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SET OF ELEMENTS, PARAMETERS AND CONSIDERATIONS TO GET THE SUCCESSFUL INCLUSION OF THE SMART GRIDS IN COLOMBIAN POWER SYSTEMS

(CONJUNTO DE ELEMENTOS, PARAMETROS Y CONSIDERACIONES PARA CONSEGUIR UNA INCLUSIÓN EXITOSA DE LAS REDES INTELIGENTES EN EL SISTEMA DE POTENCIA COLOMBIANO)

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ABSTRACT

This document is a synthesis of those parameters, considerations, elements and systems that must be implemented if the objective is based on the inclusion of smart grids in the Colombian electrical system. This paper defines the changes of the traditional figure of the electrical energetic chains that includes generators, transmission, distributors, retailers and users to introduce the new concept of ProUser. This new term generates a change in the electrical chain and it will be become bidirectional and decentralized in operation.

Keywords: smart grid, descentralized system, bidirectional, ProUser.

RESUMEN

Este documento es una síntesis de los parámetros, consideraciones, elementos y sistemas que deben ser implementadas basado en el objetivo de incluir las redes inteligentes en el sistema eléctrico colombiano. Este documento define los cambios de la figura tradicional de las cadenas energéticas que incluye generadores eléctricos, sistema de transmisión, distribución, minoristas y usuarios al introducir el nuevo concepto de ProUser. Este nuevo término genera un cambio en la cadena eléctrica y estará en funcionamiento bidireccional descentralizada.

Palabras Clave: redes inteligentes, sistemas descentralizados, bidireccional, ProUser.

INTRODUCTION

This paper presents the explanations of those aspects that have to be considered when is talked about Smart grids and that also many times is being confused with the use of telemetric and automatic system. For that reason must be formally defined for Latin America and Specific for Colombia a structured definition. Also can give the line to follow for the interconnected system to overcome and introduce the smart grids successfully.

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In this document is related the following aspect: a formal definition for Smart Grids focused on the purpose projected for Spain which introduce the term in the electric market chain. The elements that have to be included in the electrical system to could reach the Smart grid definition. After that is defined the possible Electrical Energetic Chain that satisfies the bidirectional orientation of the ProUsers[1] with the system, the changes that will be produced in the electrical energetic chain if is desired to include smart grids in the Colombian system and the purpose of a distributed system market in energy consume but automatically controlled by telemetric systems. Finally, it is presented the road to follow it is desired a successful inclusion of smart grids in Colombia.

This paper does not desire to generate controversy on the real meaning of the composed word “smarts grids”, the objective is to identify what is the real definition of the term, the elements that must be included to make reference about them and to emphasize that the surveys that have been doing in Colombia are just the first step that is defined in the fourth section of this paper.

FORMAL DEFINITION FOR SMART GRIDS

This section presents the formal definition based on the first applications of the term defined in Europe and after that are presented the objectives wanted to be reached.

A. Definition:

An Smart Grid or a smart system to distribute energy is defined as the integration of elements that allow the optimization of the energy production and distribution using automatic system that are able to ensure economic energy, sustainability, lower losses, high levels of quality, reliability, security and flexibility, integrating distributed system generation to the energy chain that can be renewable and cheaper or wasted in the case of non – renewable energy that is produced in the figures of cogeneration or self-generation (Díaz & col., 2011)

1 ProUser: It is the term that integrates the criteria used in EEUU and Europe to include the figure of Users that could generate with renewable energy in most of the cases.

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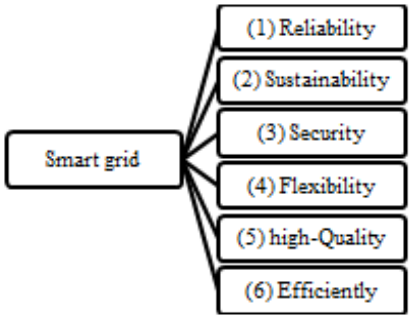
Figure 1. Inclusions of the last proprieties that must be considered in a smart distribute energy system



Source: own elaboration.

The diagram box that is showed in Figure 1 represents the formal characteristic that must be included in a design of a smart grid and they are defined as follow:

1. Reliability: as the actual definition, it is the probability that the system could be able to operate completely if one of its elements is not in operation due to a contingence or programmed event of maintenance. The reliability must be defined and structured in a smart grid, for each one of its elements and project the availability of it in a defined period of time. The global system must be able to operate in a higher condition of contingence. It makes reference when more than two elements of the system go out from normal operation. (There must be a probability of operation higher that the criteria N-2 elements).

2. Sustainability: this term is the most ambitious because it means completely autonomy. The energy of the generators must be controlled efficiently and the centralized systems have to have in real time the capacity of supply of the entire generator (included: Conventional and distributed system generators that are available to connect to the network).

3. Security: as the actual definition of security it must be focused on ensure the continuity of the supplied of energy to the users that are connected to the electrical system.

4. Flexibility: to be able the system to commute its elements to secure the energy supplied (Heiskanen and Matschoss, 2011).

5. High-Quality: this makes reference to be in rule with the current regulation of energy quality. The users of the system must be certified with the normative to avoid the inclusion of losses or quality problems in the network (Heiskanen and Matschoss, 2011). (Mendoza and Fujii, 2009). Also the distribution agent must be in rule with the respect normative that implies that all their system has to be in rule with the normative (Heiskanen and Matschoss, 2011).

Depósito Legal: PPI201002ZU3614 / ISSN: 2244-7970. Volumen 5 Edición No 2 Enero – Junio 2015

6. Efficiently: smart grids are focused also in production, transition and final use of the energy that is necessary, reducing losses, mitigate the downtime operation of machines, optimize the system and develop culture and strategies to save energy in all the energetic chain. Many efficient processes are focused in technological changes due to the actual condition of their electric and mechanical equipment (Sinha & col., 2011). For example an air-cooling system for each one of the offices in a building, could be replaced by a core cooling system for all the building. In Colombia has started the implementation of the ISO 50001 and have been introduced the RETIQ and RETILAP that contribute to improve the efficiency of the system. Smart grids will be measured also efficiently and they must be designed taking into account this aspect.

B. Objective of smart grids:

According to the definition and the properties that were defined previously, many authors and entrepreneurs that are working in this topic consider eight objectives to include smart grids in all the electrical chains around the world. They also impact in the reduction of the pollutant emissions of $C0_2$ that many processes of the industry and the electric generation are causing and they are resumed as follow:

1. Strengthening the grid implementing automation to obtain an optimal operation and reduce technical losses and gain reliability, security and flexibility.

2. Optimizing the interconnections with renewable energy systems to minimize the cost of the energy and improve sustainability.

3. Developing decentralized schemes to introduce the implementation of distributed generation.

4. Producing new technological forms of energy storage focused in alternative system generation in which the energy is not as stable as the conventional system and must be storage before it uses.

5. Developing a change in the electrical market due to the inclusion of new figures of generation system and to encourage those users that produce and use efficiently the energy.

6. Becoming the demand management of the energy in a real-time management.

7. Including into the electrical market new figures of consumption, for example the electric vehicle.

8. Reducing peaks of the daily demand respect the conventional energy generation. It is said that this peaks will be assumed by the introduction of the new figures of distributed system generators.

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ELEMENTS NEEDED FOR SMART GRIDS

According to the orientation of the document it is noticed that Colombia is not going to be ready for this system during the following years but it could be reached if are implemented strategies that could benefit the progress of smart grids.

The actual model of the energetic chain must be modified to could include successfully the smart grids. In this section will be defined those elements.

A. ProUser:

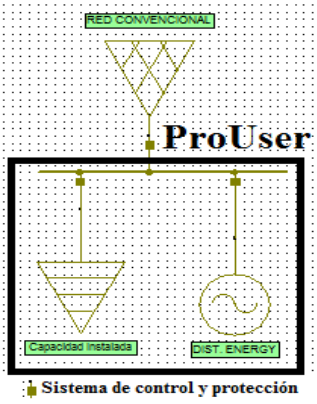
In the new model is needed to be modified the term of user for many cases in which will be projected to include new types of distributed system generation or the case of the electric vehicle. This new element became the electrical system chain bidirectional due to it could supply and in other case consume energy from the interconnected system (Energía y Sociedad, 2010).

This user must be regulated and controlled systematically and in real–time with the aim of detect how much energy it consume, in which periods register the highest consume of energy and define its sustainability in percentage values.

The overcrowding of ProUser could be the solution to the reduction in the use of conventional energy system, in hours where the daily demand is the highest of the day. Gradually, the ProUser could become own sustainable during this periods of the day using its own energy generated.

A ProUser is basically an integration of consume and production of energy based on the term distributed system as is shown in Figure 2.

Figure 2. Single line representation of a ProUser



Source: own elaboration.

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B. Renewable Energy:

As is represented in represented in figure 2 and as is expressed in the definition of a Smart Grid, this type of energy in most of the cases has to be renewable. The use of renewable energy has to increase in Colombia and more modern systems than JEPIRACHI have to be developed and installed (Energía y Sociedad, 2010) (Observatorio Industrial del Sector de la Electrónica, Tecnologías de la Información y Telecomunicaciones, 2011).

The Table 1 and 2 enumerate the range of wind and solar intensity respectively in many regions around Colombia according with the established in the UPME[2].

Table 1. Wind potential in Colombia

Wind speed (m/s)	Place with wind potential (place - department)
Same or superior as 5 m/s during whole year.	Galerazamba-La Guajira
	San Andres–Archipielago de San Andrés.
	Gacheneca–Boyacá.
Between 4-5 m/s during whole year.	La Religiosa–Huila.
	Providencia–Archivielago de San Andrés.
	Riohacha–La Guajira.
Ranges between 4-5 m/s existent in some year periods.	Villa Carmen–Boyacá.
	Obonuco–Nariño.
	Cúcuta–Norte de Santander.
	Ábrego–Norte de Santander.
	Urrao–Antioquia.
	Bogotá–Cundinamarca.
	Barranquilla–Atlántico.
	Soledad–Atlántico.
	Santa Marta–Magdalena.
	Achique–Tolima.

Source: Díaz & col. (2011).

Table 2. Solar potential in Colombia

Region	Energy (kWh/m^2/year)
Caribe	4015
Orinoquia	1643
Amazonia	1551
Andina	1643
Pacífica	1278

Source: Díaz & col. (2011).

2 UPME: Mine and Energy planning unit in Colombia

Depósito Legal: PPI201002ZU3614 / ISSN: 2244-7970. Volumen 5 Edición No 2 Enero – Junio 2015

C. Automatic control system:

The control system must be changed due to the bidirectional action of the new term introduced as ProUser. The system has to be measured and controlled from a centralized point that allows the demand management in real-time and that will be able of act in the presence of faults or contingencies (Mendoza and Fujii, 2009).

D. Telemetry system:

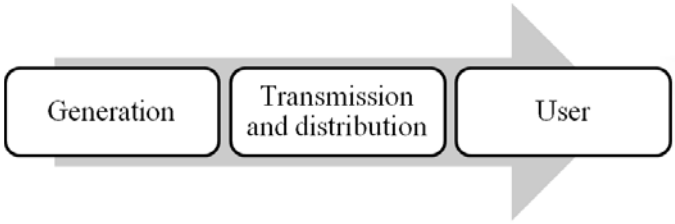
This terminology has created controversy in its implementation because is confused with smart grids and it is important to highlight that the telemetry it in this moment the form to control the user based on a control and communication system where measurement is stored directly from the system installed in the cabling (Energía y Sociedad, 2010).

The telemetry system used in this moment is in one direction due to the type of chain that is currently handled. The telemetry system required must be directional and able to sense the flux direction according to the type of user the telemetry system would have been programmed in different manners. (Energía y Sociedad, 2010).

ELECTRICAL ENERGETIC CHAIN MODIFICATION

This section finally defines a purpose to follow in order to get in operation a system based on a smart technology. Figure 3, represents the unidirectional consume chain in the electric system (Morales & Gómez, 2006) (Hashmi & col., 2011)

Figure 3. Actual system direction (Unidirectional) of the chain of energy consume



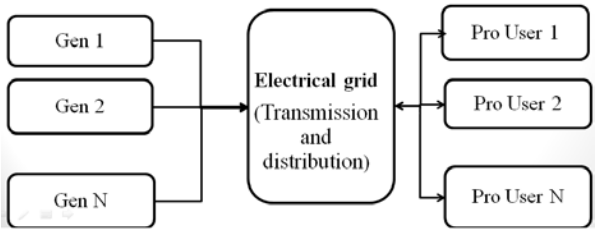
Source: own elaboration.

A. Scheme including smart grids:

The diagram showed in Figure 4 is the objective when Smart Grids started to be included in the national grid system. There is noticed the bidirectional lines orientation between electrical grid and those ProUsers. The bidirectional lines orientation means that the figure ProUser could provide energy to the electrical grid according to the needs and requirement of the grid. This includes a bidirectional control and a new implementation of a new programming of telemetric system.

Depósito Legal: PPI201002ZU3614 / ISSN: 2244-7970. Volumen 5 Edición No 2 Enero – Junio 2015

Figure 4. System purposed for smart grids acording. (Bidirectional between Pro Users and Electrical grid)



Source: own elaboration.

B. The road to reach the desired market:

According to this survey and in phase with the opinion of the researchers that have been working in this topic, it is still generating a question: What should be done to include successfully smart grids?

The answers to this question are basically good management of investigations and the support of the state to obtain the inclusion of all the parameters presented in section II (Energía y Sociedad, 2010). The following scheme responds to the possible road to follow and take the same line of implementation as is being doing in EEUU and Europe. This scheme is divided in five phases:

1) The first phase: responds to the investigations and researches to obtain a technological improve and must be oriented and supported by the state. The state have to stimulate and promote the researches and development of these technologies due to they are not mature, they are just in test as this is happing with the wind energy park (Jepirachi). These phase implicate that the state must me more constant if it wanted to reach the projections that many researchers are proposing. The telemetry also has to be tasted in a bidirectional system.

2) The second phase: implicate the successfully development of each one of the elements that need to be technological mature in the first phase and once finished they must be standardized with the aim of promote its production massively.

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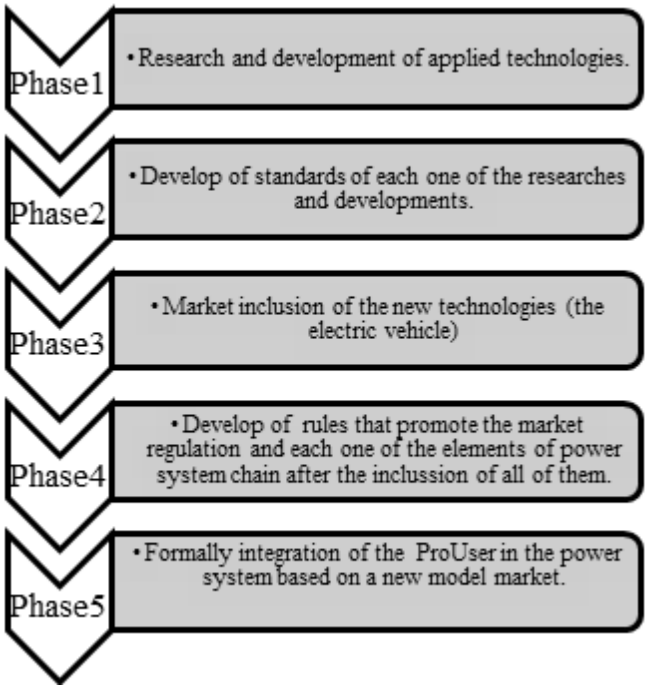
Figure 5. Scheme line to include the smart grids in the power system



Source: own elaboration.

3) The third phase makes reference to the inclusion of the technologies developed and standardized into the power system as is the case of the electric vehicle.

4) The fourth phase: will be reached until the inclusion of all the elements that integrates the smart grids and they have to be tested during their operation. This period could be called as a “taste period for smarts technologies” and after that there must be a regulation of all these elements and specify their restrictions and objectives in the chain.

5) Finally, the fifth phase is the inclusion of the smart users or ProUsers that will be able to interact with the market and be self-sustaining.

CONCLUSIONS

As an outcome of this survey was to focus the lector in which of the phase is Colombia and that the concept of Smart Grid could be understand for everyone with the aim of focus all the researches into the same line. Also it is important to take into account the participation of the state that will be the promoter of this implementation and will guide to integrate all the elements that are needed.

It cannot be talked about smart grid if there only renewable system that is being applied because this is just one element of smart grids. It cannot be confused telemetry with smart grid basically because the telemetry is just control and measurement and will

Depósito Legal: PPI201002ZU3614 / ISSN: 2244-7970. Volumen 5 Edición No 2 Enero – Junio 2015

be also just an element of smart grid. It cannot be consider a home automation that could include renewable energy as a Smart Grid. They are only a possible ProUser figure.

All these elements that were mentioned are needed and must be developed and implemented successfully for that reason Colombia will be working in Smart Grid but this is the global line of investigation that integrates: Renewable systems, efficiency, URE, power system, control and automation and economy energy management.

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