

REVIEW OF ASSET MANAGEMENT IN DISTRIBUTION SYSTEMS OF ELECTRIC ENERGY - IMPLICATIONS IN THE NATIONAL CONTEXT AND LATIN AMERICA -

Daniel NIETO
Jujeña Energy Company S.A.-
Argentina
dnieto@ejesa.com.ar

Juan Carlos AMATTI
Rio Cuarto National University-
Argentina
jamatti@ing.unrc.edu.ar

Enrique MOMBELLO
San Juan National University-
Argentina
mombello@iee.unsj.edu.ar

ABSTRACT

This work is intended to present the development of a research particularly oriented towards the highest preponderance assets, such as distribution transformers. Research started from the evolution and development of asset management in electrical utilities, especially in electric energy distribution utilities, and the implication that asset management may have in our Nation and in Latin America, as an essential base to provide satisfaction to the customers, from improvements in the company's performance. This work also aims to analyze various options for asset management at different time frames, with direct implications in the development of the company's work. Conclusions related to the main items that influence asset management utilities are presented at the final part of this work.

INTRODUCTION

The term Asset Management comes from the Economics and Finance sector. It also refers to investment portfolios, bonds, cash and other financial instruments [1]. In the non-economic sphere, ISO 55000, 55001 and 55002 regulations have been developed to define the term physical asset management [2, 3, and 4]. Prior to the ISO standards, The Institute of Asset Management (IAM) developed the standards PAS 55-1 and PAS 55-2 [5, 6], created at the beginning of the last decade. PAS standards have now been fully replaced by ISO standards. The concepts concerning physical asset management have applied in the last two decades in different fields of Engineering, particularly the one related to Electrical Engineering in electrical power systems. In spite of the apparent simplicity of this term, today it has an enormous scientific content and practical applicability. Asset management is being discussed today at both national and international scenarios. Based essentially by the changes in the regulatory frameworks of electric markets, regulating and increasing competition in today's electricity markets encourages power utilities to optimize the use of their equipment, focusing on technical and economic aspects [7].

It should be reckoned that restructuring in the electric power industry has established a series of constraints, on assets in generation, transmission and distribution, to provide electricity to customers [8]. Using management, engineering and information techniques, in the modern

context of electric markets, asset management is used to resolve a natural conflict of interest between shareholders of utilities that are natural monopolies and regulators [9]. So the biggest challenge for service utilities is to align asset management with corporate objectives.

The techniques of asset management proposed by different authors [10, 11, 12, and 13] are focused towards electrical systems according to their local characteristics, and some could not be applied in Latin America systems because of the different structures and singularities they have. Each case must be studied individually considering the circumstances of the environment to which the systems under analysis belong, even with the use of standards. Asset management allows to use methodologies and tools that can be applied to energy distribution utilities with the characteristics of Argentina and Latin America, which would allow to maintain and / or increase in a significant way the efficiency and reliability, as well as to positively influence aspects related to the environmental impact and carbon emissions that nowadays are of great importance due to the greenhouse effect.

This paper presents a study of asset management in Argentina and Latin America, focusing essentially on asset management in distribution utilities.

PHYSICAL ASSET MANAGEMENT

Asset management, in its more general definition according to ISO standards, "involves the balance of costs, opportunities and risks against the desired performance of assets, to achieve organizational objectives." Asset management enables an organization to examine the need for assets, asset systems and the performance of assets at different levels. In addition, it enables the application of analytical approaches to the management of an asset across the different stages of its life cycle (which can begin with the conception of the need for an asset, up to its disposition, and includes the management of any obligation potential after disposal). Figure 1 describes the asset management system (A.M.S.) developed in ISO 55000 standards.

For companies whose work is based on the exploitation of physical assets in the field of the electricity market is essential to determine the actions to ensure the highest return of all the goods, throughout the lifecycle of assets, there are complex interactions between acquisition costs, setup, maintenance, availability, reliability and other factors that make it difficult to accurately determine the

proper management of such assets altogether. By including the future planning of the operation, the importance of having a tool to manage physical assets, considering the possible scenarios and the interests of the organization, is noticed.

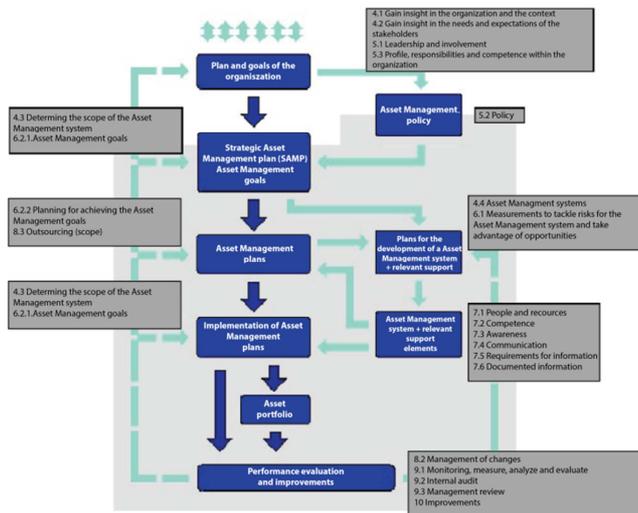


Figure 1. Asset Management System according to ISO 55000 Standards.

ASSET MANAGEMENT CONCERNING ELECTRIC ENERGY DISTRIBUTION COMPANIES

Generally, the electricity distribution utilities are composed of electrical devices for switching and protection, medium voltage lines, low voltage lines as well as other necessary elements to provide the electric power supply.

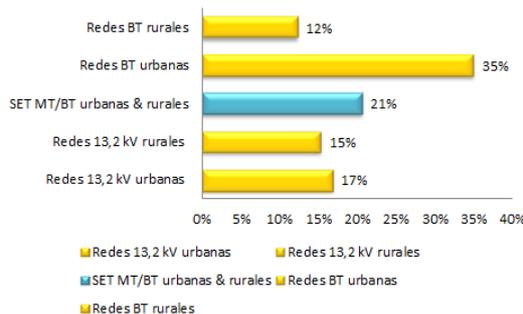


Figure 2. General Composition of Assets in Distribution Utilities.

On the other hand, they have transformation sub stations, aerial, level and underground, distributed along a geographical area or area of concession to which they belong by being related to the company. The characteristics of distribution utilities can vary in size, complexity and quantity of equipment. Considering the sub stations, in general, they have a distribution transformer, whose power depends on its geographic location and quantity of customers supplied. From the investment point of view, the percentages of each group

of assets in distribution utilities can be observed in general terms; Figure 2.

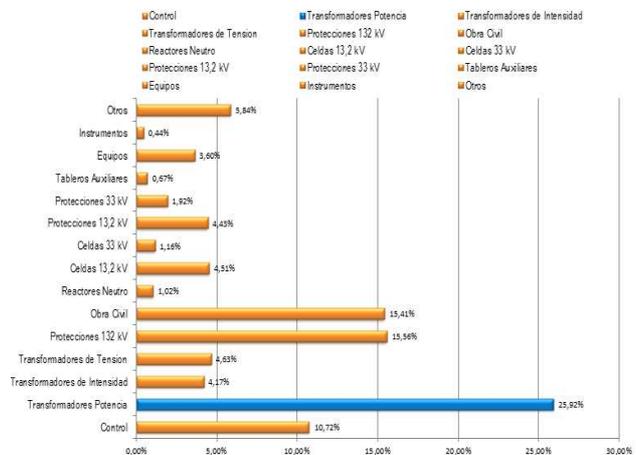


Figure 3. General Composition of Assets in Transport Utilities.

It should be considered that these values can vary according to the characteristics of the type of electricity distribution utilities, that is, if they have rural extension networks, high concentration density of transformation sub stations, few kilometers of medium voltage lines, etc. As a comparison, the percentages of investments for transmission utilities are shown in Figure 3. According to the analysis, in the distribution utilities, although the distribution transformer usually does not represent the asset with the highest investment, it should be noted that it is the most sensitive asset from the point of view of reliability and security in distribution systems. The importance of transformers as assets can vary from one company to another, there are utilities that can have thousands of distribution transformers and necessarily must maintain a continuous control and expansion of their transformation system, depending on the increase in customer demand. Power transformers, characterized by primary voltage levels, used for transport and sub-transport, although they may have a significant cost, the amount is very low in comparison, and the maintenance needed is very high.

On the other hand, in the area of distribution, transformers behave differently from power transformers, with differences like normally unbalanced loads, loads with harmonic contents, absence of complex protections, as well as differences related to the design, cooling systems, current density and insulation materials. Because of this, the reality of the distribution utilities regarding the transformers as assets is very different from the transport utilities. There's a lot of reference literature, in terms of power transformers as physical assets, which is part of power systems. Some authors have been working on this asset [14, 15, 16, 17, 18], focusing on aspects such as remaining life, risk analysis, types of maintenance, replacement strategies, and investment considerations.

ASSET MANAGEMENT SITUATION IN ARGENTINA

In Argentina, the distribution of electric power is considered a public service because of its condition as a natural monopoly. Its regulation is the setting of the prices to be applied and the control of the quality of the service supply. In Argentina there are 75 electric energy distributors Agents of Wholesale Electricity Market (M.E.M.) and 590 Non-Agents, the latter are Electric Cooperatives of public services, distributed in fifteen provinces of Argentina. Electric Cooperatives are defined as an autonomous association of people who voluntarily join to create an organization, which allows it to provide the electric energy distribution service.

The largest company, considering the number of customers supplied until the 1990s was Electrical Services of Greater Buenos Aires (S.E.G.B.A.). Due to the transformation of the electricity market in 1992, it was divided in 3 distribution companies, currently EDENOR, EDESUR and EDELAP. These companies are in charge of the distribution of electric power in the area that supplied S.E.G.B.A. and represent more than 45% of the electricity distribution market in Argentina. These 3 utilities are the largest in Argentina, under the previous consideration related to the number of customers supplied. Likewise, the electricity distribution market is made up of 75% of private companies, with only a few distribution companies (State Energy Company of Córdoba, Santa Fe Power Utility, Energy of Misiones, etc.) owned by provincial governments and cooperatives. The panorama of the large national companies in the field of investments presents a clear and important delay that can be seen in the numerous power supply cuts, as power demand increases in either summer or winter seasons, and the state of their distribution systems related to remaining life and reliability. The scales and situations of distribution companies in Argentina, as indicated above, range from companies with millions of customers supplied, to companies with hundreds of customers connected to the electricity supply network [19]. Therefore, the number of physical assets belonging to these is directly proportional to the number of customers they supply. It is known that the management of assets in large companies implies the development of much more complex methodologies, in relation to the smaller ones.

Nowadays, the distribution companies that operate in Argentina are specially interested in the regulatory framework working in a way that assures them an adequate financing of the necessary investments and a reasonable return on the invested capital. Thus, activities dedicated to the management of physical assets are not currently on the agenda. Although the internationally recognized interest in this topic has influenced local utilities to invest efforts and resources, not strictly organized in relation to the implementing standard, to achieve the goals of asset management.

Particularly, the aspects related to the management of

their networks for intelligent electricity grids or to the development of Distribution Management Systems (DMS) that normally originate with SCADA systems and G.I.S. (Geographic Information System). Standardization organizations in Argentina such as I.R.A.M. have created a committee dedicated exclusively to the issue of physical asset management. Also, C.I.G.R.E.-Argentina, for more than a decade, started its activities with its Study Committee on Development and Economics of Electrical Systems, which deals with one of its aspects, the subject mentioned [20]. This way, national research and standardization organizations take this issue as a problem to be solved, taking into account the recognition given to the situation in terms of demand growth [21], and the associated difficulties that this sector must face.

SITUATION OF ASSET MANAGEMENT IN LATIN AMERICA

Electricity distribution utilities in Latin America must deal with situations related to a regulated market [22]. In countries such as Chile, Peru, Colombia and Brazil, the payment system is applied according to the "incentive regulation" model, in which a price with a temporary trajectory of 4 or 5 years is fixed. This way, the company has an incentive to reduce costs to obtain benefits and achieve greater profitability. This requires the theoretical design of optimal networks, capable of supplying the load actually distributed by the company, whose cost is the base rate of assets to be recovered, to achieve economic efficiency. In Paraguay and Bolivia the rules establish a mechanism of coverage of costs of the service, plus a rate of profitability. In Ecuador the remuneration covers only the depreciation of the investments and the State covers the costs of expansion of the network. In Uruguay, the prices for final consumers and the implied remuneration of the distributor are determined by the government at the proposal of the regulator. It can be seen that each country seeks to adapt its electricity sector to the energy sources it has, technical characteristics and institutional models. In [23] a detailed study of the regulations and regulations for each of the countries of Latin America in the framework of the electric market is carried out. The companies related to the distribution sector in Latin America, according to the research developed, are characterized by dissimilar activities in terms of asset management policies. On one hand, countries such as Chile, Brazil and Colombia have developed an important advance in this matter, while others have little interest. In [24] a study regarding asset management in generation, transmission and distribution is described. In figure (4) characteristics of the Policy and Strategy in Asset Management in the Electric Power Distribution Sector are showed. The figure shows that there are clear differences related to the treatments of this subject in the countries studied. If the average of this group of countries is taken as a reference, it is less than 50%, due to the fact that the energy that is distributed and consumed in these

countries is close to 57% of the entire Latin American region.

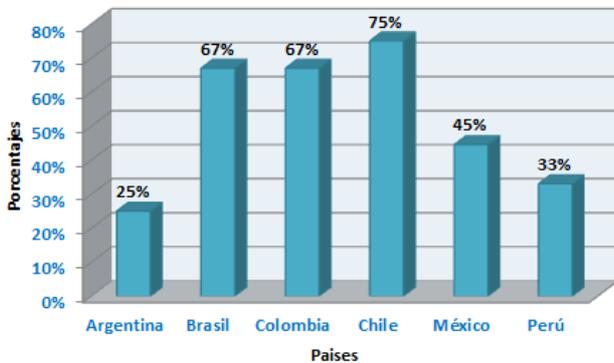


Figure 4. Percentages related to Policy and Strategy in Asset Management in the Electric Power Distribution Sector in Latin American countries.

In the case of Mexico, it was verified that it has a percentage of value equal to 45% in studies of asset management in the distribution sector, according to different developed organisms, such as the Mexican Association of Asset Management (A.M.G.A.), and Institutions like Procobre México, the Mexican Institute of Normalization and Certification (I.M.N.C.), and the National Association of Standardization and Certification of the Electricity Sector (A.N.C.E.).

The above chart also corroborates the lack of development of asset management in Argentina's distribution systems, a situation mentioned before. The case of Chile should be considered; the regulator of the country uses the information of the assets to establish the values of the electric service prices. Brazil, according to the document [25, 26], developed by National Agency for Electric Energy (ANEEL), seeks to establish short-term actions in asset management, basically actions related to the implementation of G.I.S. applied in distribution assets and accounting information, and through this, identify business critical assets. In general, within the thematic area and for the group of countries mentioned, the area of least development in asset management is linked to the life cycle analysis, which has an average value of 24%. Then the area of study and information on performance of critical assets and replacement of assets, does not reach 45%. Finally, the most developed is in the area of inspections and maintenance of critical assets, which reaches 70%. However, based on the information analyzed, there are no significant contributions and advances in the area of distribution. This way, although the issue was treated more than two decades ago, it seems that the Latin American electricity distribution sector is in an incipient state in terms of asset management. Therefore, each company interested in solving its Asset Management problem must develop, as an initial step, a management model which must be consistent with corporate objectives, knowing and accepting that each company is a particular case of analysis and study.

STUDY OF ASSET MANAGEMENT WITH DIFFERENT TIME FRAMES

Here we present analysis related to the management of assets considering different time frames.

Management of Short-Term Assets in Electric Energy Distribution Systems (EEDS)

These include real-time operation tasks, online monitoring, equipment and network control. In order to develop asset management, taking the distribution processor as the most sensitive element, in the short term, the application must contain all the necessary and detailed information of the asset, which is useful and relevant, leading to the optimization of analysis and actions to be developed. The application of systems of management of the electrical network like the G.I.S. can help to develop these goals in the short term. Reliable and safe information should be part of the characterization of the asset, among them, location coordinates, date of installation, nominal power, nominal voltage, date of last maintenance performed, operator who performed, number of customers supplied, brand, model and asset failure history should be considered. Online monitoring is done through SCADA systems which provide information regarding the performance of the asset.

Medium Term Asset Management in EEDS

This should be used to study aspects related to the remaining life and handling of investments on the asset or fleet of assets. For distribution transformers, actions based on the maintenance of the assets must be established and applied, and an option is to use maintenance focused on reliability. The maintenance tasks should be programmed and evaluated not only according to the times involved, but also in terms of the costs invested. Different reliability engineering tools are used to implement an optimized maintenance strategy. Another feasible tool to use is the so-called asset health index, which can cover the substation to which the distribution transformer belongs, together with all its components, or the distribution transformer as the only element.

Management of Long Term Assets in EEDS

Long-term scenarios typically develop information analysis features for asset renewal decision making. The distribution transformer is an asset which, with adequate maintenance, can have a life of approximately 30 years [27]. In the long-term asset management strategies, the knowledge developed based on short- and medium-term strategies is fundamental. Strategic risk management should be considered in order to evaluate the way assets are exposed and thus know the critical assets, those that require greater maintenance and money investment, during the use of the asset. Also important are the assets that, according to the technology used, offer better returns.

CONCLUSION

The Latin American sector as a whole presents an incipient development of this topic, although there are countries such as Brazil and Chile, which have a different behavior, mainly by the regulatory frameworks that apply to them or by state policies at agency or Regulators, which indicates a possible way to establish concrete actions in relation to the management of its assets. In the rest of the countries there are scarce levels of treatment around asset management. However, it is possible to establish the tendency to use tools of the management of the electrical network as the systems G.I.S. and SCADA as a means to achieve short-term asset management. In general terms, asset management remains an unknown subject in depth for most of the utilities that make up the electricity distribution sector and it is necessary to invest more research efforts in this field. It is expected that the adoption and application of ISO 55000 standards will improve the future scenario, although the management of assets in distribution utilities will always imply a corporate decision with objectives and time horizons depending on private utilities.

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