A BRAZILIAN BUSINESS CASE: SMART METERS, THE MARKET AND REGULATION

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ABSTRACT

This paper describes the characteristics of the Brazilian energy distribution market. A simulation of cost / impact due to a roll out of smart meters is preformed based on market values. The results show a significant increase in the rates to pay for the necessary investments. The paper also outlines a structure that enables the reduction of implementation costs by focusing of the expected benefits for the Brazilian reality.

INTRODUCTION

There are more than 70 million electricity customers in Brazil [1]. The majority of these customers still use old electromechanical meters, however their will soon be a giant roll out of new smart meters in order to support a smart grid system.

Even though the change over to a smart grid system is supposedly imminent, manufacturers of smart meters have been waiting for more than two years for the change over process to begin. This delay can be explained if market and regulation issues are analyzed.

The purpose of this study is to provide an evaluation of the situation in order to explore some alternatives that could solve the difficulties faced by the market and therefore finally allowing the electricity distribution system to develop.

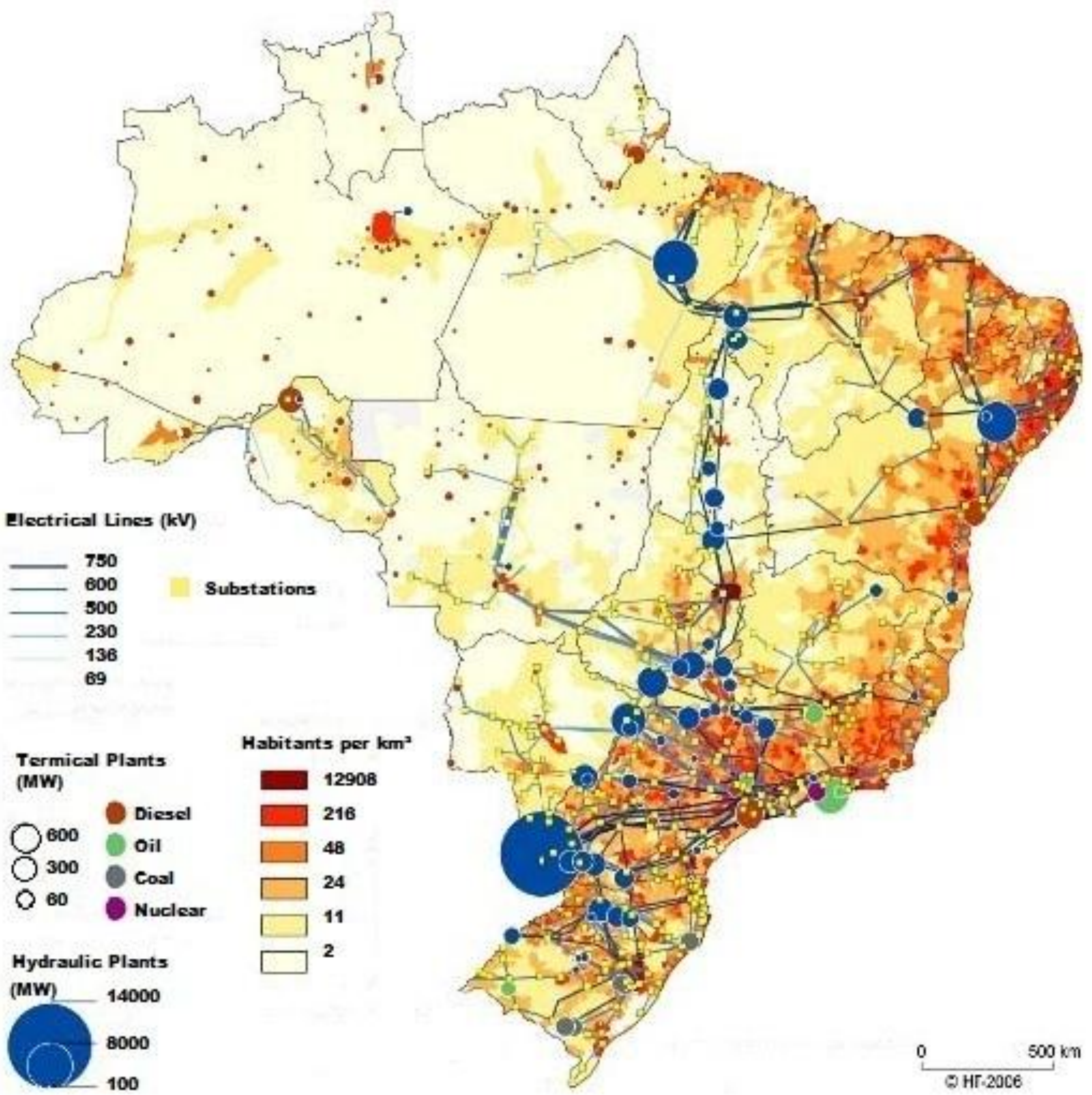

Figure 1: Brazilian Electrical Matrix

THE PATH OF SMART METERS IN BRAZIL

The global target for smart grids is usually the: integration of renewable energy generation and the reduction of pollution and emissions by obtaining better energy efficiency. In Brazil however there is also a focus on some additional goals [1]: reducing losses, improving the distribution systems quality and reducing System Average Interruption Frequency Index (SAIFI) and System Average Interruption Duration Index (SAIDI).

This difference can be explained by evaluating the profile of the Brazilian electricity system. Unlike other countries, Brazil has an energy matrix based on hydroelectric plants. This feature includes goals relating to pollution and greenhouse gas emissions. Other renewable systems do not compete economically with hydroelectric generation. Figure 1 shows the main elements of the electricity system in Brazil.

In Brazil there is no incentive for the use of electric vehicles, because, according to government policy, fossil fuels must be replaced with green solutions such as ethanol and biodiesel. Distribution generation systems are desirable, but due to fiscal constraints, there are no incentives for this model.

Generation plants are generally far from consumer centers. This results in energy failures and interruptions. Even though Brazil possesses an interconnected transmission system running from the north to the south, the country has suffered three major blackouts in the last 12 years. As the distribution network is typically aerial it is subject to tropical climate influences. SAIDI and SAIFI rates are therefore high.

As Brazil has continental dimensions and its more populated cities extend over very large areas, there are high technical losses. In addition, within the country there exists is a culture of corruption, impunity and indifference which contribute to significant rates of non-technical electricity loss.

There is no doubt that the exchange of meters for smart models could help solve these problems, however this change has not yet been adopted. The reason, as demonstrated below, is basically economic.

THE BRAZILIAN MARKET

The electrical energy market in Brazil is divided into three parts: generation, transmission and distribution. There are 64 distribution companies. The smallest of which attends only three thousand customers while the largest attends over eight million. The regulatory model for these companies involves a “price cap” which is defined by *Agência Nacional de Energia Elétrica* (The National Agency of Electric Energy - ANEEL), thus creating a natural monopoly. The controlled tariff charged to consumer’s covers; operation costs, the return on investment and the depreciation of assets [2]. According to the ANEEL, the average residential tariff (not including taxes) in Brazil is US$ 0.16 per kWh [3] while the average consumption is less than 200 kWh per month [4]. With this data, it is possible to estimate an arithmetic mean of monthly payment of US$ 32.00.

Only about 25% of this value is passed onto the distribution companies. The other part remunerates the generation and transmission segments. The weighted average cost of capital (Wacc) that represents the investment performance, is defined by ANEEL as being an annual rate of 7.5%. As taxes affect this value, customers pay 11.36% over the tariff value [5].

As smart meter´s have an expected useful economical life of 13 years [6], this means that their depreciation rate is equal to 7.69% per year. The sum of this value with the Wacc realized by customers’, results in an annual rate of 19.05%. Currently there is a law that does not allowed charges for low voltage customers [4].

ROLL OUT SIMULATION

The values set out above can be used to simulate the financial impact of a smart meter substitution. If a customer, (with an average profile) pays US$ 32.00 per month for electricity then after a meter replacement, with projected cost of US$ 250.00, there will be an additional charge of US$ 3.97 per month (US$ 250.00 x 19.05% ÷ 12 months).

In a country that is looking for ways to decrease energy costs, a planned tariff rise of 12.40% to cover meter substitution costs, is unacceptable.

For this reason, ANEEL changed its strategy in 2012. Currently it is not mandatory for distribution companies to replace all meters. Replacement of meters will occur only when customers ask for a special function. In such cases the customer will be responsible for paying for the new equipment. The rule is already valid for the new program of distributed generation (with renewable energy) and will be used for the “Time of Use” pricing model, entitled White-Tariff, which starts at 2014.

Replacement of meters using the above model, with its less concentration and not covering all customers is not advantageous to a smart grid system. Loss reduction and reliability increases will not occur. Because of this, it is essential to find alternatives that enable smart meter substitution to occur on a large scale.

NEW ALTERNATIVES

The first option is to simplify the meters in order to reduce their costs. As already mentioned above, low voltage customers can not be charged therefore there is no need for complex control systems. The substitution of meters is only interesting for the control of late paying customers (who account for less than 10% of customers).

Another alternative that could be an option, is a meter containing a clock mechanism. Such meters integrate a real time clock (RTC), battery for power failure and a scheme for adjustments. A communication system, with a centralized clock, could be much more efficient. Such simplifications could reduce the price of smart meters by 50%.

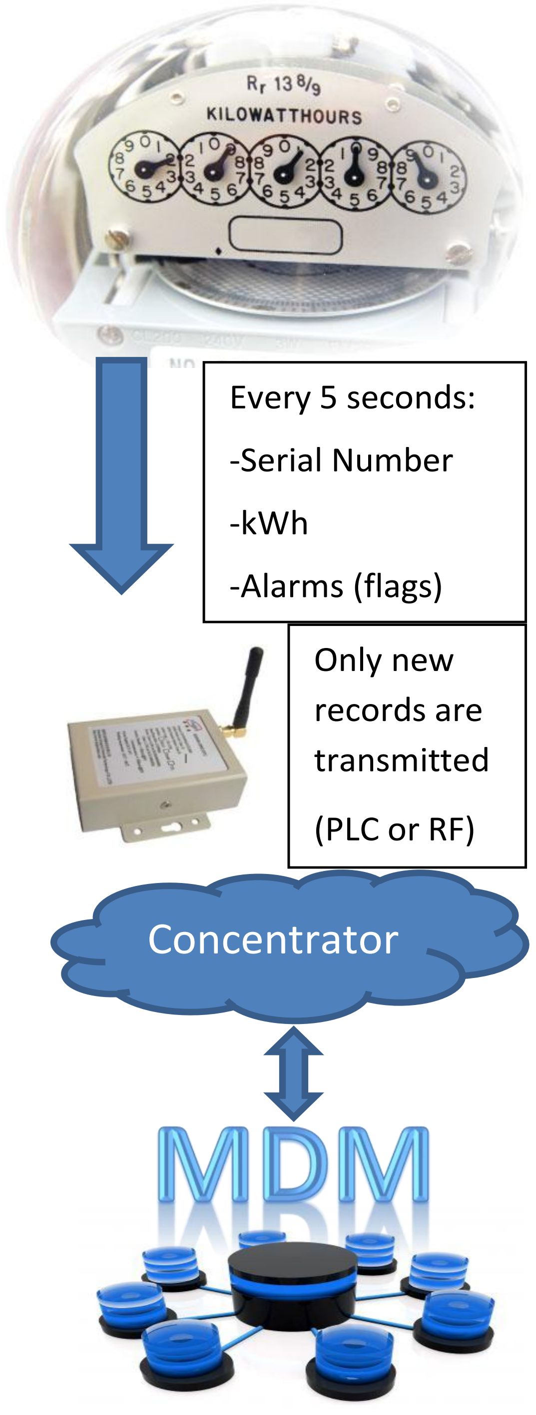

Figure 2: Architecture Diagram

With only these functions, it is evident that there is no need for a standardization of meters. Thus, the meters with only have one-way communication. Figure 2 shows this type of operation. This pattern is already in practice in Brazil and there is already a public protocol standard, where the meters send (through a serial port's) their own serial number, reading in kWh and a set of flags that identify anomalies such as alarms and voltage changes. These data is continuously sent every 5 seconds. This pattern was established in 2010 [7] and it is estimated that there are currently three million meters installed with this feature in Brazil.

To permit reading of these meters different kinds of communication are used, both for RF and PLC. In principle, any packet-based network can be used. However, the system becomes effective when the device connected to the meter reads and retransmits only new messages. That is, only when there is an increase in energy use registered or when an alarm is set off or turned off. Intelligence in this stage of processing is not necessary. This also contributes to reduction in the cost of the equipment. However, security mechanisms must be implemented in this layer. They typically use AES cryptography implemented in microcontrollers.

A set of 500 meters or more must communicate with a device hub. These should record all incoming messages in a circular buffer, adding a time stamp for each record. Certain types of alarms can be considered critical in these cases as there is a difference in treatment. Normally the system Meter Data Management (MDM) conducts periodic readings at concentrators. The interval between each reading should be sufficient to prevent an overflow in the circular buffer. In the case of critical alarms, the concentrator should generate a read request, which must occur instantaneously.

The MDM should manage the data collected. With this it is possible to trace the load curve of each consumer and identify network faults and anomalies, such as theft and fraud. Figure 3 shows an example where the comparison of five similar consumers with the occurrence of a fraud. This is a key point to help reduce non-technical losses. In certain environments, this may represent a gain in the reduction of tariffs, despite the investment required to implement the system. Additionally, the identification of gaps in the system can result in the introduction of preventive maintenance programs and consequently improvements in quality indexes.

On the other hand, if it is not feasible to reduce costs through this type of structure, one should consider the need for an external source of funds as some of the distribution companies do not have sufficient resources to provide the complete roll out of meters. However, even if there is government support for investments in smart grids, such support cannot burden consumers. Way's must be found to pay for these investments without harming distribution companies or customers.

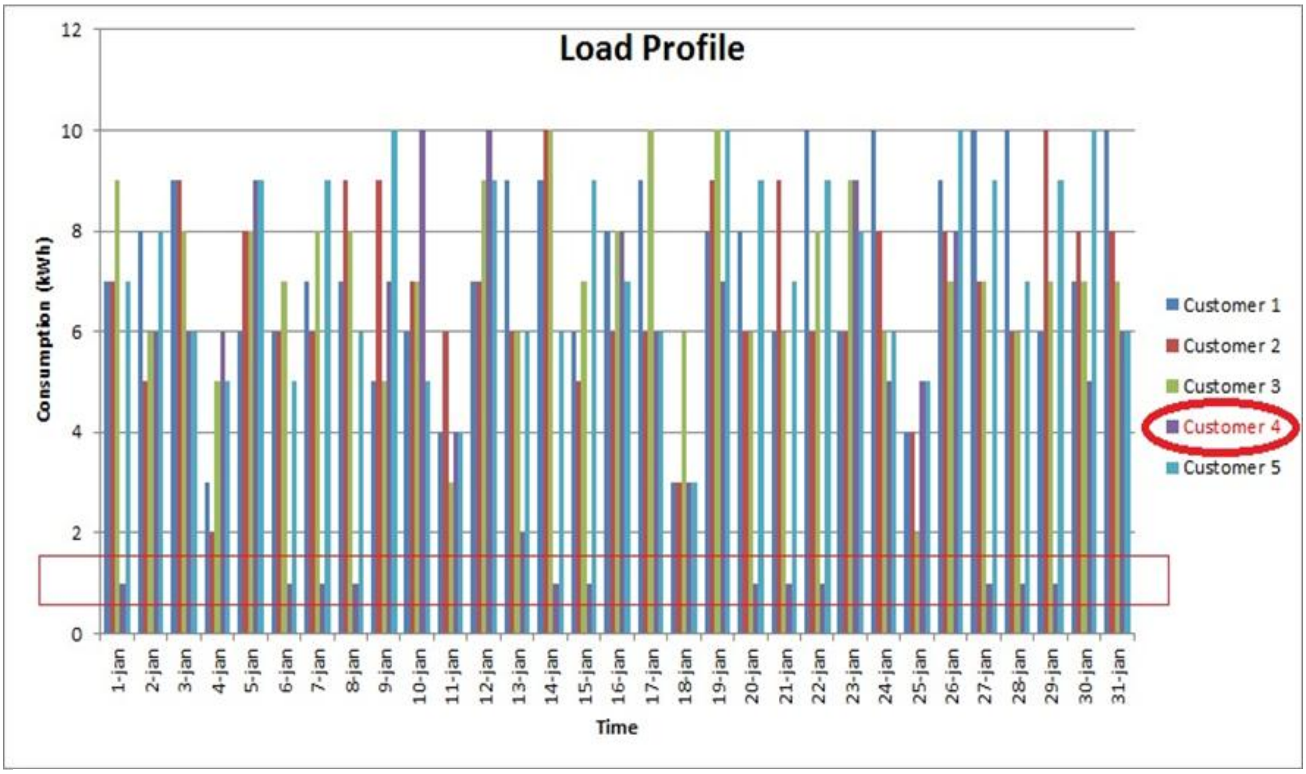

Figure 3: Load Profile - Anomaly Identification

CONCLUSION

This paper demonstrates that a massive replacement of meters is not viable in the Brazilian power distribution market. This is due to the compensation model of investments and the fact that the power consumption in low voltage segments is relatively low. A proposal to solve this problem is to reduce the costs of replacement meters. This would only be possible by reducing certain features. However, this simplification cannot compromise the objectives expected (the reduction of losses and the improvement in the quality of supply). The structure outlined in this paper meets these requirements.
Currently Brazil is demanding the reduction in energy tariffs as a tool to spur economic development. In this context, smart grids should include solutions that assist in this reduction.

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