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Analysis of the Regulatory Requirements for the Smart Grid in INDIA

[1]Aran Glenn.J
Research Scholar,
Dept of Electrical Engineering,
Anna University,
Chennai, Tamil Nadu, INDIA
E-mail id : aran@dmice.ac.in

[2]Dr.A.Srinivasan
Dean-Academics, Professor,
Department of EEE,
Agni College of Technology,
Chennai, Tamil Nadu, INDIA
E-mail id: seenu.phd@gmail.com

[3]Dr.M.Belsam Jeba Ananth
Vice Principal, Professor,
Department of EEE,
DMI College of Engineering,
Chennai, Tamil Nadu, INDIA
E-mail id: belsamjebaananth@gmail.com

ABSTRACT

In this paper it is analyzed and discussed what should be the rules that must be applied in INDIA to deploy the smart grid. It examines what kinds of standards can be applied in various systems of the mains: in the generation, transmission and distribution are the characteristics of the rules for the transmission of data. It analyzes the characteristics of the network of smart meters, and there are regulations that must be met.

Keywords— Standard, smart grid, smart meter.

I. INTRODUCTION

In the United States, Europe, Japan and China, the idea that the generation, transmission and distribution of electric power is more efficient and friendly with the environment that is, reduce the emission of CO2 to the atmosphere, this is what is conceived as an electrical network smart [1] and [2].

The difference between the smart grid and the grid electric current is that the latter is a centralized system, where the power flows in one direction from the source of generation through the transmission-distribution system towards consumers, includes supervised control and acquisition data (SCADA), whereas the intelligent electricity grid has a two-way flow, with applications of technologies technology that links generation, transmission, distribution and end-users [3].

Smart grid involves changes in topology of the network, the nature of the load (critical loads: hospitals, clinics, non-critical: domiciliares and industrial), the atmospheric characteristics (as they affect the solar, snow and wind), primary system (dropping of a pole due to collision, equipment, cable drop, etc.), faults in the secondary system (loss of monitoring and / or control, errors in measurements), and impedances of the sources (affect the voltage profile and failure levels) [4].

Smart grid requires monitoring and control in generation, transmission, distribution and users consumers. For your application and functionality it needs associated standards and norms that govern it [5-8].

Currently in India there is no regulation for the network electricity, that is why in this work analyze regulations to be implemented related with measurements and monitoring of the electrical variables for determine the quality of electrical energy, coupling of the data carrier signals with high power lines medium and low voltage, the interconnection of the different electrical generation systems, automation of distribution substations, etc.

The contribution made in this article are: first This study analyzes the standards and regulations that international level and adapt them for its applicability in future smart grid in India. In second place is incorporated the study of the type of noise found in the lines medium voltage and low voltage and their characteristics as a transmission channel. Third, new encodings that can be incorporated into electrical lines

Intelligent This article has the following settings in Section II provides the regulatory framework for the smart grid in India, Section III provides the regulations for the means of transmission, in Section IV the regulations for the bidirectional communication in the intelligent network, in the V the regulations for user meters and finally in Section VI the conclusions are given.

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II. REGULATORY FRAMEWORK

A smart grid incorporates all sources generators: hydroelectric power plants, central to fossil fuels, combined cycle plants, photovoltaic plants, wind power plants, etc., in a single energy matrix, therefore, a storage of energy to accumulate energy in moments when production exceeds demand and unloads when there is an increase in the demand, with this the optimization of electrical energy.

With the smart grid users will have a better control of energy consumption because they are replaced the current electromagnetic meters by meters digital, which indicate consumption: current, total, instant price of energy to consume, recommend it which electrical and / or electronic devices connect or disconnect. We also want to encourage local production electrical power with the installation of small generators and photovoltaic cells.incorporated into the distribution system when a excess of demand or that can be stored by the Distribution centers.

With the future massification of electric cars, need systems in the houses that allow the loading of the batteries of these vehicles. The current power grid has to change its configuration to adopt a network that allows rapid reconfiguration when there is a fault and thus avoid blackouts. This includes airports whose lighting system

runways are "smart", so that spotlights when they fail indicate where they occur and also have the ability to turn on the replacement. The intelligent electric network of generation, transmission, and distribution need real-time monitoring to ensure the quality and optimization of the system, for this must place smart remote meters with the Real-time data processing capacity Bidirectional data communication and auto take decision. According to all of the above, the electrical network intelligent must necessarily have regulations in the different areas that constitute it: in the generation, the transmission, distribution and in users (residential and industrial). You should also consider regulations for the means of transmitting the data, the meters: from the quality of electric power, of demand (users), protocol of digital data, electromagnetic compatibility and information security as outlined in [9-12]. Below is a brief analysis of the characteristics of the electrical network that is currently in India. The generation, transport and distribution activities of electricity are developed in India by the private sector and the State only fulfills a regulatory, oversight and subsidiary.

The distribution as the transmission are monopolies natural resources, and the law establishes procedures to determine tariffs (or "tolls") that users of the networks The distribution companies have the obligation to give service within their respective concession zones, as well as to respect the maximum rates set by the authority for the sale of electricity to its low consumption customers. Generating companies and transmitters for their part, they have the obligation to coordinate the operation of their power plants and transmission lines that work interconnected, in order to preserve the security of the system and guarantee the operation at minimum cost.

The Indian Electric System is divided into five areas electrically non-electrically interconnected: SING
(NORTE GRANDE INTERCONNECTED SYSTEM), SIC (SYSTEM INTERCONNECTED CENTRAL), Sistema de Aysén, Sistema de Magellan and the Easter Island Electric System. Figs. 1 and 2 show the SING and SIC systems.

The CNE (National Energy Commission) is the one that gives the technical safety regulations and the quality of service in India, from its version of November 2014, makes a summary with the most important sections:

Chapter 5: Requirements for safety standards and quality of service.

The scope of this chapter is to establish standards of security and quality of service. With regard to quality, has for example: article 5-8 that limits the disconnections for the SIC in 12 and for the SING in 25. For customer installations, the power factor is calculated in 15-minute intervals, according to the range of voltage that is worked according to whether inductive or capacitive example; 0.93 inductive and 0.96 capacitive at the points of control with nominal voltage less than 30 KV.

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Figure 1. Large North Interconnected System (SING).

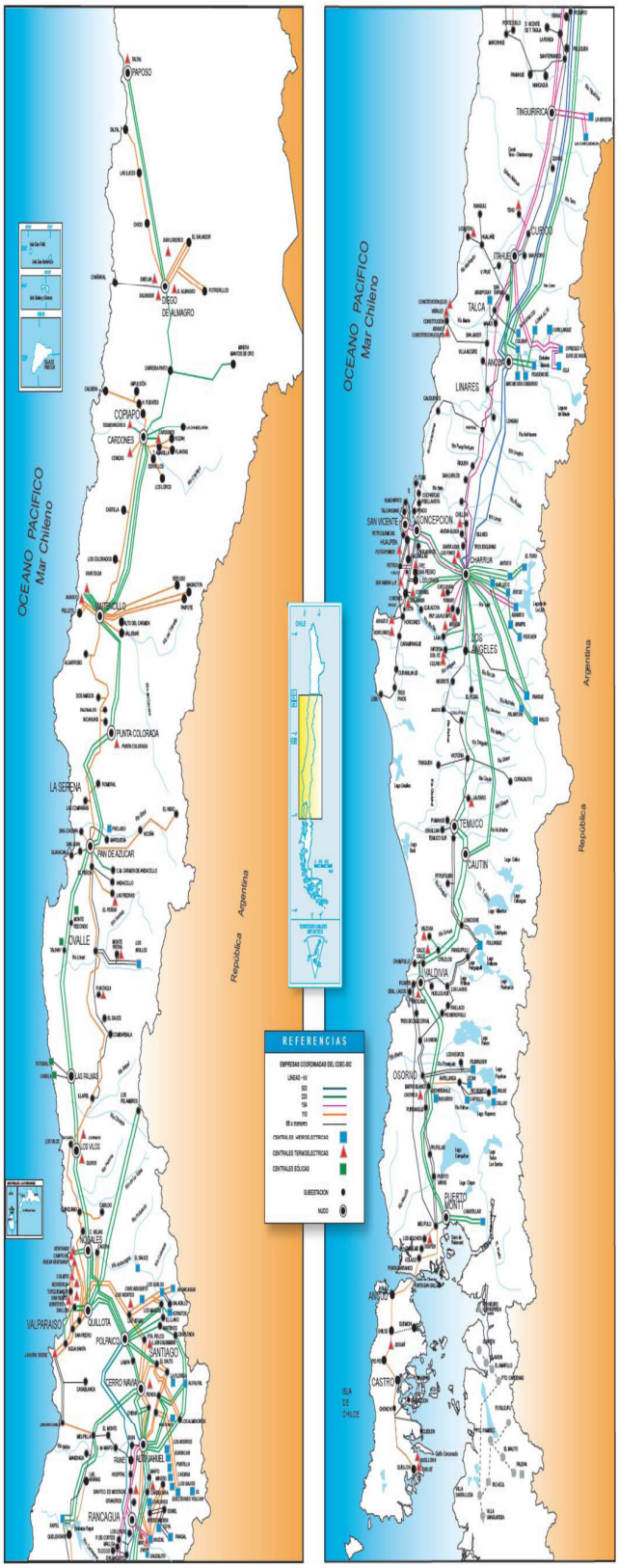

Figure 2. Central Interconnected System (SIC).

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Article 5-30 states that the SI frequency must be remain at its nominal value of 50 Hz. the acceptable ranges of: (a) current harmonics, (b) voltage fluctuations and c) flicker severity. Indicates only that the regulations given by: IEC 868, EN 60868 and EN 61000-4-15. Article 5-74 states that transmission facilities should limit the contribution to pollution of the network operating their systems so that the harmonic voltage distortion is in the ranges that are established in the IEEE standard 519-1992.

According to the revision made of the regulations India, it is inferred from it that it is conceived as a network
where the power flow is unidirectional, the system is centralized control system includes a supervised data acquisition (SCADA) and not as is the new Smart grid design requires that the flow of the information is bidirectional and the monitoring was carried out remotely and in real time, ie a system electric dynamic.

The following describes the characteristics that should be have the regulations that are needed for implementation of the smart grid in India, for monitoring in real time using the power lines as a channel of data transmission.

III. REGULATIONS FOR THE MEDIA OF DATA TRANSMISSION

It is proposed that in India the data transmission medium be the same power line, and not using telephony cellular, fiber optic or satellite, the reason for this is based on the comparative advantages that it has from the point of view of because the same existing structure is used for the transmission of data and also according to the topology of the existing electricity network in India, which shown in Figs. 1 and 2. This network covers more than 4000 km in that is called the "electric road" and interconnects the different generation systems, transmission and distribution. In many distances of the network electricity in India there is no coverage of the fixed or mobile telephony, because it is very far from the populated centers.
As the power lines were not conceived with the idea of transmit digital data this is a very adverse means as a transmission channel, but with the new modulations and Modern error detection and correction codes are Significantly decreases the probability of symbol or bit error, achieving with this a channel of high reliability.
The high, medium and low voltage lines according to measurements made in [13] it has been determined that
they present a Gaussian background noise plus a noise impulsive. Fig. 3 shows a typical noise in the lines of
low voltage (residential, in the cities Curicó, Talca and Concepción) [13].

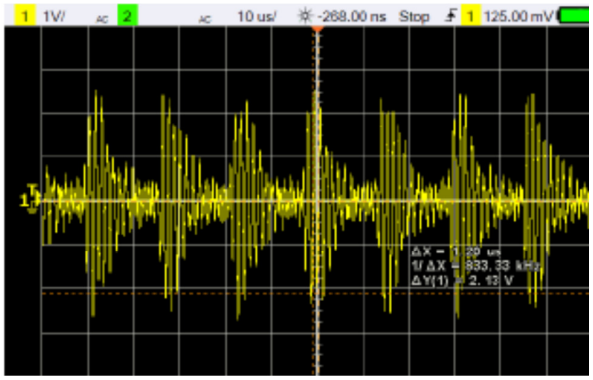

Figure 3. Typical noise in low voltage lines

From Fig. 3 it is observed that the noise is formed by a background noise and impulsive noise, impulsive noise has the following characteristics: an amplitude that varies between 43.83 mVpp and 6.33 Vpp, with periods ranging from the 684 nS and the 1.42 uS, the repetition occurs between the 15 uS and 20 uS.

According to (7) the signal suffers a rapid fading due to the effect of multiple trajectories caused by the different branches that the electrical system has and a noise composed of Gaussian noise plus impulsive noise. The question is How to combat this harmful effect?

Currently there is technology to transmit data, voice and image by the electric line what is known as "PLC" (Communications by electric line) and in particular for HAN (home area networks) whose technology can be applied for the residential meter network. As indicated in the Fig. 5

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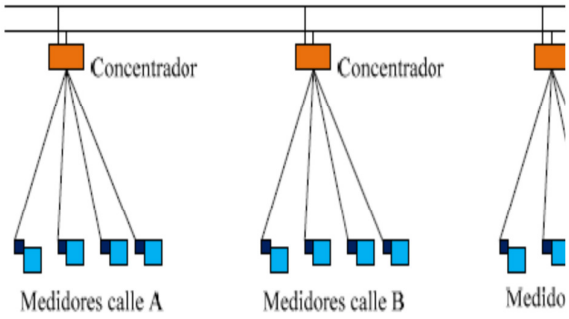

Figure 5. Schematic of the transmission of residential meters in the network smart electric.

According to Fig. 3 the meters transmit their data through the low voltage cable to the concentrator which
retransmits the data of all the meters of a street to the central control. Each street forms a local area network
(LAN).

To improve the probability of error of bits have commercially available LDPC codes (parity), for example X026, which encodes in a parity check matrix of dimension of 4083x3360 or 8158x7136. They are called low density because the amount of ones in the parity check matrix is low compared to the number of zeros, there are codes LDPC regular and irregular, the difference is that the codes Regular LDPCs have the same number of ones in the rows and columns, whereas the irregular ones have different numbers some by rows and columns. The quality of these codes is that as the size of the check matrix increases can correct a larger number of erroneous bits. In [14] it has been shown that these codes have a very good performance on channels with Class A noise.

A technique to reduce fading error signal is invented in the year 1998 by Alamouti , what is today called space-time diversity, Aloumiti performed it only for two antennas, which later it was extended to a greater number of antennas. This technique consists in transmitting n different symbols in simultaneously with time t and time t + 1, others symbols, to transmit the entire matrix.

The metric estimates that the symbol that is transmitted is the one gives the lowest value of (9). To apply the spatiotemporal technique in the lines electrical is considered a phase as a transmitting antenna, therefore, the case of two, three and four can be applied antennas considering the neutral as one more antenna. study of space-time to transmit data along the lines electrical is taken in [16] and [17].
To combat burst noise, product of noise impulsive a technique are two-dimensional codes. The two-dimensional codes that are designed in this article consist of two sub codes with (N1, k1) and (N2, k2), with generators g1 (x), g2 (x) respectively, the code Two-dimensional has a length N = N1N2 and efficiency k =. Minimum distance d = d1d2. The two-dimensional code has the form given.

The rows of the matrix C correspond to the valid words of the code, the same happens with the columns of C. The bits of information have a length of M bits and the sub-matrix of information is of dimension of MxM as indicated According to the two-dimensional codes allow to reduce notably the probability of burst error for a channel with more impulsive Gaussian noise. Therefore, apparently previously technically it is possible to convert low, medium and high power lines voltage in an efficient channel for data transmission digital systems, achieving performance and efficiency comparable to wired and wireless transmission channels. According to the generation of energy remote intelligent meters that evaluate the quality of electrical energy (frequency, stability of the voltage, etc.) that deliver to the network the different sources of electrical energy (non-renewable renewable, are located in layer 1), these have communication bidirectional with the central control (C.C, layer 4).

The technological advantages of transmission of data by the electricity lines in India is that does not have to "coexist" with different platforms of transmission, for example satellite, fiber optics, telephony which makes the transmission system less complex. Another advantage you have when using the high, medium and low voltage as the transmission channel is the shortest delay which is produced in comparison to other technologies, because there is no switching of different transmission technologies that are used and can also be synchronized with the same GPS clock that are used in the smart meters of generation, transmission, distribution and users. Economically it is more profitable because it takes advantage of existing infrastructure and should not install a new infrastructure.

IV. STANDARDS FOR BIDIRECTIONAL COMMUNICATION IN THE INTELLIGENT ELECTRICAL NETWORK

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As the smart grid will consist of different layers of domain, we propose the scheme of the communicates bidirectionally with the system operator regional (SOR, layer 5) and this one with the other operators regional networks. The meters of the substations of transmission indicate where the power line fault occurs and state of the line (layer 1), are connected in bidirectional with the automatic system of the substations (SAT, layer 2) and communicates with the central control (CC). The smart meters of the substations of (indicate the quality of the electrical energy, connect and automatically switch off the transformers in case failure) are communicated in a bidirectional way with the automatic distribution (SAD, layer 2) which, in turn, communicates in a bidirectional way with the control center of distribution (CCD, layer 3) and this with the central control (CC). Residential and industrial consumers (CRI, layer 1) communicate with the distribution network (RED, layer 2) and the distribution control center (CCD, layer 3) with the regional operating system (SOR) and with central control (CC) in bidirectional form.

Therefore, the Indian regulations for communication bidirectional data should include definitions of operating conditions, electrical interfaces, performance requirements, transmission protocols data, transmission link procedures, control of binary signals, the language for configuring the substations, define the digital interface for the electronic instrumentation of transformers. For the data communication network it is proposed for the regulations of the smart grid use the Internet Protocol (IP), for the following reasons: simplified system of architecture and control, interoperability with different types of networks, and supports current networks based on IP, this also allows the network have access to INTERNET. IPv6 version is recommended for the following: allows a greater number of IP addresses (264 sub networks), auto address configurations, has a mandatory security protocol (IPsec), processing simplified routers, etc.

For bidirectional communication it is recommended consider for the Indian regulations the following standards: IEC 61850 (Communication networks and systems for automation in the sub stations), IEC 61850.3 (Network of communication and systems in sub stations - Part 3 General requirements) and the IEEE Std 1159.3
(Practical recommendations for the transfer of data from quality of electrical power).

V.REGULATIONS OF SMART METERS RESIDENTIAL

For the implementation of smart meters a meter infrastructure is needed (AMI) to collect, measure and analyze of electric power, it is also thought that in houses, buildings are installed electric power generators (wind, solar panels) and to be allowed to deliver its energy leftover to the distribution network, in the future it will be the use of electric vehicles, for all the above is suggested have greater security and privacy of information, the Indian legislation must incorporate: Authentication, Message Integrity Protocol as suggested by [20] and [21].

Automatic meter reading (AMR) is a very important in the smart grid, for the Indian legislation proposes that the AMR should be consisting of four layers. The first layer corresponds to the meters that are located in each home. The second layer is the hub of all meters (one building, one set of houses), as shown in Fig. 5. The third layer is the network between the main hub and the layer previous. The fourth layer is the network between the concentrators and the energy distribution network (RED of Fig.
8)
One of the biggest challenges of the smart grid it is "the rate of the consumption of electrical energy in real time". So far the tariff has been "static" and it is required to be "Dynamic", with which you get the rate by which
pay consumers be like the impact on demand total electric power. The tariff on electricity networks
smart must ensure the development of the generation distributed, contribute to a flexible system in relation to the demand.

There are two ways of estimating the tariff: capacity or volume. With the use of meters smart it is better to choose the volume you consider example: proportionality (consumers pay for kW / time), progressive (rate per kW / time is increases with the increase of consumption), time of use (different online tariffs, considering the availability of the offer, depending on whether it is peak or off).

The Indian regulations for consumer should consider: calculation of the electricity tariff, consumption: current, total and daily, time indicate which electrical / electronic device connects / disconnects, also connects / disconnects the service

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remotely for non-payment, limits consumption maximum power, investigates faults, monitoring quality of electrical energy, etc

To implement the Indian regulations of the electricity network with respect to the above proposes to consider the following standards: IEC 62051 (Meters of electricity), IEC 62055 (Meters of Electricity-Tariff System), IEC 61358 (Acceptance of inspection of Watt-Hour meters for direct connection with active power), IEC 62052 (Meter equipment of electricity) IEC 62054 (Electricity meters (A.C) rate and charge control).

V. CONCLUSIONS

This article makes a brief analysis of the regulations for the implementation of the electricity network smart in India. It specifies the characteristics that must have the regulations for the monitoring, control and communication in the system of generation, transmission and distribution. The requirements for meters
intelligent people who are installed in homes and departments.

It is proposed that the power line be the platform of communication of data in the smart grid in India and it is shown that the reliability it has is equal to wired and wireless networks.

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