

## General Information about the Design of Smart Grids in Universities



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### Abstract

Until recently, the dominant paradigm in the electrification consisted of universal service and its centralization, and for loor modern times think of the power grid of the future where a qualitative and radical leap is required because of the need to manage better energy resources, promote environmental protection and meet the increasingly demanding requirements of quality of service. A power distribution network becomes intelligent acquiring data, communicating, processing information and exercising control through a feedback that allows you to adjust to changes that may arise in actual operation. Ecuador aimed at energy efficiency through smart grids, which allow the dealer to maintain absolute monitoring of energy flow and the elements of the power grid. Thus, it is possible that service companies can efficiently manage their assets and the end user to manage consumption rationally, requiring to enhance the energy efficiency of power grids, one management timely and efficient energy.

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## 1. Introduction

The energy situation worldwide has begun to show the first signs of crisis, led by the high price of a barrel of oil and current military strife in the Middle East for dominance of the deposits, which shows the desperation of transnational oil to the depletion of hydrocarbons in other areas (A: [Filgueira Vizoso et al., 2010](#)). It should focus look to nature and take advantage of clean and renewable energy offers. In the past decade, issues of conservation of natural resources and environmental protection have achieved great importance. The use of renewable energy sources is an indicator of the degree of development of a nation.

Renewable energy is any technology that solely depends on a source of energy that regenerates naturally for a short time and is derived directly and indirectly from the sun, or water or other natural environmental elements and mechanisms. In simpler words, renewable energy inexhaustible resources such stems; the sun (solar energy), rivers and streams of fresh water (hydropower), seas and oceans (tidal power), the heat of the earth (geothermal energy), waves (wave energy), organic waste (energy biomass) and wind (wind energy).

In addition, with the use of renewable energy can easily avoid the problems of energy related to the environment such as acid rain "is a way of reducing pollution in which SO<sub>2</sub> and NO produced by the combustion of fossil fuels are transported over long distances through the atmosphere and deposited via precipitation on earth "ozone layer, global climate change, and nuclear energy.

The introduction of the concept of smart grid will enable more efficient management in the current electricity grids, starting to consider their application would know how the electrical energy produced is consumed, reduce losses in power distribution and have alerts possible failures that may arise in the circuit between energy production and delivery to the final consumer, this can make decisions to avoid impacts of these failures in the different processes involved in the network.

One way has been sought in order to achieve the desired increase in energy efficiency is the automation of different elements in homes, office buildings, factories, hospitals, schools, recreation and cultural centers among others. Under this principle appear terms such as Home Automation and Building Automation, among others, although interrelated through automatic processes, its scope and application are different.

This paper is oriented to the use of smart grids to support the efficient work in universities, applying building automation facilities of the university premises, based on the automated management of all key elements that will be present in the system. To do this we rely on the incorporation of an alternative energy in this case solar or photovoltaic with the aim of ensuring a substantial energy saving mains

Building automation offers the possibility of monitoring the overall functioning of the building, elevators, energy balance, irrigation, air conditioning and lighting of common areas, the temperature of local, giving it a dual system of fire detection, etc., and greater access control and continuous monitoring of the entrance to the building.

Although the operation of the existing power grids could be considered correct, it is necessary to work with not only correct view but to provide a power supply with total quality, ie, reliable, efficient, sustainable and sustainable.

## 2. Materials and Methods

The global energy system has been rated as inefficient, highly polluting and unsustainable. That is why governments of different countries seek to improve the system and have seen great potential in smart grids. In Ecuador, the rights of good living or *sumak kawsay* guarantee citizens the power to live in a healthy and ecological environment. For this reason, the current government has decided to change the energy matrix of the country, by a more effective that guarantees these rights. This change in the energy model may involve the implementation of smart grids.

Smart grids consist of a system of interconnected networks that are able to integrate the production and distribution of energy in a smart way. This produces an efficient, safe and sustainable energy model. With REI's existing centralized model, it becomes a decentralized, two-way model. This means that not only consumers efficiently distribute energy, but turn beneficiaries can produce energy through various technologies, such as solar panels, and return it to the REI. This is certainly one of the most significant characteristics of REI's, allowing efficient management of renewable energy sources that can be incorporated, fulfilling the objective of protecting the environment and thus helps to reduce pollution levels.

Currently, at the Universidad Técnica de Manabí, there is an electrical system that has become insufficient to rising infrastructure facilities in laboratories, offices, and buildings, causing unwanted incidents in the normal

development of academic activities. It is necessary, therefore, seek to improve the service; the introduction of technology management and smart grids is presented as a way of a solution that would impact not only on the university but in other universities, both from the point of view of efficiency and sustainability. This research has the support of the authorities of the Universidad Técnica de Manabí.

Planning, design, and selection of an isolated system must take into account several restrictions. The optimal design of a power system depends on the power required a connection, energy consumption, the type of consumers, the period of use and weather restrictions.

Isolated networks are primarily used to power remote network loads. This energy must be provided in a form suitable for use by consumers. For isolated networks coupled AC this means that all sources operate on the basis of voltage and frequency levels defined.

In the smart grid isolated you can connect several different power generators, for example, photovoltaic installations, installations of the wind, hydro and diesel power generators. In this paper we propose applying artificial intelligence techniques to the work of a smart grid isolated looking for the maximum use of electricity, But to have an accurate idea of the smart grid, we define it as one able to integrate the actions of all actors, producers or consumers, to distribute energy-efficient, sustainable, profitable and safe.

"The network" is the grid, a network of transmission and distribution lines, substations and transformers supplying electricity from the power plant to your home or business. What makes the "smart" network is digital technology that allows two-way communication between the utility company and its customers.

The intelligent network uses innovative products and services as well as advanced technologies for monitoring, control, and communications, bringing benefits to both the environment and customers.

The concept that has recently retaken is energy efficiency, which some have begun to call "the fifth fuel" (Aguado, 2011). The so-called "energy efficiency" ensures that the amount of energy required is used to perform a given activity without affecting its quality, or put another way, that the energy used for a purpose be utilized to 100% or as close as possible to this value. One way has been sought in order to achieve the desired increase in energy efficiency is the automation of different elements in homes, office buildings, factories, hospitals, schools, recreation, and cultural centers among others. Under this principle appear terms such as Home Automation, Building Automation, among others, although interrelated through automatic processes, its scope and application are different.

The term home automation has its origin in the Latin *dominus*, meaning "home" and also the French term "Informatique" (computer) or "robotic" (robotics). In Spain it is normal the name "domotic home" or "home automation housing", however in Latin America is given the name of "smart home". It is understood the set of home automation systems capable of automating a home, providing energy management services, security, welfare and communication, wired or wireless, and whose control has a certain ubiquity from inside and outside the home. It could be defined as the integration of technology in the intelligent design of an enclosure.

Instead, the term home automation means "building management system" is the one who really controls and regulates a building, ie its "full management". You can differentiate both terms in that home automation is applicable for housing and building technologies incorporated into systems automated facilities of production and services (industrial plants, hotels, hospitals, office buildings, airports industry technical management, technology parks, banks, universities, etc.) in order to reduce energy consumption, increase comfort and safety of themselves. Building automation offers the possibility of monitoring the overall functioning of the building, elevators, energy balance, irrigation, air conditioning and lighting of common areas, temperature, giving it a dual system of fire detection, and greater control access to the building.

From the foregoing, we can define the convergence of the three situations listed below: photovoltaic power generation and other renewable energy sources to be used in homes. The management of this energy into the housing through an intelligence-based distributed system (agent multi-systems) and analysis of connections to the public grid to supply housing, or providing a public network in case of there is surplus energy through the smart grid (Smart Grid, in English). Then the focus from three points of view is the use of solar energy in homes, home automation as a tool for energy management and smart grids as integrators of distributed power generation. The three approaches finally come together to integrate the project arises as a globalizing element of work.

The growing need for distributed generation of electricity it will be currently one of the generally accepted solutions for energy saving and sustainable social and economic development level (Aguado, 2011). This distributed generation involves the generation of energy from homes and buildings to solve their particular needs, and constantly interact with the public network, bidirectional flow of energy and information. Installation in a housing, systems generating solar power or other, must be analyzed from various perspectives, considering the architecture of the house, the materials used and conversion technologies and energy distribution.

Many especially countries of the European Union, have implemented regulations for buildings relating to renewable energy, in which such property is obliged must have, what is called an "energy certificate" whose involvement is not only related to energy efficiency, but also to the generation of clean energy, at least those for feeding the climate of environments (air conditioner and heater). As it is shown in the article entitled "Regulatory framework for home automation and building automation systems," [Al-Hader and Rodzi \(2009\)](#), in which the standards are voluntary while legal provisions are mandatory.

Under this brief analysis, we can justify the study requirements of renewable energies, to be applied in homes and buildings in the cities, in the specific case of university institutions of Ecuador, and that in the medium term could be incorporated in the main cities of the country

In a second glance, home automation systems primarily meet three needs within the home: comfort, security and energy management. Energy management is implicit promote friendly systems environment, not only through energy efficiency but also in the generation of energy by clean means.

In response to and control systems based on artificial intelligence and distributed artificial intelligence, [Al-Hader and Rodzi \(2009\)](#) networks experimentations are exposed to low-cost devices for the construction of electronic measuring instruments allowing optimization based solar energy systems, achieving very good results in measurements, stability, and low power consumption. Devices ranging was from 8-bit microcontrollers to low-cost digital sensors. Design systems allow complex algorithms harboring controlling normal operation thereof. It is necessary to note that the paper considers very few variables to be considered for measurement in photovoltaic solar installations, and has not considered Control integrated systems that consider as whole all subsystems.

Using intelligent communications networks for sensors and actuators is very viable in automation environments, including through intelligent agents, which generate very robust and fast systems. In [Chung et al., \(2013\)](#) a model of environmental intelligence facilitated by the integration of wireless sensor networks (Wireless Sensor Networks, WSN) with intelligent agents, which has the ability to offer (sensitive to the environment in areas such as knowledge of context studied acting) and smart wireless networks. In addition, a new classification of a context that makes it easier to deduce the current state of the environment and its consequent adaptation as well as the definition of an architecture for developing systems Environmental Intelligence, however, has not been described the implementation of agents in sensors to improve system performance. In [Conelec Período 1990-2008 \(2009\)](#), it is concluded in relation to the multi-agent systems: "a distributed approach gives the architecture of a high resilience to errors as well as greater flexibility to adapt their behavior at runtime".

A third view is the analysis of smart grids. A home automation system, with respect to energy management, must provide their own energy (generation of clean and renewable energy) and the ability to manage the production of the same with the public network, so that it can be provided when production internal not enough, store it in case of energy storage or provide the public power grid, if this allows.

### 3. Results and Discussions

There are other works similarly qualify based on distributed intelligence, as robust, versatile, with a capacity of adaptability very good context with a time of very low response [M. MacGranaghan \(2010\)](#) systems, in which he states: "The intelligent agents theory allows a collaboration between them to resolve complex processes and manipulate large quantities of information with accuracy and reliability that would otherwise not be possible. ". It also claims that intelligent agents based systems are increasingly used in businesses because they allow easily handle current data, provide continuous monitoring and visibility uninterruptedly; They are flexible, run-oriented process objectives; clocked or delay if required decision making; increase the speed of decision and allow the dynamic redefinition of the situation, in the case of continuous work.

The features defined in home applications of multi-agent systems into four categories: detection of emergencies, health, home safety, comfort, and efficiency. Accordingly, it can be stated that the applicability of multi-agent systems goes beyond the functions initially designed for home automation, providing very useful services. Based agents and multi-agent intelligent systems provide a very suitable and convenient to develop intelligent systems for automation solution, applied in networks of sensors and actuators to interact according to predetermined configurations and context, allowing in the case of silver project generate solutions best to efficiently manage the energy consumption of the instruments and equipment operating in a home ([Martínez Ochoa, 2012](#)).

An analysis of what the smart grid and a projection short and medium term its advances in technology and integration issues is made. He states that "Thanks to a large number of projects being carried out in the world, smart

grids are already a reality. This shows the awareness of individuals, businesses and governments with the environment, which is reflected in the Horizon 2020 Plan, the document Plan for Energy and Climate Change Horizon 2020 (2014) of the city of Madrid ([Restrepo et al., 2014](#)).

You bet on a distributed rather than centralized generation, which will allow energy generation is much more sustainable and efficient in finding that the client can generate its own power, reducing generation centers with high power.

The new models of the smart grid, distributed generation drive, autonomy in its control and integration of information technology for transmission and data handling.

In addition, reducing telecommunications costs, advances in sensors and smarter and more powerful and faster processor systems is making the generation, distribution and management of energy cheaper, ecological and allow to offer a series of new services end users.

It is necessary that homes and other properties begin to prepare for what is a new generation of systems and equipment intelligent, they have begun to invade our environment and appropriate use will not only improve the quality of life of the inhabitants, but they will more friendly systems environment. In Ecuador, through the Ministry of Electricity and Renewable Energy, in early 2015 has launched a program Intelligent Networks, according to the head of the Ministry, "seeks to incorporate a new management model electric system, based on advanced technologies measurement, monitoring and communication and involving from production to consumption of electricity".

It is necessary to initiate studies of this nature, to determine its applicability in their cities, ensure efficient connectivity with home automation systems and encourage the design of systems based on the real needs of the population, and not repeat as in the case

many other technologies that have arrived in the country and the population and environment, who have had to adapt to them, preventing their maximum advantage.

In the three books that have given the proposed project, the need to address issues related to renewable energy, home automation, and smart grids is clear. But much more important is the need to integrate these three approaches into one, a comprehensive system that is controlled by systems with distributed intelligence, that is robust, versatile and context-sensitive (ambient intelligence), with the ability to interact with others systems or networks and even integrated into larger systems, such as project "Smart City" ([Smart grid system report, U.S., 2009](#))

Analyzing the benefits of smart grids, you can argue that by introducing these concepts, increase the level of reliability and quality of electricity supply when there is a fault, technologies of intelligent network can detect and isolate the problem and contribute recovery to electricity develops fast and strategically returning electricity emergency services; In addition, the intelligent network takes full advantage of the power generators owned by the customer when no electricity is available from the electric company. That is, if the demand is greater than supply of, the client utility that generates energy by unconventional means (photovoltaic, wind, hydro, energy storage such as electric cars), will sell energy to the electricity company so that it is energy coverage to this demand, in this case, the customer becomes seller.

These smart grid systems make it easy for customers instruments that allow them to optimize their own energy consumption and improve the functioning of the global system (active demand management). Smart grids give the user the information and tools necessary to make decisions about their use of energy: the customer can see how much electricity they consume, when to use it and how much it costs, and save money by generating their own energy and choosing the best time to consume electricity, ie move their consumption at different times of day, day, night, peak hours.

The system helps maintain environmental sustainability, integrating distributed generation from renewable sources and deploying charging infrastructure for electric mobility. contributing to the reduction of CO2 emissions. Facilitate the storage of electricity, improving efficiency in the distribution of energy flows and flexibility in managing peak demand, resulting in reduced requirements for new generation facilities.

In the case of the "intelligent distribution" it refers to the part of the intelligent network that deals with the distribution system of electricity, ie, cables, switches and transformers that connect the substation to the customer, in figure 1, can see two esquemas and conventional electrical structure (A) and (B) intelligent infrastructure.



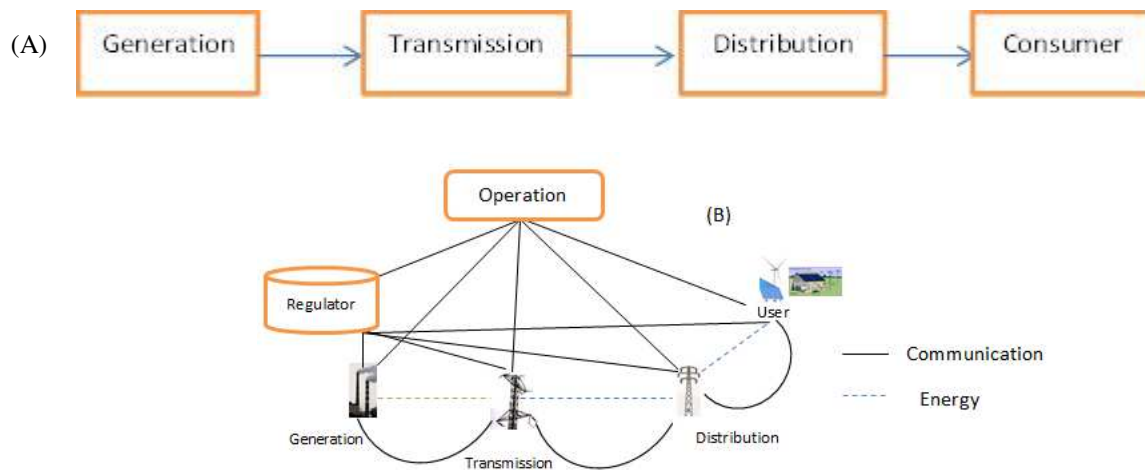


Figura 1. Conventional electrical infrastructure (A) and intelligent infrastructure (B)

The smart grid has sensors that can alert that certain parts of the distribution system have lost power, and by combining automated control with an intelligent system that determines the best way to respond to a power outage, you can restore the supply electricity to most customers within seconds, or maybe even milliseconds.

#### 4. Conclusion

The intelligent network can be monitored using information systems, which allows you to view the details of networks in space so that layoff of the company and the user can have real information of what is happening in the territory.

In the case of analysis and projection work with smart grids, if artificial intelligence techniques applied to the management of information in a smart grid isolated, with renewable energy sources, it can increase efficiency and service reliability electric. In this case, we will work at the Universidad Técnica de Manabí as application case.

The generation is performed at different points at a time, a generation close to the consumer, thus greatly reducing transmission losses, lowering the cost of kWh

This is essential to have tools from computer (creating software) support to manage this so that they do not conflict the different contributions of the generators-users. It must be determined in time when a user connects power to buy and when to sell to the network. The balance between energy supply and demand at all times with a tool for decision making timely and efficient.

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#### *Statement of authorship*

The author(s) have a responsibility for the conception and design of the study. The author(s) have approved the final article.





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