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Framework to design water-energy solutions based on community perceptions: Case study from a Caribbean coast community in Colombia

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Abstract: The off-grid communities in Colombia are characterised by the diversity of their geography, socio-cultural contexts, and structures of the system. Despite their potential, the opportunities for access to energy and therefore other conditions to develop education, productivity, health, technological projects, and recreation are highly limited. Under those conditions, the implementation of projects with water and/or energy solutions based on renewable sources would bridge the gaps of isolation and social marginalisation that have detained the future of these communities for years. Projects around water and/or energy require the input of external stakeholders to communities, despite of the willingness to change their realities towards a better lifestyle. To achieve a common point of interests among stakeholders, the dialogues, the understanding of the community cosmovision and the ethical perspectives

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PUBLIC INTEREST STATEMENT

The off-grid communities in Colombia are characterised by the diversity of their geography, socio-cultural contexts, and structures of the system. Despite their potential, the opportunities for access to energy, and therefore other conditions to develop education, productivity, health, technological projects, and recreation are highly limited. To achieve a common point of interests among stakeholders leading to water-energy sustainable solutions, the dialogues, the understanding of the community cosmovision and the ethical perspectives regarding the use of natural resources are needed leading to the development of a framework “Community, wAter-Renewable Energies, Diversity” (CARED).
regarding the use of natural resources are needed. Furthermore, it is necessary to identify perceptions of confidence and risk of renewable energy projects within the community. To design water and/or energy solutions based on the abovementioned in a sustainable manner, the framework “Community, wAter-Renewable Energies, Diversity” CARED is being developed, for which the first phase in its implementation is presented. The process has been carried out in the Wayuu indigenous community “La Paz” located near Manaure in La Guajira state in the northeast of Colombia.

**Subjects: Engineering Education; Power & Energy; Renewable Energy; Life-Long Design**

**Keywords:** Community participation; water; renewable energies; diversity; social-environmental psychology; off-grid zones; Sustainable Development Goals (SDG)

1. **Introduction**

The design of water and/or energy solutions aimed at communities far from urban centres—impovertied in economic terms, but with the richness of their socio-cultural constructs, world-views, ways of establishing a relationship with nature—poses the challenge of understanding diversity to the fullest of the concept. That is, in the recognition that “diversity in the experience of the world is inexhaustible and therefore” (Santos, 2017) one could not intervene in these communities with universal methods or solutions.

The intention of generating water and/or energy solutions for communities is governed by imperatives such as: ethics, justice, equity, and universal rights; however, its development and applicability depend on the particular human relationships between stakeholders; confidence in the process of discovering the outlines of the region’s problems and possibilities; the ability of the developers of water-energy solutions to build self-confidence in communities and transfer the knowledge for the empowerment of people to achieve stability in the solutions created.

In this sense, this article sets out the framework proposal called “Community, wAter-Renewable Energies, Diversity” CARED, to design water and/or energy solutions for the Media Guajira area, municipality of Manaure, village of La Paz. This region is occupied by the Wayuu indigenous people, who retain their worldview and customs.

Firstly, it presents the locations of enunciation to think of the framework proposal. After that, it details the process carried out, so far, to structure the CARED framework and the content of the instruments to produce information, oriented from the perspective of action-participation research. Subsequently, progress is made in the implementation of this framework, which corresponds to the first visit to the community, that is to first face-to-face encounter with key information sources, generate initial conditions, not only for community demand of water and energy, but for empathy and trust, and raise a second visit for the exercise of surveying socio-cultural, productive, educational aspects, among others.

It is concluded that an approach to provide water and/or energy solutions that can be coupled with the rhythms, knowledge, internal dynamics of the communities, offers a better prognosis in the face of the relationship between stakeholders, feasibility, and sustainability in the implementation of solutions created with community participation.

2. **Community perceptions-based solution design approach**

This approach has had its main applications in the field of psychosocial care in emergencies and/or humanitarian care, in close “relationship with the rights approach and its underlying principles of participation, inclusion and equality” (United Nations High Commissioner for Refugees, 2008). Its structuring has favored the reduction of errors in the design and implementation of psychosocial interventions in communities and opens the way to other types of interventions in the fields of
medicine, architecture, engineering, urban and rural development, among others (Martínez, 2016). In this present work, the design of community-based solutions has been proposed from at least the following three places of enunciation.

3. Ethics
The place from where the ethics are raised here is relative to the responsibility for the other (nature), the others (human); environmental ethics in the sense of (Eschenhagen, 2017); that focuses on the search of the best conditions for the dwelling, the inhabiting of all in the here and now of our world and for the future generations. “To inhabit indicates an essential relationship of belonging to the proper and propitious place of human existence” (Noguera, 2016). This is precisely the reason for this search for water and energy solutions through other forms, techniques, and technologies that can be applied in diverse ecosystems.

What we call community-based solutions refers to the transcendence of the encounter between scientific-technical knowledge and community knowledge; the encounter between human beings whose experience in inhabiting spaces-times is their good and their gift. Our framework called “Community, Water-Renewable Energies, Diversity” (CARED) gives special relevance to the encounter, the face to face between stakeholders, as an event in which we recognise ourselves as so equal and at the same time so different, opening the way to the experience of otherness.

“The closeness to the other is not to know him/her; therefore, this is not a cognitive relationship, but a relationship of a merely ethical type, in the sense that the other affects me and matters to me, so it demands that I take care of him/her, even before I choose him/her” (Amorcho & Malpica, 2019).

Emmanuel Levinas is precisely the most important author about ethics as responsibility for others. There are ethical questions in the encounter with the face of the other, “is an appeal of an imperative given to your responsibility: to encounter a face is straightforward to hear a demand and an order” (Andrade, 2019).

4. Culture-ecosystem relationship
This relationship is taken up again insofar as it allows us to look at the profound and mutual incidence between the cultural productions of human beings (societies) and the ecosystems (nature). Maya (2013), and Bourdon and Burgos (2016) offers—for its analysis- the ecosystem-culture model, through which it establishes the various phases in which this relationship could be explained theoretically.

The culture-ecosystem relationship integrates the artifacts, techniques, and technologies created by man. Some are environmentally more sustainable than others; it depends on the greater or lesser understanding that each culture has of the ways of being of the ecosystems” (Romero, 2016).

5. Territory
“Territories are the manifestations or expressions of the inseparable and continuously changing relationship between the human species and the earth” (Guerrero & Rodríguez, 2018; Noguera, 2004). A powerful relationship built on vital exchanges, which people integrate physical and symbolically to their daily lives, creating habitats, which go beyond the tacit experience of cold, heat, thirst or hunger, the mountain, or the desert. Furthermore, “Constant self-organisation and self-construction of meaning which is what we call culture” (Noguera, 2004).

Although it is not a general rule, the solutions for water and energy supply, most of the time, are directed to communities—with high levels of vulnerability in different senses- whose strength, in order not to fail, consists of the rooting to their territories and to their ways of inhabiting them (Figure 1).
These places of enunciation reinforce the work of thinking to create water and energy solutions with and for the community. This work is not limited to the technical and technological aspects of these solutions, but aims to understand the Wayuu community’s habitat in La Paz, Manaure (Guajira), in a dialogue of knowledge that can be organised through the framework proposed here.

6. Design and social innovation

The design of solutions for access to drinking water and energy by remote and highly vulnerable communities requires attention to the norm of no harm. The solution’s design for indigenous communities, in this case, has traditionally been carried out by external stakeholders in recent years, through actions of prior consultation with people in the community. This approach has not been sufficient and has been revised from the theories of social innovation and democracy, as well as from new perspectives: designs based on respect to the territories, and on the involvement of different stakeholders in the processes or projects. “This ethical position implies an alternative technical rationality … design is inextricably linked to decisions about the type of life we live and the worlds where we live them” (Escobar, 2016), that is why those who live in the territory actively participate in design.

7. Background

This work has, as a background, a mapping review named “Community perceptions, beliefs and acceptability of renewable energies projects: A systematic mapping study” (Colmenares-Quintero et al., 2020), which presents important topics about renewable energy acceptance by communities in different places of the world. The research questions were the following:

“Q1. How many articles have been published on issues of perceptions, beliefs, and acceptability of communities regarding renewable energy projects between 2008 and 2019?

Q2. Where has this research been carried out?

Q3. What kinds of perceptions, beliefs, or criteria of acceptability have been studied?” (Colmenares-Quintero et al., 2020).

The perspective that the mapping review allowed to develop is, precisely, that of positioning the community as co-designer of its solutions through a process of gaining knowledge of the parties, trust in others, as well as self-confidence, motivation, as well as a set of agreements, ideas, and shared knowledge. For this reason, it is irreplaceable community participation all along the way (Figure 2).
On the other hand, this study showed the kind of situations, attitudes, prejudices, among others, could become a barrier when renewable energy and water projects are planning for implementation on communities’ territory.

To consider those results, this work presents the challenge to create instruments and routes that allow to overcome the barriers found and facilitate the approximation and work of co-creation of water and energy solutions along with the community (Figure 3 and 4).
8. Methodology
The framework “Community, wAter-Renewable Energies, Diversity” (CARED) has been developed from the perspective of action-participation research, which refers “to methodological conduct involving union between theory and practice, reflection, planning, action, education, transformation, individual and communal well-being, and social values” (Paredes-Chi & Castillo-Burguete, 2018). This perspective proposes community participation as co-creator of solutions design. This task is carried out using a survey constructed for this aim. The propose is to reach the first level of relationship with communities based on knowing different aspects of culture, lifestyle, beliefs, perceptions, needs, and other topics which could be important to establish the first conditions to work as co-creator of their energy and water solutions. On the other hand, it is indispensable to show intentions, the scope, and the limit of the project to the community throughout every encounter or meeting.

9. Survey construction

9.1. Categories definition
The categories for the organisation, understanding, and relation of information in each community, according to the studies analysed and the experience of the team, correspond to the
following aspects: socio-demography, housing conditions, worldviews (cosmovisions), social-cultural cognition, nature benefits, among others.

9.2. Items construction
Based on systematic mapping, the information review on the experience of research peers in terms of community diagnosis, renewable and non-renewable energies, water, project development, education, among others - has been carried out for each category defined as necessary. The questions were formulated on open and closed-ended types.

9.3. Methodology triangulation
Methodological triangulation in this reasearch involves the theoretical and technical standpoint of more than one researcher about a topic to work on. It is considered to occur when: “1) each researcher has a prominent role in the study; 2) the experience of each researcher is different; 3) the disciplinary bias of each researcher is evident in the study” (Martínez & Suárez, 2019).

9.4. Implementation
A team of researchers in engineering and psychology faculties of the Universidad Cooperativa de Colombia (UCC) moved to La Paz in Manaure area to develop the first steps of CARED framework.

10. Results
This framework has been implemented as follows:

11. First visit to the community
The arrival in La Guajira state allows observing the contrast between areas of enormous natural beauty with very important mineral resources such as coal and salt, a variety of thermal floors. The Media y Alta Guajira is the area with the greatest energy potential, with solar radiation levels of up to 6.5 kWh/m² in the summer season (Carvajal et al., 2019); however, it is also one of the areas of the country where the inhabitants have the greatest difficulty in meeting their most basic needs (Aarón et al., 2018). The widest is the Alta Guajira with the Wayuu ethnic, which includes the municipalities of Maicao, Manaure, and Uribia. The first visit to the community took place in the Media Guajira, the municipality of Manaure. Those who attended the visit belong to La Paz Ethno-Educational Institute, which is located in the village of the same name. La Paz is one of the 9 villages in rural Manaure. 90% of the student population of the La Paz Institute are Wayuu Indians.

As part of the CARED framework, the first visit to La Guajira has allowed seeing, at first hand, the difficult community conditions for access mainly to water, which suffer its inhabitants and more intensely those who live in the highlands, as is the case of La Paz, in the municipality of Manaure. “For over a decade the Colombian state of La Guajira has been suffering widespread malnutrition and premature death largely due to poor access to clean water for its poorest, most marginalised communities. The Wayuu indigenous group, the largest indigenous group in the whole Colombia with over 200,000 members, have disproportionately suffered the consequences of this tragedy” (Aviles, 2019).

The minimum amount of water accessed by the community comes from jag-eyes (ditches) and groundwater wells that are located long distances from the family's houses. Another part of the water is collected in rainy seasons or carried in tank trucks. They have a desalination plant which is not in operation due to a lack of financial resources for maintenance. Thus, the population can only use limited amounts of water to prepare food, bathe, and irrigate their crops (Daza-Daza et al., 2018).

On the other hand, limited access to electricity deepens the difficulties of overcoming the adverse conditions experienced by the communities like La Paz. The inhabitants of these territories must, periodically, purchase Diesel fuel which is very costly, high polluted, and limited efficiency, to minimally meet their energy needs (Rodríguez et al., 2015).
Stressing the importance of access to electricity, focused on poverty reduction and the achievement of the Millennium Development Goals (MDGs) or Sustainable Development Goals (SDGs), much of this problem could be diminished if indigenous people had access to electricity. The water supply could be improved using water pumps, the economy of communities would benefit by the conservation of their food, as well as the possibility of adding value to their artisanal and agricultural products. Hospitals could increase care coverage, education would improve in coverage and quality (due to the access to ICT tools), among others (Ojeda et al., 2017).

Carrying out the process of recognising the territory from a perspective of community participation as co-creator, is one of the critical moments of the implementation of projects with populations of all kinds, but significantly relevant when it comes to populations historically marginalised, isolated, and socio-culturally diverse. The method and technique for the construction and implementation of the diagnostic process can provide the groundwork for further development of the project. It is a time when the project developers are also being tested by the community. It is the space-time to demonstrate honesty, clarity, genuine interest in support, capacity, and confidence in achieving the proposed goals.

12. Second visit to the community
The second visit was the moment in which the encounter is extended to other interlocutors in the community, apart from just the formal leaders. Studies regarding the implementation of renewable energy and water projects in traditional and vulnerable communities have shown the relevance of generating and facilitating the maximum opportunities for encounters and real participation of the communities, in recognition of the appropriation of their territory, their knowledge about community beliefs, their needs, and their life plans as well as their agency capacity with responsible and recognition-based support. According to Pandey (2021), “to seek the active participation of all stakeholders, transition frameworks must be sensitive to the dynamic and complex interaction of power and agency”.

Highly vulnerable communities with urgent needs for water and energy might create resistance to this sort of initiatives if they consider their rights to define the present and future of their communities neglected, non-participation of local stakeholders in Renewable Energy Target (RET) might lead to significant challenges and even failure of such projects. In this sense, taking the time to carry out the project implementation processes represents respect and ethics whose relationship between the key actors, in the process, is assumed. A relationship in which together they work on solutions for life and design the paths to be followed towards their sustainability. According to Escobar (2016), the design has to do with the production of worlds and ways of existing. Indigenous communities have designed their ways of living and will continue to do so, even with non-indigenous stakeholders. Due to the Covid-19 pandemic, the meeting with the enlarged community took place in La Paz Ethno-educational Institution; it had the participation of the teachers, principal, counsellor, and a representative of the youth of the community.

Another objective of the second visit to the community is related to the application of the second part of the community characterisation survey, to know aspects of its culture, education, productivity as a pathway to understanding their reality as indigenous Wayuu and their lives meaning. The results derived from these encounters have offered at least three aspects to be analysed so that the community view is preserved.

The community has previous experience with projects which have been attempting to give them drinkable water and solar energy. However, the community does not yet have access to these benefits. This is a challenge to generate confidence for a new project related to these aspects due to previous bad experiences. They hope that this time their access to clean water and energy can become a reality.
It is relevant to re-create their worldview (i.e. cosmovision) to respect nature beings and natural resources like the sun, wind, and water. Their ancestral culture teaches different visions about the sun, wind, and water, which at the same time, are the resources for renewable energies. Every encounter with the community allows us to understand their position in front to use their nature beings to produce energy, and to understand the topics related to their sacred sites and the relevance of that for the water and energy solutions design.

The last encounter with “La Paz community” has highlighted how electricity and water have different challenges for men and women. That happens due to the strict gender roles with which is organised the social life in this community. Electricity and clean water reaching the homes would generate changes in duties and, therefore, in the relationships within the families and community. Gender perspective and intersectionality are shown as aspects to consider during the social analyses of the solutions for water and energy within the community.

13. Discussion
The framework to address the design of water and energy solutions for territories in non-connected areas CARED, has been thought out from the vision of alter-design, in other words, from the recognition of the other (community), as a co-creator, co-designer, co-dreamer, of new realities in which energy and water, are part of every day of the community, directed to the common wellbeing.

So far, during the process of design and implementation of the CARED framework, it has been possible to recognize the transcendence to the encounter with the other (i.e. individual, community, and nature). “It appears, it becomes a look, a recognition, the desire of the proximity; the step is given, throwing to the emptiness, the exit of itself, the opposite to the egology; that is to say, a choice by the encounter, the otherness”. (Viveros & Vergara, 2014).

Consequently, it is possible to affirm that beyond seeking a technical approach, related to the cosmovision, and understanding of the Wayuu community, the CARED framework assumes an ethical approach. Having an ethical approach as a guide for the forms of relationship with the other allows one to transcend the technical coldness that leads to planning and delivering solutions created by external agents to communities in conditions of vulnerability mainly without understanding their ways of inhabiting the world; their perceptions regarding their vulnerability, strength, needs, and solutions for them.

The first visit to the Wayuu indigenous community of La Paz (Manaure) gave place to a first meeting carried out from the uses and customs of the Wayuu people. Those who were visitors and those who were hosts tried to connect despite the differences in their ways of inhabiting the world, with their vulnerabilities, but with the courage to go in a relationship with each another that, far from being violent, is complementary. This is the moment of the encounter with the face of the other, the urgency of the response to the call of the other that is given in responsibility.

Mentioning the meeting from the Wayuu uses and customs does not exempt the sense of the meeting from the team of UCC staff who visited the community, but it does leave it in suspense. The diversity in the visions and experiences of the western world concerning those of the Wayuu indigenous community gave the first intuition of otherness. Time began to take on diverse categories and thus profane time that of daily life and sacred time was revealed, in which the worldview is recreated in its moments (Marin, 2014). Given the relevance and implications of the solutions of energy and water for the community, the profane time had to give way to sacred time, which recovers the value and meaning of the present moment giving rise to the feeling, and with it to the contemplation of paths to be followed (Viola, 2016). It is, then, that the meeting prepared by the western researchers would no longer last one or two days. That moment discovered an agenda prepared from different visions of being under the sun.
Following the above, this meeting with the community has consisted of a journey towards the other, which is different. Listening to his words of disassociation, uncertainty, and hope (Fernández, 2015) reaffirming the fundamental role that the linguistic dimension has in terms of explaining the modes of relationship with otherness. “The word bridges the gap between two othernesses” (Fernández, 2015) and in this sense, it can be stated that “to converse is to make the world common, to create common bonds”.

Finally, this creation of common bonds can be understood as the way to establish the first contacts; to reach some first agreements; to capture and give sense to the relations of its ecosystem in the Guajira Media and its Wayuu cultural system, as suggested by Maya (2013) in his text “The Challenge of Life”. It takes us beyond the recognition of the difference to the questioning of the responsibility we have in front of that other and their inequality conditions. This inequality makes a call not to deepen the vulnerability that already exists; on the contrary, to build opportunities of equity for the realisation of what each person considers their wellbeing, a purpose that is only possible to achieve through the effective involvement of the people of the community.

It fits in very well with the proposal of autonomous designs made by Escobar (2016), in that this article is suggesting a route for the design of water and energy access solutions for Wayuu indigenous communities. This article refers to when the encounters with the other (the community in this case) happen, it is highly important to reaffirm that its main aim is the setting up of an agenda for the design of these solutions, and not in the ordinary sense of prior consultation with the communities. In summary, they are then “conversations for the coordination of action and emotion” (Escobar, 2016), or in the words of Manzini (2016): „encounters, conversations, working days for design and social innovation."

14. Conclusions

- The framework for the design of water and energy solutions for communities in non-interconnected zones requires an integrated approach to community life, in a relationship of co-design in which the link between the cultural system and the community’s ecosystem which occupies a relevant place within them.
- The ethics of responsibility for the other is proposed as an approach that will allow otherness to be maintained as a value and not as an obstacle to the purposes of aid and collaboration towards the communities.
- The perceptions and experiences of time may be different between traditional communities and those who live in cities which must be taken into account to develop solutions for community in water and energy. The schedule can be constructed considering these differences and negotiating the moments of intervention.
- To the extent that the linguistic dimension occupies a privileged place in the encounter with the communities, caring for expression is a fundamental element for relationships based on the recognition of otherness and the responsibility for the other who asks for help and requires the support of his or her fellow human beings, in this case, to obtain water and energy that allows them to contribute elements for their common wellbeing.
- Incorporating the contributions of the new design culture for social innovation is fundamental to carry out the processes of intervention in communities, from a vision that understands the current ecological crisis and the need to do things differently to obtain results different from those that have been achieved so far through traditionally ethnocentric design formulas.
- The gender perspective is needed to understand the challenges and impacts of the project inside the families and community.
- To continue the development of the CARED framework, in such a way that it is possible to evaluate and adjust it continuously, which allows the consolidation of a proposal for the relationship with communities.
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