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Renewable energy sources and their importance for the energy sustainability of Manabí Province, Ecuador

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Abstract

Manabí is a province that presents renewable energy resources that can be used to improve the energy matrix. The objective of the research was to analyze the benefits of the different renewable energy sources that exist in the province and their influence on energy sustainability, because when implemented, these allow the sustainability of the electrical system and contribute to the care of the environment. A bibliographic review was applied as a methodology, obtained through scientific articles, books, and websites, which will give relevance to the research topic. It was concluded that implementing power plants based on the use of renewable energy sources that are present in the province would be feasible due to the good climatic conditions due to its location in the coastal region, allowing the use of energy from the sun, water, wind, organic matter, and sanitary landfill; due to the wealth of the province that can enhance local development, thereby reducing the carbon footprint, protecting the environment, and using these energies allows improving the economic and social situation of the inhabitants; Since we would have clean and safe electricity without fear of suffering scheduled disconnections that affect the economic development of the province and the country, in this way the electrification needs are met.

Contents

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1 Introduction

Renewable energy sources are characterized by the ability to regenerate naturally over time and are replenished, as they use energy from water, the sun, wind, vegetation, or animals, etc., and they do not use fossil fuels to generate electricity.

It is worth noting that the main objective of renewable energy sources is to utilize the clean energy generated by the planet. Installing a power plant has minimal environmental impact, as it does not pollute like conventional energy sources do; it doesn't generate greenhouse gases and doesn't damage the ozone layer. Furthermore, the benefits include diversification of the energy mix, economic development, tourism promotion, and environmental protection (Meunier, 2007).

The province of Manabí, located in the coastal region, offers viable opportunities for implementing power plants due to the province's favorable environmental conditions. Using the renewable energy found in the province helps meet the needs for electricity and improves the economic and social well-being of its residents.

It's important to note that the implementation of renewable energy plants brings multiple benefits, ranging from reducing environmental pollution to generating electricity that helps power the country's National Interconnected System, ensuring energy security (Mussard & Amara, 2018).

2 Results and Discussions

“Renewable energy is energy obtained from virtually inexhaustible natural sources, either because of the immense amount of energy they contain or because they are capable of being regenerated by natural means” (Spiegeler, 2016). Therefore, renewable energies require the construction of renewable power plants to harvest the energy found in the streams to generate electricity. It should be noted that these energies are unlimited and are generated naturally, but are sometimes limited in quantity due to the location of the energy collection site.

The process for obtaining electricity from the use of renewable energy can be seen in the following figure 1:

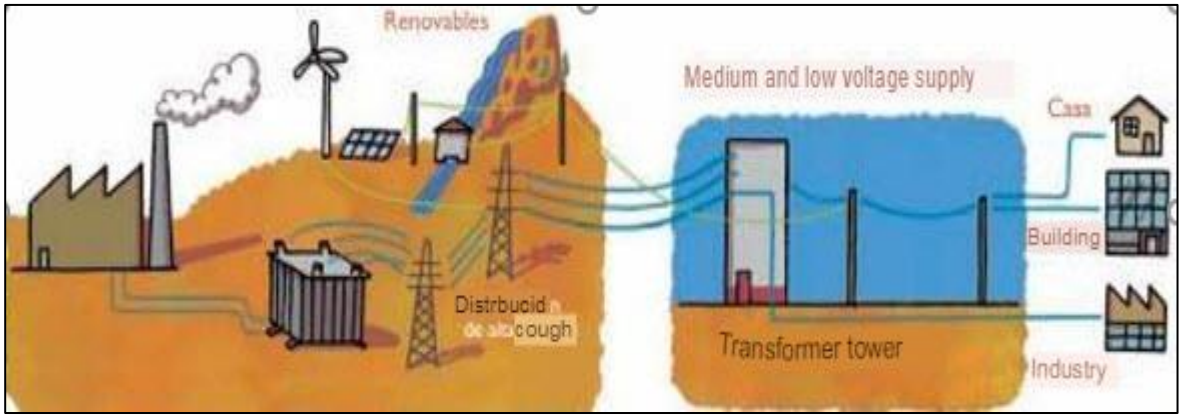

Figure 1. Obtaining and distributing electricity using renewable energy sources
Source: (Schallenberg, 2008)

The figure shows the process of obtaining mechanical energy from renewable sources and then converting it into electrical energy. Once the energy is extracted, it is distributed through high-voltage lines to reach the transformer, which regulates the appropriate voltage for delivery to homes, buildings, and industries. This way, people's electrification needs are met.

The importance of renewable power plants lies in their use of clean, inexhaustible energy, distinguishing them from thermal power plants that use fossil fuels, which emit gases and steam that give rise to the greenhouse effect and cause climate change due to high pollution. The advantage of using renewable energies is that they have a "wide geographical distribution, are diverse, have a low environmental impact, have the capacity to generate jobs, and their capacity to be exploited in areas not interconnected to the energy grid" (Valencia, 2015).

It should be noted that the use of renewable energy is the most viable solution to the environmental degradation that has been occurring for years because it is environmentally friendly. Furthermore, this energy reduces manufacturing costs, making it competitive with thermal power plants. Therefore, the use of renewable energy plants is making it a sustainable solution, both environmentally and economically, due to its method of production (Østergaard et al., 2022).

Renewable energy sources in the province

The province of Manabí is in the geographical area known as the coastal region, bathed by the Pacific Ocean. This creates real opportunities for the development of renewable energy sources due to its favorable environmental conditions, as detailed in Figure 2.

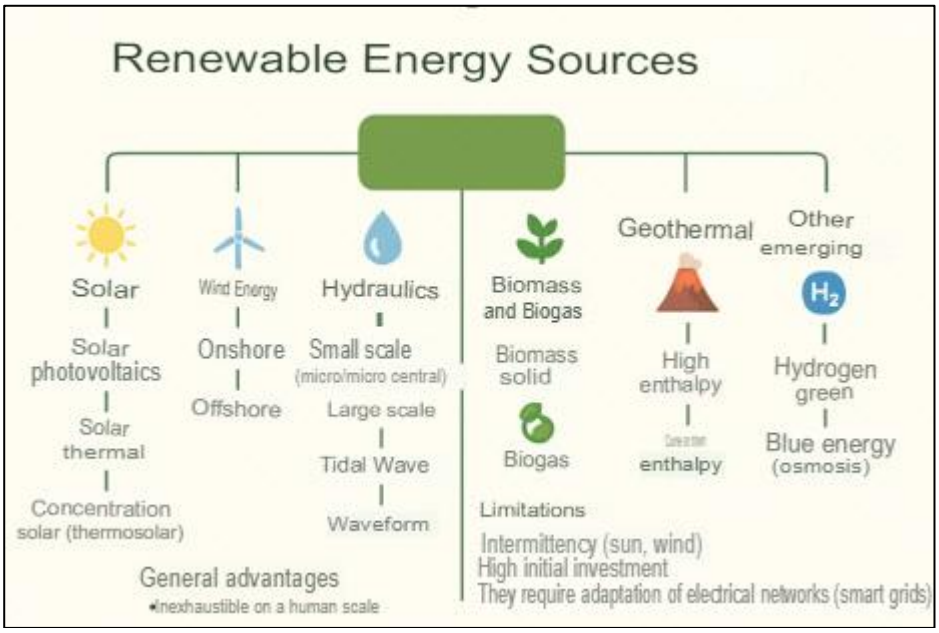

Figure 2. Renewable energy sources in the province of Manabí

Solar energy is present in the cantons that are part of the province of Manabí, with high levels of solar radiation reaching approximately 5803 Wh/m2(Watts per square meter) per day; these radiation levels indicate that the installation of solar panels is viable and feasible, where the population will use the electricity produced to meet their needs for electricity, water pumping, and lighting. Today, this energy source is one of the most extensively studied in the province of Manabí. Solar maps for each canton can be seen in the book Photovoltaic Energy in the Province of Manabí (Rodriguez & Vazquez, 2018).

Wind energy is also present in the province of Manabí, specifically in Pedernales, Jama, San Vicente, Sucre, Jaramijó, Manta, Crucita, Puerto Cayo, and Puerto López. Wind speeds of 2 to 3 m/s (meters per second) are available, making it possible to implement wind turbine technology, where the generated energy can be stored and distributed to the population to meet their electricity needs in the event of a power outage.

In terms of hydropower, the province is characterized by its fast-flowing rivers that flow into the Pacific Ocean. The Chone and Portoviejo rivers are the only ones with the deepest channels, indicating that the

implementation of a hydroelectric plant would allow for clean, renewable electricity production, contributing to the energy mix, but also for small-scale consumption in isolated communities.

In the province, biomass energy is present in areas with a greater influx of livestock, such as Chone, Bolívar, Rocafuerte, and the northern part of the Sucre Canton. The areas with the greatest presence of corn crops are Paján, Tosagua, Jipijapa, and Pichincha. There is also residual sugarcane, rice, and banana crops, among others. In this context, the implementation of bioenergy could solve energy problems in many rural areas where electricity is currently unavailable or of poor quality. Biogas production would be ideal for the development of the province because it is obtained from the decomposition of solid waste, which can be used by converting from garbage in sanitary landfills. For its operation, waste would be collected from the 22 cantons of the province, thus producing electricity without causing environmental damage. There are other energy sources currently under investigation, such as tidal, geothermal, and hydrogen (Chere-Quiñónez et al., 2022).

Importance of using renewable energy for the province's energy sustainability

Renewable energy sources bring benefits in four areas, contributing to the local development of the province while generating energy sustainability, leaving positive impacts in the various areas detailed below:

Energetic. Energy independence is achieved because producing electricity locally will reduce dependence on national power plants, as the province generates electricity for its residents.
Economic. By building renewable energy plants and once they are operational, they generate employment for residents, fostering economic and social development by improving the population's quality of life. Furthermore, over the years, the maintenance and operating costs of renewable energy plants will be low, which will lower the cost of electricity sold to residents, and when there is excess electricity, it can be sold to neighboring provinces, generating income.
Social. Having renewable energy sources in the province improves the quality of life for residents, as they would have safe and reliable electricity. Furthermore, implementing these power plants impacts people's quality of life, as they can improve their social status.
Environmental. Reducing the greenhouse effect by reducing the carbon footprint contributes to achieving the Sustainable Development Goals (SDGs) and reducing emissions, which are currently contributing to the exacerbation of climate change and the depletion of the ozone layer.

The province of Manabí is very rich in these types of renewable sources; therefore, it is necessary to implement programs that help meet the electricity needs of its residents.

It should be noted that in the country, the clean energy power plants that generate the largest supply of electricity are hydroelectric plants, accounting for 92% of the total. Non-conventional energy sources such as photovoltaic, wind, biomass, biogas, geothermal, and others account for 1% of the total. Thermal power plants represent the remaining 7%. For this reason, it is vitally important to support non-conventional energy projects, as these have not yet been fully exploited. When they are fully utilized, they will directly contribute to the energy mix.

3 Conclusion

According to the work carried out, it is concluded that renewable energy sources generate electricity in a clean manner that does not pollute the environment, causing the ozone layer to not deteriorate while electricity is obtained. In addition, these energies are unlimited since they regenerate naturally over time.

Implementing power plants using renewable energy in Manabí would be feasible due to the province's favorable climatic and environmental conditions, which include solar, water, and wind energy sources. It is also a province with abundant livestock and agricultural sectors that produce biomass energy, and biogas is obtained from landfills in all cantons.

It is important for the country to give greater importance to non-conventional renewable energy sources, such as photovoltaic, wind, biomass, biogas, geothermal, and others, because they can be used to generate electricity. This way, the country will not rely solely on hydropower, since the downside of such energy is its dependence on rainfall. When it fails, planned power outages would be required, impacting the population's economic and social activities.

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References

Chere-Quiñónez, B. F., Martínez-Peralta, A. J., & Mercado-Bautista, J. D. (2022). Technical-economic analysis of the implementation of a microgrid with integration of renewable energies in the Esmeraldas Canton, Ecuador. *International Journal of Physical Sciences and Engineering*, *6*(3), 91–108. https://doi.org/10.53730/ijpse.v6n3.13783

Manabí Governorate. (2020). Geographic data.https://www.manabi.gob.ec/sitio2020/datos-manabi/datos-geograficos

Manabí. (2024). The weather for today.

Meunier, F. (2007). The greenhouse effect: A new source of energy. *Applied thermal engineering*, *27*(2-3), 658-664. https://doi.org/10.1016/j.applthermaleng.2006.05.028

Mussard, M., & Amara, M. (2018). Performance of solar photovoltaic modules under arid climatic conditions: A review. *Solar Energy*, *174*, 409-421. https://doi.org/10.1016/j.solener.2018.08.071

Østergaard, P. A., Duic, N., Noorollahi, Y., & Kalogirou, S. (2022). Renewable energy for sustainable development. *Renewable energy*, *199*, 1145-1152. https://doi.org/10.1016/j.renene.2022.09.065

Rodríguez, M., & Vázquez, A. (2018). Photovoltaic energy in the province of Manabí. *Portoviejo*.

Schallenberg, J. C. (2008). Renewable energy and energy efficiency.

Spiegeler, C. (2016). Definition and information on renewable energy.

Tapie, M., Duicela, L., Solorzano, J., Molina, C., Zambrano, T., Caiza, F., Aranguren, J. (2022). Realities of cattle farming in the province of Manabí.

Valencia, L. P. (2015). Importance of renewable energy in energy security and its relationship with economic growth.

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