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ENERGÍA RENOVABLES Y MEDIDAS DE EFICIENCIA ENERGÉTICA APLICABLES A LAS INSTITUCIONES PRESTADORAS DE SALUD EN COLOMBIA

RENEWABLE ENERGY AND ENERGY EFFICIENCY MEASURES APPLICABLE TO HEALTH PROVIDING INSTITUTIONS IN COLOMBIA

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Abstract: Context: Nowadays' global context has increased the demand and use of electrical energy, since most of the tools or machinery used in all market sectors depend on electricity. For this reason, renewable energies have become a key element to guarantee sustainability, developing fairer societies with equal conditions for all. Health Service Provider Institutions (HSPI) enjoy high energy consumption, so incorporating renewable energy sources is an important opportunity to diversify the energy basket. The objective is to identify the types of renewable energy that can be incorporated into energy efficiency measures in the HSPI of Barranquilla. Method: The research is descriptive, accompanied by a documentary review. The data collection techniques used were observation and documentary matrices. Results: Solar energy is considered as an opportunity to provide economic benefits to the IPS with the incorporation of a mixed system with PV solar cells or modules, whose costs are attractive compared to the energy rates of electricity service companies and promote the culture of energy saving. Conclusions: The massification of the use of renewable energies for use in all sectors and activities of humanity is presented as urgent and the IPS are essential for this task, both at a public and private level, because they should promote development and application of these from the planned investment, guaranteeing their efficient management.

Keywords: Renewable Resources, Energy Efficiency, Energy Savings, Sustainability.

Resumen: El contexto global actual ha incrementado la demanda y el uso de la energía eléctrica, ya que la mayoría de las herramientas o maquinarias que se utilizan en todos los sectores del mercado dependen de la electricidad. Por esta razón las energías renovables se

han convertido en un elemento clave para garantizar la sostenibilidad. Las Instituciones Prestadoras de Servicio de Salud (IPS) requieren un alto consumo de energía por lo que incorporar fuentes de energía renovables es una oportunidad importante para diversificar la infraestructura energética. El objetivo es identificar los tipos de energía renovables incorporables en medidas de eficiencia energética en las IPS de Salud de Barranquilla.

Método: La investigación fue de tipo descriptiva acompañada de una revisión documental. Las técnicas de recolección de datos utilizadas fueron la observación y matrices documentales. Resultados: Se considera la energía solar como una oportunidad para brindar beneficios económicos importantes a las IPS con la incorporación de un sistema mixto con módulos o celdas solares FV, cuyos costos resultan atractivos en comparación con las tarifas energéticas de compañías prestadora de servicio eléctrico y promover la cultura de ahorro energético. Conclusiones: La masificación del uso de las energías renovables para su uso en todos los sectores y actividades de la humanidad se presenta como urgente y las IPS son fundamentales para dicho cometido, tanto a nivel público como privado, debido a que estas deben potenciar el desarrollo y aplicación de estas desde la inversión planificada, garantizando una gestión eficiente de las mismas.

Palabras clave: Recursos Renovables, Eficiencia Energética, Ahorro Energético, Sostenibilidad.

1. INTRODUCTION

Economic development, globalization and internationalization of economies, urban and industrial growth have increased the use of electricity, since most of the tools used in the different structures of all market sectors depend on electricity. Cortés & Arango Londoño (2017) emphasize that this development boom accompanied by technological advances has caused the increase in energy demand and limitations to cover such consumption; it is for this reason that efficient energy management has become an indispensable factor for the functioning of the economy and the provision of services.

For various authors in the literature, energy sources can be renewable and non-renewable; the non renewable ones depend on hydrocarbons such as coal, gas, oil and nuclear energy; however, they are usually exhaustible resources in time (Nogar, Clementi, & Decunto, 2021); these resources are usually the most used in the world to generate energy, being today finite sources that do not guarantee sustainability over time. On the other hand, renewable resources come from: water, wind, sun, among others; being resources that have the particularity of renewing themselves, remaining in time and preserving the environment (Caraballo Pou & García Simón, 2017).

The use of renewable energies has become a key element to ensure human and environmental sustainability; developing fairer societies with equal conditions for all. Latin American countries are regions that have these resources and the environmental conditions to generate energy plans (Hernández Palma & Niebles, 2020). In Colombia, approximately 78% of the energy consumed comes from fossil sources; while a remaining 22% comes from renewable energies (Cortés & Arango Londoño, 2017); so from the 1990s, the use of water and thermal resources (Ñustes & Rivera, 2017) as energy generators began to be used.

Energy has become part of the everyday life of societies without thinking about the state of reserves and the impact they have on the environment. Currently, the need has emerged to reflect on the use of the various types of energy used and to design energy efficiency plans; these are based on renewable resources that can guarantee sustainability, permanence over time and cover non interconnected areas (Nogar, Clementi, & Decunto, 2021).

Additionally, Ballesteros-Ballesteros & Gallego Torres (2019) emphasize that the energy crisis that encompasses all the saving plans in consumption and use of renewable energies have not been successful due to the lack of knowledge of society in relation to efficient energy management. It is essential to re-educate the community about the polluting impact of non-renewable resources, the benefits of renewable resources and the efficient use of the types of energy that can guarantee both human

and environmental sustainability. This is important, since the management and efficient use of energy has much to do with the impact of human activities; being necessary the educational dissemination on the subject (Reyes Carvajal et al. 2016).

In this way, according to Robles Algarín & Rodríguez Álvarez (2018), the current energy context proposes an outdatedness with respect to new innovative alternatives in terms of energy 124 ISSN: 1692-7257 - Volume 1 - Number 41 - 2023 efficiency, which propitiates a wide spectrum of improvement that can be taken advantage of by the various sectors of a country's economy. Thus, according to Andrade & Real (2021), the various sectors are lagging behind in terms of their economic disposition because they do not see the benefits of efficient energy management, which, although at the beginning proposes important investments, in the future the saving aspect is considered to have a much greater impact on the economy.

The same Robles Algarín & Rodríguez Álvarez (2018), propose that in Colombia the various economic sectors present needs to align with energy efficiency practices, among them the health sector is one of the most permissive in terms of improving in the energy field. Thus, the need for the present study is established where the applicable proposals in terms of management and energy efficiency in the health sector in Colombia are developed.

Barragán-Escandón et al. (2019) state that, in order to introduce renewable energies to any industrial, urban or health sector, an energy planning must be carried out to know the real demand and satisfy it; in this case of the Colombian Health Care Institutions (IPS). Usually, energy plans were based on investment costs; therefore, the low costs of renewable energies facilitate their inclusion in the urban sector, which in turn promotes a sustainable urban model that goes beyond the industrial sector.

The redesign of the energy structure is amplified to the urban sector, as the support of localities is required to advance sustainable energy development, so cities must become "smart cities" (Barragán-Escandón et al. 2019) to improve the quality of life of all citizens.

Reyes Carvajal et al. (2016) explain the importance that at the time of implementing an energy plan, an information system by production areas that contains a record of the organization's consumption is needed. For this, they propose three phases that must be fulfilled: Behavioral monitoring and control of energy consumption. Educational training plan for human resources personnel on the influence of efficient energy consumption and use. Design and implement plans to improve energy efficiency in the short, medium and long term.

The mechanisms for designing energy management systems depend on the conditions, characteristics, needs and interests of each company. In turn, they must take into account what is established by the International Standards Organization ISO 50001 (Gómez Gómez & Cárcel Carrasco 2019).

The IPS are part of the urban sector, and these develop a high energy consumption so identifying opportunities for renewable energy sources in Colombia, is an important opportunity to diversify the energy basket, develop efficient plans and measures that promote environmental sustainability (Luna & Hernández 2021). On the other hand, this diversification would bring positive impacts on the progressive decrease in investment costs, the evolution of performance and technological sophistication (Ñustes & Rivera, 2017).

For this reason, for Martínez-Sierra et al. (2019) efficient energy management has become a fundamental piece for the development of new alternatives that guarantee sustainability; with the help of technological advances that have been support for the design of new energy forces such as photovoltaic, wind, water and some solid waste, which can be incorporated in health sector institutions, so it has become a sensitive field to incorporate cleaner energy sources given its high consumption and negative impact on the environment. For this reason, plans have been implemented in Colombia to incorporate renewable energy sources into the private and public health sector, known as "Green Hospitals".

Green Hospitals according to Luna & Hernandez (2021), are an institution that promotes the creation of environmental preservation measures, awareness and ecological actions that guarantee sustainability; taking into consideration 5 components: water, energy, waste, green areas and chemicals (Gil Morales et al. 2019).

From this perspective, the objective of this text was to identify the types of renewable energy that can be incorporated into energy efficiency measures in the IPS of the city of Barranquilla.

2. METHODOLOGY

The research was descriptive and accompanied by a documentary review. The data collection techniques used were observation and documentary matrices. The population consisted of 34 public and private IPS in the city of Barranquilla. The sample was selected by simple random selection considering 31 IPS.

The procedure consisted of two phases, the first consisted of a documentary review of the types of renewable energy available in Colombia and the world, and their incorporation into energy efficiency plans. The information was collected in the documentary matrices.

In the second phase, based on a thorough understanding of the current state of IPS management in general, energy efficiency measures were constructed in the form of a proposal for the application of solar energy detailed in 5 sub-phases that stipulate the development provided so that these institutions can develop them and achieve environmental sustainability.

3. RESULTS

The results are presented below expressing the previously established phases, first, phase 1 exposing the Renewable Energy Sources in Colombia, and then phase 2, which details the proposal for the application of solar energy to health care institutions in Colombia through several sub phases.

3.1. Renewable Energy Sources in Colombia.

Wind energy: it is one of the most modern and widespread renewable energy sources in the world, which consists of harnessing the forces of the wind in areas with high air currents. Colombia has a capacity of 19.5 MW connected to the SIN and has not shown an increase since its installation in 2003 (Cortés & Arango Londoño, 2017). This energy source is available in regions such as: The Department of La Guajira, a large part of the Caribbean, Department of Santander and Norte de Santander, specific areas of Risaralda and Tolima, Valle del Cauca, Huila and Boyacá have usable resources, which in the specific case of La Guajira are considered to be among the best in South America. This department concentrates the highest trade wind regimes that the country receives throughout the year with average speeds close to 9m/s (at 80m altitude), and prevailing east-west direction; which are estimated to represent an energy potential that can be translated into an installable capacity in the order of 18 GW of electricity (UPME, 2015).

Water Energy: it is considered one of the most reliable energy sources that guarantee prices and supply, since it is an abundant resource in rivers, seas, waterfalls, among other water bodies, which has allowed it to be the most used renewable resource to build electrical systems. However, currently because of climate changes and the effect of drought originated by phenomena such as El Niño, which are a direct product of the effects of deforestation in the area (Galeano & Mancera, 2018); nations have had to redesign their policies and expand the energy basket. Colombia has an installed capacity of approximately 16,000 MW of which 69.77% is generated from hydroelectric power plants, 18.30% corresponds to thermal power plants and 11.94% to other renewable energy sources such as wind (UPME, 2015).

For this reason Hernández Pasichana & Posada Arrubla (2018) support the integrated management of water resources to promote the proper management of water so that it does not threaten the sustainability of ecosystems; since this resource is limited and there is an important need for public policies to adopt measures to promote a reasonable and efficient use of the same resource.

Solar energy: it is considered the second renewable energy source with the highest incorporation in the world after wind energy. For the case of Colombia, the available sources of this solar resource indicate that the country has an average irradiation of 4.5kWh/m2/d which exceeds the world average of 3.9kWh/m2/d (Cortés & Arango Londoño, 2017). According to data published by UPME, the regions with the highest solar irradiation are: La Guajira, the Caribbean coast and other specific regions in the departments of Arauca, Casanare, Vichada and Meta, among others, which present radiation levels above the national average that can reach the order of 6.0kWh/m2/d. Therefore, it is considered a renewable energy source applicable to the health sector and in this case to the IPS (UPME, 2015).

Among the reasons that consider solar energy an opportunity to provide important benefits to the national energy sector are: the decrease in technology costs (UPME, 2015), especially of solar PV modules or cells, which have led to the fact that the levelized cost of solar PV energy today is competitive with retail electricity market rates, at commercial and residential levels. In addition, through the implementation and massification of

small distributed self-generation systems, positive impacts can be achieved, such as allowing users to generate their own energy, thus reducing the risk of consumers being subjected to certain volatility and usual increases in electricity costs. With this resource, it is also possible to design a photovoltaic energy system that generates electricity and in turn can work as solar heaters for water heating and air conditioning (Barragán-Escandón et al. 2019).

3.2. Proposal for the application of solar energy in health care institutions in Colombia.

Since the Caribbean Coast has favorable radiation conditions during most of the year, this region has a high potential for the profitability of this sector. Due to the type of services provided by the IPS, in some cases the available space does not allow the installation of the photovoltaic panels necessary to supply all the energy demanded by this sector; even so, it is proposed the implementation of a mixed system that complements two energy sources integrated to the power circuits of the entity.

On the other hand, it is important to implement savings measures that can have an impact on the reduction of ratios in order to facilitate a renegotiation of tariff changes for energy collection; in general, the supplier companies have tariff groups that depend on consumption levels. When adopting renewable energy technologies to improve the energy efficiency of an institution, it is necessary to ensure that all technical and economic aspects are considered in order to adequately size the energy needs of a system (Figure 1). In turn apply the following sub-phases:

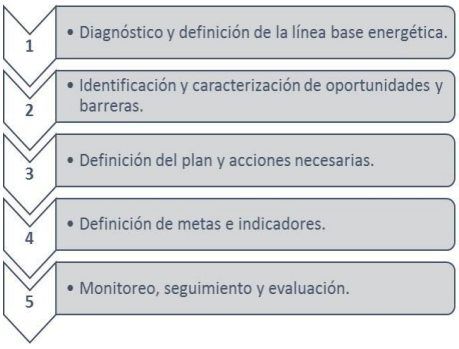

Fig. 1. Guide for the Development of Energy Efficiency Projects

3.2.1. Diagnosis and baseline definition.

In this phase, the following is taken into account:

a) Structural elements: the general requirements according to the area of the institution, its organizational policies and strategic plans.
b) Fundamental elements: of measurements of energy use and analysis of energy
consisting performance indicators. For this, the following baselines should be followed (Figure 2).

Fig. 2. Determinants of the Baselines

Data collection should be based on the measurement of electricity and related fuel consumption in the service provider's invoices, preferably within time periods similar to those of production, in order to be able to make a proper comparison of the same.

Next, a review of the main variables that have the greatest impact on energy consumption, such as: type of activities, volume of work or frequency of use of the equipment, should be followed by an analysis of the data obtained in order to establish whether it is necessary to define several baselines due to the complexity of the operation or whether one baseline is sufficient (Viloria et al. 2020a).

3.2.2. Identification and characterization of opportunities and barriers.

From the initial characterization it is possible to determine the energy saving needs of the organization, to the extent that the areas or processes of excessive consumption that can be addressed with intervention measures are identified. In addition, it allows the incorporation of alternative energy generation with renewable sources, for

which a technical and economic feasibility analysis of the investment project must be made (Figure 3).

Fig. 3. Technical-economic feasibility model of a photovoltaic energy project.

The steps considered in Figure 3 include an analysis of the historical behavior of the organization's energy performance, followed by the study of the technical aspects of the chosen generation model, such as: photovoltaic conversion efficiency of the systems available in the market, inverters, energy storage devices, protection devices, maintenance alternatives and availability of spare parts, among others.

As a complement to the second phase, the technical aspects of the external factors that will influence the installed photovoltaic system must be taken into account. In such a way that solar radiation levels are evaluated in terms of their power and seasonal cycles during the year, as well as the effects of temperature on the performance curves of the equipment.

Subsequently, the acquisition, installation and maintenance costs of the system's equipment must be investigated, estimated and calculated so that they can be compared with the economic values resulting from the savings produced by alternative energy generation. Finally, based on the previous analyses, the economic feasibility of the project is analyzed, using profitability calculations and expected time of return on investment to facilitate decision making in the strategic planning stages of the organization (García Garnica et al. 2018).

3.2.3. Definition of the Plan and actions required.

The implementation of photovoltaic energy systems will require the establishment of specific responsibilities, schedules and resources that may be different from the development of measures such as the adequacy of infrastructure. Among the energy saving alternatives that can be applied in IPS are: lighting system, air conditioning system, motors and biomedical equipment, renewable energy and internal management (see Table 1).

Table 1: Types of Strategy and Actions

TYPES OF STRATEGY	ACTIONS
Lighting Systems	• Identify areas where there is over lighting and replace them with lower wattage lighting. • Install energy-saving lamps or implement the use of LEDs. • Make the most of the lighting in spaces with natural light. - Use light colors on the walls, as they can reflect up to 80% of the incident light, while dark colors only reach 10% reflection. • Design electrical circuits that allow the separation of operating sectors. • Incorporate elements of automatic switching on and off of luminaires through the use of occupancy detectors or timers. • Raise the maintenance of the lamps in order to remove the dirt that minimizes their performance.
Air Conditioning System	• Define the zones that can be sectorized to make the air conditioning systems independent. • Use thermostats that facilitate temperature regulation of air conditioning systems. • Consider insulating roofs and decks, sealing doors and windows to minimize leaks, installing double insulated windows, and using solar radiation shields on glass. • Use efficient air conditioning technologies that maximize performance with minimum energy consumption. • Incorporate intelligent control systems that allow programming temperature changes in relation to outdoor climate variations. • Ensure timely and frequent maintenance of thermostats and air conditioning equipment. • Ensure the good condition of insulation in pipes and ducts in order to avoid air leaks.
Motors and Biomedical Equipment	• Desarrollar mantenimientos preventivos oportunos y con la frecuencia propuesta por el fabricante de los equipos. • Realizar seguimientos con el fin de monitorear la eficiencia de los motores sobre todo en aquellos de mayor tamaño y gran relevancia para la institución. • Mantener calibrados los tableros de control. • Elaborar diagramas de los sistemas eléctricos, tablas de control con puntos de diseño y funcionamiento esperado.
Renewable Energies	Photovoltaic Energy.
Internal Management	• Invest efforts in training the personnel involved. • Promote awareness of rational energy consumption, encouraging interest in information and the exercise of sustainable practices.

Source: Own elaboration (2022).

3.2.4. Definition of goals and indicators.

The effectiveness of the measures developed is decisive if the measurement parameters are not adequately defined, which must be comparable with the energy baseline in order to establish their evolution (Viloria et al. 2020b). Accordingly, indicators are proposed that offer an example of the main aspects to be measured (see Table 2).

Table 2: Energy Management Indicators.

INDICATOR	DESCRIPTION OF VARIABLES
Annual energy consumption	Energy consumed in kWh per year.
%Savings compared to the previous year.	%Savings compared to the previous year.
Energy costs (pesos).	Cost of energy in pesos for one year.
Final energy consumption broken down by sector.	Energy consumed in kWh by sector.
Scatter plots of monthly electrical energy consumption / Beds-day-occupied.	Monthly energy consumption in kWh vs. average number of occupied beds per month.
Per capita energy consumption.	Annual energy consumption in kWh vs. total number of workers, students and patients.
Consumption rate per unit of constructed area (kWh/m2 -year).	Annual energy consumption in kWh vs. total number of square meters built.

Source: Own elaboration (2022).

3.2.5. Monitoring, follow-up and evaluation.

It is necessary to contemplate the scheduling and development of energy management audits of the IPS, so that evaluation records can be obtained in a timely and accurate manner, facilitating the detection of opportunities for improvement that can be developed in future planning periods. It is important to emphasize that the people responsible for this process must be defined from the beginning of the energy efficiency project, ensuring the availability of sufficient resources and tools for the exercise of their work.

The phases described above are a key aspect in all the IPS of Barranquilla, considering the characteristics of each context to achieve an improvement in energy management; being the health sector incorporated in this work to achieve human and environmental sustainability.

It is important to note that according to Luna & Hernández (2021), health institutions in Colombia have acquired responsibility in the area of energy management and have begun to implement policies and plans for the preservation of the environment. Considering the geographical location of the city of Barranquilla, photovoltaic energy is an opportunity to diversify the energy infrastructure. Therefore, it is necessary to design and implement ecological actions aimed at reducing the negative impacts on the environment; to become organizations that promote environmental health, serving as an educating and awareness-raising entity for society (Ruiz-Cabezas, García-Moreno, & Martínez Zabaleta, 2019).

4. CONCLUSIONS

Is ratified the urgency of the massification of the use of renewable energies for their use in all human activities that involve or require the generation of energy. The IPS play a fundamental role in this regard, both at the public and private levels, since they must make the necessary investments to promote the development and application of renewable energy sources and have the responsibility to ensure their efficient and effective management.

However, there is also a need for a real will on the part of the governmental, social and business sectors to carry out projects involving the conversion of all means of fossil fuel energy generation to more environmentally and economically sustainable methods in the medium and long term. The confrontation between those who today profit from fossil fuels and those who advocate a radical change in the origin of the energy used for any activity leads to dead ends in the absence of clear solutions. The change must be organic, gradual and as pragmatic as possible, but undoubtedly necessary and increasingly urgent.

5. REFERENCES

Andrade-Zambrano, E. E., & Real-Pérez, G. L. (2021). Las PYMES y la eficiencia energética con la ISO 50001. Polo del Conocimiento, 6(6), 674-694. DOI: 10.23857/pc.v6i6.2777

Ballesteros-Ballesteros, V. A., & Gallego-Torres, A. P. (2019). Modelo de educación en energías renovables desde el compromiso público y la actitud energética. Revista Facultad de Ingeniería, 28(52), 27-42. DOI: https://doi.org/10.19053/01211129.v28.n52.2019.9652

Barragán-Escandón, E., Zalamea-León, E., Terrados-Cepeda, J., & Vanegas-Peralta, P. (2019). Factores que influyen en la selección de energías renovables en la ciudad. EURE, 45(134), 259-277. DOI: http://dx.doi.org/10.4067/S0250-71612019000100259

Barrera, M. H. (2019). Fundamentos para la Administración Energética en las Organizaciones. Revista de Gestión Empresarial y Sustentabilidad, 5(1), 1-11. Recuperado de: https://rges.umich.mx/index.php/rges/article/view/46/30

Caraballo Pou, M. Á., & García Simón, J. M. (2017). Energías renovables y desarrollo económico. Un análisis para España y las grandes economías europeas. El trimestre económico, 84(335), 571-609. DOI: https://doi.org/10.20430/ete.v84i335.508

Cortés, S., & Londoño, A. A. (2017). Energías renovables en Colombia: una aproximación desde la economía. Revista Ciencias Estratégicas, 25(38), 375-390. Recuperado de: https://www.redalyc.org/pdf/1513/151354939007.pdf

Galeano-Rendón, E., & Mancera-Rodríguez, N. J. (2018). Efectos de la deforestación sobre la diversidad y la estructura del ensamblaje de macroinvertebrados en cuatro quebradas Andinas en Colombia. Revista de Biología Tropical, 66(4), 1721-1740. DOI: http://dx.doi.org/10.15517/rbt.v66i4.31397

García Garnica, J. E., Sepúlveda Mora, S. B., & Ferreira Jaimes, J. (2018). Viabilidad técnico-económica de un sistema fotovoltaico en una planta de tratamiento de agua. INGE CUC, 14(1), 41-51. DOI: http://doi.org/10.17981/ingecuc.14.1.2018.04

Gil Morales, J. A., Guayán Ardila, I. C., Polania Sánchez, L. H., & Restrepo, H. F. (2019). Análisis situacional de los hospitales verdes colombianos pertenecientes a la red global. Revista de Salud Ambiental, 19(1), 12-22. Recuperado de: https://www.ojs.diffundit.com/index.php/rsa/article/view/918

Gómez, C. G., & Carrasco, F. J. C. (2019). Elección de sistemas de gestión para el mantenimiento, rehabilitación y eficiencia energética de edificios. 3c Empresa: investigación y pensamiento crítico, 8(3), 12-63. DOI: http://dx.doi.org/10.17993/3cemp.2019.080339.12-63

Hernández Pasichana, S. M., & Posada Arrubla, A. (2018). Avances de la investigación sobre la gestión integral del recurso hídrico en Colombia. Revista UDCA Actualidad & Divulgación Científica, 21(2), 553-563. DOI: https://doi.org/10.31910/rudca.v21.n2.2018.1079

Luna, C., & Hernández, J. (2021). Estado de las condiciones de gestión ambiental en instituciones prestadoras de servicios de salud de nivel II a nivel IV en Cali, Bogotá y Pereira acorde a la normatividad vigente ya la red global de hospitales verdes 2020. Recuperado de: https://repositorio.uniajc.edu.co/handle/uniajc/633.

Martínez-Sierra, D., García-Samper, M., Hernández-Palma, H., & Niebles-Nuñez, W. (2019). Gestión energética en el sector salud en Colombia: un caso de desarrollo limpio y sostenible. Información tecnológica, 30(5), 47-56. DOI: http://dx.doi.org/10.4067/S0718-07642019000500047

Nogar, A. G., Clementi, L. V., & Decunto, E. V. (2021). Argentina en el contexto de crisis y transición energética. Revista Universitaria de Geografía, 30(1), 107-131. DOI: http://dx.doi.org/https://doi.org/10.52292/j.rug.2021.30.1.0018

Ñustes, W., & Rivera, S. (2017). Colombia: Territory for investment in nonconventional renewable energy to electric generation. Revista Ingeniería, Investigación y Desarrollo, 17, 37-48. DOI: http://orcid.org/0000-0002-2995-1147

Palma, H. H., & Niebles, W. A. (2020). Financial Evaluation of Photovoltaic Energy Projects in Colombia. International Journal of Energy Economics and Policy, 10(6), 225-228. DOI: https://doi.org/10.32479/ijeep.9976

Robles Algarin, C., & Rodríguez Álvarez, O. R. (2018). Un panorama de las energías renovables en el Mundo, Latinoamérica y Colombia. Revista Espacios, 39(10), 10-26. Recuperado de: https://www.revistaespacios.com/a18v39n34/a18v39n34p10.pdf

Ruiz-Cabezas, M., García-Moreno, A., & Martínez-Zabaleta, M. (2019). Gestión ambiental para la innovación y competitividad de las organizaciones ecoturísticas en áreas protegidas. IPSA Scientia, Revista científica Multidisciplinaria, 4(1), 21–32. https://doi.org/10.25214/27114406.944

Unidad de Planeación Minero Energética (UPME). Integración de las Energías Renovables no convencionales en Colombia, Ministerio de Minas y Energía de Colombia, 2015. Bogotá, Colombia. Ministerio de minas y energía. Recuperado de: http://www.upme.gov.co/Estudios/2015/Integracion_Energias_Renovables/INTEGRACION_ENERGIAS_RENOVANLES_WEB.pdf

Viloria, A., Hernandez-P, H., Lezama, O. B. P., & Vargas, J. (2020). Prediction of electric consumption using multiple linear regression methods. In Advances in Cybernetics, Cognition, and Machine Learning for Communication Technologies (pp. 463-469). Springer, Singapore. DOI: https://doi.org/10.1007/978-981-15-3125-5_45

Viloria, A., Hernandez-P, H., Lezama, O. B. P., & Vargas, J. (2020). Prediction of electric consumption using multiple linear regression methods. In Advances in Cybernetics, Cognition, and Machine Learning for Communication Technologies (pp. 463-469). Springer, Singapore. DOI: https://doi.org/10.1007/978-981-15-3125-5_46