International Journal of Physical Sciences and Engineering
Available online at http://sciencescholar.us/journal/index.php/ijpse
Vol. 1 No. 3, December 2017, pages: 1~8
e-ISSN : 2550-6943, p-ISSN : 2550-6951
http://dx.doi.org/10.21744/ijpse.v1i3.53

The Future of Micro-Grids in Ecuador

Wilber Manuel Saltos Arauz [a]; María Rodríguez Gámez [b]; Antonio Vázquez Pérez [c]; Guillermo Antonio Loor Castillo [d]; Lenin Agustín Cuenca Alava [e];

Article history: Received 10 August 2017; Accepted in revised form 15 November 2017; Approved 25 November 2017; Available online 1 December 2017

***Correspondence Author* [a]**

Abstract

An analysis is made on the development of power lines worldwide and that offer the approaches of the impacts that are generated in the economic and environmental, which justify the application of smart grids in Ecuador, as an effective way to raise the efficiency of the electric power service and to achieve a more efficient use of the energy that is generated by showing the different technologies used in electricity generation where renewable energy sources are incorporated. A comparative analysis of how the installed generation power has been increasing until 2016 is shown.

Keywords

Electricity generation;
Energy efficiency;
Impacts;
Renewable sources;
Smart-grids;

[a] Universidad Técnica de Manabí, Faculty of Mathematical, Physical and Chemical Sciences, Portoviejo, Manabí, Ecuador
[b] Ph.D. Universidad Técnica de Manabí, Faculty of Mathematical, Physical and Chemical Sciences, Portoviejo, Manabí, Ecuador
[c] Doctor Aspiring Universidad Técnica de Manabí, Faculty of Mathematical, Physical and Chemical Sciences, Portoviejo, Manabí, Ecuador
[d] Doctor Aspiring, Universidad Técnica de Manabí, Faculty of Mathematical, Physical and Chemical Sciences, Portoviejo, Manabí, Ecuador
[e] Doctor Aspiring, Universidad Técnica de Manabí, Faculty of Mathematical, Physical and Chemical Sciences, Portoviejo, Manabí, Ecuador

Contents

1. Introduction

Since in 1882 the American inventor Thomas Alva Edison developed and installed the first large power station in the world in New York [1], the processes of generation, transportation, distribution and marketing of electricity have been governed by the pace of demand and the exponential increase in the consumption of electric energy on a social scale. During the first half of the 20th century, the use of oil as the energy carrier par excellence was enshrined and with it an increasingly centralized generation system was formed, based on monumental thermoelectric plants, with extensive transmission networks and a complex managed distribution system with network operators specialized in maintaining the balance between supply and demand of energy permanently.

For the second half of the twentieth century in the first world countries, the centralized systems of generation, transport, and distribution of electricity, were reaffirmed as a technical paradigm capable of guaranteeing and extending the electric service in the internal plane of the countries and transferring the national borders; but the successive energy and environmental crises motivated by the over-exploitation of natural resources, has called into question the capacity of the current energy matrix to continue supporting the current conditions of the economic and social development of humanity.

The successive increase in the price of fossil fuels and the pressing situation derived from the environmental impacts associated with the widespread use of energy resources that are part of the planet's endowment [2] have accelerated the irruption of renewable energy sources in the world. energy panorama, notably changing the energy flows in the network and the adoption of a new philosophy based on the principles of distributed generation, where users not only consume, but also produce electricity through the same network and therefore, the flow of energy is no longer just one-way, charging more and more a bidirectional sense.

The gradual consolidation of a new energy paradigm based on the concepts of sustainability and based on the universal right of humanity to access services imposes the transition towards a novel and diverse energy matrix, which can no longer be effectively managed with the traditional methods of network operation.

The dynamic integration of electrical engineering developments and advances in information technology and communications within the Electric Energy business require that the areas of Protections, Control, Instrumentation, Measurement, Quality and Energy Management Coordination, they are linked in a single Management System with the primary objective of making efficient and rational use of energy. Smart grids are called to fill this technical space that can not be managed with the traditional methodology of network operation.

The electrical network is now the center of technological innovation, influenced by economic, political and geographical factors, for its incorporation into the company can apply different technologies such as: Geographic Information System (GIS), Advanced Metering Infrastructure (AMI), System of Court Management (OMS), System of Acquisition, Supervision and Control of Data (SCADA), Demand Management Systems (DMS) and Distribution Automation (DA) [3], among others.

For the geographic focus in the REI, there are the GIS, which are able to provide artificial intelligence to the solution of the problems and conflicts of the network, serving as a basis for its implementation as a decision platform, data capture, smart meters, analysis of consumer behavior, computerized structure of information in a geographical context [4], these can also be used: in public service companies; in the management of data and assets; operational management; work orders; and to provide the customer information, allowing us to know the optimal location of measurement systems, the incorporation of renewable energy and energy efficiency, being a viable tool for the fulfillment of functionality in the implementation, planning, automation and analysis, ensuring the objective perception of the situation of the system and the projects at spatial levels [3].

The objective of the research work is focused on justifying the technical, economic, social and environmental conditions for the introduction of smart grids in the Ecuadorian electrical system.

2. Research Method

To carry out the work, different bibliographic reviews were carried out aimed at showing the technical, economic and scientific potential of Ecuador for the introduction of the smart grid infrastructure in the country's energy development.

National and international documents related to the subject were reviewed and an analysis was made of the current structure of the Ecuadorian electrical system and its possible future growth with the penetration of renewable technologies, mainly hydraulics and grid-connected photovoltaic systems. the load, starting from the principle that the key of the future are micro-networks, small and autonomous systems with a combination of renewable and conventional technologies adapted to each particular case, that allow individuals, communities and companies to generate their own electricity, as well how to sell surpluses to the main network [4].

The analysis-synthesis method was used in the study of the available bibliographic material. The historical-logical for the offer of precise considerations relative to the logic of the development of the international energy scheme, since its evolution in previous centuries. The induction and deduction method, to reveal the existence of the content of our object of study, to obtain our own conclusions, thereby allowing us to deduce the essences, causes and why of the foundations and proposals raised.

3. Results and Analysis

Intelligent electricity networks (REI) can be defined as a form of efficient electricity management, where computer technology is used to optimize the production and distribution of electricity, in order to better balance supply and demand between producers and consumers.

Among the newest features of the REI is the ability to offer a detailed billing by time slots, allowing consumers not only to choose the best rates but also to discern between the hours of consumption, which would allow a better use of the network. The system would also allow us to more accurately map consumption and better anticipate future needs at the local level.

The automatic reading of the meter is the technology of automatic collection of consumption, diagnosis and status data of the electricity meter and the transfer of said data to a central database for billing, problem-solving and analysis. This advance saves service providers mainly the expenses of periodic trips to each physical location to read an accountant. Another advantage is that billing can be based on consumption almost in real time and not on estimates based on anticipated or previous consumption. This updated information, together with the analysis, can help both public service providers and customers to better control the use and generation of electricity.

The technical equipment includes portable, mobile and network technologies, based on telephony platforms (wired and wireless), radio frequency, or the electrical transmission that is the most used for electricity.

As an important element to point out, it is the fact that in Ecuador the system of electrical lines and networks is digitized, constituting a technical starting element in order to facilitate the introduction of the REI.

An REI is capable of supplying electricity from suppliers to consumers using bi-directional digital technology, to control consumer needs. This helps to save energy, reduce costs, increase the usability and transparency of management, encouraging the efficient use of energy and reducing CO_2 emissions into the atmosphere.

Information Technology and Communications Technologies (ICT) have been revolutionizing industrial and technological processes. The introduction of REIs is a milestone in the new perspectives of the management and development of services in electricity distribution networks, for the maximum use of energy generated by different sources.

The technologies associated with REIs are introduced in the market depending on the characteristics of each country. In Ecuador, there are currently different sources of generation [5]. In Figure 1, we can see the types of sources that are interconnected in the National Electric System, being able to note that hydraulic energy is one of the most important and there is a program to install approximately 6,780 MW in 2016. The comparative values of the installed power are already observed in 2016 [2].

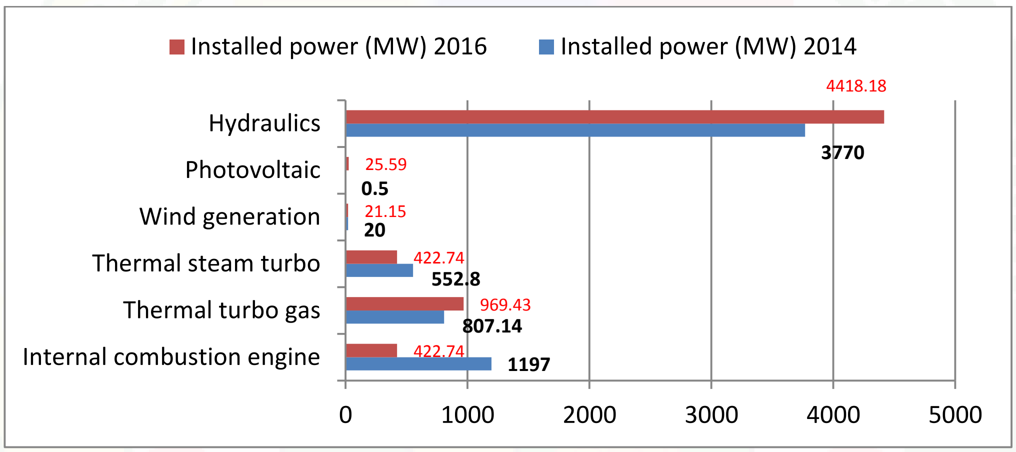

Figure 1. Comparison between installed capacity in 2014 and 2016

Parallel to the development program on the use of hydraulic energy, it is planned to gradually replace the domestic cooking of food that is now based on gas, with the introduction of more efficient, hygienic and less risky induction cookers, enabling an additional availability of gas that will be used for electricity generation through efficient and less expensive processes.

The distributed generation mode incorporates concepts that are interesting for users, generating energy close to the load centers. Renewable sources of energy are incorporated as elements of the system distributed in the territory, being participants of the different forms of generation.

REIs can modulate the insertion of renewable sources of energy into the power electrical system, having a greater use of automation as a new product of the system, including the automatic reading of electricity meters, expanding the accessibility to integrate and connect different generation technologies.

For countries like Ecuador that are currently engaged in social development programs, where energy has a priority for the country with the implementation of plans for the insertion and incorporation of new hydroelectric plants and significant changes in the energy matrix, from generation to consumption of energy, is a revolutionary change where distributed generation acquires a more active participation by the user, achieving greater employment in the automation and distribution of information as well as in the control of consumption.

As part of the planning and innovation carried out by the government of Ecuador in the electricity sector, the Ministry of Electricity and Renewable Energy, with the support of several actors in this sector, presented the Intelligent Networks Program Ecuador, which seeks to incorporate a new model of management of the electrical system, sustained in advanced technologies of measurement, monitoring and communication, and that it involves from the generation to the consumption of the electrical energy [6].

This program seeks, among its objectives, to optimize the way of planning and operating electrical systems, improve the quality of service, offer timely responses when imponderables occur and know how customers consume electricity.

With this modernization of the electrical system, it will be possible to obtain a real-time record of everything that happens in the elements of the energy system through which electricity circulates, from generation sources to final customers, which is also part of the process of energy efficiency led by the Ministry of the industry.

Ecuador is a pioneer in the region in the implementation of smart grids, as several initiatives are underway, among the most important: change and diversification of the energy matrix through the development of renewable energies (8 hydroelectric projects, 1 wind, several photovoltaic and biomass), new transmission infrastructure in 500 thousand volts, modernization and incorporation of cutting-edge technologies for network management, distribution and supply of electricity [7].

The fundamental objective of the new smart electrical infrastructure is to reduce losses and achieve energy efficiency by taking advantage of the generation and distribution networks of the service that they currently have [7], thereby making the most of the infrastructure they have, in addition to making improvements that will allow the parallel incorporation of communication networks in the country's energy infrastructure.

At the same time, it will be necessary to assume a regulatory framework that facilitates the ordering of social relations derived from the new energy scheme and its control [8], enabling the fulfillment of the political will deployed in terms of reducing the consumption of fossil fuels and achieving adequate management environmental derived from the energetic function.

This program seeks, among its objectives, to optimize the way of planning and operating electrical systems, improve the quality of service, offer timely responses when imponderables occur and know how customers consume electricity.

With this modernization of the electrical system, it will be possible to obtain a real-time record of everything that happens in the elements of the energy system through which electricity circulates, from generation sources to final customers, which is also part of the process of energy efficiency led by the Ministry of the industry.

Ecuador is a pioneer in the region in the implementation of smart grids, as several initiatives are underway, among the most important: change and diversification of the energy matrix through the development of renewable energies (8 hydroelectric projects, 1 wind, several photovoltaic and biomass), new transmission infrastructure in 500 thousand volts, modernization and incorporation of cutting-edge technologies for network management, distribution and supply of electricity.

The fundamental objective of the new smart electrical infrastructure is to reduce losses and achieve energy efficiency by taking advantage of the generation and distribution networks of the service that they currently have [9], thereby making the most of the infrastructure they have, in addition to making improvements that will allow the parallel incorporation of communication networks in the country's energy infrastructure.

At the same time, it will be necessary to assume a regulatory framework that facilitates the ordering of social relations derived from the new energy scheme and its control, making viable the fulfillment of the political will deployed in terms of reducing the consumption of fossil fuels and achieving an adequate environmental management derived from the energy function [10].

4. Conclusion

REIs are a form of efficient electricity management, combining the efficient use of computer technologies to optimize the production and distribution of electricity, in order to better balance the supply and demand between producers and consumers.

In Ecuador, important transformations are being carried out aimed at the transformation of the energy matrix, which includes the processes of generation, transportation, distribution, supply, and consumption of energy, gradually assuming the introduction of the concepts associated with the distributed generation model such that the maintenance of the traditional operation scheme of the network can be very complicated, so it is necessary to assume the scheme of the REI in such a way that the efficiency of the electrical system is assured in the new conditions.

Acknowledgements
The authors thank for the contributor of ScienceScholar Publishing for their review, editing as well as advice to publish the present study.

References

1. Albornoz, I. (2006). Software para el sector agropecuario. *Littec, Buenos Aires*. View in (Google Scholar) (Scopus)
2. Arauz, W. M. S., Cedeño, G. I., Chávez, S. S., Pérez, A. V., & Gámez, M. R. (2017). Microgrid With a 3.4 kWp Photovoltaic System in the Universidad Técnica de Manabí. International Journal of Physical Sciences and Engineering (IJPSE), 1(2), 11-20. View in (Google Scholar)
3. Castillo, G. A. L., Álava, L. A. C., Fernández, M. C., & Llanes, M. V. (2017). Roadmap for the Introduction of Smart Grids in Ecuador. International Journal of Physical Sciences and Engineering (IJPSE), 1(2), 1-10. View in (Google Scholar)
4. Electricidad, A.d.c.y.r.d., Estadística anual y Multianual del Sector Eléctrico Ecuatoriano. http://www.regulacionelectrica.gob.ec/wp-content/uploads /downloads/2017/ 2016. View in (Google Scholar)
5. Gener, P. (1923). JM Bartrina. *Revista del Centre de Lectura de Reus*, (93), 289-294. View in (Google Scholar) (Scopus)
6. Jain, P., Billaiya, R., & Malaiya, S. (2017). A Correlational Analysis of Academic Stress in Adolescents in Respect of Socio-Economic Status. International Journal of Physical Sciences and Engineering (IJPSE), 1(1), 68-71. View in (Google Scholar)
7. Licuy, Á. P. (2012). Estudio del Potencial solar incidente en el Ecuador, para su empleo en diversas aplicaciones energéticas. *Revista Renia, ISBN*, 978-959. View in (Google Scholar)
8. MEE., Programa de redes inteligentes en Ecuador. www.ministeriode electricidad y energía.ec, 2013. View in (Google Scholar) (Scopus)
9. Molina-Pfennig, P. D., & Covarrubias, O. A. (2017). Sustainable Management Model Based On Renewable Energies for the First Capital of the Californias, Loreto, Mexico. *International Journal of Energy Production and Management*, *2*(4), 360-369. View in (Google Scholar)
10. Ogunsiji, A. S., & Ladanu, W. K. (2017). A Theoretical Study of Performance Measures in the Strategic and Corporate Entrepreneurships of Firms. International Journal of Physical Sciences and Engineering (IJPSE), 1(1), 72-80. View in (Google Scholar)
11. Omer, A. M. (2017). Sustainable Development and Environmentally Friendly Energy Systems. International Journal of Physical Sciences and Engineering (IJPSE), 1(1), 1-39. View in (Google Scholar)
12. Ortega, I., & Mauricio, E. (2012). Redes de comunicación en smart grid. View in (Google Scholar) (Scopus)
13. Pérez, A., Castillo, G., Alava, L., & Chilan, J. (2016). The Regulatory Framework for Renewable Energy Sources. *International Research Journal Of Management, IT & Social Sciences, 3*(11), 7 - 19. doi:10.21744/irjmis.v3i11.302. View in (Google Scholar) (CrossRef)
14. Rodríguez, M., La Ordenación y la Planificación de las Fuentes Renovables de Energía en la Isla de Cuba desde una perspectiva territorial. Estudio de caso en el municipio de Guama a partir de un Geo portal [Libro]. - Sevilla: Doctorado Estrategias y Planificación Territorial-Facultad de Humanidades. Universidad Pablo Olavide, 2010. View in (Google Scholar)
15. Suleiman, O. M. E. (2017). Linear Deflection of Laminated Composite Plates using Dynamic Relaxation Method. jiA, 6(2), 1. View in (Google Scholar)
16. Vivas, F. E. V., Cuello, R. L. C., Macías, D. M., & Rosado, G. P. (2017). Elaboration of Essential Oil from the Oregano for Medicinal Use Sheet. International Journal of Physical Sciences and Engineering (IJPSE), 1(1), 81-87. View in (Google Scholar)
17. Zapata Ruiz, N. A. *Caracterización y evaluación de plataformas transaccionales inteligentes para la implementación de Redes Eléctricas Inteligentes en Colombia* (Doctoral dissertation, Universidad Nacional de Colombia, Medellín). View in (Google Scholar) (Scopus Content)

Biography of Authors

	Aspiring Doctor of Technical Sciences, Electrical Engineer, Has worked in various research primarily directed to the use of microgrids with renewable energy sources, it has participated in scientific events as the author of several currently working on the issue of the use of renewable sources in form of distributed generation through microgrids that enhance power quality and decrease environmental impacts.
	PhD. Strategies and Planning territory Renewable Energy Sources, Universidad Pablo de Olavide, Sevilla, España, Ph.D. In Geography. Associate Professor and researcher at the Universidad Técnica de Manabí. It has participated in various international research projects aimed at rural areas using renewable energy sources currently working on studies using GIS to study renewable potential and use in distributed generation
	Aspiring Doctor, Lawyer, Master in International Environmental Education, Professor and Researcher, a specialist in risk assessment and disaster reduction, Civil Defense of corporate systems, project management of renewable energy sources, professor in environmental law and natural disasters. Scientific collaborator at the Faculty of Sciences of the Universidad Técnica de Manabí
	A graduate of Electrical Engineering at the Universidad Técnica de Manabí (UTM), Portoviejo, Ecuador. Master of Educational Management. Assistant Department of Electrical and deputy dean of Electrical Engineering at the Faculty of Mathematics Chemistry, Physical in the UTM, Portoviejo, Ecuador. Professor, currently she is working on her doctoral work on the topic of smart grids for efficient application to university facilities.
	A graduate of Electrical Engineering at the Universidad Técnica de Manabí (UTM), Portoviejo, Ecuador. Master of Educational Management. Assistant Department of Electrical and coordinator of the School of Electrical Engineering at the Faculty of Mathematics Chemistry, Physical in the UTM, Portoviejo, Ecuador. Professor currently working on his doctoral work on the topic of artificial intelligence for efficient application to university facilities.