

Resource assessment, technology development, public policies, and deploying large-scale projects of marine and ocean energy in Colombia

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Electricity generation mix



Type	%
Hydropower	66.3
Thermal	30.2
Biomass	0.9
Solar	2.5
Wind	0.1

Effective capacity of national electricity system

20 GW

Updated on Jan 2024

Opportunities for Renewable Energy

After the peace agreement signed on 26 de September de 2016 between Colombian government and FARC, several the non-interconnected zones need to solve energy supply

Most of these homes without electricity are located in rural areas where poverty affects the

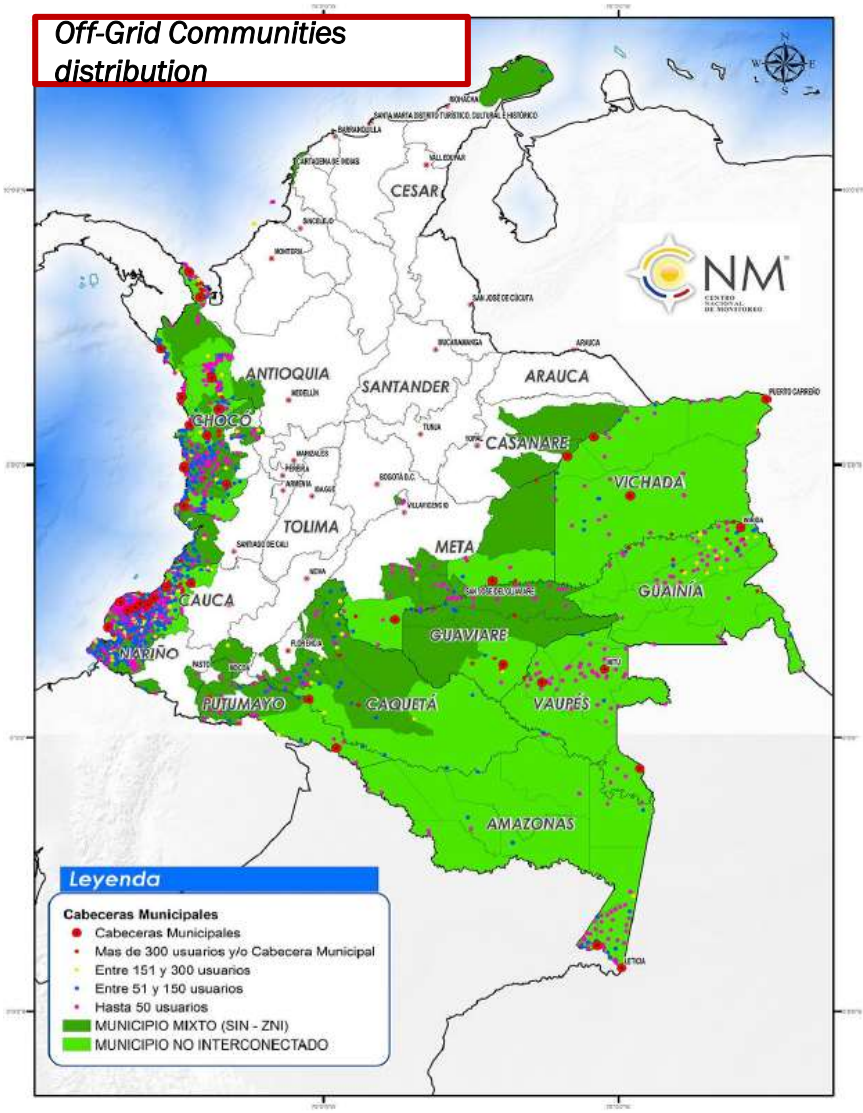


It announces an investments that exceed US\$70 Mill, with the goal of guaranteeing safe, affordable and modern energy, contemplated in the Sustainable Development Goals (SDGs).



Using internal combustion plants with diesel for the supply of electric fluid

Electrical grid



Electrical grid

Type of line	Tension	Length (km)
National transimision-STN	Above 220 kV (up to 500 kV)	16,474
Regional-STR or local distribution-SDL	Below 220 kV	11,954
	Total	28,428

Overview

- Most non-urban coastal areas depend on STR systems, e.g., the north and south **Caribbean** (La Guajira and Urabá).
- The **Colombian Pacific** region only has STR lines to Quibdo, Buenaventura, and its surroundings due to the vast tropical jungle.
- **Non-connected areas** fulfill their electrical needs through small systems fed with fuels.

Challenges for Offshore renewables

- They must compete against land-based renewables for transmission within SIN expansion over the medium and long term.
- Currently, there **is no available capacity in La Guajira to connect small, medium, or large amounts** of offshore energy to the national transmission infrastructure.
- **The limitations in transmission infrastructure and competition for future access will substantially impact the offshore renewables growth scenarios for the country.**

Regulation

LEY 1715 DE 2014

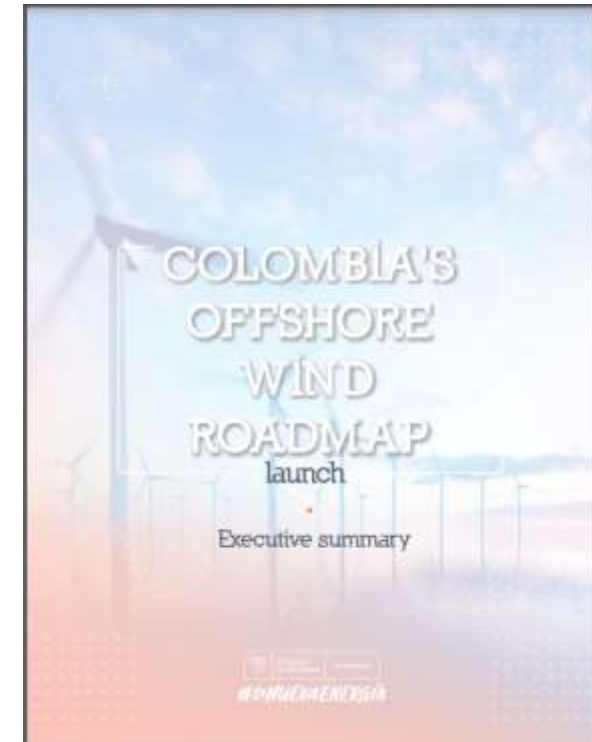
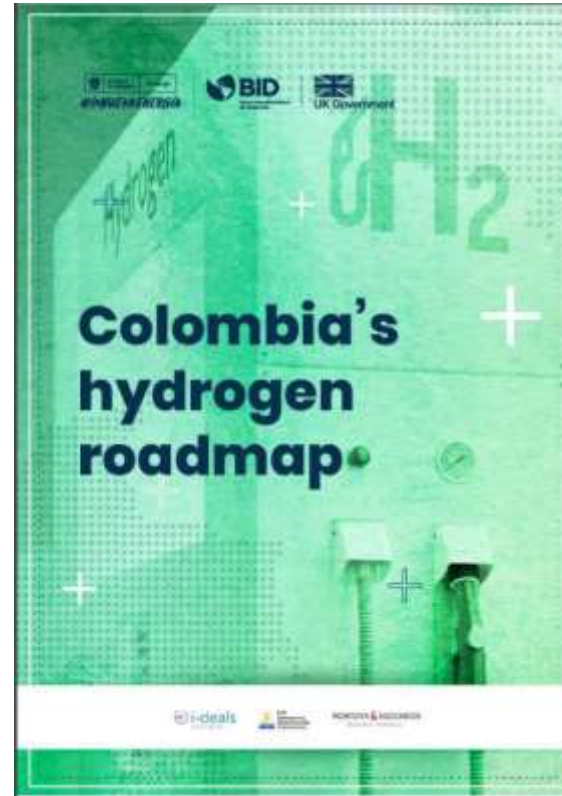
(mayo 13)

Diario Oficial No. 49.150 de 13 de mayo de 2014

CONGRESO DE LA REPÚBLICA

Por medio de la cual se regula la integración de las energías renovables no convencionales al Sistema Energético Nacional.

ARTÍCULO 23. DESARROLLO DE LA ENERGÍA DE LOS MARES. Será considerada la energía de los mares, entendida como el aprovechamiento de las olas, el aprovechamiento de las mareas y el aprovechamiento del diferencial térmico de los océanos



Regulation

Documento
CONPES

CONSEJO NACIONAL DE POLÍTICA ECONÓMICA Y SOCIAL
REPÚBLICA DE COLOMBIA
DEPARTAMENTO NACIONAL DE PLANEACIÓN

4075

POLÍTICA DE TRANSICIÓN ENERGÉTICA

Bogotá, D.C., 29 de marzo de 2022

Documento
CONPES

CONSEJO NACIONAL DE POLÍTICA ECONÓMICA Y SOCIAL
REPÚBLICA DE COLOMBIA
Departamento Nacional de Planeación

4050

POLÍTICA PARA LA CONSOLIDACIÓN DEL SISTEMA NACIONAL DE ÁREAS PROTEGIDAS

-SINAP-

Bogotá, D.C., 27 de septiembre de 2021

MINISTERIO DE AMBIENTE Y DESARROLLO SOSTENIBLE

RESOLUCIÓN No. **1312**

(11 AGO 2016)

"Por la cual se adoptan los términos de referencia para la elaboración del Estudio de Impacto Ambiental – EIA, requerido para el trámite de la licencia ambiental de proyectos de uso de fuentes de energía eólica continental y se toman otras determinaciones"

LEY No. **2099** **10 JUL 2021**

POR MEDIO DE LA CUAL SE DICTAN DISPOSICIONES PARA LA TRANSICIÓN ENERGÉTICA, LA DINAMIZACIÓN DEL MERCADO ENERGETICO, LA REACTIVACIÓN ECONÓMICA DEL PAÍS Y SE DICTAN OTRAS DISPOSICIONES.

Artículo 1. Objeto. La presente ley tiene por objeto modernizar la legislación vigente y dictar otras disposiciones para la transición energética, la dinamización del mercado energético a través de la utilización, desarrollo y promoción de fuentes no convencionales de energía, la reactivación económica del país y, en general dictar normas para el fortalecimiento de los servicios públicos de energía eléctrica y gas combustible.

CAPÍTULO II

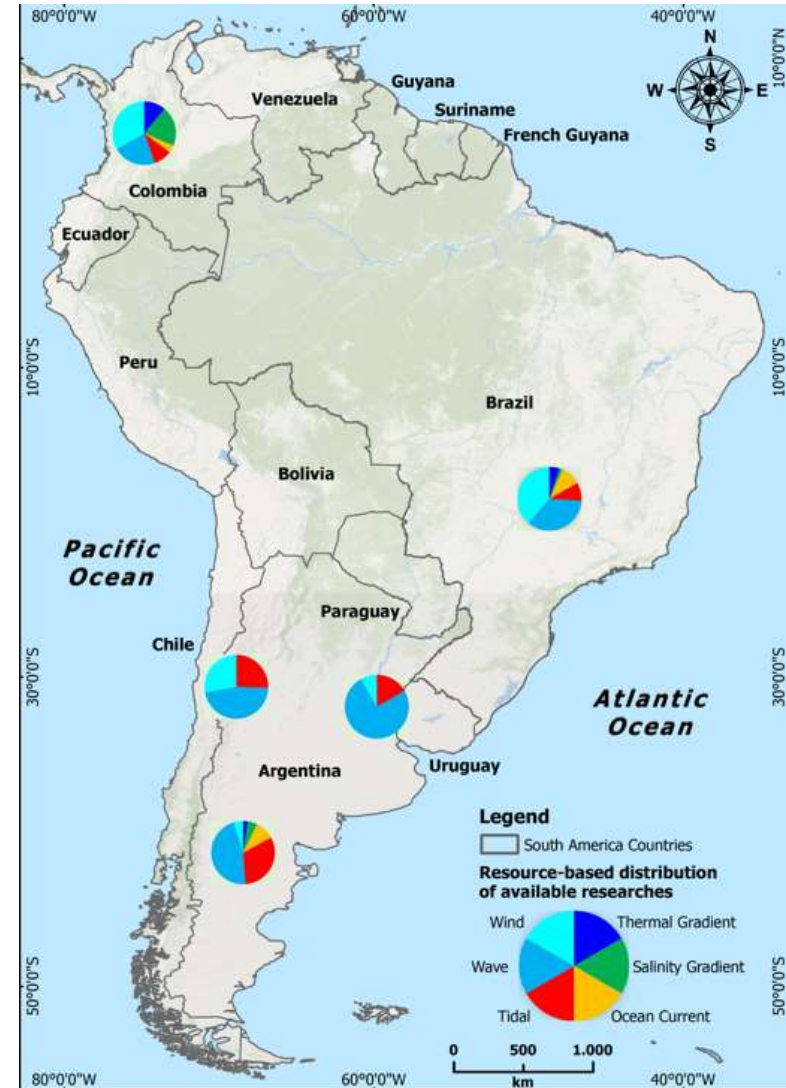
MODIFICACIONES Y ADICIONES A LA LEY 1715 DE 2014

Regional context – Marine Energy in Colombia

Related papers



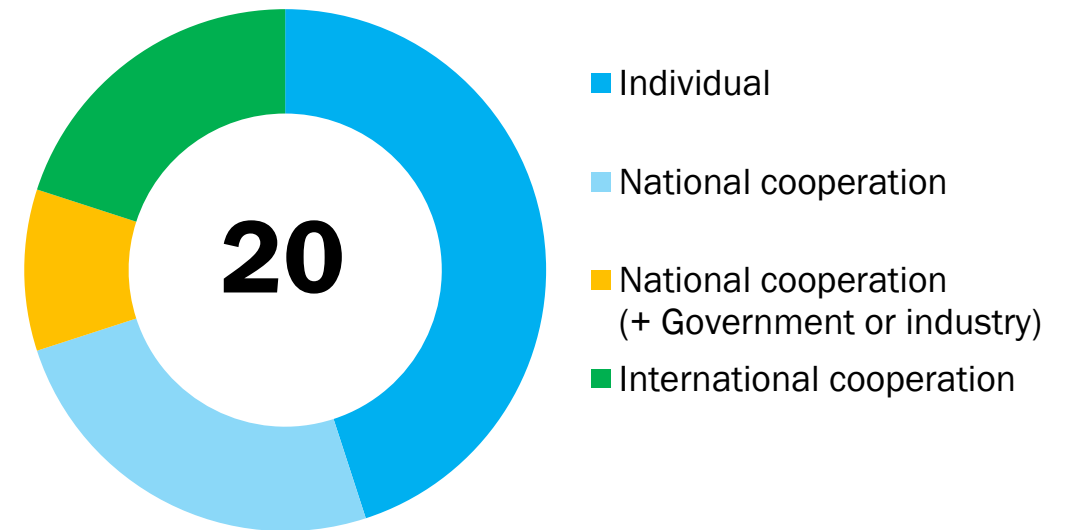
Sources of interest



Marine energy initiatives/projects in Colombia

Starting date	Total
Before 2010	1
2011 – 2015	2
2016 – 2020	14
2021 - 2022	3

Type of consortium



Papers published

Aim of the studies	Total
Theoretical potential	14
Technical assessment	9
Roadmap	4
Generalities	3
Technology development	2
Multidisciplinary assesment	1

- Ocean Currents and Tides
- Salinity Gradient
- Thermal gradients
- Waves
- Offshore Wind



National networking

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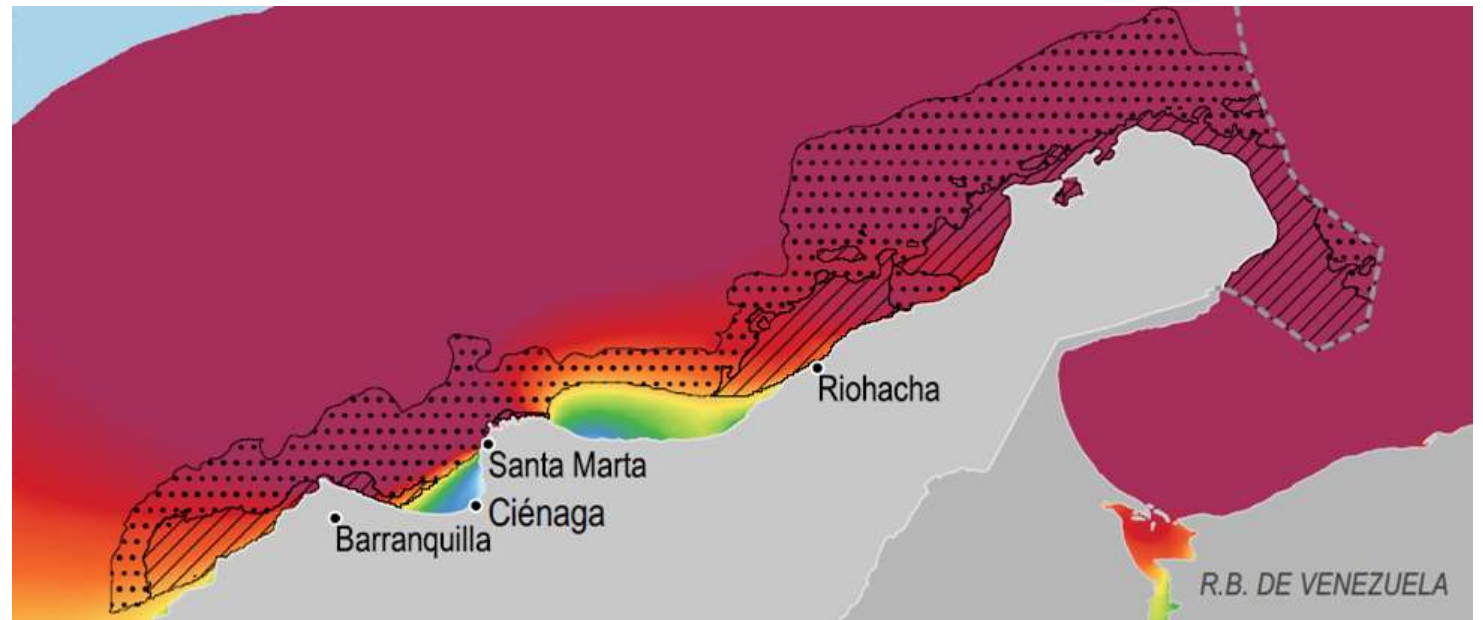
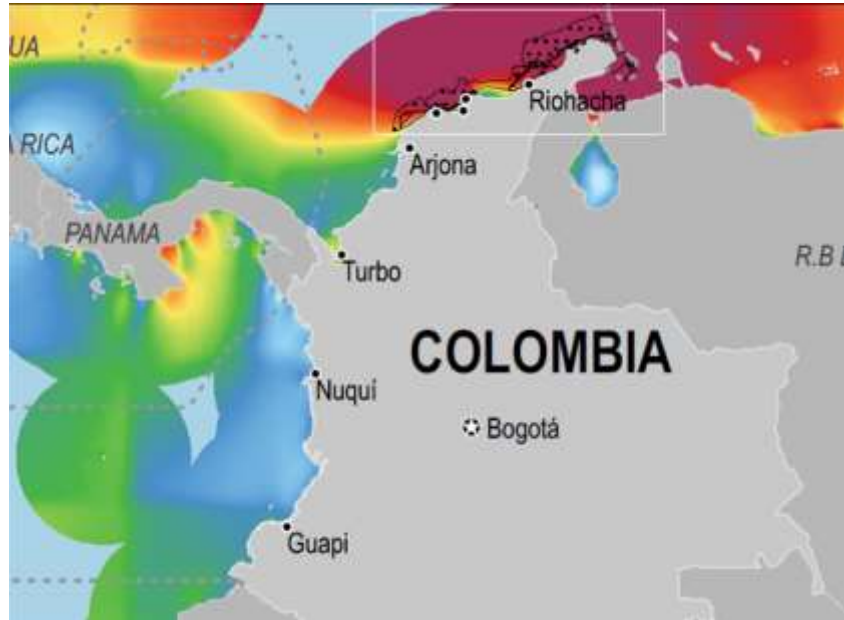
Supported by:



International networking



Off-shore wind potential



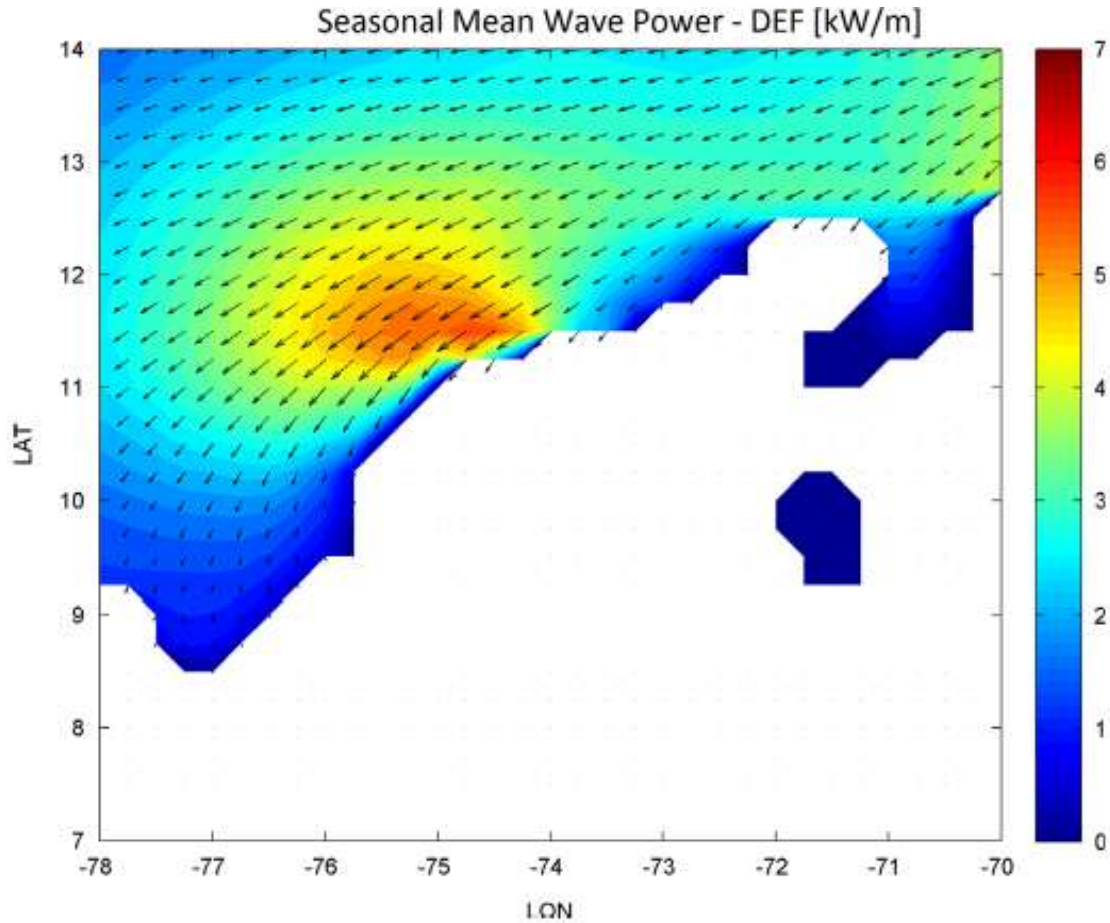
- Fixed 31 GW, and Floating 78 GW
- Total 109 GW
- The wind speed at Barranquilla's coast is >15 m/s on average (at 100 m height).

- ▨ Fixed (water depth < 50m)
- Floating (water depth < 1000m)
- Exclusive Economic Zone (EEZ)



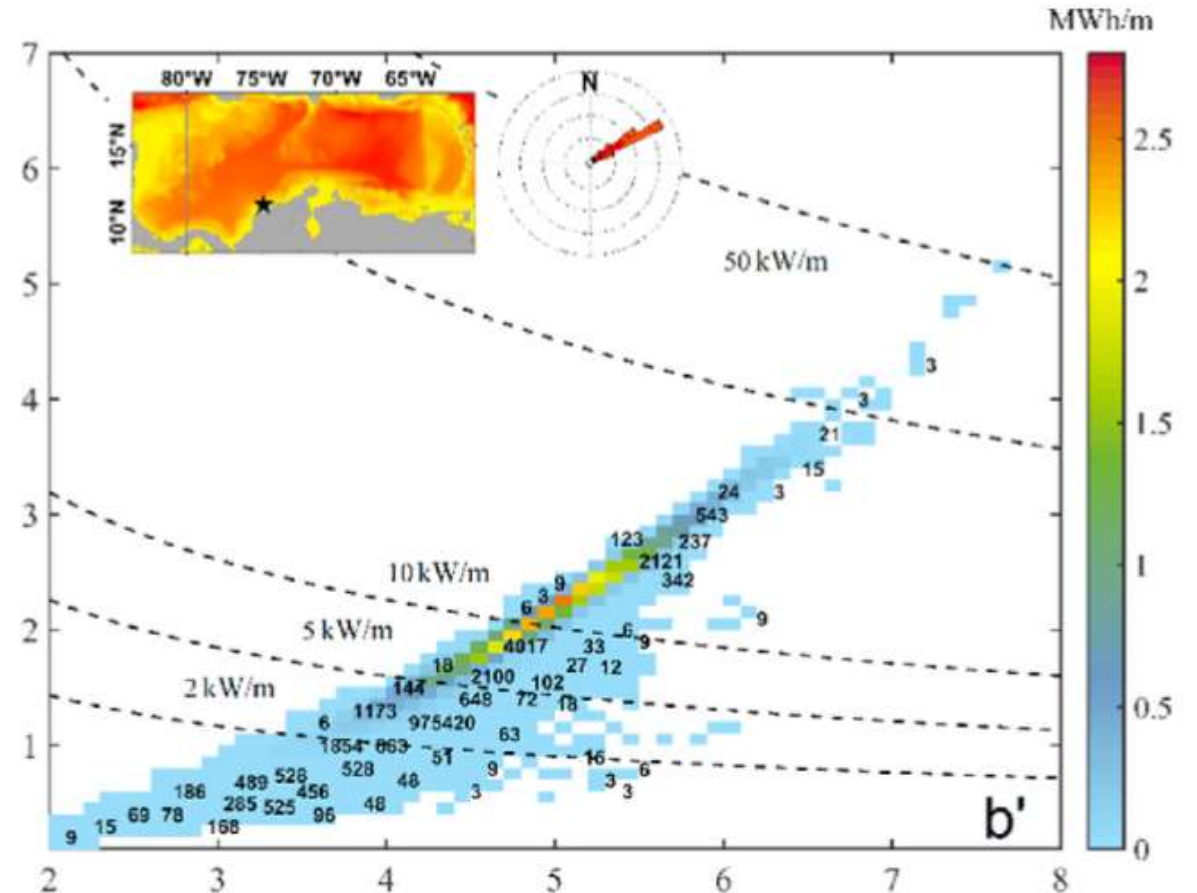
Wave energy - studies

Osorio et al. Renewable and Sustainable Energy Reviews 53 (2016) 966–977



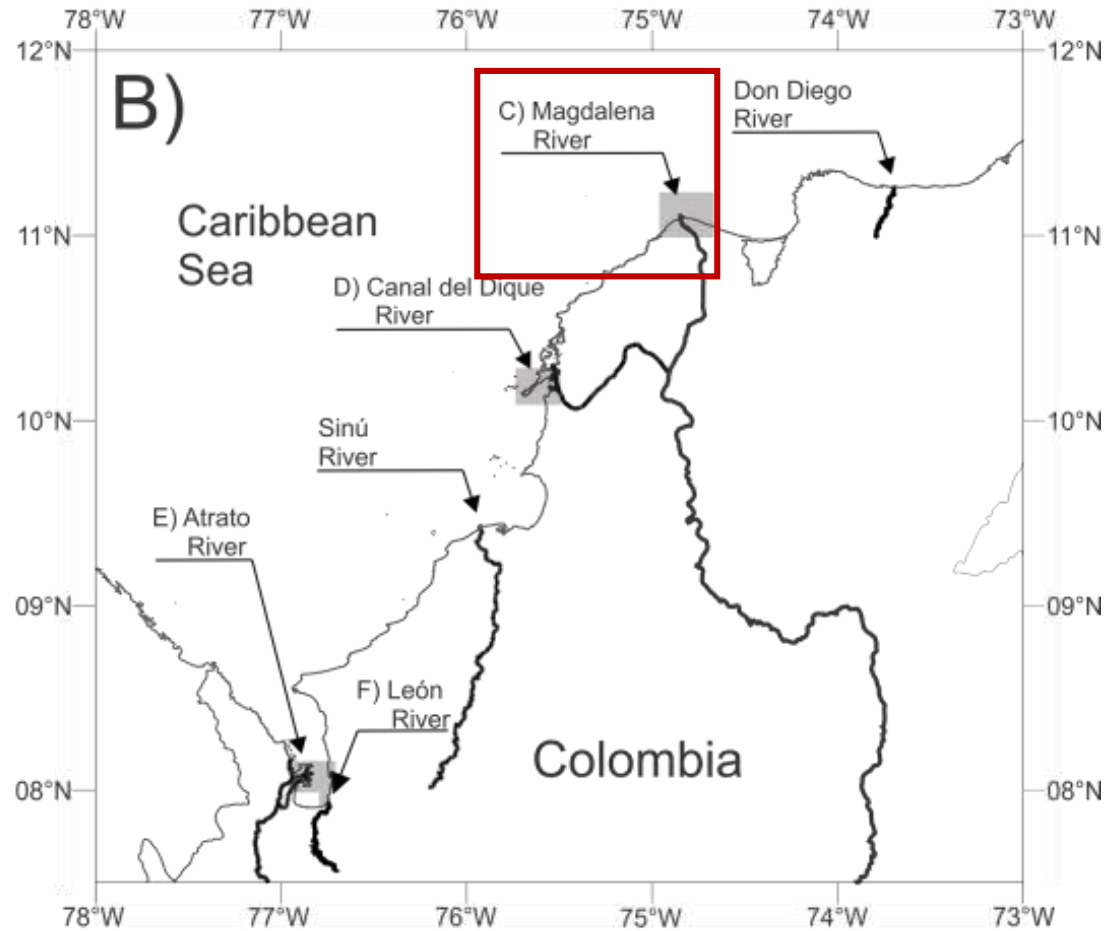
Mean wave-power variation in the Colombian Caribbean during (December–January–February).

Orejarena et al. Renewable Energy 181 (2022) 616-629.



Wave annual energy contributions in Barranquilla from 1989 to 2017

Salinity gradient energy potential



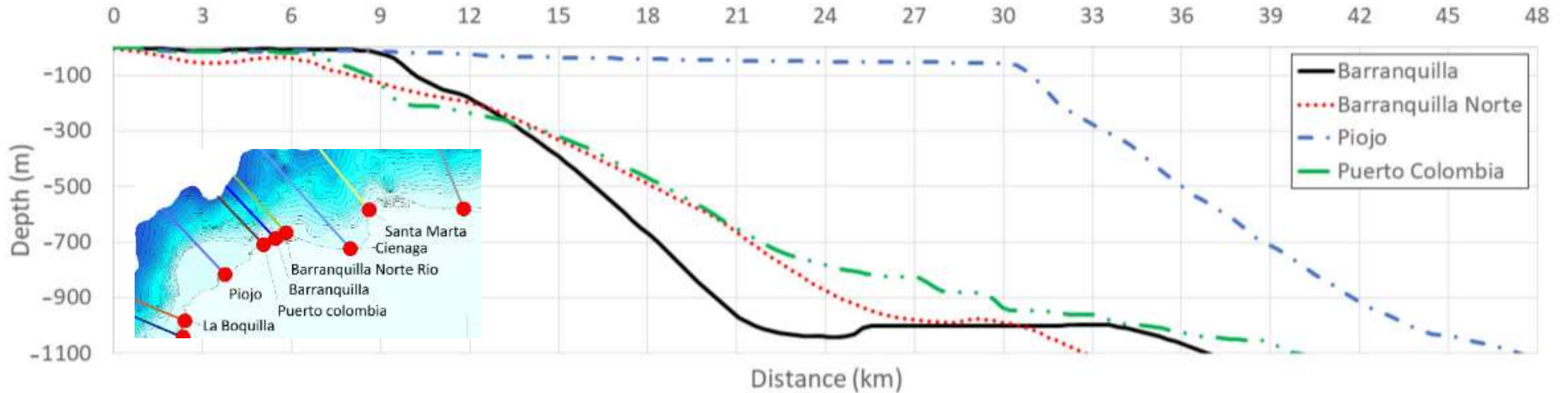
River	mean	no-ENSO year		El Niño year		La Niña year	
		Dry season	Rainy season	Dry season	Rainy season	Dry season	Rainy season
Magdal.	620	556	632	638	632	634	626
Dique	6.4	6.4	8.6	1.6	3.6	8.8	8.8
Atrato	3.8	1.4	7.4	1.4	5.4	1.6	5.6
León	7.6	7.6	7.6	7.6	7.6	7.6	7.6
TOTAL	638						

Alvarez-Silva O. & Osorio A.F. (2015). *Renewable Energy*. 74, 737-748.

Technical potential: 0.8 GW

Roldan-Carvajal, M. et al. (2021). *Desalination*. 503:114933.

Thermal gradient energy potential



	Distance to platform break (km)	Depth at platform break (m)	Distance to 1000 m depth (km)	slope	ΔT_{min} ($^{\circ}C$)	ΔT_{max} ($^{\circ}C$)
Barranquilla	9.43	-37.94	21.68	36.10	18.65	22.59

Herrera, J. et al. (2022). Journal of Marine Science and Engineering, 10(4), 519.

From the laboratory to a natural environment



Test CENTER for Marine Energy
First field pilot of **salinity gradient**
energy in Latin America:
The Magdalena River, Colombia



WAVES

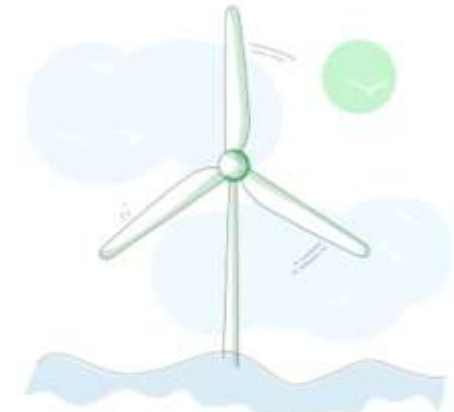
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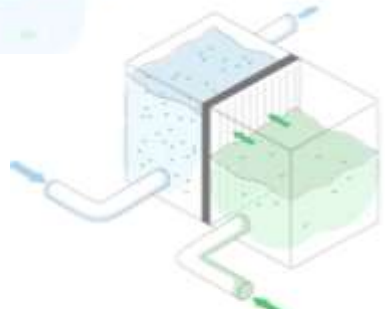
Universidad del Norte: Oscar
Alvarez-Silva, Aymer Maturana,
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TEST CENTER FOR MARINE ENERGY

WIND
OFFSHORE



THERMAL
GRADIENT

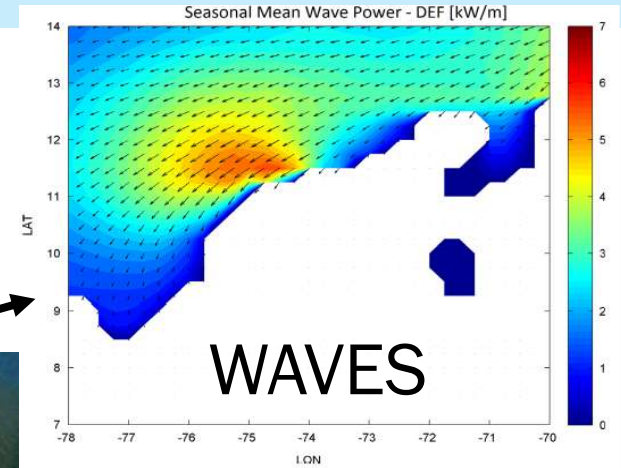
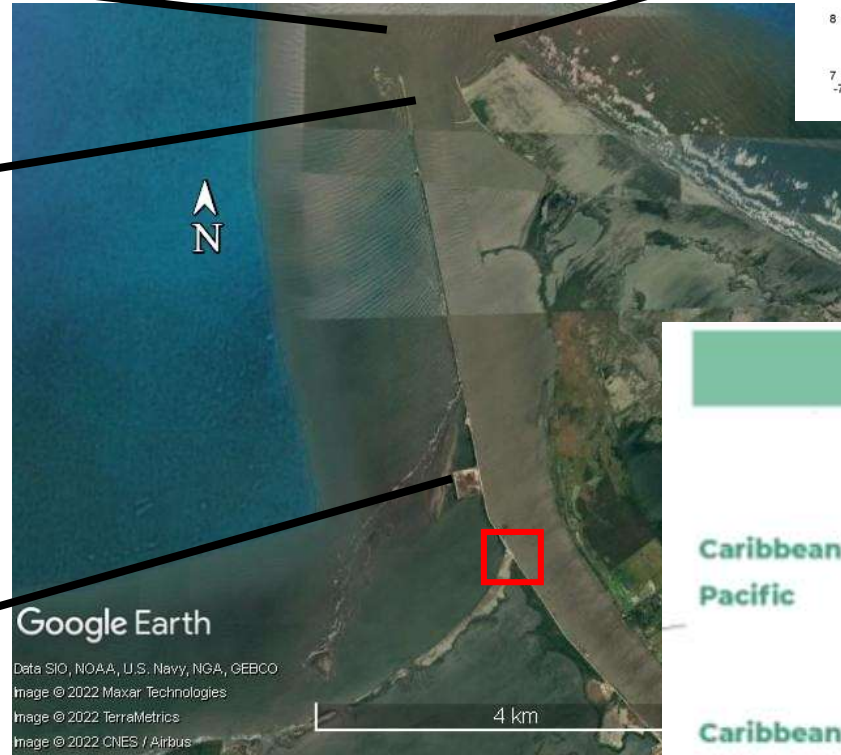


SALINITY
GRADIENT



Test CENTER for Marine Energy !!!!!

Latin America
The Magdalena River, Colombia



Estimated potentials				
Caribbean Pacific	15.6* GW	50** MW	-6 kW/m	NF
	NE/NF	NE/NF	-4 kW/m	-3 kW/m
Caribbean Pacific	109** GW	-0.4 kW/m ²		
	NE/NF	NE/NF		

Specific sites assessment. Estimated in an area.

Challenges for marine energy in Colombia

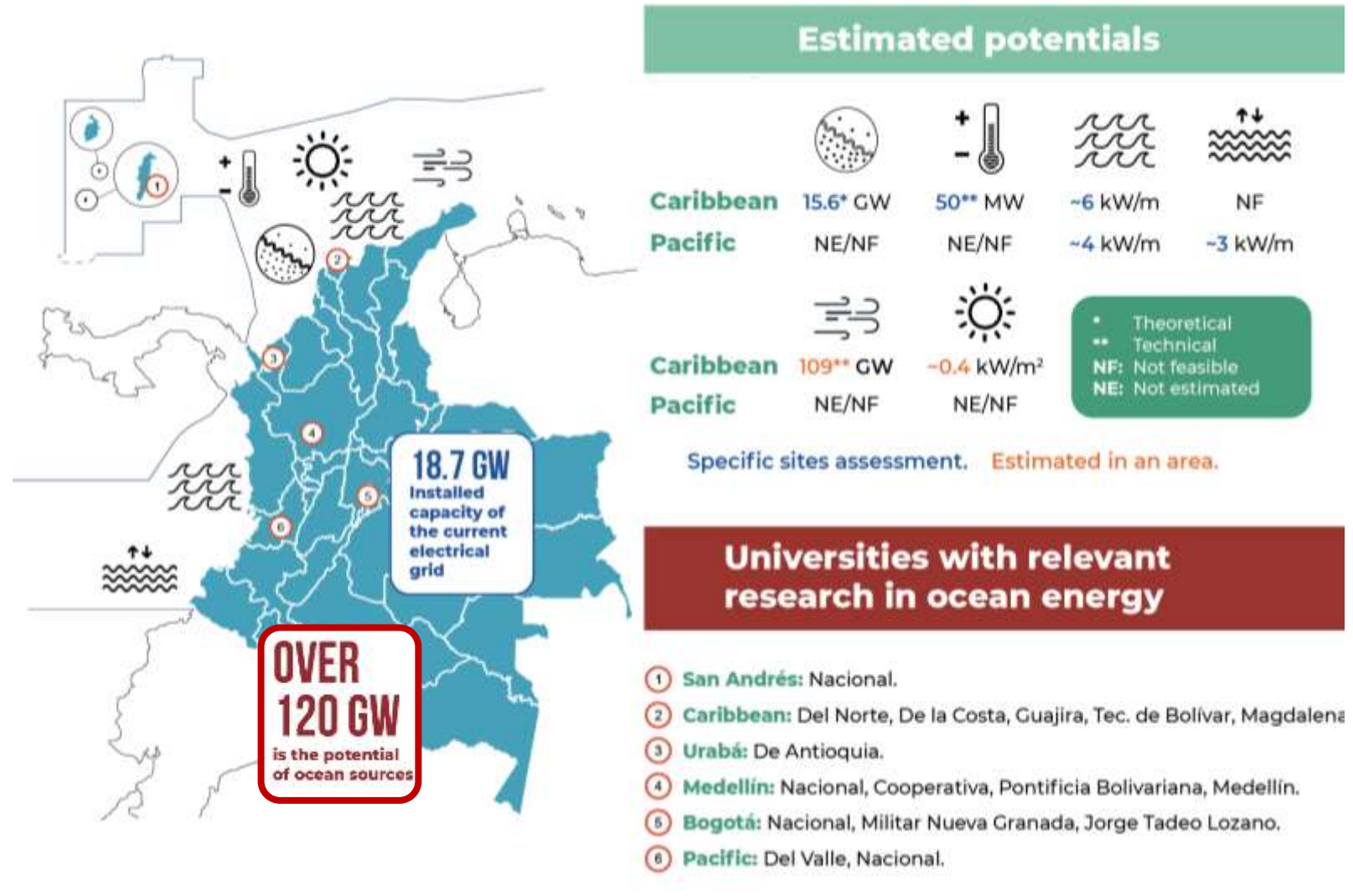
1. Country policy regulation

2. Develop and incorporate local - national capacities.

3. Actively involve communities in solutions.
Real needs in the territories (energy, water, food, hydrogen, local industries..) - Blue Economy

4. The *marine resource* has been study in the last 15y. We have explored resources (Salinity and Temperature) with a natural storage and higher capacity factors than traditional renewables (0.84 and 0.95)

5. Develop test and scale-up centers for Latin America - Barranquilla Case (Colombia)



ACKNOWLEDGEMENTS



PAMEC 2024
Pan American Marine Energy Conference
Barranquilla, Colombia Jan 22-24, 2024

