example and once proved the technology and verified business case numbers, the Utility can choose to expand number of analysis to cover its' full concession area using the same scheme or alternatively to internalize the technology by implement an in-house Intelligence Center operated by its own team together with Choice specialists. This decision would then be backed up by practical experience and solid field results to support the business case assumptions.

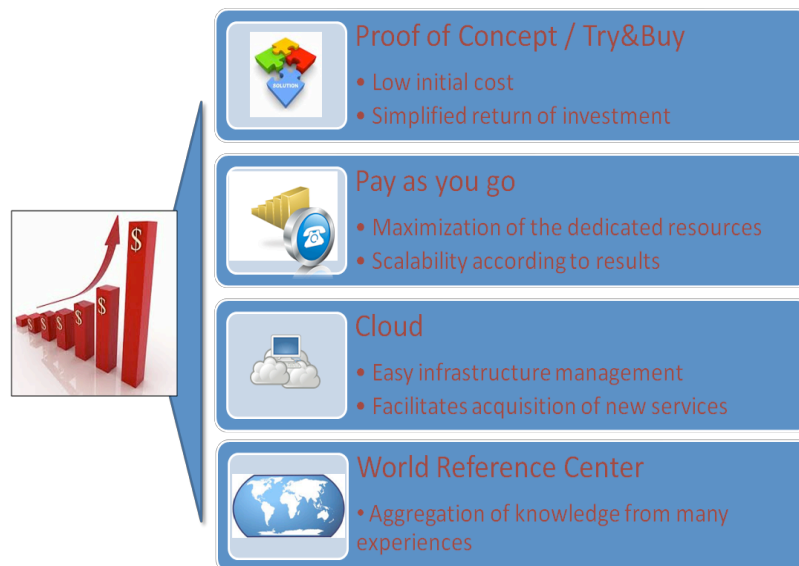


Figure 13 - Application and advantages of the RAISE business model

## 5.4. How to compare alternatives and select the best option for your Company

To support understanding and comparison we have developed a table showing Business Model characteristics, side-by-side. This comparison table of the different models is presented below:

	<b>Intelligence Center model</b>	<b>RAISE model</b>
<b>Business Model</b>	Risk-Reward	Pay-as-you-go
<b>Price structure</b>	Software licenses (per n# of customers) + Support + Consulting (man-hours)	N# of Transactions (inspections, disconnections, etc)
<b>Investment reduction</b>	All cost components	Infrastructure
<b>Revenue Share</b>	Yes	No
<b>Experts</b>	Choice + Utility blend	Choice
<b>Contract relationship</b>	Long term	Short term, renewable
<b>Location of Servers</b>	Utility	Cloud