Smart Grid implementation in developing countries: analysis focussing consumer behaviour, markets and regulation

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ABSTRACT

The objectives of this work were the organization of future scenarios for the electric power sector considering smart grid mainly in the so-called emerging countries, where Brazil is pointed. This will shed light on the regional diversity of consumer behaviour, including considerations about the current Brazilian electricity market arrangement as well as the energy matrix, the climate and local resources conditions. Issues are presented concerning the transmission and distribution grids, and the role of customer participation into the process, as a conscious consumer and also a co-generator. Also, initial regulatory actions that are being discussed in the country concerning the measurement and quality of electric power monitoring are presented. Additionally, some models are proposed as consumers' market segmentation, along with the cultural/operational changes from usage until the billing of new services could be provided and the client recognized as decision maker into this evolutionary scenario.

KEYWORDS

Smart grid, client, regulation, culture, energy efficiency, Regulatory and legislative influence, customer relationship

INTRODUCTION

We are living an historic moment int the energy provisioning market. Mainly in so-called emerging countries, where Brazil is included, there is a clear opportunity to manage the transition the process and (re) organize the business to find out emerging needs and commitments to the future. Smart grid could be the path if its complexity and intrinsic knowledge are unveiled.

Smart Grid has a role on developing new business opportunities, as technically and strategically presents itself as the renewal of the world power industry. Its positive impacts, mainly in emerging countries, may help their economic development in the near future. Following this path of changes, one can find the structural and operating conditions for the evolution of the Brazilian power grids, which, in this study, are presented as a business case. Also it represents some possibilities and issues reflecting a different reality from those in European Community as well as American markets, pointed out as references mainly concerned to their technological development, already available infrastructure, experiments and business results.

A level of commitment to an energy efficient and sustainable model will depend on a number of arrangements, such as the adequacy structure of generation and delivery, the understanding

of customers' needs and also, socio-cultural efforts to motivate the conscious use of energy. These needs should be backed by vigorous and modern designed regulation and legislation, enabling not only the presence of profitable business but also generating mechanisms for modernization the electric grid.

The need for electricity, fuels, telecommunication and water supply companies to take part in this reflects the concern with the possibilities and demands of this change, in a broad sense, involving both political and social movements. The necessary effective participation of water supply companies in the Brazilian market reflects the characteristics of the national electricity matrix and on hydroelectric generation. Differing from Europe and USA, gas companies are only now starting to take over their space in thermo electrical generation in Brazil, with a customized representation in the process and on the influence over operational treaties.

At this point, it is necessary to prove the concept, adapt models and test these models to the regional reality. The structuring of incentives and the evolution of regulating devices are fundamental to the maintenance/broadening of the energy offering, and of commitment possibilities between client-customer, dealers[1] and return on invested capital.

The objectives of this research were the organization of future scenarios for the electric power sector considering smart grid in Brazil. This will shed light on the regional diversity of consumer behaviour, including considerations about of the current Brazilian electricity market arrangement as well as the energy matrix, the climate and local resources conditions. Issues are presented concerning the transmission and distribution grids, and the role of customer participation in the process (as a conscious consumer and also a co-generator). Also, the paper presents initial regulatory actions that are being discussed in the country concerning the measurement and quality of electric power monitoring.

Additionally, some models are proposed as a market segmentation to involve Brazilian consumers, based on their current consumption and as future decision makers. We summarize the actions and decisions expected from the standpoint of regulatory and legislative, as well as business and the electricity supply industry.

THE EVOLVING ELECTRICITY MARKET

In Brazil as well as around the world, many opportunities are presented by the characteristics of current electricity grids, whose energy delivery systems [1] are almost entirely mechanical systems, with a modest usage of sensors, minimal digital communication and usually with no electronic control. Electricity companies, following the trend of other industries, must update themselves with the use of sensors, communication and computational skills to expand the overall functionality of supplying electricity, controlling and through feedback, continuously self-adjusting.

This technological gap and apparent simplicity in presenting the evolution as a change to the digital environment can be translated, however, in a multitude of possibilities, broadened by the questionings of energy usage and climate change posed by COP-16 [2]. These

[1] In Brazil, the energy business has been regulated ever since 1995 (Concessions Act – Law # 8987 from February 13th, 1995), with the market being formatted through the concession to private consortia for exploiting the market of either in electricity generation, transmission and distribution/trading. Some Brazilian regions are still served by government electricity companies due to regional low performance operation situations, which so far have made it impossible for them to be privatized. In December, 1996, Law #9427 created ANEEL (Agência Nacional de Energia Elétrica) as regulatory agency for the sector.

possibilities bring along business variables that need to be researched, and mainly, dynamically integrated in the future business moment [1]: new energy sources and electricity generation, storage, transmission, distribution, electric cars, distributed resources, distribution voltage practices, consumption, demand, and end-user commitments, reliability, energy usage optimization, mitigation of environmental impact, and also energy industries assets management, controls and costs (and return on investments). Other variables, with more subjective connotations than those presented at this moment, such as welfare user commitment and customer relationship must also be considered and listed to measure the general impact on the planning of changes.

From the EPRI smart grid concept [3], which also translates that in the digital era it is pivotal to have appropriate government and industry investments in electric infrastructure, with the consumers demanding better quality in services, more reliable energy, and unprecedented demand indexes. The development and implementation of a more robust, functional and fail-proof delivery (transmission and distribution) systems are necessary, as well as the dimensioning of the capacity and location of generation, adapted to meet the demand.

It is expected that with *Smart Grid* as an advanced system, there will be a productivity increased, with consequent repercussion in the electricity usage. At the same time, it is expected that smart grid will organize the backbone for implementing new technologies and services in the future. In Brazil and other countries under developing economies, this conscious positioning strategically assures the guarantee of necessary energy conditions for future growth that they have been preparing themselves.

Regional diversity

It is important to mention the great diversity presented in the distribution of electricity consumption in Brazil, as well as the income and cultural issues of the population, with their own regional characteristics. The consumption and the distribution of this consumption can be seen in Fig. 1 and Fig.2 as for consumption, regional electricity cost per Brazilian region (in Euros, using an exchange rate of 1 Euro=R$ 2.31, on 07.03.2011) and consumption classes. These analyses are based on ANEEL data, available at [4].

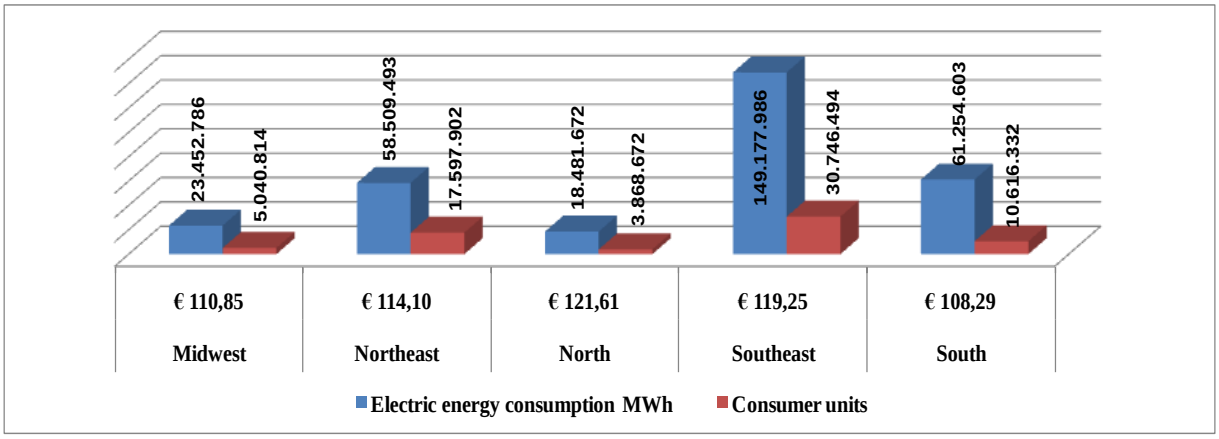

Figure 1. Regional electric consumption and costs in Brazil 2010

The overall analysis of this consumption, in 2010, also brings the singularity of income distribution considering, for example, that in the Brazilian Northeast region more than 60% domestic customers have an average monthly expenditure in electricity of less than 10 € (or around 156 KWh [4]), with obvious implications in the business structures of the regional dealers.

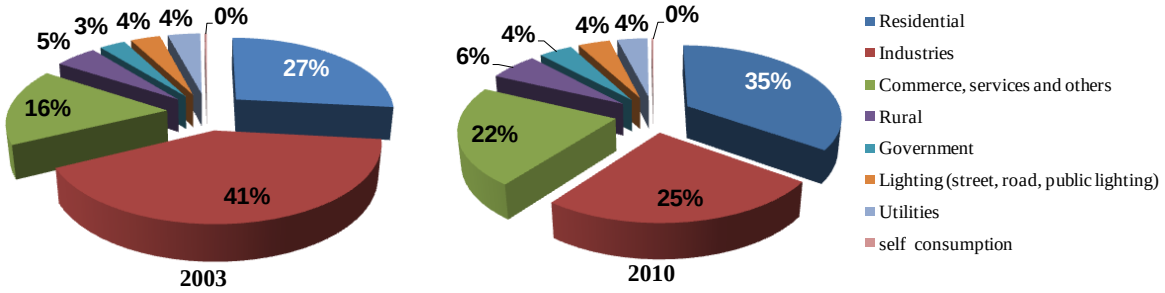

Figure 2. Electric energy consumption in Brazil (2003 and 2010)

Some additional deliberation, required from the electric energy industry, must be achieved on the current domestic consumption structure of electricity in Brazil which has increased alongside the general consumption of the productive sector, as seen in the graphic of consumption distribution from 2003 compared to 2010 in Fig. 2. An improvement in the usage of energy by the productive sector which has used its own resources for part of its energy, as well as, the enhancement in number of consumer unities deployed translate this trend in the offer of regulated energy: in 2003 there were around 52.8 million unities, that have grown in number to 68 million by the end of 2010 (residential consumer unities evolve from 44.8 million to 58.3 million respectively) [4]. The monthly average residential consumption moved from around 143 KWh in 2003 to approximately 156 KWh in 2010.

As a reference, it is worth to mention that the Brazilian GDP (Gross Domestic Product) has enhanced 216% from 2003 to 2010 [6]. Furthermore, it is important to note the Brazilian population growth from around 169.8 million in 2000 to 185.7 million Brazilians in 2010 [7], and the ongoing social changes in the country.

This consumption and growth environment needs to be understood to improve the grid and the customer relationship. Considering the grids digitization heralded by smart grid, sensing and metering represent a substantial possibility of significant change in the relationship between the distributor and the consumer, capable of assembling demand management mechanisms. However, it means an investment of high figures considering the amount of consumers that shall be assisted. These sensors/meters must be integrated through close to real-time communication system. Data must be managed through a fast simulation system and computational modeling capacity, being presented in order to empower both operators and managers.

In Brazil, although some critical components are already monitored, such as interface audit meters as well as large customers meters, the data analyses are not systematic nor in real time for all dealers. In the best of cases, when some kind of accounting science is applied to this information, this knowledge becomes sectored and used to support a business segment (such as, in the loyalty of large customers). In general, for the domestic customers in Brazil, there is no detailed information collected on the daily electricity consumption and their consequent analyses. Moreover, there is no specialization in the usage of that piece of information and the knowledge gathered from it.

Therefore, sensing, metering, data presentation, their systematic usage, simulation environment, tests, business intelligence reports, as well as electricity quality, need a business (re) organization to go through this focus. Directly, these implies in structural changes, investments, operational commitments in the scope of current activities, which are falling into obsolescence.

In the Brazilian reality, this can also imply business possibilities, such as the creation of bundled services as well as an electricity offering based on seasonal or real time prices (real time pricing [5]). This will need a new organization on tariffs regulation. Brazilian regulator ANEEL proposed this year an initial movement toward this, with 3 possible time use tariffs to residential user to be implemented soon. Real time pricing could be offered in the near future, but it is not into the Brazilian regulator priority and grid infrastructure possibility at this moment.

Broadening this monitoring and keeping the current Brazilian business model, with the registration of only monthly measurements, will incur only in costs. For positive accountancy results, the large volume of information generated must be organized into a systematic, automated system, signaling the low-demand consumers information as a guidance of the usage (for example, in order to detect theft, "leakage of electricity" or points of inefficiency). This could derive and incentive strategic change in customer relationship, with a differentiated operational dynamic.

Energy mix

A "new frontier" for the *Smart Grid* advances, this area includes integration of distributed generation, micro-generation, storage and resources side by side with demand response, as co-participants in the electric system operation. The products used by customers, such as intelligent appliances and electric vehicles, must become important components in this study area, driving the generation of renewable energies, derived from biomass, wind and solar sources. Aggregation mechanisms for distributed electricity resources must be considered. In this context, relevant issues must be brought into discussions, and incentives must be addressed by regulation and must be run into the government strategic scope.

Brazil has a long tradition in clean energy usage [8]. Yet, a large amount of it is still been developed. The recent investments in wind energy, with auctions of this kind of energy, have brought new possibilities. However, thermoelectric generation is progressively composing the Brazilian electricity mix, assuring the supply continuity due to weather and water bodies perennial flow in the hydroelectric generation. Moreover, the availability of energy resources from the pre-salt layer program, and possibilities related to technology progress with *Smart Grid*, are yet to be integrated to this sector.

The evolution predicted in the energy matrix is presented by the Brazilian Energy and Mining Ministry (MME – Ministério das Minas e Energia) in Fig. 3 [9]. The internal offering of electricity increases from 460.5 TWh in 2006 to 1,195 TWh in 2030 – a growth of 4.1% per year, with great presence of renewable sources (81%). The generation by hydraulic energy and oil derivates decreases in relative terms. The generation by natural gas and biomass presents a significant relative growth, followed by nuclear and coal generation. From this forecast of growth in consumption/demand, issues such as usage efficiency, awareness in consumption, and losses control in the sector might be very relevant to ensure operational future.

This may have future influences in the supply composition. A new research and planning for the composition of the model and energetic mix are in process in the new Brazilian reality after 2008 suggesting subsidy and orientations from the government recognizing the future energetic scenario as a basis for the country development. The change is to be gradual and not of sudden transformation, according to DOE [10] and ETP [11]. This analysis item will directly influence the Brazilian regulatory entity.

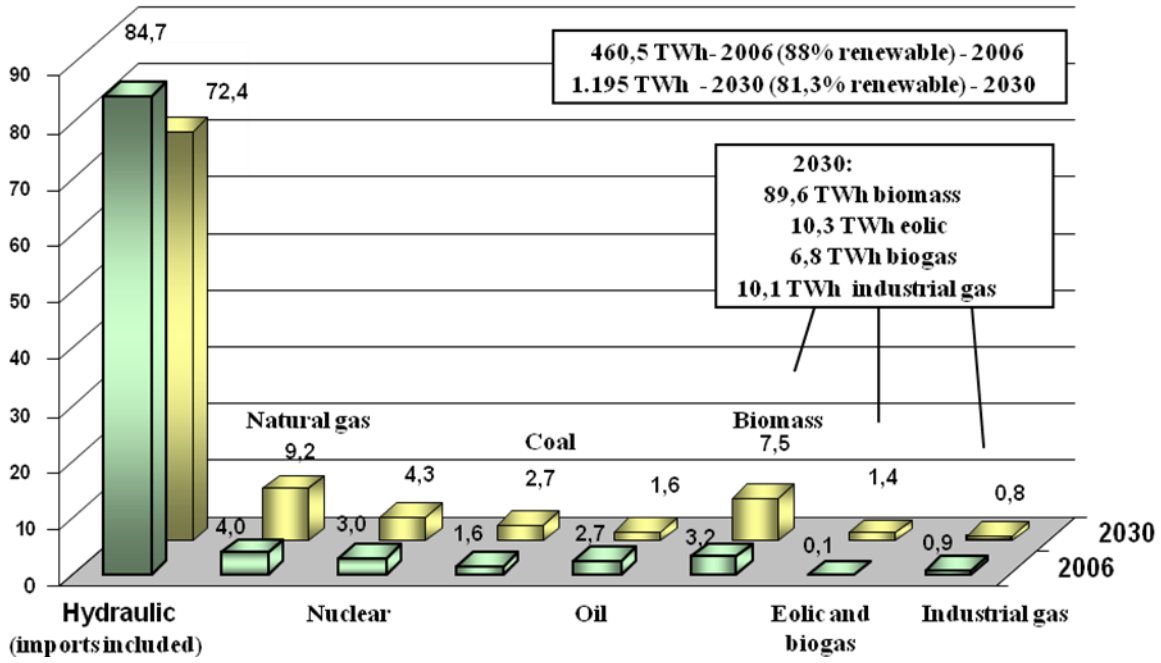

Figure 3 – Internal offering of electricity 2006-2030 (%) – source (MME, 2011 [9])

Climate

The emission of greenhouse effect gases day by day becomes one of the most relevant matters in the worldwide growing concern about the global climate changes, especially the global warm [2]. In this matter, according to MME [8], Brazil has stood out presenting lower emission indexes compared to the rest of the world. Essentially, this is due to the elevated percentage participation of renewing sources of energy in the Brazilian[2] energetic matrix responsible for 44.5% of the internal energy offer in the country in 2005.

According to 2007 forecast for the 2030 scenario, there will be intense evolution growth of the total primary energy consumption in Brazil [8]. Albeit, this intense expansion the growth rate of energy demand is gradually minor to the GDP rate. New scenarios, however, are been prepared due to the great movement in the world economy after 2008 that has enhanced the production, the worldwide Brazilian participation and that result in new energetic paradigms. Indeed, the emissions of CO_2 expected are a lightly more than 770 million tons in 2030, with an annual average rate of 3.5% over 2005, while the energy demand grows 3.8% per year.

The evolution of the profile of primary energy consumption implies distinct growth rates of the total CO_2 emission. Indeed, to the renewing sources of energy (derived from sugar cane, forest firewood and charcoal) it is associated null (liquid) contribution to these emissions. Therefore, petrol byproducts are the greatest contributors to the total emissions in the end of the horizon – approx. 58% of the total. Notwithstanding, natural gas presents smaller emissions factors than the other fossil fuels, it might expand its contribution to approx. 21% of the total in 2030, because of the greater penetration in industry, as well as electricity generation. The expansion of steelworks activity in the country and by coal thermoelectric plants which increase the consumption of charcoal and byproducts will make this energetic responsible for 18% of the total CO_2 emissions by 2030 [8].

[2] The participation includes power generation from hydraulic energy, crushed sugar cane, and wind power farms, the use of automotive ethanol in the transport sector and of the charcoal in the steel industry

Transmission and distribution grids

Brazil's power generation production and transmission system is considered unique worldwide due to its size and features. It is a large hydrothermal system, with a vast number of hydroelectric power plants and multiple owners. The National Interconnection System (SIN) is made up of companies from South, Southeast, Center-west, Northeast and part of North region. Only 3.4% of the capacity of electric production in the country is out of SIN, in small isolated systems mainly located in the Amazon region [12]. Though being very efficacious in transmission organization, Brazil faced several blackouts in 2010 due to multiple cause failure situations. The system is in constant evolution and the endeavor to the regulation in the construction of this organizational pattern of energy warrants offer and the search for stability for the Brazilian grid of electrical energy should be acknowledged.

The electric energy distributors are in charge of the connection and assistance to the consumer, regardless of their size. Besides, the rural electrification cooperatives, small entities transmit and distribute electric energy exclusively to their associates. ANEEL has listed 39 of such cooperatives which are spread all over the various regions of the country and assist small communities [13]. The electricity energy distribution market is made of 72 concessionaires, which are in charge of assisting over 68 million of consumption unities. The controlling shareholding of such companies may be either governmental or private [13].

The horizon presented by the legal and regulating challenges from smart grid on could alter the rate and the way the grids will be operated within the Brazilian market. It could also respond to questions and stimulus to energy preservation investments, as well as organize these investments in order to guarantee the transition from this current technological obsolescence phase.

Moreover, it could provide the appropriate conditions for a differentiated operation that can also care about the more accelerated physical obsolescence of the energy companies' assets with the digital equipments and the grid intelligent management, and likewise with shorter lifespan of the assets compared to the electromagnetic environment currently in operation. Customer/client service must also be developed and differentiated.

Quality indicators

One polemic issue in the guidelines from the Brazilian regulatory agency (ANEEL) is associated to the models organization that figure out the delivered energy quality and the indicators reliability that show operational performance of the systems and their interfaces. These guidelines are presented in the models proposed for the reference company in the electric sector and in public referendum for the electronic meters [14, 15]. It is expected to reach the offering of services guided by levels (SLA – *Service Level Agreement*), such as in the telecommunication market.

The near horizon (until 2020) signals the exchange of more than 68 million meters in Brazil, migrating to electronic metering technology, and if possible, intelligent and into a smart communication grid. It will seek to update the installed metering devices and the entire measuring system, as well as improve electricity supply quality, reducing operational costs for distributors, fighting the losses and aiming towards energy efficiency [15]. The amount of contributions received by the regulatory agency ANEEL in the public consultation ending in January, 2011, reflect the involved interests, as well as ran the minimum requirements for new device and grids improvement, from communications and systems, as well as exposing the need to organize the implementation in order to ensure the effectiveness sought.

The establishment of commitments is questioned concerning to implementation, tariffs and incentive conditions to be granted that the costs of this process could be feasible in the current dealer regulation structure and also to the customers. The vendors have being mobilized to supply devices and systems. Those should validate the requirements of inter-operability, standardized interfaces, and certified by Brazilian measurement entities, following standards that are also under analysis.

CUSTOMER PARTICIPATION – CONSCIOUS CONSUMER

Research already conducted in the USA [16], although the energy usage pattern could be different from the Brazilian one, bring some relevant issues on the apprehensions of adopting technology, like ineffectiveness of making excessive information available on consumption, control mechanisms, and mainly, on the persistence of consumption reduction habits improving efficiency in usage. This learning is relevant, in that it develops pro-active attitudes in campaigns that need to be made for a change on electricity usage and population education paradigms in a commitment to Earth, according to COP-16 [2].

In the Smart Grid concept, the analysis is widened with the questioning whether this modernization and natural obsolescence can reflect on the energy efficiency and on the return on investments in the future. In this space, variables and costs must be analyzed, such as: amount of meters to be exchanged, their capacity to export information, communication and safety available information, as well as integration and standardization by multiple suppliers. It brings to light the commercial interests of meters vendors, the concern associated to the demand increase and nation meeting the present and future needs. It also shows the need for strategic analysis, customer segmentation, and building strength indicators that represent the decision-making/results in the change process and the commitment of the customer and the broadening of the feeling on the electricity delivered value.

Incentives must be implemented to best practices and regulatory guidance, mainly for the regions or sub regions with low-consumption customers and social commitment, seeking a cultural change, as well as control high default or electricity deviation. Actions to make this consumption more efficient, and the understanding of the specific regional needs, may guarantee the breaking of the historic cycle regulation-cost-default-cut-theft. The creation of income conditions and the broadening of the feeling on electricity value, respecting commitments and rights, are very important to minimize these issues that are both social and cultural in nature.

Business Models - Market segmentation

This new millennium business vision applied to the electricity sector glimpsed through smart grid translates the concept that the new electricity energy business may go farther than the general reference of been a commodity, according to Kotler [17]. It indicates that the pathway to follow necessarily goes by the broadening of the value perceived by the client of the product/service offered. An understanding must be warranted of the difference of provisioning and an effective support for the use of products/services offered. The enormous possibilities (and difficulties) on the capillarity of the current energy grids must be recognized, as well as on the limitations and costs of service, the energy quality, and of the needs and demands of the client in this new environment. The availability of services and the "demand generation" for new services will necessarily go through brand recognition with services and products. It generates the difference between the services offered to a consumer and the client relationship, considering his/her particular needs. The focus on bulk action necessarily changes to segmentation and directed offering.

According to ANEEL, in its Normative Resolution 414 [18], an initial and natural segmentation comes from the one made to organize the energy offer in Brazil: large consumers (group A - unities that provide in voltage equal or superior to 2,3 kV, or assisted from underground system in secondary voltage) and others (group B, subdivided into residential, rural, further classes and public lightening).

Considering the macro groups presented, the aim was to highlight the relevant service characteristics for each one of them. An analysis and proposition of additional segmentation was especially done for the residential client, according to their specific characteristics and Brazilian market determinants. This segmentation aimed to present a way to foster questioning about the operation strategy of the energy companies in their amplified relationship with smart grid. Simultaneously it should facilitate the construction of cost hypotheses and of customized services offer. It is registered and resumed a vision of actions, marketing, strategies, infrastructure, relationship and the application structure of smart grid that should be executed.

But the regional dealers will have their own strategy to implement their smart grid infrastructure based on, for instance, the regional reality or local goal, this proposal incremental approach is already concerned with R&D segmentation done by their staff to find out electricity deviation and profit recovery.

Segment Group A (captive and wholesale customers). The amount of clients in this group is around 1% (or less) of the clients of each energy distribution company and can represent over 60% of its distributed energy. The offer of services and aggregated value to these clients profile inherently brings the recognition of the quality of the delivered energy, the follow up of the consumption and demand planning. Ordinarily, these clients have their own team to control the delivered energy, whose technical understanding is dedicated to their needs. To such clients, the energy is relevant to their products costs composition. Usually there are requirements as the quality of the delivered energy, but they can be reference as new tools and solutions users.

The after-sales dissatisfaction presented by Ana Silva [19] represents a business opportunity in service and operational reorganization, in relationship and in the creation of loyalty. New services may be structured through a special research to understand the needs and organization for customized and specialized services. There are some services characteristics required by the large customer, such as the availability of effective real time information about their consumption and about the energy. Such issues as rigidity in the negotiations, low energy quality and inadequate after-sales service, indicated in the research presented by Dr. Silva, render how this energetic transition moment should involve operational and business changes.

As to structure, these clients are geographically isolated; however, investments on communication and on digital methods and systems for *on line* follow up (as close as possible to real time) should offer the appropriate evaluating and controlling conditions, which enables the creation of a value added relationship.

Segment Group B (commercial and industrial). This group could be subdivided in different offers for each productive sector represented and according to the usage characteristics, demand and explicit need of the quality of the delivered energy.

Services and products offer to this segment must follow the customized Brazilian regional

characteristics, the amount of clients and, always understanding the necessities and expectations of energy usage, looking for a loyalty relationship to the brand, with effective after-sale and recognition of the singleness and relevance in the attendance.

Considering the amount of clients in this macro segment, analytical systems must be structured to mining clients presenting low consumption, as well as to establish performance indicators and energy usage skill manage: tools for the evaluation of consumption profile by productive sector must be implemented, for instance, the possible seasonality and generating individual limit warnings to guarantee the operation and the financial returns efficacy. Changes in cultural patterns and value of energy usage must be established, through an effective communication concerning the technological switch-over accomplished thorough detailed consumption reports, guarantying total transparence.

These clients may be geographically and structurally concentrated (as in shopping malls and industrial districts in large cities). Energetic efficiency application should be offered with great results within the Brazilian actuality, and it could generate the operational conditions for the return of investments on communication, IT and smart grid infrastructures. A systematic supervision of these clients can also bring financial return, considering the energy control of losses.

Segment Group B productive rural customers. It presents typical characteristics and seasonality usage based on regional production, climate and implanted mechanization. Several issues, such as the difficulties and cost for the implementation of an effective communication with data collection and measuring system, must be characterized and technological special solutions studied to supply the prospective long distances between the client and the energy company operations center. The organization for the structural changes and the technological engagement of the clients within this segment must be established.

Segment Group B residential. This segment presents very different regional and cultural characteristics. It represented about 58.3 millions of consumer unities in 2010, that is, 85% of the clients' portfolio of the Brazilian energy distribution companies [4].

Some regional and strategic issues linked to the understanding of this segment in Brazil must be recognized, such as: in the north and northeast regions of Brazil, the low consumption clients represent over then 60% of the concessionaires clients portfolio (consumption inferior to 120 KWh/month whose family income does not guarantee the payment of the normal energy services fees). Therefore, governmental assistance, incoming generation and a strategic-operational customized treatment must be pursued, aiming to guarantee an evolution, in the usage regulation, accomplishing recognition of the energy value by these clients. They are very sensitive to the unknown, to the lack of information and to the duty that might result from the regulation of their energy use (theft and lack of metering). There must be a great educational and transparent campaign in the service offered to these clients in order to generate positive results to all. For such care to become effective to this public, it must be done under regulation.

Table 1 organizing a proposal segmentation, depicts the main issues in the service skill for Brazilian domestic electricity market. A great challenge the dealers must still overcome in this new paradigm of decisions, strategies and investments is the creation of products and solutions with focus on the client, in each of the segments or sub-segments presented with an enlarged vision of the business and opportunities, as well as the segment profile.

Table 1. Proposal segmentation model with smart grid for Brazilian domestic clients

	Consumption characteristics	Smart grid service characteristics	Products, services and commitments to be organized
Vertical urban area	Large and medium consumption	• Vertical (apartments) • Concentrated smart grid equipment and communication • Building and residential efficiency • Collective, familiar, social and worldwide awareness	• Warnings and detailed demonstratives • Usage efficiency (habits and equipments) • Collective and familial decision • Co-responsibility in success
Vertical urban area	Low consumption (inferior to 200KWh/month)	• Vertical (apartments) • Concentrated smart grid equipment and communication • Building and residential efficiency • Collective, familiar, social awareness	• Warnings and detailed demonstratives • Usage efficiency (habits) • Thefts and awareness • Collective decision • Institutional image
Horizontal urban area	Large and medium consumption	• Horizontal (houses and condominiums) • Scattered smart grid equipment and communication • Residential and condominiums efficiency • Collective, familiar and worldwide awareness	• Warnings and detailed demonstratives • Usage efficiency (habits and equipments) • Storage and co-generation • Familial and condominium decision • Co-responsibility in success
Suburb	Large and medium consumption	• Horizontal • Scattered smart grid equipment and communication • Residential efficiency • Collective, familiar and worldwide awareness	• Warnings and detailed demonstratives • Usage efficiency (habits and equipments) • Storage and co-generation • Familial decision • Co-responsibility in success
Suburb	Low consumption	• Horizontal • Scattered smart grid equipment and communication • Residential efficiency • Collective, familiar and social awareness • School and community campaigns	• Warnings and comprehensive demonstratives • Usage efficiency (habits) • Community decision • Thefts, default and awareness • Institutional Image
Rural residential	All consumption	• Horizontal • Scattered smart grid equipment and communication • Residential efficiency • School and community campaign • Ecological and familial awareness	• Warnings and comprehensive demonstratives • Familial decision • Usage efficiency (habits and equipments • Co-responsibility in success • Storage and co-generation • Institutional image
Slums	Low consumption	• Horizontal • Scattered smart grid equipment and communication • Residential efficiency (current governmental and controlling support) • Collective, familiar and social awareness • School and community campaign	• Warnings and comprehensive demonstratives • Usage efficiency (habits) • Community decision • Income generation and e sustainability • Thefts, default and awareness • Institutional image

The learning on the transparency and efficacy of a precise communication is known to most Brazilian dealers in its liaison with customers, mainly with those of low purchasing power, in risk areas, and in attempts to change cultural and consumption patterns. Conflict cases between customers and electricity providers that are media broadcasted are references to create more transparent models involving a regionalized and differentiated didactic. Continuity in the involvement of education in schools, in forming new influencers, will be very important in the times of technological transition.

Brazilian governmental programs such as PROCEL[3], implemented in the scope a number of actions aiming to combat waste and support electricity efficiency, must be reviewed in their form and dynamism, to ensure more appropriated information with changes of behavior and awareness in the usage of energy, not only in the changes in the Brazilian electricity scenario, but also to the rights and obligations of customers.

The regulation of responsibilities and requirements in future offerings, as well as incentives in the execution of projects and implementation of advanced metering solutions, evaluation of electricity quality, remote control of equipment is currently in the scope of research and innovation projects by the Brazilian dealers and regulatory agencies. There are some experiments collectively called Brazilian Smart Cities, presented and recognized by ANEEL as R&D projects by regional electricity dealers as CEMIG for the city of Sete Lagoas, MG [20] and by Eletrobrás for Parintins, AM [21].

It is important to highlight, along with the cultural/operational changes from usage until the billing of services provided, the issues related to the investments needed and the economic environment for the acquisition of technology related to *Smart Grid* implementation progress.

Connectivity (broadened) empowerment for consumers and tariff model

All the prior functionalities are reflected on the end user care, recognized as the relationship on the customer point of view. This broadened view directly shows on the offering of connected services to the electricity delivery. For example could be pointed additional information for billing and real-time pricing, according to criteria established depending on the demand and load shape objectives, evaluation started by ANEEL [22], value-added services (such as safety and monitoring applications), and services involving the existing or added electricity infrastructure, established by *Smart Grid* implementation (such as internet and data communication services).

It is intentional in the evolution of the Brazilian tariff model [22], several changes in the form of dividing the tariff components among the several users of the system. This shall cause specific tariff variations for each customer, depending on the group/sub-group/tariff category of the consumer, its consumption profile, as well as tariff flags creation and the dealer tariff value (tariffs are pre established and periodically reviewed by the regulator based on the dealer performance). These flags must be extended to all the low-consumption customers (domestic and others), with signals in three time points: at the peak, intermediary, and out of the peak. Its implementation and viability are conditioned to the implementation of electronic meters (substitution of current electro-mechanic by electronic ones that allow the registration and differentiation of consumption by hours in a day). According to the agency, this change must not involve other expenses to consumers.

[3] PROCEL – Programa Nacional de Conservação de Energia Elétrica, Intergovernmental Act # 1.877, from December, 30, 1985, is the seeds of Brazilian electricity conservation and efficiency programs.

This discussion is also under regulation and must provide the conditions for the necessary evolution at the onset of structural changes for the smart grid. It is also true that if the consumer is elected and respected as the decision maker in the process, new horizons will be conquered because of the smart arrangement of the grid and of the "new" business.

Business and electricity supply industry standpoint summary

In Brazil, the transmission grids are unbundled although lines and connectivity to generation plants are privatized, in most cases. The energy distribution and retail companies retain all the responsibility for the grids, for the delivery of energy quality to the end client/consumer and for the meters. With smart grid, the amplified communication responsibility with the measuring terminal to as much as 68 millions of consumers may overtax or compel the local industry, generating jobs and related development. Such aimed effects may launch, promote and reinforce the development of the country as a goal for the current government staff.

One must evaluate the business cases aspects, as well as quantify the intangible benefits in the implanting movement. The pilot projects must be used to identify the likely benefits, to be multi-departmental and multifaceted as to business, exhaustively using all the entrepreneurial verticality, from HR to Marketing, engineering, big clients and low consumption clients, billing, IT, telecommunication, infrastructure and assets control.

Co-generation is another important point to be studied closed to the Brazilian customer capacity to acquire and maintain some source of energy in Brazil. Some initial lights are shining mainly with rural photovoltaic and wind generation (and national technology availability), but the grids and operation are not already prepared to the double direction energy flow. Cooperation on generation and electricity usage by groups are R&D.

Generation distribution and grid interconnection as well as (hybrid) electric vehicle charge are other interesting subjects under huge analysis by the government and energy industry.

There must be extreme proximity and synergy with the regulating organs during the tests, while one assures total transparence throughout the way, and permits positive influence on the future organization of the policy to be established. Along this way the client never can be forgot!

CONCLUSION

Smart Grid includes in its approach a concept of organization, systematization, automation and search for quality in the offering, management, dealing and commitment with the consumer (now considered as a non-commodity client), as well as (re) think the electricity and development space into emerging economic powers countries. It is based on existing technologies and/or new solutions, on regulations, measurement methods, and business rules that guarantee the offering and rights, with the commitment of investments from dealers and service providers. Issues such as generation, co-generation, safety in information from customers and information systems, network sensing and self-recovery have always been very relevant. New products and services come along. The acknowledgement of the huge importance of communications and information technology is pivotal and brings along joint business opportunities in the offering of telecommunication services as another opportunity.

This paper sought to present scenarios and issues that represent the demand for regulatory appropriateness and for understanding the relations of offering-demand-commitment of/with clients. It also sought to not create false expectation of simplicity on the implementation or minimizing the need for a systemic and broad view in this new paradigm.

The Brazilian domestic customer has cultural and historical regional characteristics so as to their commitment in the usage of electricity and in acknowledging its rights and obligations with the electricity distribution dealers. Changes for a scenario of effective usage and recognition of participation from clients as major players must be made in a different way along the country. Incentives and educational programs must be created/modified to extend the cooperation with the process, in the efficiency facet, in the usage of networks, as buyers of services and other added services, as well as enabling their positioning as micro-generator.

The social differences are marked in each Brazilian region, as well as the form of electricity consumption, which should characterize distinct actions segmented by social and consumption class in the guidelines to be implemented. The fundamental point, however, as already experienced in Brazil and in international tests, is that appropriate communication be made, involving the client as co-participant in every action to be taken.

The evolution of the electricity business is not presented as a possibility in this analysis. It is indeed a course of action that must be accomplished. Its non implementation can generate a complete inconsistency with the needs of the countries, considering the current obsolescence, the trends and adhesion to the global sustainability pact. The governmental strategies must show the dynamic of the relationships in the regulation scenario, promoting and seeking results for a new business model reflecting and guiding actions that contemplate regional nuances and aggregate the customer.

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