CHALLENGE 3: UTILIZATION OF PRODUCTION WATER FOR OTHER PURPOSES

An open innovation challenge for the purification of production water from La Guajira fields for the benefit of nearby communities.

BACKGROUND

Hocol is a subsidiary of the Ecopetrol Group with over 65 years of experience in production and exploration. Its operations primarily focus on the northern regions of Colombia (Guajira, Sinú San Jacinto, Valle Inferior del Magdalena, and Cesar Rancherí a), the Llanos (north of Meta and south of Casanare), and the Upper Magdalena Valley (Huila and Tolima).

Nearly 70% of its organic production comes from fields discovered by Hocol, and its four strategic differentiators include: technical expertise, agility, sustainable cost efficiency, and proactive environmental management, with a strong emphasis on competitiveness and sustainability.

Historically, they have consistently met and exceeded their set goals, thanks to the way they carry out their tasks:

- Working closely and harmoniously with communities, contractors, suppliers, authorities, and other stakeholders.
- Always applying clear principles of responsibility and coherence that enable them to operate in an environment of respect and reliability in their activities.
- A team of individuals with a deep-rooted sense of professionalism, commitment, and leadership.

Hocol has significantly contributed to Colombia's development by building trust, maintaining a legitimate and genuine relationship in the regions, and aligning with the priorities of the local areas.

We embrace our mission of "Sharing Colombia's life" by becoming an integral part of the local landscape and contributing to the construction of a sustainable common future that fosters the growth of our stakeholders. We approach this objective guided by our distinctive values, which include being pioneers and innovators, caring genuinely about the well-being of others, and being trustworthy through the fulfillment of our word and commitments. At all stages of the life cycle of our assets, from identifying new opportunities to their eventual closure, Hocol designs and implements actions that promote the harmonious development of operations and relationships with the communities and other stakeholders in the regions where we operate.

The open innovation challenge we've initiated is primarily centered on the Chuchupa and Ballena fields in the La Guajira department. These assets are highly regarded in the Colombian oil industry, as they are the sole commercially producing offshore gas fields. Their production plays a crucial role in meeting the country's energy demands, and their history and management have served as global benchmarks for other operations. Currently,

alongside gas production, there is a significant water production associated with it, whether it's due to the condensation of water vapor in the gas or the gradual entry of water from the natural reservoirs of these fields. This water production currently ranges from 600 to 800 barrels of water per day (bpd) with expectations of growth to 1500 - 2000 bpd in the next 10 years. We aim to make this water production beneficial for the community in the influence zone. Our objective is to shift paradigms regarding its potential use in other processes by applying new technologies and innovative approaches.

To understand the physical and chemical properties of the water from the two fields, we've included the studies characterizing the produced waters.

- **Document:** Produced and processed wastewater before undergoing treatment at the operation.

What are the objectives linked to the open innovation challenge?

The document below addresses the challenge: **"How to make use of production water for community needs?"**

- By implementing water treatment systems with a capacity of 1000 to 2000 bpd, the aim is to provide for domestic requirements within the community, support environmental processes in the surrounding area, or address existing needs, excluding consumption.

1. PROBLEM STATEMENT:

The extraction process of crude oil and natural gas involves the handling of millions of barrels of water per day (bpd) without subsequent utilization in other human needs. Typically, this water cycle concludes with discharges into bodies of water within legal parameters, wasting all the energy used in the extraction process. Another approach focuses on reinjection into the reservoir to maintain energy conditions or improve hydrocarbon recovery efficiencies. Circular use processes for other human needs are restricted by the same existing paradigms and risks. Nevertheless, there are already pilot projects exploring the use of this water for purposes such as agricultural irrigation and soil maintenance, among others.

Currently, the production water resulting from the extraction processes in La Guajira is directed to a treatment plant with a maximum capacity of 1200 bpd. In 2022, the average water production volume fluctuated between 600 and 800 bpd in the Chuchupa and Ballena fields. 100% of this water is treated according to regulatory standards. The maximum volume of production water that needs treatment corresponds to approximately 1000 to 2000 barrels per day.

Considering the water scarcity in the region, stemming from the desert ecosystem that characterizes the La Guajira department, along with Hocol's water positivity strategy that

began in 2023, the teams from Guajira Operations and Guajira Development have identified an opportunity in treating and utilizing production water from the Guajira Association fields. This opportunity aims to create a solution that results in shared value actions with the communities surrounding the operational influence zone of the natural gas production fields. The goal is to provide non-potable domestic water for purposes such as irrigation, bathrooms, cleaning, disinfection of surfaces and inhabited areas, land and marine vehicles, among others.

2. WHO IS THIS CHALLENGE TARGETED TOWARDS?

Hocol is seeking companies or teams interested in providing a solution to the challenge: "How to harness production water for community needs?" with creative, innovative, and actionable alternatives.

Potential solvers for this challenge may include:

- Companies (national or international) that have identified the problem with the current state of the art and have developed a solution that is tested in controlled environments at a minimum.
- NGOs working on water treatment and decarbonization that have a proven solution in controlled or real-world environments.
- Companies with research capabilities, the ability to produce a pilot, and the capacity to implement their results in the fields.
- National research centers, technological development facilities, or technology parks.

All prospective solvers must have the capacity to develop a prototype at a scale that allows for validating its applicability to the production water conditions of the prioritized fields.

Solutions must comply with legal conditions as certified by laboratories recognized by the Ministry of Environment and Sustainable Development.

This call does not have a geographical restriction and will accept proposals at a national/international level, as long as they meet the specified requirements based on the variables indicated for the solution.

3. NATURE OF THE RELATIONSHIP BETWEEN HOCOL AND SOLVERS

Once a solution is selected, the solver will proceed to conduct a solution test, which may lead to a direct award depending on the results and the company's decision.

For the development of the pilots, it is expected that the solver, at a minimum, undertakes the following activities:

- Visit the La Guajira production facilities, including the platform and Ballena station.
- Review the operational conditions and field facilities of Chuchupa - Ballena.
- Establish a minimum water volume for conducting the pilot.

In all cases, it is expected that the effectiveness results of the selected field's water treatment solution will **be validated through a multilateral approach**. This means that both the solver and Hocol will conduct tests in certified and trustworthy laboratories for each party involved.

4. WHAT IS EXPECTED FROM THE SOLUTION?

Solutions that enable the adaptation of production water quality for domestic use by the communities within the influence zone of the La Guajira fields.

Some expected solution conditions to address the challenge include:

- Modular solutions that align with the production chain.
- Solutions incorporating desalination processes.
- Operation using solar and/or wind energy.
- Treated water with potential domestic applications (floor cleaning, bathrooms, etc.).
- Water quality criteria: Parameters such as BOD5, COD, oils and fats, turbidity, suspended solids, phenols, microbiological percentage, and conductivity in accordance with Resolution 631 of 2015.
- Solutions that complement the production process (to avoid stockpiling).
- Capacity to handle a minimum of one thousand (1,000) barrels of water per day.
- The solution may encourage partnerships with local companies or stakeholders.
- Include the option for real-time water quality measurement viable on-site.

5. SELECTION CRITERIA

The solutions will be evaluated based on the following criteria:

Criteria	Description	Percent weight
Solution Maturity Level	The solution has been tested, proving to be successful in addressing the problem established by the challenge (Minimum TRL5)	20
Technical knowledge	The solver has	20

	experience, technical skills and capabilities relevant to meet the challenge. It has an interdisciplinary team with technical capabilities that can support the proposed solution	
Innovation	The proposed solution addresses the challenge in a novel or unconventional manner, and it aligns with the conditions described in the challenge.	20
Description	The proposed solution is clear, includes technical information and budget to understand how the pilot test will be developed. Furthermore, it demonstrates in its proposal the intention to work collaboratively with the challenging team.	20
Time	The proposed solution has a pilot test development time that aligns with the complexity of the solution.	20
	Total score	**100**

6. EXPECTED IMPACT OF THE SOLUTION

Measurable indicators for the solution are established as follows:

- The resource's usability in community activities.

7. PARTICIPATION BENEFITS

The selected solver will receive the following benefits:

- Specialized guidance from Hocol during the solution's testing in an environment controlled by Hocol.
- Public recognition for the selected solver within the hydrocarbon sector's business circles.
- Possibility of direct award based on the test results and the company's decision.

Result of the physicochemical parameters of the production water.

Parámetros	Unidad	Salida ARI Sump Tank – CA 2	Salida ARI Sump Vessel – CB 2	Resolución 883 de 2018 Artículo 10: Producción	Estado normativo
FISICOQUÍMICOS					
Aceites y grasas	mg/L	6	15,17	42 mg/L diario 29 mg/L promedio mensual	Cumple
Acidez	mg/L	11	54	Análisis y Reporte	--
Alcalinidad	mg/L	148	174	Análisis y Reporte	--
Arsénico	mg/L	<0,005	<0,005	Análisis y Reporte	--
Bario	mg/L	<1	<1	Análisis y Reporte	--
BTEX	mg/L	<0,010	<0,010	Análisis y Reporte	--
Cloruros	mg/L	12512	4975	N.E.	--
Cromo total	mg/L	<0,05	<0,05	Análisis y Reporte	--
DBO_5	mg/L	494	521	Análisis y Reporte	--
DQO	mg/L	898	915	Análisis y Reporte	--
Fenoles	mg/L	0,96	0,27	Análisis y Reporte	--
Fosforo total	mg/L	<0,08	<0,08	Análisis y Reporte	--
Hidrocarburos Aromáticos Policíclicos - PHAS	mg/L	<0,001	<0,001	Análisis y Reporte	--
Hidrocarburos totales	mg/L	5,26	14,11	Análisis y Reporte	--
Nitrógeno total Kjeldahl	mg/L	20,6	58,6	Análisis y Reporte	--
Plata	mg/L	<0,05	<0,05	Análisis y Reporte	--
Plomo	mg/L	<0,05	<0,05	Análisis y Reporte	--
Selenio	mg/L	<0,005	<0,005	Análisis y Reporte	--
Sólidos Suspendidos totales	mg/L	37	73	Análisis y Reporte	--
Vanadio	mg/L	<0,1	<0,1	Análisis y Reporte	--
DETERMINACIONES EN CAMPO					
Conductividad	µS/cm	3100	663	N.E.	--
pH	Unidades	7,20	7,04	6,0 – 9,0	Cumple
Temperatura de la muestra	°C	28,37	26,84	40	Cumple