

# ***EMPOWER ENERGY COMMUNITIES BASED ON HYBRID SOLUTION IN A NON-INTERCONNECTED AREA IN MACEDONIA, COLOMBIAN AMAZON.***

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## **Overview**

The present work develops the construction of strategies to manage and empower energy communities and sustainability in a hybrid generation system located in an indigenous community of the Colombian Amazon, investment that was developed by the Colombian's state with catalytic capital and according to socio-economic connotations and the experience in this kind of investments estimated by the investors a low or null sustainability.

To this end, the authors develop a financial evaluation based on cost of generation and the kWh per month and user, considering the market prices, regulation, and the system own performance, were modeling breakeven sceneries and minimum internal rate of return in social projects with the objective of evaluate in which conditions the systema will perdure at the time.

The results allow to build business strategies that attribute to results that directly impact to the Tikuna Indigenous community in ambience economic, social, and environmental that indicated virtuous circles to development and sustainability from energetic generation's perspective.

After those results and conclusions, this work, also represent strategies to generate an adequate scenario to empower the community to establish an energy community by productive activities and focalizing in a real energy transition.

## **Methods**

The working hypotheses of this article:

- Is it possible to incorporate alternatives in energy demand that make a hybrid solution sustainable in ZNI with the presence of Indigenous populations?
- Can first-order or subsistence productive activities generate a substantial increase in demand and make the implemented solution sustainable?
- Is the System Management and Operator responsible for ensuring the sustainability of the centralized hybrid solution located in Indigenous communities?

To respond to the previously mentioned hypotheses, the general objective and the specific objectives of this work are established:

- Identify an alternative focused on energy demand that generates sustainability for a hybrid solution in ZNI with the presence of Indigenous population.
- Define which productive activities can respond to the energy demand of the system that are framed in a sustainable scheme for an SHDF.
- Define under which management strategy a sustainability scheme can be guaranteed for a centralized hybrid solution with the presence of Indigenous population.

It should be noted that Colombia has limited information on hybrid solutions centralized in Indigenous territories, the case study dates to 2015, with variations in execution and budget, until 2023 the system will be implemented and presumes a sustainability scheme linked purely to the tariff in an unregulated and residential market.

It is intended to provide a solution to the hypotheses proposed, the experience obtained by the authors and the methodological integration between the state of the art, regulatory context, discussion of the hypotheses and identified results that will generate the best alternative of sustainability in this type of centralized hybrid solutions with the presence of the Tikuna indigenous community.

## **Results**

The results found according to the evaluation conditions are:

### **Strategies that generate sustainability in the system.**

- Considering the maximum unit cost defined by the incumbent market and the real OPEX costs, under the established parameter of 12% IRR, it is identified that it generates a positive cash flow during the evaluation horizon, the technical evaluation is suitable and optimizes 85% of the generation: this result adduces an average consumption of 486 kWh/month per user and a cost of \$438 kWh as a break-even point.
- For the scenario where the unit cost defined by the regulation and real OPEX costs and an IRR at 12%, it is identified that an

average monthly consumption of 395 kWh/month is required, obtaining a positive cash flow, generation efficiency close to 70% and an average unit cost of \$539 kWh as a break-even point.

- In the scenario where the unit cost of the kWh defined by the regulation and the OPEX costs that the regulation itself remunerates were evaluated, under an IRR parameter of 12%, an average monthly consumption of 686 kWh per month per user and a unit cost of \$432 kWh are estimated, the cash flow of positive and a generation efficiency of 75%.

#### **Definition of strategies to ensure sustainability in a hybrid generation system.**

According to the scenarios proposed and the results found, it is defined that the best scenario to generate sustainability strategies is identified under the following conditions:

- Average consumption of more than 173 kWh/month, a scenario that guarantees efficiency in electricity generation of 70%, IRR of more than 12% and positive cash flow.
- Under these parameters, the most favorable scenario identifies that the average consumption is determined by the amounts of 395 kWh/month per user and a maximum unit cost of \$2,477 COP per kWh.
- It should be noted that it was estimated that the total number of users, 191 residential, determines a subsistence consumption of 173 kWh/month and that it has a surplus of 222 kWh/month, which in usual and real terms will not be consumed by residents due to factors such as availability of payment, little or no requirement, energy efficiency, etc.
- Given the above and the question of how to make the system sustainable, strategies are determined within the business scheme, productivity incentive scheme, energy efficiency and sustainability of the public entity.
- To this end, it was found that the energy surplus of 222 kWh/month satisfies the generation of 41,307 kWh and that they will be distributed or disposed of to the productive sector of the Indigenous community.
- According to the energy demand of the indigenous community and its productive system, it will be implemented in the following activities: hospitality, fishing cold chain (freezing), drying of corn, fruits, drying of garlic, ahuyama, cassava; as well as the allocation of tools to support the technification of artisans (wood, fabrics, and ceramics).
- As energy efficiency, it is identified that the system can produce 70% of the energy requirement and that it reaches 30% as support to meet the future energy demand due to factors such as population increase, increase in demand for production, increase in tourism, increase in migrant population due to job opportunities, etc.

These strategies are the first step to rethink in the medium and short term in expanding coverage under concepts of modularity, time windows by capacity and schedules, financial incentives for production, integration of public policies that under intensive activities in the use of energy resources can generate sustainability in this type of hybrid generation.

It should be noted that sustainability is not only a technical result, but that its sustainability is made up of variables: environmental, economic and social; and that in the best of cases, when more variables are intervened or modeled, it will allow not only to evidence real scenarios but also alternatives that in the short, medium and long term are strategies that allow this type of system to remain over time.

#### **Conclusions**

- To precisely energetic efficiency in a hybrid system in rural communities and Indigenous, usually is related to demand's limits. It implies that demand curve will retract and could create oversized systems, less consume and instable systems.
- A sustainable energy community identify break-even point and strategies for generation, distribution and commercialization that optimize productive capacity.
- In case of evidence of growth economy that apply directly to increase energy demand, the first step is supply the demand with modular systems that respond to new scenarios for communities and create sustainable and virtuous circle.
- Exist a proportional inverse relation between energy demand, cost of each kWh defined by regulation and unitary cost define by itself identifying cash flow performance and Internal Return Rate - IRR higher than 12%, although it is understandable that CAPEX is catalytic, and it is not in vain that must be identified at least a social IRR, or an opportunity cost compared with the minimum projected.
- As a conclusion, has realized that scenarios that are directed to attend an efficiency less than 30% are not viables, not only but technical reasons, also because activities as management's system, cost control in that point will not consider as savings, due to an incipient management operation will consider resources at least nearest to 60% according to generation's capacity.
- Evaluation of scenarios with IRR nearest to 12% could define an optimization about generation's capacity of 76% on average, this average allows suggest that the system by itself could work by solar generation, batteries and in exceptional cases use diesel generator.
- Talking about dynamization of the consumption, it is not necessarily directed to residential user, an imminent asset could be produced by hostels, tourism, restaurants, and all kind of activities associated to create an economic circle and could deduce improvements in terms of payments and incomes of each small business according to studied variables.
- The scenarios allow to identify that de hybrid generation system is no sustainable, and its necessary to empower community, participated with all agents since tariff's analysis until public policy.
- Macedonia's community, Indigenous people and its activities are the entrance for knowledge of use, customs, languages that are in constant relation with the "external world."