SUSTAINABLE PRACTICES FOR ELECTRICAL ENERGY NETWORK MANAGEMENT: A LITERATURE REVIEW AND PROPOSAL

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Abstract – Many different approaches have been proposed for improving energy network management. Although these diverse contributions, most approaches for clearly identifying and accurately solving the real problems remain rather inefficient. This is greatly due to the absence of use of completely integrated and sustainable models with Organizations playing fundamental rolls through the use of effective and efficient decision support tools. One such typical problem is related to the accurate identification and the precise calculation of electrical energy losses, which still remains unsolved as well as the clear specification of the critical points and segments in the networks were problems do occur. Consequently, there is still a lack of effective prioritization of actions and interventions in order to reduce those problems. Therefore, in this paper we propose a model for sustainable energy network management were the organizational element assumes a crucial function.

Keywords – energy network management, sustainable energy

1. Introduction

The consumption of energy, in the Iberian Peninsula, namely in Portugal, has grown dramatically in recent decades.
Moreover, the consumption of energy per capita shows huge disparities. Because every inhabitant of the United States consumes more than seven times one of China, and this turns unrealistic to think that the world energy consumption will be able to decrease in the next decade. For example, the consumption of energy per capita in Portugal is about 75% of the one reported in Spain [1].
The supply of energy continues to be mainly based on primary energy sources, such as fossil fuels, renewable and nuclear energy.

Moreover, electricity is the universal energy vector of excellence in Portugal. It is obtained from renewable energies, and much of the energy is obtained from fossil fuels, which brings big concerns regarding our Portuguese electrical energy system sustainability.

Given the impossibility of accumulating energy in meaningful quantities for the Portuguese electricity market, the temporal variation of demand is a very important feature of the whole electrical system.

The introduction of competition regarding the appearance of various alternative energy suppliers may enable to provide more competitive energy prices. Achieving this goal cannot put us aware of various concerns regarding sustainable and clean energy production system requirements. Moreover, to enable security along the energy supply chain must also be safeguarded.

Energy in our modern society is one of its basic needs and energy prices should not be considered just as a means of gathering customer's sufficient income to cover all the costs that are originated regarding energy production, transportation, distribution and commercialization. Therefore, we should also promote a rational and efficient use of resources, both on the supply side and on the demand side. As a consequence, we should be able to reach a balance between the interests of companies and the ones of consumers for reaching sustainable practices regarding the overall benefits arising from effective and efficient energy supply chain management.

Besides, the work already performed along the last years regarding effective and efficient energy supply chain management, regarding different approaches about different and complex concerns allover energy distribution networks all over the world, in general, the existing approaches focus mainly on empirical and probabilistic data. Hence, there is still a clear gap between real information and the considered one, which tends to be poor and imprecise. Due to this reality and the lack of appropriate software applications, which still does exist, namely in Portugal, there continues to be a need for improvements, namely regarding the use of appropriate methods and software for supporting a sustainable energy network management practice. Therefore, in this paper we propose a model for improving energy networks management, were organizational aspects are enhanced, along with the other typically considered ones regarding economical, social and environmental issues.

For accomplishing this proposal, in this paper we present some brief insides about electrical energy, in section 2. In section 3 we summarize some main characteristics of the electrical energy distribution network and in section 4 we briefly describe some important related work. In section 5 the proposed model is presented and finally, section 6 refers to some main conclusions.

2. Electrical energy

During the last decades electrical energy distribution companies have developed several improvements to their electrical energy distribution systems. Due to the high costs involved in electrical energy generation, transmission and distribution, the efficient usage of the available energy along with the efficient management of the network are fundamental issues to be tackled. Furthermore, concerns with environmental issues must also be considered along with the whole underlying management and decisions processes. In general, Companies are aware of the strong competition they are currently facing, largely driven by the liberalization of the electrical energy markets. Energy efficiency measures can represent the difference between having electrical energy quality at affordable prices and having energy shortages with or without lack of quality.

Another typical and big concern is about the minimization of energy losses along a distribution network. Solving this kind of issues leads not just to higher incomes, but also to improvements on the quality of the product offered to consumers. In addition, companies can expect to gain new markets and to afford an expanded network capacity. For all those reasons, the energy losses that may occur along the whole electrical energy distribution network is still a major concern, both for electrical energy distribution Companies and to Regulators. In fact, Energy Regulators are responsible for: proposing measures concerning the quality and the maintenance of the assets of the distributor; to ensure the proposed energy quality; and to regulate tariffs for the market.

The growth of world population and economic conditions in developed countries necessarily implies an increase in the energy consumption levels. However, energy production increase should be bounded for a sustainable development and environmental responsibility.

As shown in Figure 1, by 2040 it is expected an increasing demand below the rate of world population growth energy. The figure illustrates the prediction of the evolution of energy demand (blue stain) and population (red curve) [1-7].

Whether the existence of large proportion of humanity with very low fuel consumption, whether the high rate of growth of world population, show how much is vain to hope for a zero growth in world energy demand in the short or medium term. The prediction of the evolution of global energy demand, illustrated in Figure 1, assumes that in the medium-term, there will be a lower per capita consumption [1-7].

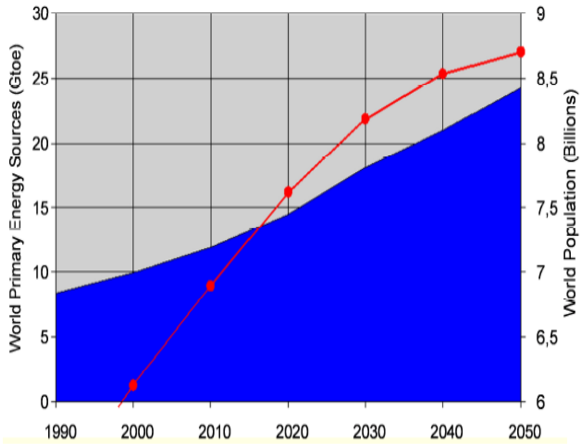

Figure 1: IEA report "Energy to 2050 – scenario for a sustainable future (2003), presented in [1].

Energy saving does not have to mean lack of comfort but we should be concerned primarily with the elimination of waste and with the increase on efficiency regarding the energy used. Some general examples refer to better house insulation, smaller and more efficient cars and to the adoption of processes requiring less energy to achieve the same ends [1].

3. Environment

Energy is a good example of how to manage the usage of a scarce resource. Although the price is usually the most important criterion for selecting a given kind of energy, we just can validly use this parameter when we are sufficiently safeguarded about other conditions of use, such as supply security or safety of persons and property, along with the big issue regarding preservation of the natural environment [1,8, 9,10].

Portugal is a country with scarce energy resources, being those that ensure the generality of the energy needs of most developed countries the ones that prevail in Portugal, such as oil, coal and natural gas (8). The scarcity of fossil resources leads to a high dependence on foreign energy (79.4% in 2012), including imports of primary fossil fonts. Therefore important to increase in the energy consumption the contribution of renewable energy: hydro, wind, solar, geothermal, biomass remains very important. The rate of energy dependence has been declining since 2005. The highest value of the decade did occur in 2005 due to low producibility of the results of a hydrological very dry hydro year, and the rise recorded in 2011 results primarily from the increase coal consumption in the electric power production to offset the reduction in water production [1-7].

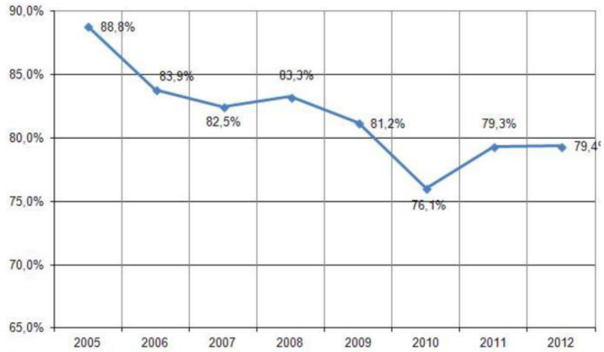

Figure 2: Rate of energy dependence in Portugal source: [1,7].

4. Primary Energy

The following graph shows the evolution of the consumption of Primary Energy in Portugal, in the period 2000-2012 [1-7].

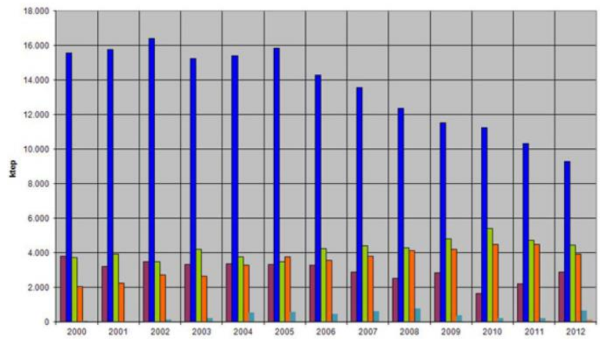

Figure 3: Evolution of primary energy consumption in Portugal (%).Source: [1,7].

Legend: : coal, : petroleum, : renewable energy, : natural gas, : balance of importing electricity, : industrial waste.

In relative terms, the oil retains an essential role in the structure of supply, representing 43.3% of total primary energy consumption in 2012, compared to 46.8% in 2011 [1, 7].

Natural gas contributed in the last decade to reduce oil consumption, diversifying the structure of energy supply and reduce dependence on foreign oil. The use of natural gas has registered an increase (15.1% in 2007 and 20.3% in 2011). In 2012, representing 18.4% of total primary energy consumption due to declining consumption of this energy source for electricity production (-44.0% compared to 2011) [1, 7].

Coal consumption accounted, in 2012, 13.6% of the total primary energy consumption. Provides a progressive reduction of the weight of coal in electricity production due to its impact on CO2 emissions, although the last two years have increased their weight as a result of the reduction in the price of this energy source in the international markets as well as the low CO2 allowance [1,7].

In 2012 the contribution of renewable energy in total primary energy consumption was 20.8% against 21.4% in 2011. In 2012, about 78.4% of the primary energy consumed was imported, including 75.2% from fossil fuels (oil, natural gas and coal), 20.8% from renewable sources, and the remaining 3 9% is from industrial waste and imported electricity [1, 7].

Given the scarce fossil fuel resources endogenous to domestic energy production depends entirely on renewable energies. Was reached in 2012, 11 054 MW of installed capacity is 5,539 MW in hydro, 713 MW in biomass, 4,531 MW of wind, 29 MW geothermal and 242 MW in photovoltaic. In 2012 20.654 GWh of electricity from RES were produced [1, 7].

5. Distribution network

The current system of electrical energy distribution is based on large central power generation, which transmits power through systems of high voltage transmission, which is then distributed to distribution systems in medium and low voltage. In general the energy flow is unidirectional and the power is checked and controlled by the center (s) in an order based on pre-defined requirements [11].

The share of electrical energy distribution is a segment of the electrical system, consisting on the primary electrical networks (distribution networks of medium voltage) and secondary networks (distribution networks for low voltage). Electrical energy distribution companies are in charge of the construction, operation and maintenance of these networks.

The primary distribution networks are electrical circuits with three-phase three-wire (three phase), connected at distribution substations and are usually built in the classes of voltage of 15 KV, 23 KV or 34.5 KV.

In these classes of tension, the nominal operating voltage may be 11 KV, 12.6 KV, 13.2 KV, 13.8 KV, 21 KV, 23 KV, 33 KV and 34.5 KV. The levels of voltage: 13.8 KV and 34.5 KV are standardized by law; the other levels exist and continue to operate normally. Primary distribution networks are installed with distribution transformers, fixed on poles, whose function is to lower the voltage level to the primary side voltage level (e.g., for download from 13.8 KV to 220 volts). The secondary distribution networks are electrical circuits with three-phase four wires (three phases and neutral), typically operate at voltages (phase - phase / phase - neutral) 230/115 volts, 220/127 volts and 380/220 volts. These networks are connected consumers, including residences, bakeries, shops, and so on, and also the fixtures for street lighting. These networks serve the large consumption centers (namely, population and large industry, among others). Establishments such as large buildings, shops and markets consume more power, and require individual processors of 75 kva, 112.5 kva and 150 kva. In some cases, the tension between supplies is 380/220 volts or 440/254 volts.

The entire distribution system is protected by a system composed by circuit breakers at the substations where the primary networks are connected, and with key fuse in distribution transformers, which in case of short circuit switch off the power grid [12, 13].

The increasing energy consumption over time may partially explain the rising awareness with the quality of electricity. Namely, in Portugal, considerable improvements on the power systems quality and supply were achieved. The promotion of adequate levels of service quality in the electricity sector is a precondition for the welfare and needs of populations as well as increases on economic activities to become globally competitive [5,6].

The quality of service in the electrical energy sector can be analyzed in its two components [11]:

- Quality of service, regarding its technical nature;
- Quality of service, regarding its commercial nature.

The quality of technical service in the electrical energy sector, also known as electrical energy or power quality is provided through the analysis of [3]:

Reliability of electrical energy supply (continuity of service) measured by the number and duration of interruptions in supply.

Characteristics of the waveform of AC voltage (voltage waveform quality), measured through the evolution of their values of frequency, amplitude, harmonic distortion, unbalance, among others.

The quality of commercial service provided to customers by businesses, whether network operators or retailers, encompasses a range of topics such as: the speed of service, the response to several requests, the meter reading and evaluation of customer satisfaction [6].

Regarding the percentage of losses in the Portuguese electrical distribution network, although energy consumption has increased over time (Figure 4) the percentage of energy loss followed a downward trend, although there is some fluctuation over time [9,10].

Given the scarce fossil fuel resources endogenous domestic production rate losses of electricity distribution networks measured as the ratio of losses and electricity supplies in the period 1997 to 2009, decreased by 1.9 points percentage and found some fluctuations over this period [7].

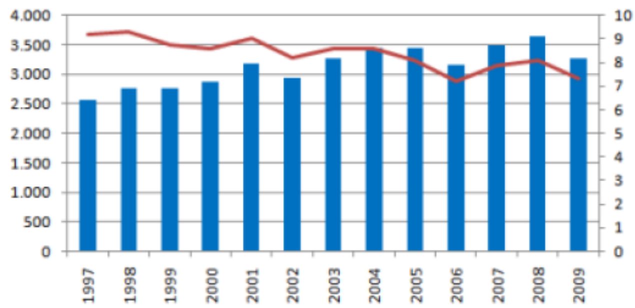

Figure 4: evolution of electrical energy losses in a distribution network. source: [7].

6. State of the art

There are many methodologies in the literature with the purpose to managing an electrical distribution network by calculating the energy losses in a power distribution network in low voltage (LV), but all they have several "gaps" either in their development, often due to being based on empirical data and probability, and/ or in its implementation, because although much discussion about energy losses has been carried out along the last decades, great improvements have not yet been implemented over the time in terms of the software development for supporting to manage electrical distribution networks, which makes it very difficult to make a comparison of what already exists in this area and what is clearly still necessary to be developed and researched, since unfortunately there is still not much information available.

Although the lack of information put available about this subject, some work is already being made and the paper developed by Strauch [14] presents a software for calculating electrical energy losses in distribution networks, in terms of low voltage power, resulting in a flexible business tool, which allows the user to make calculations based on typical data for modeling their networks, based on measurements made on the ground.

In [15] an approach is used based on expert systems, to assist in managing the distribution of LV power, knowing that these systems generally treats a very large variety of variables, many of which expressed through natural language, which turns the systems treatment strongly influenced by experience, trial, human perception and reasoning.

The work in [16] presents a methodology for calculating the energy losses in the secondary network, the primary network and distribution transformers, already implemented and in use at “Companhia Paulista de Força e Luz” (CPFL), in Brazil, along with the GISD system, which is a database for geo-referencing with engineering applications (Planning, Design, Maintenance and Operation).

In [17] the work presents an extensive discussion on fraud and non-technical losses in Brazil, a collection of papers, resolutions and technical documents describing a systemic view on non-technical losses, by identifying the main types of fraud and theft and also shapes and equipment used to minimize or eliminate them. Finally, they analyzed the forms of combat that can also be applied to distributors in other countries.

The work put forward by Méffe [17] refers to a methodology and computational implementation for the calculation of technical losses in the various segments of a distribution system, and some comments about the most critical elements are made, also including some discussion about possible actions to reduce losses.

Moreover, the paper in [18] presents the development of a 3D graphical interface based on virtual environments technology. The referred interface is intended to assist decision making in a computer system for loss reduction in electricity distribution networks.

In paper [11] is put forward a methodology and computational implementation based on real data, obtained through telemetry instead of empirical and probabilistic data, which enables to obtain precise results, namely in terms of losses determination.

Electricity losses are divided in two main categories: technical and non-technical ones, which have to be precisely identified and calculated [19,2,3,11]. Moreover, the system proposed in [11] enables to clearly identify the losses in the distribution network points and activate a mechanism for analyzing and accurately solve the identified problems, by proposing corresponding repairing actions. The system architecture follows a Peer-to-Peer (P2P) structure and includes a Data Base, where all relevant information, including parameters and data about diverse electrical energy losses types are stored, in order to enable an effective and efficient electrical energy information and losses management. The main system functionalities also include modules for billing and payment processing [11].

The paper [20] proposes reduction of energy losses in low voltage distribution network using Lab VIEW as a simulation tool. It suggests a methodology for balancing load in all three phases by predicting and controlling current unbalance in three phase distribution systems by node reconfiguration solution for typical Indian scenario. A fuzzy logic based load balancing technique along with optimization oriented expert system for implementing the load changing decision is proposed by the authors. The input is the total phase current for each of the three phases. The average unbalance per phase is calculated and checked against threshold value [20].

If the average unbalance per phase is below a given threshold value, the system is considered to be balanced. Otherwise, it goes for the fuzzy logic based load balancing approach. The output from the fuzzy logic based load balancing is the value of load to be changed for each phase. A negative value indicates that the specific phase is less loaded and should receive the load, while a positive value indicates that the specific phase is surplus load and should release that amount of load. The load change configuration is the input to the expert system which suggests optimal shifting of the specific number of load points, i.e., the consumers [20].

Network reconfiguration, of distribution systems is an operation in configuration management that determines the switching operations for a minimum loss condition and in [21] an artificial neural network (ANN)-based network reconfiguration method is developed to solve the network reconfiguration problem to reduce the real power loss in distribution networks. According the authors, training-sets for the ANN are generated by varying the constant P-Q load models and carrying out the off-line network reconfiguration simulations. The developed ANN model is based on a multilayer perceptron network and training is done by a back propagation algorithm. The trained ANN models determine the optimum switching status of the dynamic switches along the feeders of the network, which thereby reduce real power loss by network reconfiguration. The authors state that there proposed ANN method is applied to a 16-bus test system and that test results indicated that the developed ANN models can provide accurate and fast prediction of optimum switching decisions for minimum loss configuration. Moreover, their proposed ANN method is compared with the Kim's method [21] and a comparative study is also presented by the authors. The authors refer that their proposed method can achieve minimum loss configuration with drastic reductions in the number of ANNs and less computational time [21].

According to [D], although real power is the main traded commodity in electricity markets, reactive power plays crucial roles in power systems reliability and security. Moreover, the authors in [22] state that the Market participants utilize the network differently to maximize their profits, which means that their effects on the system, such as losses, can also be different. They also refer that the development of a fair and accurate loss allocation scheme for real and reactive power is significant to avoid cross subsidies and to have the correct charge for each participant [22]. Their paper [22] introduces a new method to allocate real and reactive losses in pool-based markets. The basic idea that the authors propose assumes that network users have their own effects on the system as well as their interactive effects which are based on their contributions to currents flows. The authors also state that their proposed method determines these contributions and adjusts them, due to system nonlinearity, according to Current Adjustment Factors (CAFs) [22], and they refer that unlike other approaches, their proposed method can easily and effectively allocate real and reactive losses simultaneously without any additional calculation except the substitution of line reactance instead of resistance. Their proposed method is illustrated on a simple system and tested on the standard IEEE-14-bus and IEEE-30-bus systems, and the authors affirm that their obtained results have shown validity and consistency of their proposed method [22].

The authors in [23] refer that distribution system companies intend to supply electricity to its customers in an economical and reliable manner whereas customers in most distribution system are outspread and connect to distribution system with different type of equipments. Moreover, they state that this equipment usually has various types and resistance together, that produce highest loss and lowest reliability for distribution systems and customers that are not appreciated in networks. Therefore, the authors affirm that distributed generations (DGs) are one of the best reliable solutions for these problems if they are allocated appropriately in the distribution system [23]. Their paper [23] presents a multi-objective function to determine the optimal locations to place DGs in distribution systems to minimize power loss of the system and enhance reliability improvement and voltage profile. Time varying load is applied in their optimization process to reach pragmatic results and all of the study and their requirement are based on cost/ benefit forms. The authors did use an approach based on dynamic programming to solve this multi-objective problem, and according to them, their proposed methodology was successfully applied to a study case and simulation results are reported to verify the proposed approach [23].

Another interesting work is presented in [24], which contributes to the understanding of how bus and area prices are affected by losses and congestion. According to the authors, recent papers have described area pricing to include bus prices that are equal within in a price area or zone. Moreover, the authors state that according to present Norwegian practice, the bus prices within a price area differ by an amount that is due to losses. Therefore, the authors did use a full AC optimal power flow model to illustrate this. Moreover, they also did demonstrate that the combined effect of transmission congestion and losses may yield a substantial change in individual bus and area prices compared with a situation with no congestion or losses [24].

The authors in [25] refer that recently, there has been great interest in the integration of large numbers of small generation and storage resources at the distribution level, and that this will require new control strategies for efficient system performance. Moreover, they affirm that one issue that has not been addressed sufficiently is the coordinated dispatch of large numbers of these units, and in their paper [25] an optimal distribution power flow strategy is proposed and implemented. The authors refer that their proposed algorithm decomposes the overall system problem into two components: economic dispatch for energy and ancillary services based on market prices at the system level; and loss minimization at the distribution level, and a combined quadratic programming and sectioning algorithm is used to find the solution, and their simulation results did show the effectiveness of their proposed approach [25].

In [26] the authors refer that network reconfiguration is one of the feasible methods for reducing the distribution network loss in which the power flow in the distribution network is altered by opening or closing the appropriate switches on the feeders. They propose a geometrical approach for loss minimization, and in their method, each loop in a network is represented as a circle, which is derived from the relationship between the change of loss due to the branch-exchange and the power-flows in the branches [26]. The authors state that if there is no change of loss in the system, then all the circles touch each other at the (0,0) coordinate and the circles with no loss-change are called zero loss-change circles. Moreover, the maximum loss-reduction loop in the network is identified by comparing the radii of all the zero loss-change circles and the corresponding loop of the largest zero loss change circle gives the maximum loss reduction in the network [26]. The authors also refer that the possible branch-exchanges in the maximum loss-reduction loop are investigated by comparing the size of the circle for every branch-exchange and if the power losses are reduced due to a branch exchange, the size of the circle diminishes and hence the smallest circle gives the maximum loss-reduction and the corresponding branch-exchange is considered to be the best candidate for maximum loss-reduction [26]. The authors refer that the performance of their proposed technique was tested on a 69-bus distribution system, and that their test results did show that their method was found to reduce the computational effort and time considerably by reducing the numerous load-flow studies as compared to the method of Baran and Wu [27].

In [27] the authors refer that one of the most basic requirements in cost/ benefit assessments of generation and transmission systems are the costs incurred by customers due to power interruptions. According to the authors, their paper provides a consistent set of cost of interruption data that can be used to assess the reliability worth of a power system [27]. Moreover, in addition to this basic data, methodologies for calculating the customer damage functions and the interrupted energy assessment rates for individual load points in the system and for the entire service area were also presented by the authors, and their proposed model and methodology were illustrated by application to the IEEE-reliability test system (IEEE-RTS) [27].

Another interesting contribution I presented in [28], where according to the authors they present an efficient algorithm for the loss minimization by automatic sectionalizing switch operation in large-scale distribution systems. The authors do also refer that simulated annealing is particularly well suited for large combinational optimization problems, but the use of this algorithm also requires excessive computation time to solve their problem [28]. Moreover the authors state that tabu search attempts to determine a better solution in the manner of a greatest-descent algorithm, but it cannot give any guarantee for the convergence property, therefore, they did apply a hybrid algorithm of these two methods with some adaptations in order to improve the computation time and the convergence property [28]. According to the authors, their numerical examples did enable to demonstrate the validity and effectiveness of their proposed methodology using a Korea Electric Power Corporation’s distribution system [28].

An additional interesting work in [29] introduces development of a user-friendly and quite effectual energy monitoring system which, according to the authors, has been installed in Electrical Education Department of Gazi University in Turkey and in use since November 2007 [29]. The system developed by the authors monitors data in real time, using a powerful energy analyzer, which is capable of measuring many parameters of energy consumed in the building, and the authors state that the real time data measured by the power analyzer are transferred to a host computer via RS485 serial communication protocol and then collected in a database continuously, and that parameters of energy measured are successfully followed, archived, and presented as graphical forms [29]. Moreover, that authors refer that their monitoring system integrates a quite visual and user friendly interface with powerful and flexible hardware, allowing several functions to be performed easily and safely through simple actions and that their system was developed in a university, so it can be used by students to learn energy systems and parameters [29].

7. Proposed model

Interesting work has already being put forward over the last years regarding electrical energy distribution networks management, but there is still some need for further developments, as some very important aspects are still not properly considered and treated by the several existing contributions, regarding sustainable practices, which are urgent to be adopted. This issue about sustainability has emerged in recent decades, by both governments, as well as through economic systems being a word that has been gaining significance in the public domain, including in the broad energy domain, although there is still a lack regarding its effective application for solving real world energy problems, for instance the ones related to electrical energy distribution networks, and this conscience did motivated this study and a proposal of an integrated and extended view of this concept in this context.

Therefore, in this paper we propose a model that besides the already classical branches about economical, social and environmental branches also includes another considered as fundamental branch for enabling fully sustainable practices regarding electrical energy distribution networks management, which is an organizational branch, which is represented in Figure 5.

We do believe that this organizational branch is crucial for a better integration and effective and efficient treatment of the sustainability model because without taking into account specific organizational requirements, in this particular case, of a electrical energy distribution system, nothing else may be able to really work properly.

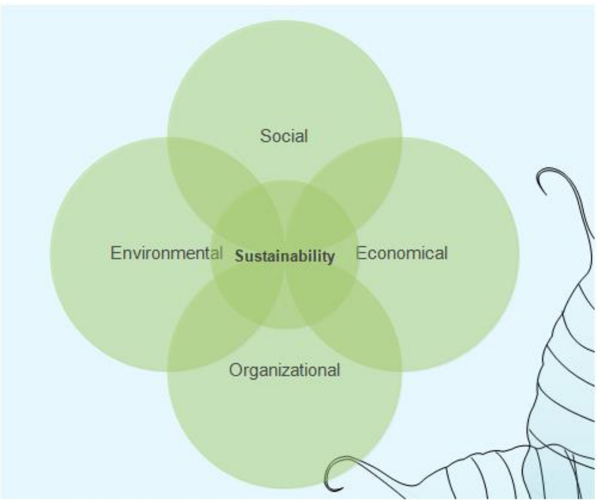

Figure 5: sustainable model for energy network management.

8. Social branch

The development of technologies, models and methods in the energy market, give more importance to the public and their acceptance decisions for investments. This acceptance is imperative when natural resources are used to satisfy present needs and cannot commit to meeting the needs of future generations.

Being the end customer who pays part of the investments and increasingly taking social responsibility, he/ she should be kept informed about the energy system performance, along with the typical information regarding price and other factors. This is particularly important regarding other providers of the same service, so that with their participation models can be evaluated and improved the applied underlying methods.

9. Environmental branch

Everyone one is nowadays conscientious about the importance that has to be given to the natural environment, which of course is of high interest. We all know that the man is the main source of methods of destruction of the world in which we live. Thus, it is of imperative enormous importance to include the environmental component in any model, as it is of upmost importance to provide a less polluted, more sustainable and environmentally friendly world.

We have to be aware of the fact that in Portugal, in a quite similar way as in other countries, the scarcity of fossil resources leads to a high dependence on foreign energy (79.4% in 2012), including imports of primary sources of fossil origin [1-7]. Therefore, it remains of highest importance to increase the contributions regarding renewable energy: hydro, wind, solar, geothermal, biomass.

10. Economical branch

As in any model, economic management is highly important in this matter, and particularly the production, transportation and marketing of energy have to be viable. In Portugal, the transmission losses of electricity decreased by almost half in the period 1997-2009 and distribution losses decreased 1.9 percentage points over the same period [7] but still some increasing efforts have to be taken to accomplish sustainable levels of energy losses.

In relative terms, the oil retains an essential role in the structure of supply, representing 43.3% of total primary energy consumption in 2012, compared to 46.8% in 2011 [1,7].

Investment in research in this area should be taken into account. It is of primer importance to find a method of storing energy in large quantities and over a reasonable period of time, which can enable to change the whole paradigm currently installed on this matter. Many of the peaks of greenhouse gas emissions and production using indigenous fossil could be undertaken by supply from large central energy storage, with production from renewable sources [1,7].

11. Organizational branch

Numerous companies have been created to meet the growing need for energy in the world in which we live. Therefore, including the organizational aspect on the sustainable model promotes education for effective and efficient energy consumption by citizens and, therefore, should be encouraged by organizational/ governmental systems. Therefore, we should reward what it done well, regarding this subject, therefore promoting a low ecological degradation. Thus, it becomes necessary to persist and strengthen the path already started as it is crucial for reaching accurate energy policies and environments, as they are not a threat to the economy, on the contrary, they may contribute to increase the economic competitiveness of a country as well as to enable a better and faster development of indigenous resources and to promote creating added value, along with more jobs and thus enabling to better prepare the future on the energy context. Therefore, some important characteristics that are put forward in this paper, regarding the organizational aspect of the proposed sustainable model are briefly summarized next.

Proposed model and underlying framework characteristics

The proposed model intends to enable to fully support an integrated framework for monitoring and managing an electrical energy distribution network. The proposed framework features to allow for the definition of an interface for each user, customizing and configuring a decision support system (DSS) according to each specific interests and needs along an energy distribution network. The DSS should also to be easily adapted and new features implemented, according to future specific requirements. Important features includes the possibility of characterization of the distribution network, including the geodesic survey, the physical description in terms of infrastructure, the technical and behavioral characteristics of the network, and the assessment of connection points and ways of connecting networks and customers, along with technical information retrieval and calculations, namely regarding energy losses determination, including technical and nontechnical ones.

Moreover, in order to come to an effective analysis of the quality of customer service, by the operator of a distribution network, the DSS should be fully implemented and put forward for a daily base use by each person acting along the electrical energy distribution network. The main objective is to allow, measuring and continuously localizing problems, for instance energy losses, in order to obtain information about real-time behavior, including about the power quality and the overall service provided to the organizational stuff.

Another important goal of the proposed framework is to be able to offer various features that may help providing essential information about the quality of service to each individual customer, allowing them to be proactive on the resolution of potential problems.

Among the expected general benefits is the enhancement of the overall improvement in quality of service, the significant reduction in response time to failures along an electrical energy distribution network, along with a better customer service line. The quality of service is a current need of the markets; the system service quality and efficiency record all complains cuts and changes in delivery of consumption, among other data. These data enable the customer to analyze and verify the service that is being provided as well enable the supplier to access the needs for action by using a combination of automatic and manual processes.

The framework should also allow a continuous acquisition and recording of events on file that result in the detection of anomalies related to several distinct problems, for instance regarding power quality and losses management, among many other important electrical energy distribution control parameters. The information gained can, therefore, be viewed in tables and/ or graphics, and thereafter generate reports in order to provide full support a real-time decision-making process for accurately manage an electrical energy distribution network. Another important aspect consists on enabling different kind of reports to be sent directly to the printer and inserted into other windows applications for further use, and can also be accessed via the Internet by using a web browser, along with other kind of peripherals.

Another important feature of the proposed framework is related to the possibility of being integrated with other systems or sub-systems, taking advantage of the potential it has for communicating with Internet applications based on web technology, for example, by implementing remote access to systems for data acquisition or even to use wireless technology.

Therefore, some important technical aspects of our proposed framework include: the identification of all TC's within a electrical distribution network; their geographical location (map with TC's in Google Maps with photograph of the site; the control of leakages and losses on TC; the identification of types of clients at any given TC; the emission of several different kind of reports, namely related with electrical energy consumption per day and respective tariff. This last feature is expected to support the analysis of the consumption time pattern. Other system features include the possibility of sending early warnings via SMS, GPRS or email in case of failure or other problems arise. Moreover, the framework also intends to be of great importance for collecting readings between previously defined time intervals, e.g., every 15 minutes from all counters, or to control the time of technical interventions for repairing and/ or maintaining the TC's, including the index points of failures, consumption, losses, and necessary interventions management.

Summarizing, the main characteristics of the proposed framework, underlying our proposed sustainable model for enabling to accurately manage an electrical energy distribution network, as previously shown in Figure 5, intends to enable to:

- Identify all TC's. Geographical location (map with TC's in Google Maps with photograph of the site, used "snapshot" and contracted power), with information on the type of TC urban distribution (in cash), rural distribution, air (suspended pole) with cooling dry or oil), public or private.
- Control electrical energy leakages and losses,

namely on TCs (global, technical and nontechnical ones).

- Identify the types of clients at each TC (micro ordinary consumers or producers) to detect whether there is injecting electricity network, or just usage.
- Reports with consumption per day and respective tariff to allow analyzing the times of highest consumption, compared to the same period (e.g. minute, hour, day, week, month or last year). This capability allows appropriate consumption management and analysis of the evolution over time through graphical and/ or table results for future prediction.
- Reports to the average (e.g., monthly) consumption for information and verification of the moments of greatest consumption, and thus know if there is a power surge at a given time interval or instant and prevent any failure of distribution and/ or marketing of energy.
- Reports to compare the number of customers in the previous moment (e.g., year), for information and verification of developments over time.
- View existing records to request a new network connection, which shows the power that the consumer requests and the voltage level of the request. Based on the information in the completed form online, the network manager can determine the need to conduct a study (which integrates the data contained in the request) in order to support the implementation of the budget to present to the requester.
- Early warning system via SMS, GPRS or email in case of failure, inconsistency of consumption, fraud, power and voltage exceeded the maximum permitted by the TC, among others.
- Collection of readings every considered needed instant or interval, (ex. Each 15 minutes) from all counters, at a certain time automatically or by user request in real time and instantaneous.
- Control the time of intervention of technicians to repair and/ or for maintaining each TC.
- Conducting comparative analysis about all TC's installed, including the index points of failures, consumption, losses, and necessary interventions, among others.
- Management of phases in case of failure or technical assistance for improved performance in cutting time.

12. Conclusions

In this paper an extended model for sustainable energy network management, where the organizational element assumes a crucial function, was proposed and briefly described.

In order to enable to put the proposed model to work, in practice, a fully integrated framework was also proposed for monitoring and managing an electrical energy distribution network. The proposed framework features to allow for the definition of an interface for each user, customizing and configuring a decision support system (DSS) according to each specific interests and needs along an energy distribution network. The DSS should also to be easily adapted and new features implemented, according to future specific requirements. Important features include the possibility of characterization of the distribution network, namely the geodesic survey, the physical description in terms of infrastructure, the technical and behavioral characteristics of the network, and the assessment of connection points and ways of connecting networks and customers, along with technical information retrieval and calculations, namely regarding energy losses determination, including technical and nontechnical ones.

Some other important technical aspects of our proposed framework include: the identification of all TC's within an electrical distribution network; their geographical location (map with TC's in Google Maps with photograph of the site; the control of leakages and losses on TC; the identification of types of clients at any given TC; the emission of several different kind of reports, namely related with electrical energy consumption, e.g., per day, and respective tariff. This last feature is expected to support the analysis of the consumption time pattern. Other features include the possibility of sending early warnings via SMS, GPRS or email in case of failure or other problems that do arise along the electrical energy distribution network. Moreover, the framework also intends to be of great importance for collecting readings between previously defined time intervals, e.g., every 15 minutes from all counters, and to control the time of technical interventions for repairing and/ or maintaining the TC's, including the index points of failures, consumption, losses, and necessary interventions management, among others.

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