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Article

Integration of green technologies for the generation of electric energy using microgenerators and atmospheric batteries in the irrigation district #043 Alejandro Gascón Mercado, *Canal Centenario, State of Nayarit*

Integración de tecnologías verdes, para la generación de Energía Eléctrica utilizando Microgeneradores y Baterías Atmosféricas en el Distrito de Riego #043 Alejandro Gascón Mercado, *Canal Centenario Estado de Nayarit*

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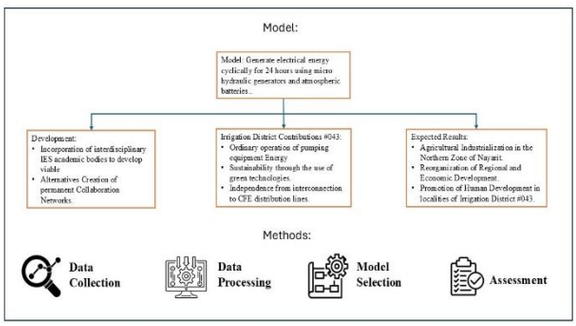
Abstract

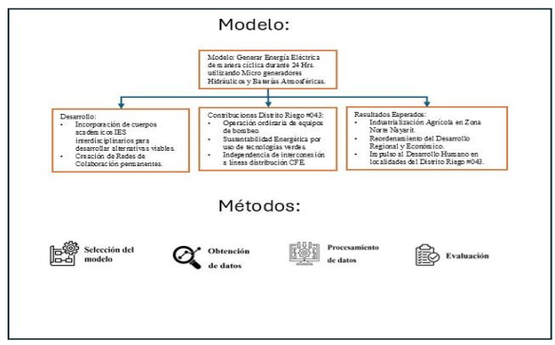
The project integrates the start-up of two modules: #1.- A revolutionary mechanical, hydrokinetic microgenerator that converts more than 50% of the slow flow of water into electrical energy, used in Irrigation District #043 in the State of Nayarit, Mexico, feeding three centrifugal pumps that operate with three-phase 10 Hp motors in each pump; module: #2.- It is proposed to carry out hydraulic works including elevated dams, where large quantities of water are momentarily stored, creating conditions for it to operate as an atmospheric battery and maintain the continuous operation of a generator driven by a Francis turbine with a continuous capacity of 0.25 to 0.5 MW at 60 Hz for a range of 8 hours. The sum of the two operating modules are called: Microgenerator Group and Pumping with Atmosphere Battery, being possible to triple the sum of the two modules through an arrangement to sustain a load of 0.25 a 0.5 Megawatts for a 24 hr cycle, exploring the increase in the number of microgenerators and consequently modify if necessary the capacity of the elevated dam, the general conditions of use and exploitation consider that it is not necessary to interconnect to the public state transmission network called Federal Electricity Commission (CFE). Achieving the sustainable operation of a new regional development engine that takes advantage of green energy in a cyclical manner.



Slow movement of the water, combination of technologies, microgenerator group, atmospheric battery and Economics Development

Resumen

El proyecto integra la puesta en marcha de dos módulos: #1.- Un microgenerador mecánico, hidrocinético revolucionario que convierte más del 50% del paso lento del agua en energía eléctrica, aprovechados en el Distrito de Riego #043 en el Estado de Nayarit México alimentando a tres bombas centrífugas que operan con motores trifásico de 10 Hp's. para cada bomba; módulo: #2.- Se propone realizar obras hídricas incluyendo diques elevados, donde se almacenan momentáneamente grandes cantidades de agua, creando condiciones para que opere como una batería atmosférica y mantenga la operación continua de un generador impulsado con turbina Francis con capacidad continua de 0.25 a 0.5 MW. a 60 Hz por un rango de 8 horas. La suma de los dos módulos operando, se denominan: Grupo Microgenerador y Bombeo con Batería Atmósfera, siendo posible triplicar la suma de los dos módulos mediante un arreglo para sostener una carga de 0.25 a 0.5 Megawatts por un ciclo de 24 hrs., explorando el aumento del número de microgeneradores y en consecuencia modificar de ser necesario la capacidad del dique elevado, las condiciones generales de uso y aprovechamiento consideran que no es necesario interconectarse a la red pública de transmisión estatal denominada Comisión Federal de Electricidad (CFE). Logrando la operación sustentable de un nuevo motor de desarrollo regional que aprovecha energías verdes de una manera cíclica.



Movimiento lento del agua, combinación de tecnologías, microgenerador hidráulico, batería atmosférica y desarrollo regional

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Introduction

Our passage as humankind on planet earth will record a high level of pollution by the year 2023. The prevailing way of life due to the application of the linear economy method continues to generate deterioration of the environment: damage to the ozone layer, increase of the carbon footprint and depletion of natural resources due to human activity. The increase in temperature has changed normal climate cycles, causing serious damage to biodiversity with climatic implications: hurricanes, severe droughts impacting watersheds, lakes and rivers, some states in Mexico have declared water emergencies similar to other places globally.

Leading these environmental improvement efforts is the UN through the governments of the world with the 2030 Agenda and the 17 Sustainable Development Goals, seeking to change the way electricity is generated and consumed, the impact of the transition from petrol cars to hybrid and/or electric cars to establish new ways to promote human mobility. All other human activities imply further changes in the consumption of other natural resources: water and air.

With this frame of reference, the present research developed by the members of the multidisciplinary academic body of the Technological University of Nayarit[1] ITCAR[2] (Technological Innovation in Environmental Sciences and Renewable Energies) is identified. During the period 2022 - 2024, a formal investigation was established that has taken as its starting point the chapter entitled: 'Characterisation of Potential Clean Energy Generators in the State of Nayarit, to elaborate the Energy Transition Matrix 2020-2050'[3].

This course is directed towards hydroelectric microgeneration of electrical energy, with exploitation of slow water flows in streams, rivers and canals. In Mexico, and especially in the Nayarit Territory, there is a large capacity of hydrological resources that can be used throughout the year.

Below is an illustration of the availability of surface water in Nayarit, a water basin with its rivers and canals with a potential for microgeneration of electrical energy calculated at 2,491 MW/Hra (Microgeneration by rivers and water runoff) including dams of 4,314 GW/Hra (Microgeneration by rivers and water runoff). See (Fig.1).

Box 1

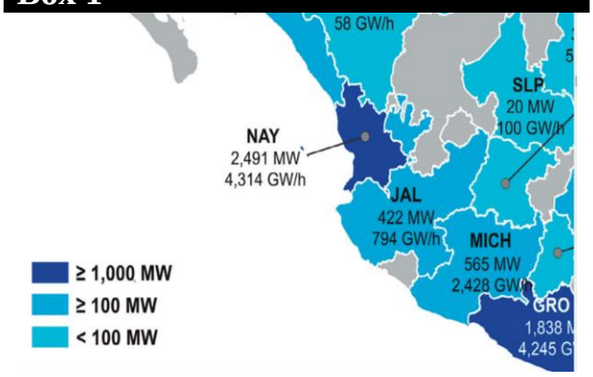

Figure 1
Capacity in MW and GW. of electricity generation in Nayarit, by means of hydropower potential

Subsequently, the focus was to study and select the type of microgenerator already tested with the best results and adapted to rivers and canals, particularly the irrigation District Canal No.043. Thus, after several months and experiences in communities of Nayarit as Santa Cruz de Miramar, where with the few resources available, the 'Rio El Naranjo' was characterised, with possibilities of using a helical screw, which has been developed in Spain and is for sale, costs were obtained only. In the months of May and July 2024, after the PRIMSO call of the Government of the State of Nayarit, through the COCYTEN (Council of Science and Technology of the State of Nayarit), assigned economic resources to this research work specifically to be designed and potentially selected to be implemented in the irrigation district N0. 43 Alejandro Gascón Mercado. After analysing the characteristics and measurements of the canal or irrigation district No.45, the best option was the WATEROTOR Microgenerator, a device that harnesses the kinetic energy of slow moving water to generate electricity. It works by means of a rotor or turbine that is installed in water currents, such as rivers or canals, to convert the constant flow of water into rotational movement.

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The WATEROTOR is an efficient and sustainable solution for generating energy in areas where there is access to water resources. Moreover, its environmental impact is relatively low, as it does not require reservoirs or large infrastructures, as in traditional hydroelectric plants. This technology can be especially useful in rural or isolated communities that do not have access to conventional electricity grids. The WATEROTOR microgenerator will be the means to generate enough electrical energy to power 3 three-phase 10 Hp pumps. Each one with its own pumping pipe work to fill in a cyclical manner, an elevated dam (ATMOSPHERIC BATTERY), which will be calculated to sustain for 8 hrs. With a constant generation capacity of 0.25 to 0.5 MW/Hra. At 60 Hz. Without interconnection to C.F.E. (Electricity supply company)

Methodology

The challenge begins with the selection of the type of microgenerator that will adapt to the measurements of channel 043 (See fig.2) in question and whose capacity is in the range of 10 to 50 KW/Hra. at 60 Hz. Three-phase, which does not use fossil fuels or chemicals that pollute the atmosphere.

This microgenerator is ideal for this type of canal, which met the expectations of this project, after an analysis and which makes perfect use of the kinetic energy of slow moving water flows and which adapts to the measurements of the irrigation district in question.

It was the WATEROTOR microgenerator that works efficiently at water velocities as low as 3.2 km/h (0.9 m/s), ideal for the 'Irrigation District 043, Canal Centenario located in the state of Nayarit'. Below is an image of the selected Microgenerator. The design of the WATEROTOR is totally underwater, that is to say it is submerged in water, easy to install and uninstall, totally mobile.

Box 2

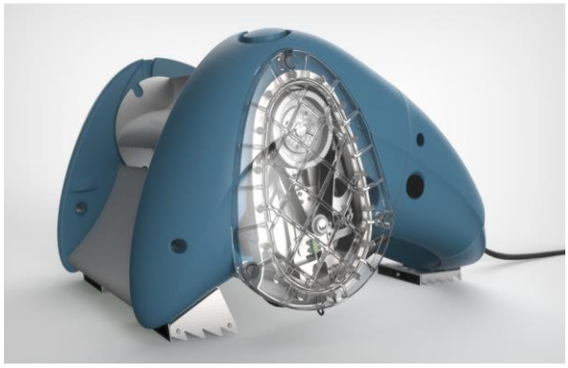

Figure 2
Waterotor Microgenerator for slow water flow. MODULE 1

It is observed that the selected microgenerator, with the function of electrically feeding groups of 3 three-phase pumps of 10 hp's each. So that through pipes properly calculated to fill the elevated dam (element considered in the Atmospheric Battery) MODULE 2. That contains, the quantity of cubic meters necessary to, in turn, manage to maintain an electric generator of 0.25 to 0.5 MW. working in a range of 8 to 24 hrs.

At this stage, it is worth mentioning that with the resources allocated to this project, from the PRIMSO call of the Government of the State of Nayarit, through COCYTEN (Council of Science and Technology of the State of Nayarit). A photometric study of the terrain (8 kilometres of the canal, irrigation district 043) will be carried out using a photometric drone. This will be used to define the places where the best conditions for the installation of the microgenerators can be found.

On the other hand, the aforementioned pumping equipment will have hydraulic works to raise the water to an elevated dam. Strategically placed in a place close to the canal.

From the above, it is required to build a hydroelectric work of pipe that will gradually decrease diameter from the high dam to the entrance snail to the body of a structure with Francis turbine, which with sufficient force moves the shaft of an electric generator with a capacity of 0.5 MW/Hra. And the output of the generator is considered to be 0.5 MW. Return the water to the canal or irrigation district again.

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Based on the characteristics and geometry of the irrigation district, Alejandro Gascón Mercado. Where these measurements are the basis for selecting the WATEROTOR microgenerator.

Below are the measurements of the geometry of the Irrigation District #043.

The centennial canal has a trapezoidal channel, with the following measurements

- Channel Width = 2.40 mts.
- Slope Distance = 1.75 mts.
- Total Channel Height = 3.50 mts.
- Flow Depth = 3.00 mts.

Box 3

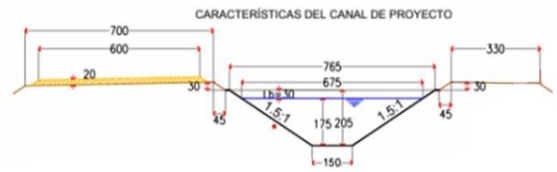

Figure 3

Cutting of the Centenario Canal, Irrigation District #043, Alejandro Gascón Mercado

The geometry of the channel determined the measurements of the depth and width of the base of the channel. And it was this data that determined the size and kilowatt capacity of the WATEROTOR microgenerator. That if they coincide with the KW. That are required for the group of pumps proposed in this research work.

The use of sustainable energy and natural environments, are a source of inexhaustible and affordable energy where there is no direct damage to the environment, plus the prototypes do not have a footprint or carbon footprint to obtain electricity. Another important point is to take advantage of the resources offered by the State of Nayarit, as is the Centenario a left bank channel without operating, the main source is the fall and the energy provided by the flow and velocity of natural water in a specific geographical space, where a study was conducted that affects the agricultural sector, rural economy, this channel will be used as the natural source of hydraulic energy to be potential energy and / or electricity.

Box 4

Figure 4

Geographical location of Margen Derecho "Distrito de Riego #43, Alejandro Gascón Mercado." from QGIS

The 2,047 hectares of the localities El Tambor and Corral de Piedra, both located in the Municipality of Santiago Ixcuintla Nayarit Mexico, are highlighted in blue. Surveys will be carried out with a Drone Photometric along the Irrigation District #043. The purpose is to know the topographic features associated with the area of influence of the Centennial Canal, to determine the best locations of the microgenerators for electricity generation.
QGIS software was used to process the field photometric information to generate numerical elements.

For the generation of illustrations of mechanical components, as in the case of the proposed microgenerator, the Solid Works platform was used.

Box 5

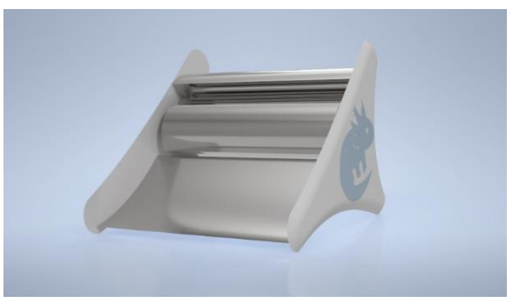

Figure 5

Illustration of Proposed Microgenerator Generated in Solid Works

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This proposal brings together a green, environmentally friendly means of microgeneration of electricity and is combined with an atmospheric battery. To which is added a hydroelectric type work with a Francis turbine of special dimensions for a generator of 0.25 to 0.5 MW, to take advantage of the fall of water from a height of more than 7 mts. to 10 mts. with a dam of more than 180 cubic metres. With a potential to sustain the production of electrical energy for almost 10 hours of generation. The combination of modules 1 and 2 of this project, as well as the hydroelectric work required, can be replicated several times along the canal or irrigation district No. 043, and the 2 modules and the hydroelectric work can be sized according to the needs in target generation capacity. According to what can be invested and the electrical load that needs to be fed. A versatile and sustainable design can be considered, taking into account the following aspects listed, in order to be successful when implemented in the field:

- On the initial route of 9 kms. of the trajectory of the Irrigation District #043 considered in the terms of reference of the call PRISMO 2024, using as a means of support overflights with the use of a Drone that uses a photometric camera. The intention is to have clarity of the real and existing topography in the canal area; by identifying the available elevations and in case of not having natural elevation elements, then we will proceed to suggest the construction of elevated dams as water reservoirs and/or some type of project available in CONAGUA[1].

Box 6

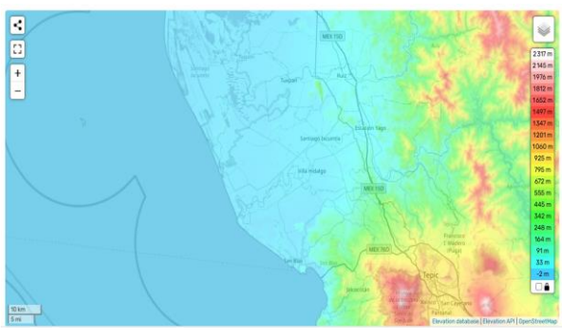

Figure 6
Topographic Profile, Zona Canal Centenario State of Nayarit

- For the operation of the modules: Microgenerator + Gravity Pump, it is necessary to have structures that allow the temporary storage of water at a height of 7 to 10 mts. with variable capacities that allow the calculated electricity generation.

- The generation of sustainable electrical energy considers it fundamental not to pollute and to be a green energy proposal with moderate investment, with the potential to achieve a great social impact in the region where Irrigation District #043 is located.

- The system of microgeneration and generation with hydroelectric work with capacities in the range: 0.25 to 0.5 MW/hra. does not consider being interconnected to the Public Networks of the CFE, being used 100% in the area of the Irrigation District #043.

Box 7

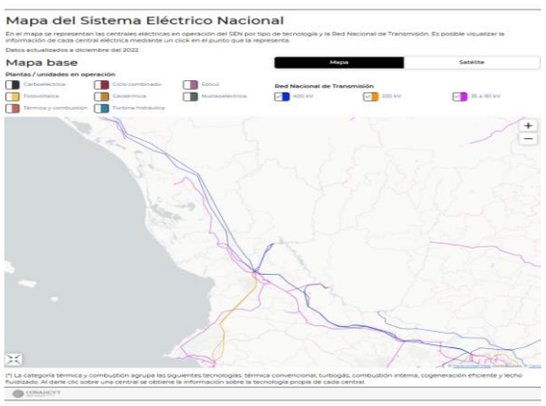

Figure 7
Public Networks CFE, State of Nayarit

- It is necessary to manufacture a series of components that, when installed in the areas identified for generation, allow the purification and, if necessary, diversion of: waste, suspended solids and other agents present on the water surface that affect the operation and rotation of the microgenerator rotor. Allowing ordinary operation with a low level of scheduled preventive/corrective maintenance.

[1] Topographic identification of the study area Mapa topográfico Nayarit, altitud, relieve (topographic-map.com) https://es-mx.topographic-map.com/map-xnm57/Nayarit/?center=21.75775%2C-105.05703&popup=22.18168%2C-109.76786&zoom=13

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Benefits with high social impact are contemplated for the northern region of Nayarit, by achieving production in the generation of electricity in the range: 0.25 to 0.5 MW of continuous three-phase type available in a minimum range of 10 hours extended to 24 hrs, it is possible to consider the following goals:

- Attract foreign investment to global companies, by means of different agreements, with differentiated and attractive regulated prices in peso tariffs per KW/Hra consumption.

- 2Through being able to increase the pumping of water over long distances from the canal, it is feasible to consider increasing the number of hectares that will become potential generators of crops in the region. With low cost electricity in pesos. Causing new lands to abandon the temporary use and to be adhered to the new Irrigation District #043. As a strategy to ensure food security for the national population.

- Strengthening the generation of jobs, with better remuneration, as a strategy to retain the migration of young people, due to the fact that they cannot find employment in their area of origin.

Low-cost electricity, aimed at developing micro-enterprises in each of the communities, to give added value to their crops (dehydrating, canning, etc.), promoting national sales and export abroad with higher profit margins.

We identified the potential to boost the local economy by extending the initial surface area by 24,000 hectares of irrigated land in the northern zone along the municipalities: Santiago, Tuxpan, Ruiz and Rosamorada with electricity availability along the 58 Kms. of the Centennial Canal 365 days a year.

Laying the foundations for attracting investment and the establishment of global companies. The present implementation presents the feasibility of being able to be replicated in the states where its hydrological characteristics allow it, at least the following are identified:

Box 8

Figure 8
Surface Water Availability Summary in Mexico

The integration of a model to attract foreign investment, promoting the empowerment of the countryside and the promotion of growth in these regions, is a matter of another type of scope, and in this sense the detonating and articulated role that the availability of electricity can play when considering regional development strategies is emphasised.

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