Smart Grid will be a Reality. For Developing Countries, Energetic Matrix, Socio-cultural Issues, Regulatory and Local Development Shaping Outcomes, Incomes and Feasibility Efficiency Awareness

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Abstract:

We are living in a historical moment in the energy provisioning market. Mainly in the so-called emerging countries, Brazil is included, there is an opportunity to transfer the management and (re)organize the business to establish the current needs and commitments for the future. This level of commitment to an energy-efficient and sustainable model depends on a number of arrangements, such as the adequacy of generation and delivery, understanding customers' needs and also socio-cultural measurements built to motivate conscious use. These needs should be supported by vigorous and modern regulation and legislation, enabling not only profitability but also generating mechanisms for monitoring and evolving the electric grid, and thus, the quality of use. The objectives of this research are to organize possible future scenarios for the electric power with smart grid in Brazil as a study case. This will shed more light on the regional diversity of consumer behavior, including considerations about the current Brazilian electricity market arrangement as well as energetic matrix, the climate influence and local resource conditions, the transmission and distribution grids, and even on the extension of customer participation in the process (as a conscious consumer to co-generator). We summarize the actions and decisions expected from the standpoint of regulatory and legislative departments, as well as businesses and the electricity supply industry. The paper ends with the presentation of 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 market segmentation to involve Brazilian consumers, based on their form of current consumption as future decision makers.

Keywords:

Energy Efficiency, Client, Culture, Regulation, Smart Grid.

1. Introduction

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 reflexes, mainly in emerging countries, should and can guarantee the presence of these countries as economic powers in the near future, or reverse their tendencies towards development. 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, and represent possibilities and issues reflecting a different reality from those in European, American and Japanese markets.

Thus, knowledge of the structures guiding the business must be investigated and organized, not only in Brazil, but also worldwide, from the generation until the effective delivery of electricity to the customer/ end user. This paper also sought to analyze a more effective participation of this new agent, the customer, who can also be a generator and active participant in the electric grid.

A wider offer, with the availability of associated resources/services, must go through a cultural change in relationships and a sharing of commitments, as well as being regulated and incentivized to present public benefits associated to this new setting. A new perspective of regulating entities must be established in order to start the transformation process proposed by *smart grid* and to validate the transition of a network in obsolescence into a controlled, controllable and guaranteed business space for all stakeholders.

The global historical moment is one of uncertainties, of reference research and of results, and, for some, if possible, to prepare guidelines for this (re)evolution on the energy business structure.

The need for electricity, fuels, telecommunications 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, USA and Japan, gas companies are only now starting to take over their space in thermo electrical generation in Brazil, with a differentiated 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 regional reality. Due to the large social and cultural diversity, the great territorial extent and the differentiated demand for energy by region, this adaptation is of utmost importance. This is necessary as both an opportunity and a challenge in the adhesion to the efficiency and updating of energy business structures. Offerings of new energy sources, new technologies, new service possibilities and different pricing should be carefully studied. 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 objective of this study is to infer the consequences of not putting it into effect, in the long term, using concepts involved in the new energy business, presented from a perspective of possible short and mid-term change for the market. The paper seeks to outline *Smart Grid* applicability conditions in the reality of electricity dealers in Brazil, creating possible strategic milestones for the onset of implementation, starting from the greatest problem or best effects on the business of these dealers. Discussions are extended into the territory of regulation, reinforcing the need for regulatory and even legislative action to promote and conduct the change process in an organized manner, recognizing Brazilian national reality and international experiences.

The methodology employed uses comparative international studies including the analyses of Brazilian regulatory mechanisms, organizing a knowledge database in order to build a reference framework for the theme.

In consonance with the theme, the relationship with the regional client is presented as the basis for regulating service supply. Thus, new regulations involving the electrical and telecommunication industries must develop an anchor role, and be used as guidelines for the developing of *Smart Grid* in economic and industrial relationships guiding the development of this sector in the country.

2. Smart Grid promotes Electricity Industry development

[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 regulating agency for the sector.

Many opportunities are presented by the characteristics of current electricity grids, whose energy delivery systems [1] are almost entirely a mechanical system, with a modest usage of sensors, minimal electronic 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 poised by COP-16 [2]. These 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 (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.

The Smart Grid concept used in this paper is the one according to EPRI [3]:

> *"The term Smart Grid may be best understood as the overlaying of a unified communications and control system on the existing power delivery infrastructure to provide the right information to the right entity (e.g. end-use devices, T&D (Transmission & Distribution) system controls, customers, etc.) at the right time to take the right action. It is a system that optimizes power supply and delivery, minimizes losses, is self healing, and enables next-generation energy efficiency and demand response applications.*
>
> *Smart Grid encompassing three elements:*
>
> - *Transitioning the grid from a radial system to a true network to ensure connectivity from generation sources to end-use customers;*
> - *Converting from an electro-mechanical to a fully digital system to support information and automation-enabled assets; and*
> - *Enabling two-way communication within the grid community so that customers can, if they choose, move from passive to active participation in the marketplace.*
>
> *A Smart Grid entails an open standard for communications with devices – both T&D and end use devices – advanced metering infrastructure (AMI), two-way communications between a utility and its customers, and smart interconnections to distributed energy resources."*

From this concept, 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) system 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 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.

2.1. Internationally adopted actions for a conscious *Smart Grid* implementation

Some actions and samples are presented herein on the implementation of *Smart Grids*. These data were internationally collected, from projects and results of actions to promote grids development and business intelligence. Certain interest points are highlighted and should be used as reference for a Brazilian new electricity business modeling:

- **United Kingdom:** the British structure to customer choice, with implementation of intelligence for the electricity offering as a free market (where the customer could elect its energy supplier), places England one step ahead in the restructuring of the energy business [4]. Their energetic mix, the conception of sensing into their grids, their customer care and services associated offerings, yield an apparatus that should allow, without traumas, the (re) evolution of their electricity services and transition to *Smart Grid*. They still discussing this subject. Consumers will expect to have a choice of tools for viewing and managing home energy use. It is worth mentioning that the British Parliament passed in July, 2009 [5], ruling to apply *smart metering* until 2020 by the gas and electricity companies, who must provide the whole communication network needed. In the English model, the cost and acquisition of meters are customer responsibility;
- **Japan:** the country has a well-designed plan, which is being applied, for the efficiency of equipment, appliances, household gadgets, buildings, transport and industrial production, with established targets and regulations [6] and [7];
- **United States:** several incentives can be mentioned for the promotion of Smart Grid, such as one of the first acts of the current US President (Mr. Barack Obama), with a package of US$ 4.5 billion in direct expenses to update the electricity network with *Smart Grid* technology [8].

  There are several test fields for the *Smart Grid* concepts, and these must be evaluated in their achievements and as learning centers. One of these centers is the city of Boulder, in Colorado (USA) [9] where the Xcel Energy consortium has been testing mechanisms to increase the usage of energy. Traditional and emerging forms of electricity on site generation are being evaluated in some residences in order to verify the efficiency of this type of grid improvement [10].
- **European Community:** several projects have been implemented, as tests and even in national levels [11]. Special attention must be given to the ENEL business group project, which performed the exchange of approximately 32 million meters in Italy, implementing the smart metering apparatus, with proven financial and structural results [12].

Thus, the complex global scenario with Smart Grid insertion is being quickly developed. Starting from the facts or probable tendencies, this study essays evolutionary proposals to electricity market into developing economies, with the initial consideration of taking into account relevant points, without the intention, however, of been exhaustive and analyses all possibilities and requirements.

2.2. Functional Structure of a Smart Grid Operation

Smart Grid must use digital technology for better reliability, safety and efficiency of the electrical system. Due to the large number of technologies involved and their many perspectives of usage, it could be applied within areas throughout the electric system, related to optimization and operational dynamics of the system, maintenance and planning. This can be summarized in

Fig. ***1***, which offers an overview of the several aspects in the electric system in the concern framework for Smart Grid [10]. It is worth mentioning once again that the interfaces between the elements within each area must be considered, as well as the systemic issues that extrapolate the areas presented.

Considering the current stage of the electricity companies, mainly in Brazil, since the basic concept of its distribution grids to the operational organization of its business through billing, many changes, systems and cultural transformations should be pointed to a systemic and broad application of *Smart Grid.* Some functionalities and commitments are highlighted, which can be grouped as:

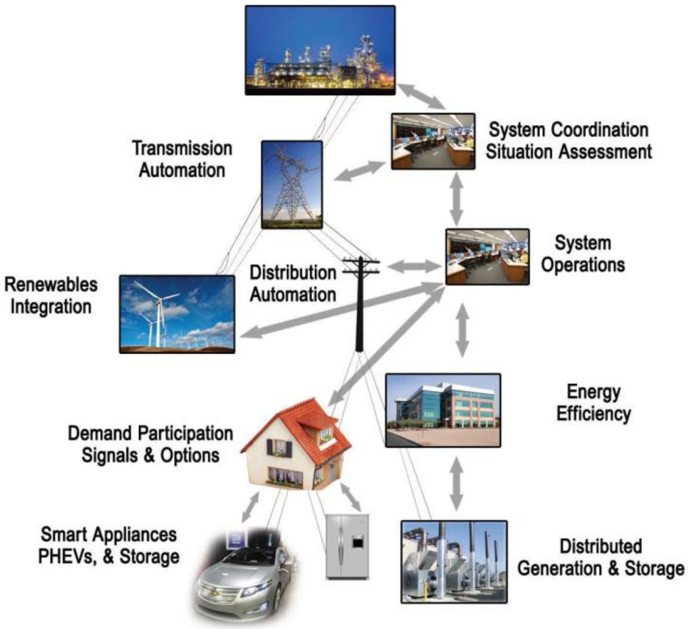

Fig. 1. Scope of smart grid concerns (source: (DOE,2009)[10]))

- **Visualization of real time energy system:** the grid sensing is a relevant item for the electricity system, broadening the knowledge over the grid and critical components. These sensors must be integrated through a 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.

  Sensing, 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* [13]). This will need a new organization on tariffs regulation.

  In Brazil, although some critical components are already monitored, such as interface and 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 free (large) customers, those who can chose the structure of its supply, due to its high consumption).

  In a general way, for the domestic customers, there is no information available in Brazil on the daily usage of electricity and their consequent analyses. Moreover, there is no specialization in the usage of that piece of information and the knowledge gathered from it.

  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 to efficiency). This could derive and incentive strategic change in customer relationship, with a differentiated operational dynamic.

It may seem obvious that there will be a short-term return on the investment made in sensing, mainly in regions where there is high default or electricity deviation. Although, this action must involve two subjective and relationship items: 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. Actions to make this consumption more efficient, and the understanding of the specific regional needs, may guarantee the breaking of the cycle regulation-cost-default-cut-theft. The creation of income conditions and the broadening of the feeling on electricity value, respecting both commitments and rights, are very important to minimize these issues that are both social and cultural in nature.

It is important to mention the great diversity presented in the distribution of electricity consumption in Brazil, as well as the income distribution and cultural issues of the population, with their own regional characteristics. The consumption and the distribution of this consumption can be seen in Fig. 2 and Fig.3 as for consumption, electricity cost (in Euros, using an exchange rate of 1 Euro=R$ 2.31, on 07.03.2011) and consumption classes.

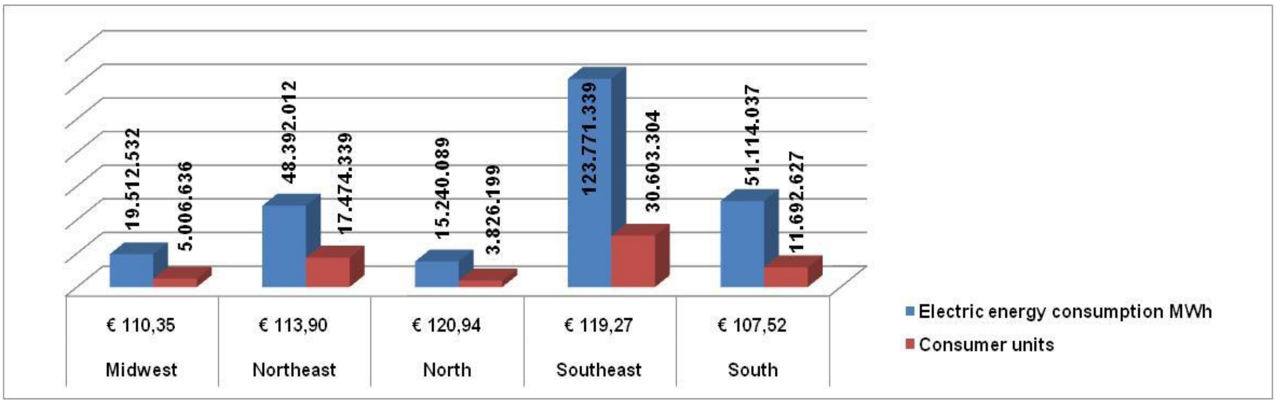

Fig. 2. Regional electric consumption and costs in Brazil (source ANEEL, 2011[14])

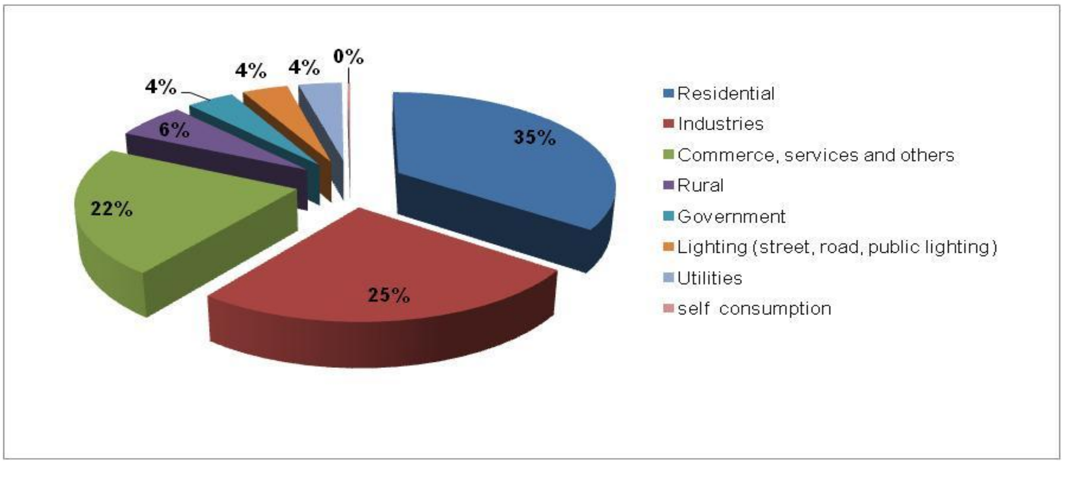

Fig. 3. Electric energy consumption in Brazil (source ANEEL, 2011[14])

The analysis of this consumption, as presented in Fig. 3, 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 less than 150 KWh), with obvious implications in the business structures of the regional dealers.

- **Storage and retrieval information:** These aspects are related to the legacies information technology systems, many times inappropriate to storage and organize rouge data volumes collected and exported in real time. This problem, or from a pragmatic point of view, this solution, is a current structural practice in telecommunication companies, which have, historically, similar concerns of sensing and supervision its network elements, its customers individually, as well as its entire capturing and data exchange system (boarder measuring, registration for tickets and clearing), geo-positioning of assets and interconnectivity, as well as price composing and billing according to timing and usage. This cultural and structural change in storing and processing high volumes of data presents an appropriate cost-benefit relationship currently, with the technological evolution/availability of servers, storages and cloud computing [15], ensuring strength and marketable products. Nowadays, in the Brazilian market, the electricity dealers are updating and also making investments in information technology, as well as changing its control processes. This is, therefore, a very favorable moment of (re) planning investments and organization for a differentiated operation.
  However, it is important to conduct extensive cultural change work and improve operational processes for the future "smart business".
- **Qualification of information and systems inter-operability**: must be mentioned an alert to the current state of *Smart Grid* specifications, norms and standards for the information capturing and transferring, the data structure detailing to allow systems and suppliers inter-operability , as well as the establishment of communication technologies that bring results.
  Basically, tests conducted with *Smart Grid* sensing focus on the qualification of the communication requirements, as well as the validation, quantification and characterization of relevant parameters for an effective sensing, according to the perception of the dealer or energy company (standardization examples can be found at IEC Standards [16] and [17]).

  It is also important to mention, in a way that is coherent with its responsibility focused on the current energy service business, the lack of training in communications in Brazilian electricity companies. It is worth mentioning also, the restrictions related to the Brazilian regulation model to electricity dealers to operate and offer different services from electricity, such as in the area of telecommunications. The obsolete or low networks connectivity is an action field. This knowledge is necessary for the maintenance of a sensing infrastructure and remote measuring requirements into a smart metering network. It is also both a business opportunity and a commitment. In the United States, this issue is also handled by the FCC (*Federal Communications Commission*), as mentioned in reference [18], reinforcing the involvement of several knowledge sectors for the composition of a business solution with all the necessary guidance.

  In Brazil, this evolution and "joint" business opportunity among the electricity dealers and telecommunication system operators is a future commercial supposition, although some dealers have already ventured in studies on the supply of basic telecommunication services using its infrastructure and capillarity of their electricity grids.
- **Increase in system capacity:** basically canalize efforts to build or reinforce the capacity in the high-voltage systems. The building of lines and transmission circuits must also characterize investments towards the (re) structuring of substations, adding criteria of robustness and failure tolerance, the broadening of control centers, systems and protection and relay schemes. For instance, the great distances to be overcome to deliver energy generated in hydroelectric plants planned in Brazil, in the basin of Madeira River (Jirau with 3,300MW and Santo Antônio with 3,150MW), in the Amazon region, in the North of the country, to the cities in the Southeast, are

engineering challenges yet to be solved. There are approximately 2,400 km of transmission lines to be built, with all their environmental impact still under studies. The interconnection, protection and operation of the system with this new generation are questions yet to be answered [19].

- **Coordination of areas, regions and national control system and integration of electricity grids:** this is a sector that clearly must have special attention. A series of inter-related structural coordination roles must be conducted for an economic and trustworthy operation of the electrical system. Charging compensation and balancing, generation system coordination, transportation and distribution dealers, electricity market operations, government and emergency operation centers are included. The elements of *Smart Grid* in this context might include the collection of measurements of the entire system to determine its state and quality of electricity, and coordinate actions to increase the economic efficiency, reliability, environmental compliance, and respond to disruptions or systemic failures.
  The need for this functions regulation in the integration space is evident, as well as the updating existing control system in Brazil. This system is presented as robust, but its conditions of self-adjustment, control and recovery in case of simultaneous failures, of isolating problems and rebooting still need to evolve. The recent blackouts in several Brazilian regions in 2010 and 2011 show that more intelligent and more dynamic mechanisms in the decision making process in the Brazilian grids operation, as well as and not restricted to the structuring of the offering of generation and (re) composition of the electricity matrix.
  More and more actions and operational indicators must be defined, obtained, controlled and managed by operators and by systems, a great challenge for the Interconnected National System [20].
- **System's bottlenecks and self-recovery control**: controls for eliminating or at least recognition of the attention points or controlled overload. Together with the analysis of the system capacity, functionality includes increase power flow, enhanced voltage support, manage fault currents, allowing the operation, reaction and recovery from failures in the system in an effective and dynamic base. Surely, much technology is yet to be developed towards this effective control, such as power electronic devices, such as power electronic circuit breakers and others controllers.
  The focus on robust interconnectivity, failure control and recovery is evidenced, mainly when the aim is to ensure the automation of real time actions. It also reinforces the importance of regulating, guiding and controlling entities on the interconnectivity between dealers, vendors and systems. Many inter-operability and multi-vendor tests are being made to ensure the robustness and self-recovery in the structures of the Brazilian transmission and distribution networks.
- **Quality indicators**: must be resultant from implementation and used to demonstrate systems efficacy. 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 [21] and [22]. 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 68 million meters in Brazil, in a migration to electronic metering technology, and if possible, intelligent. It will seek updating 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 [22]. 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 as subject as implementation, tariffs and incentives 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.

- **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 delivery of electricity (for example, additional information for billing and real-time pricing (according to criteria established depending on the demand and load shape objectives), evaluation started by ANEEL [23]), 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 [23], 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 review performance process. 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.

  This discussion is also under regulation and must provide the conditions for the necessary evolution at the onset of structural changes for the intelligent grid.

2.3. Organization for Operation with Smart Grid

In many cases, *Smart Grid* is reduced and restricted to the concept of *smart metering or AMI (Advanced Metering Infrastructure)* due to the connectivity and great impact of costs of this specific subset. Focusing the analysis on an economic point of view, this can be explained since the relevant issue presented for the implementation of *Smart Grid* throughout the world is on the necessary modernization of the installed plant, mainly related to the meters, billing processes and grid capillarity.

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.

These issues have been previously addressed to Brazil into this study, and it is clear that the regulatory agencies are concern planning and beginning the process.

Although, some points beyond the metering issues must be organized for an effective operation:

- **Technology of energy distributed resources:** 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. Yet, much is still being 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 conditions in the hydroelectric generation. This might also have future influences in the supply composition. Studies have been started on the co-generation and usage of SHC (Small Hydroelectric Centrals) interconnected to the grids. This interconnection process is still being defined and its influences on the grid presented (continuity of supply and instabilities).

  The evolution predicted in this matrix is presented by the Brazilian Energy and Mining Ministry (MME – Ministério das Minas e Energia) in Fig. 4.[24].

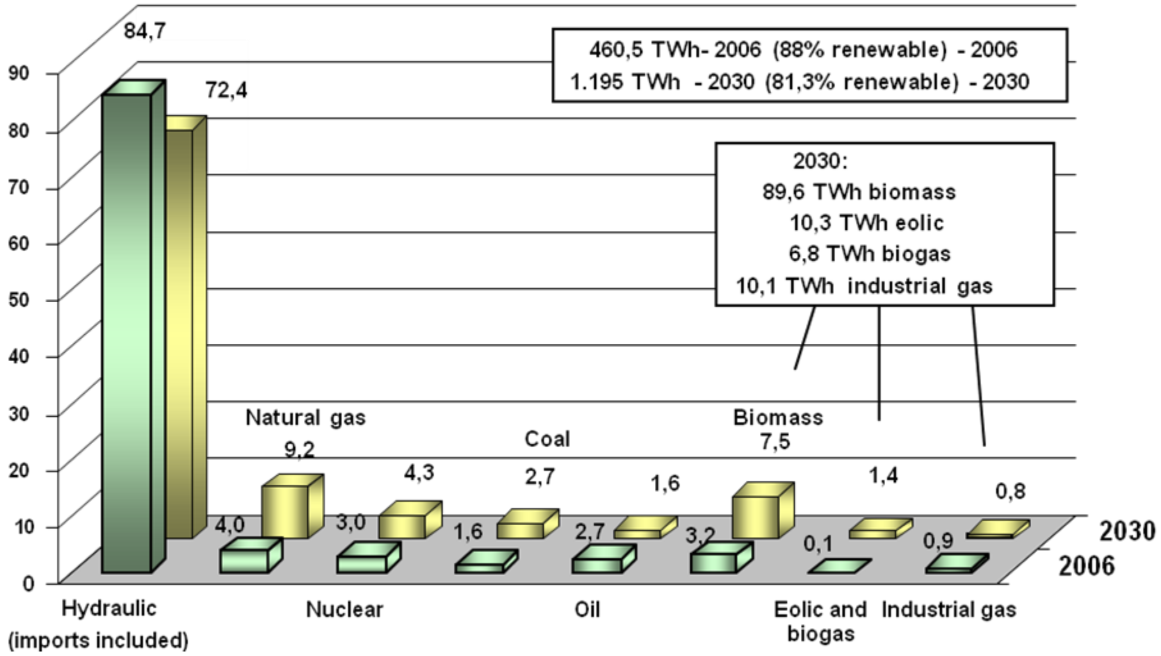

Fig. 4 – Internal offering of electricity 2006-2030 (%) – source (MME, 2011 [24])

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.

- **Generation:** generation power plants already have sophisticated automation systems in its facilities, qualifying and quantifying production and providing clear indicators for investments and operative actions. The differences in the Brazilian energy matrix are widely known, originating from hydraulic and renewable sources, with low greenhouse gas emissions. However, diversification with the entrance of thermo-electric plants, availability of energy resources from the pre-salt layer, and possibilities related to technology progress with *Smart Grid*, are yet to be integrated to this sector.

The change is to be gradual and not of sudden transformation, according to DOE [10] and ETP [11]. This is another analysis item for the Brazilian regulatory entity.

- **Information and finance networks:** information technology and telecommunications are pillars of *Smart Grid*. Although the information networks required (capacity and performance) be different in different areas, their attributes tend to transcend its application areas. Examples include the inter-operability and ease to integrate automation components, as well as concerns with cyber-safety. Information technology standards, methodologies and tools related are also inserted in this context. There is a clearly overlapping of Energy and Telecommunication regulatory entities activities, considering that this is a business opportunity both for telecommunication companies and electricity dealers. Financial networks must be point out as a part of the solution that shall be implemented.
- **Safety management (of information and consumption data):** this involves safety analysis areas related mainly with the authentication for exporting data (publishing information from data acquired from client consumption) and to ensure the integrity of the information associated to the customer, identification of usage and behavior patterns, as well as remote real time vigilance. The commercial use of consumption data, resulting from the information collected, for example, in marketing actions, is also another item to be regulated, as well as management practices for this information usage. This issue is being under intense discussion by American regulatory institutes [25]. In Brazil, this issue has relevance, but without the strong American cultural nuances of commitment to individual freedom and privacy.
- **Focus on customer, education and commitment for the efficient usage of energy:** studies and research must be conducted to shed light on the effective needs of Brazilian customers. The segmentation of these clients into different interest groups must provide conditions to understand the benefits expected by each segment with *Smart Grid*. This segmentation must go beyond the standard classification vision (residential, rural, commercial and industrial), but lighting the diversities related to the region, consumption patterns, due to the cultural differences and purchase power.

  Research already conducted in the USA [26], where the energy usage pattern is very different from the Brazilian, bring some relevant issues on the apprehensions of adopting technology, ineffectiveness of making excessive information available on consumption, control mechanisms on this consumption, and mainly, on the persistence of consumption reduction habits from initial efficiency in usage. This learning is very 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].

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[2], implemented in the scope of actions aiming to combat waste and support electricity efficiency, must be reviewed in their form and dynamism. They also must be reviewed for the educative content applied in schools, 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 for Brazilian smart cities, such as those presented and recognized by ANEEL as R&D projects by CEMIG for the city of Sete Lagoas, MG [27] and by Eletrobrás for Parintins, AM [28][3].

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* for the implementation progress.

The question that must be addressed, with all its regional shades, is who will pay the bill for these investments: the customer, the government, the equipment and systems suppliers, the electricity and commercialization dealers, or the results of the effectiveness generated from the process? A composition of all these options!

3. Conclusion

The opportunity, with a Smart Grid ecosystem, is the possibility of renewing the energy business with structural subsidy to (re) think the electricity and development space into emerging economic powers countries.

Smart Grid includes in its approach a concept of organization, systematization, automation and search for quality in the offering, management, relationship and commitment with the consumer (now considered as a client). It is based on existing technologies and/or new solutions, on regulations, metrics, 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, as well as listing important technical issues in an operational organization with *Smart Grid*. 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 evolution of the electricity business is not presented as a possibility in this analysis. It is indeed a fact that must be accomplished. It is transparent the positioning of executing actions within an appropriate planning, with costs and returns that must be previously studied, involving all possible stakeholders, building and evolving the electricity network in all its aspects – quality, physical, and

[2] 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.

[3] CEMIG and Eletrobrás are Brazilian regional electricity dealers.

interconnectivity, in a sustainable manner and following a conscious segmentation of offer-demand and return on investments. 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, incentivizing and seeking results for a new business model reflecting and guiding actions that contemplate regional nuances.

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.

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