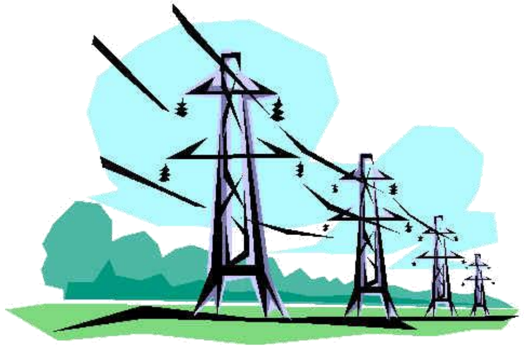
CYTED PROGRAMA IBEROAMERICANO DE CIENCIA Y TECNOLOGÍA PARA EL DESARROLLO

INTEGRACIÓN EN REDES ELÉCTRICAS IBEROAMERICANAS DE LAS ENERGÍAS DEL MAR
REMAR

**WORKSHOP**

# Technologies and Policies to support the Integration of Marine Renewable Energies into a Grid

Marcos Lafoz, Rodrigo Rojas, Andrés Osorio



January 20th, 2024

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

# Workshop agenda

- 9:00h. Presentation and description of workshop methodology
- 9:15h. Presentation of REMAR-CYTED Network
- 9:30h. Technology issues related to grid integration. Marcos Lafoz
- 9:50h. Social and environmental perspective and ocean energy grid integration. Rodrigo Rojas
- 10:10h. Challenges for marine energy policies. Andrés Osorio
- 10:30h. *Coffee break*
- 11:00h. Discussion tables among the participant to answer the key questions
- 11:30h. Conclusions from the groups and sum up of the session

CYTED PROGRAMA IBEROAMERICANO DE CIENCIA Y TECNOLOGÍA PARA EL DESARROLLO

**CYTED is the Ibero-American Programme on Science and Technology for Development**, created by the governments of Ibero-American countries in order to promote cooperation in science, technology and innovation for their harmonious development.

CYTED was established in 1984 through an Interinstitutional Framework Agreement signed by **21 Spanish and Portuguese-speaking countries**. Since 1995, the CYTED Program has been formally included among the Cooperation Programs of the Ibero-American Summits of Heads of State and Government.

CYTED achieves its **objectives** through various funding instruments that mobilize Ibero-American entrepreneurs, researchers, and experts, enabling them to **acquire training** and generate **joint research, development, and innovation projects**.

The **Thematic Networks** are clusters of research and development (R&D) formed by public or private entities and corporations from the member countries.

- Agroalimentación
- Salud
- Desarrollo Industrial
- Desarrollo Sostenible
- TICs
- Ciencia y Sociedad
- Energía
- Incubadora de empresas
- Proyectos en Temas Estratégicos

77 Redes en curso | 21 Países participantes | 2129 Instituciones | 7335 Investigadores

# REMAR

## Integration of Marine Energies in Electric Grids of Ibero-American countries

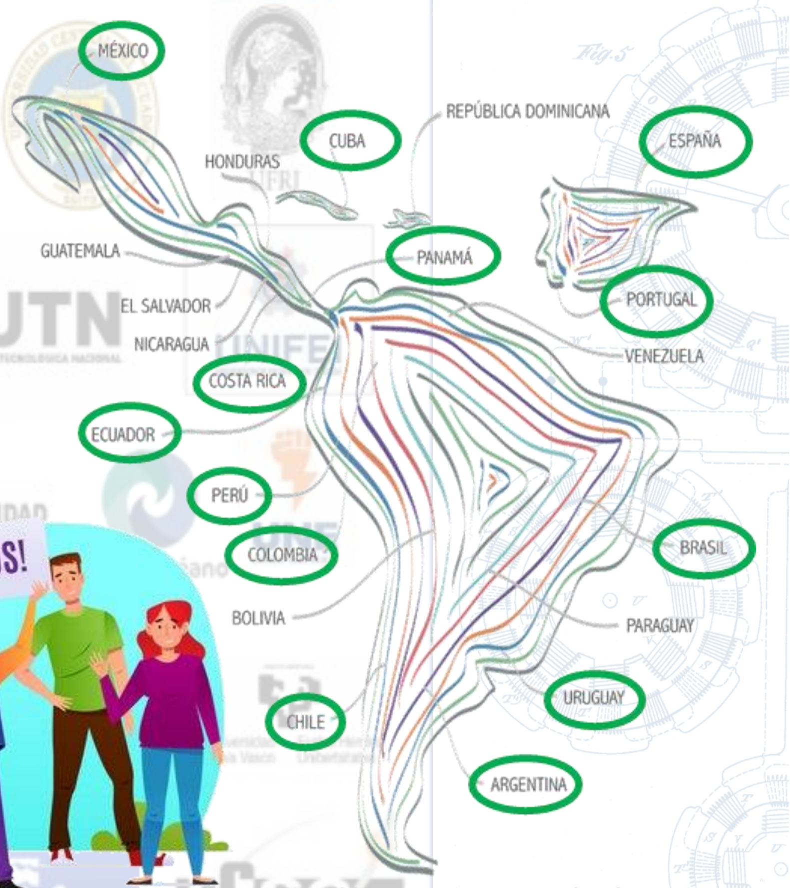
Groups of experts in Ocean Energies (wave, tidal, OTEC, saline gradient)

Groups of experts in power systems and grid integration

**13 countries, 150 researchers**

**Objetives:**

1. **Improve the profesional skills of the researchers in the area of marine energies integration.**
2. **Foster the research activities with special interest in the experimental facilities related to ocean energy and grid integration.**
3. **Collaborative scientific publications.**
4. **Foster the policies to support the development and grid integration of marine energies in Ibero-American countries.**


http://www.cyted.org/es/cyted

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

INTEGRACIÓN EN REDES ELÉCTRICAS IBEROAMERICANAS DE LAS ENERGÍAS DEL MAR
REMAR

PROGRAMA IBEROAMERICANO
CYTED
CIENCIA Y TECNOLOGÍA PARA EL DESARROLLO

Ciemat
Centro de Investigaciones Energéticas, Medioambientales y Tecnológicas

ice

CEMarin
Corporation Center of Excellence in Marine Sciences

PROGRAMA IBEROAMERICANO
CYTED
CIENCIA Y TECNOLOGÍA PARA EL DESARROLLO

*Fostering research activities*

*Support for researchers mobility*


*Courses, seminars and workshops*

LatWaves



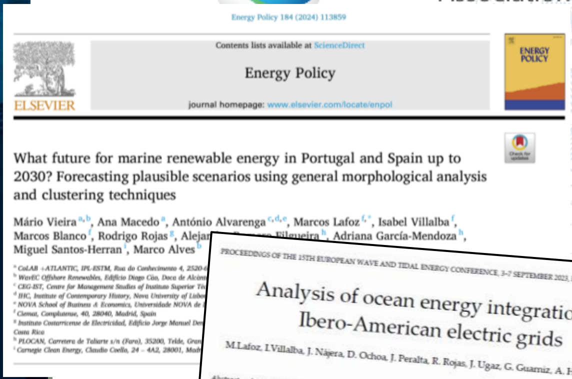

*Map of experimental and validation facilities.*

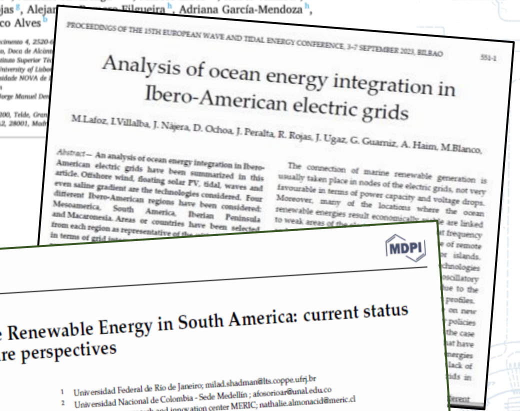

*Publications in journals and conferences*

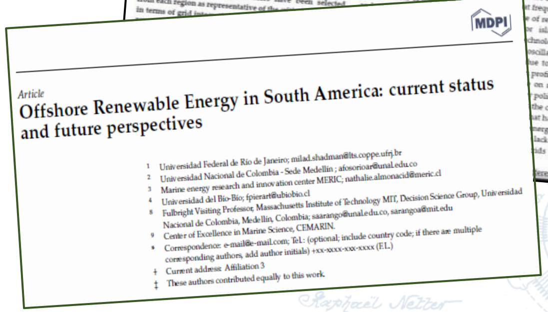
15th EWTEC 2023
European Wave and Tidal Energy Conference Series

ICOE 2022

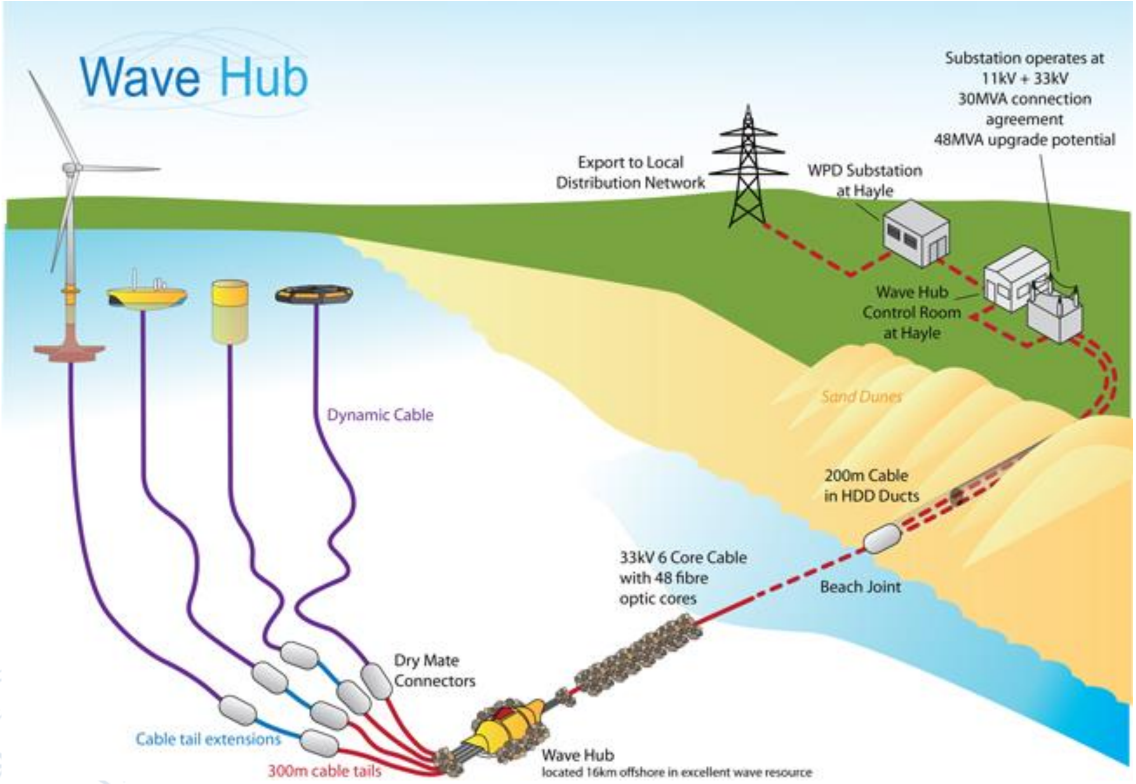
PAMEC Energy Association



# Technology issues related to grid integration of marine renewable energies




Dr. Marcos Lafoz-Pastor
marcos.lafoz@ciemat.es

http://rdgroups.ciemat.es/web/usep/

# Problems derived from the marine energies penetration

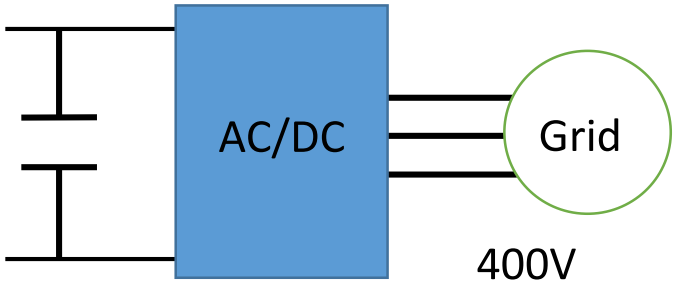


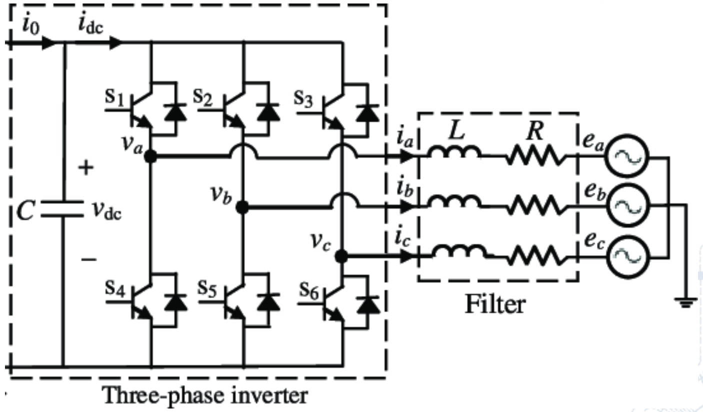

- It is expectedd that 50% of the electricity consumed in the world is produced by renewable energies by 2050.
- Inherent unpredictability and intermittent nature of renewables affects system reliability and stability.
- Conventional synchronous generators are replaced by renewable energy sources which are based on power electronics, lowering the rotational inertia of the system.
- Decreasing rotating inertia in a power system can affect seriously the system frequency responses, producing: frequency instability, power outages, and potentially dramatic frequency variations, as well as voltage variations out of operation ranges.

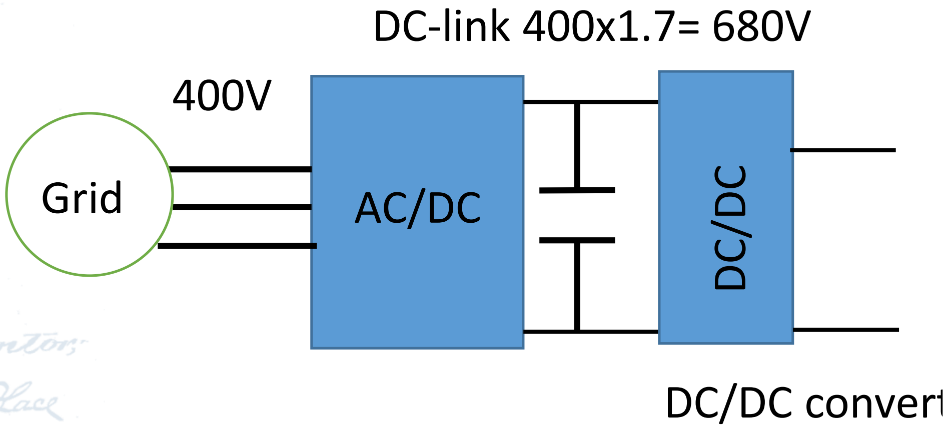
# Problems derived from the marine energies penetration

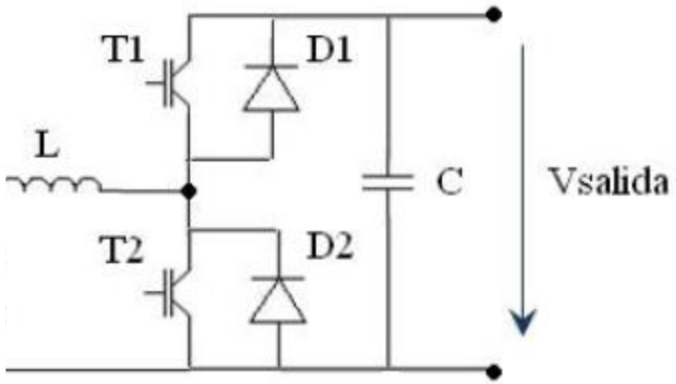
**How is the connection of the different marine energy technologies to the electric grid?**

- Offshore wind energy
- Floating solar PV
- Wave energy
- Tidal energy
- Saline gradient
- Thermal gradient (OTEC)



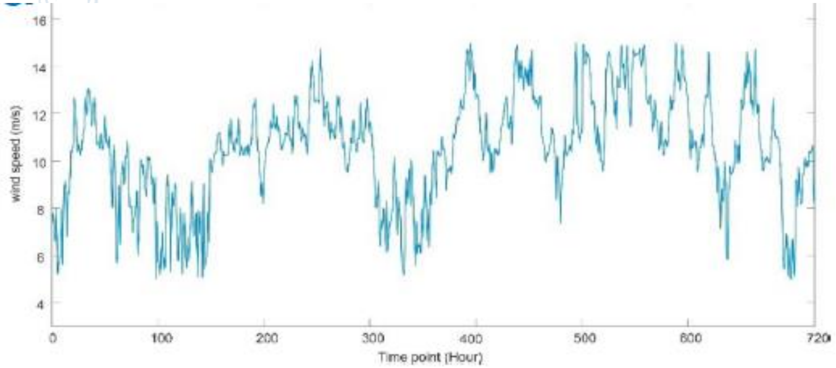



# Problems derived from the marine energies penetration

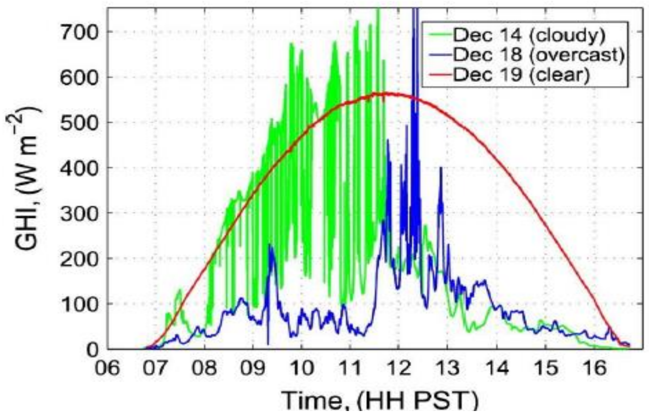
**How is the connection of the different marine energy technologies to the electric grid?**

- Offshore wind energy
- Floating solar PV
- Wave energy
- Tidal energy
- Saline gradient
- Thermal gradient

- Renewables run at maximum power point tracking, not being able to increase their energy production when necessary.
- When using power electronics and this control, the system inertia is reduced leading to frequency and voltage issues.



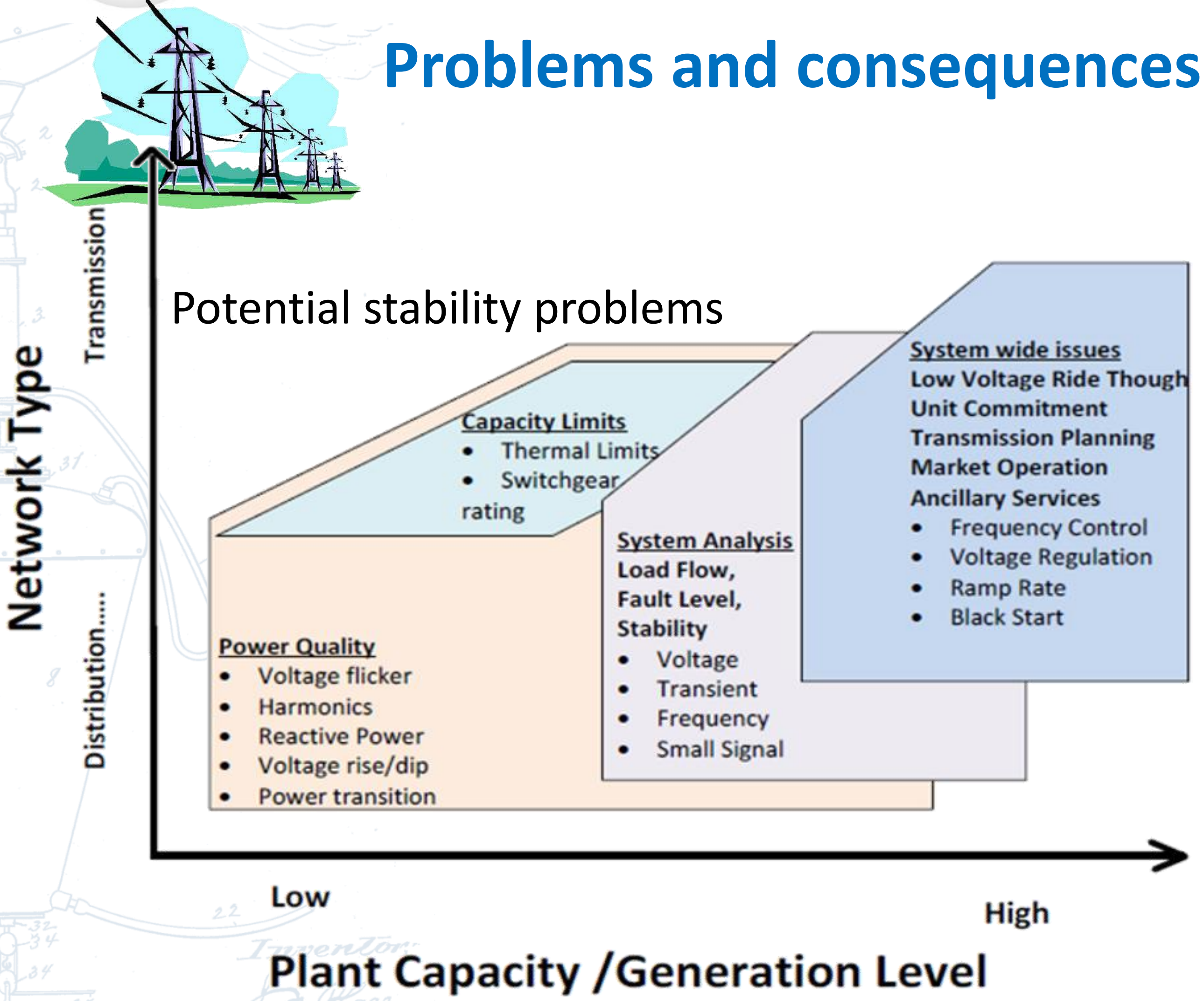

Fuente: doi.org/10.1016/j.energy.2018.08.212



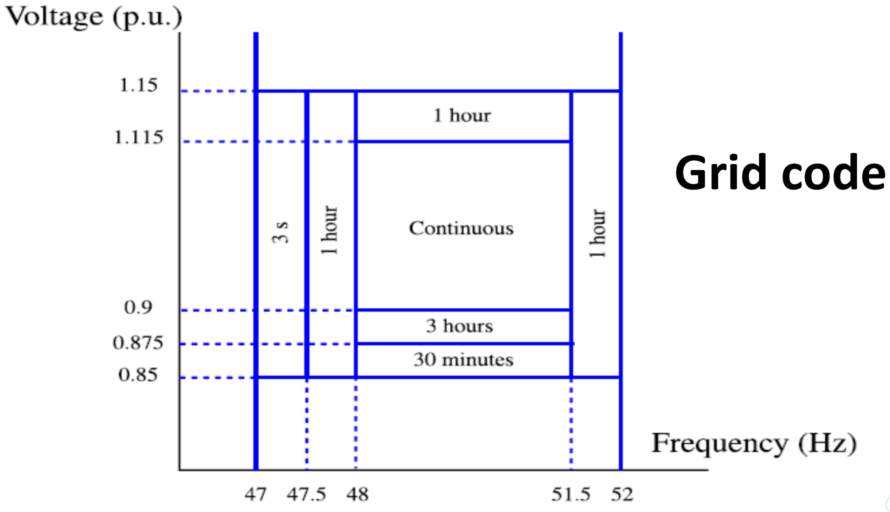

Fuente: doi.org/10.1016/j.solener.2016.03.019

# Problems and consequences of marine energy integration

Potential stability problems




Grid code conditions




**Consequences:**

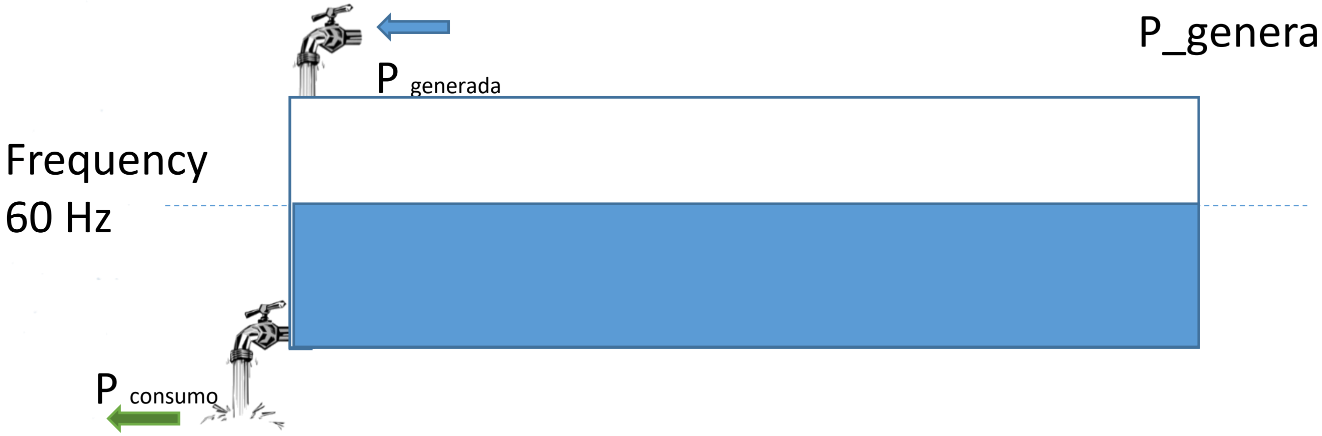
1. Limited dispatchability
2. Reduction of efficiency
3. Equipment malfunction or disconnection
4. Loss of information
5. Overheating of conductors
6. Electromagnetic interferences

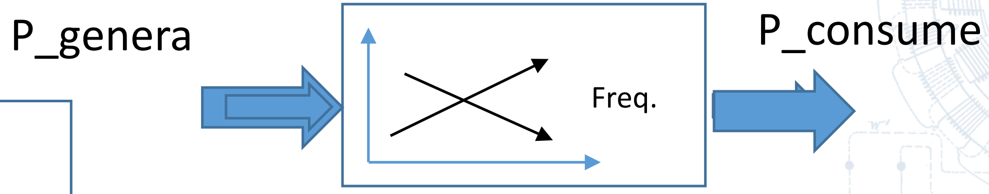
*Source: Robles, E. et al.*

*Technologies and Policies to support the Integration of Marine Renewable Energies into a Grid*

# Effects of renewable energies penetration on the system stability

Concept of stability and relation to inertia of the system



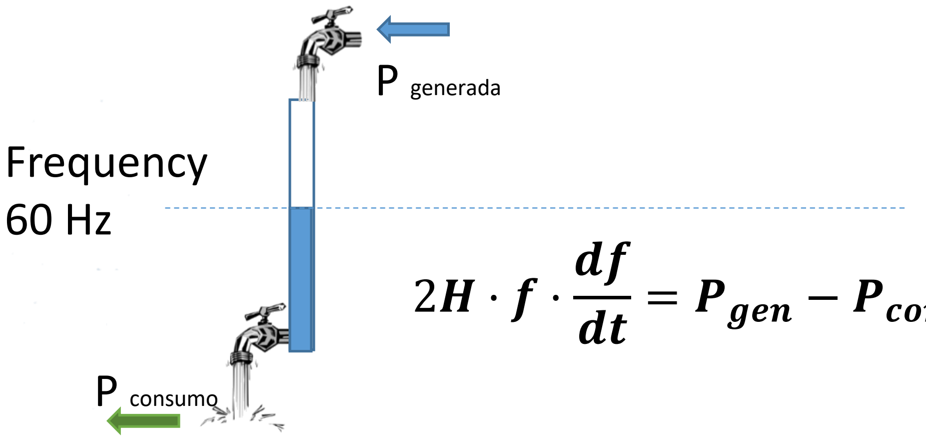

$$2H \cdot f \cdot \frac{df}{dt} = P_{gen} - P_{con}$$

**Electric Grid with large inertia**

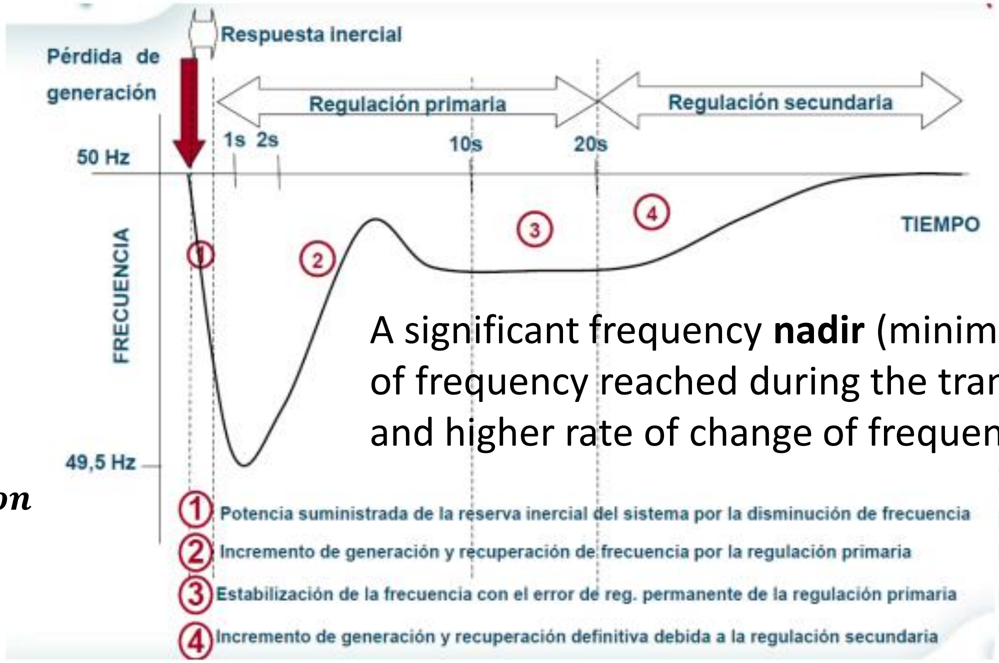
Small or even medium differences between generated and consumed power takes long time to produce frequency deviations.

# Effects of renewable energies penetration on the system stability

Concept of stability and relation to inertia of the system




$$2H \cdot f \cdot \frac{df}{dt} = P_{gen} - P_{con}$$




A significant frequency **nadir** (minimum value of frequency reached during the transient period) and higher rate of change of frequency (**RoCoF**)

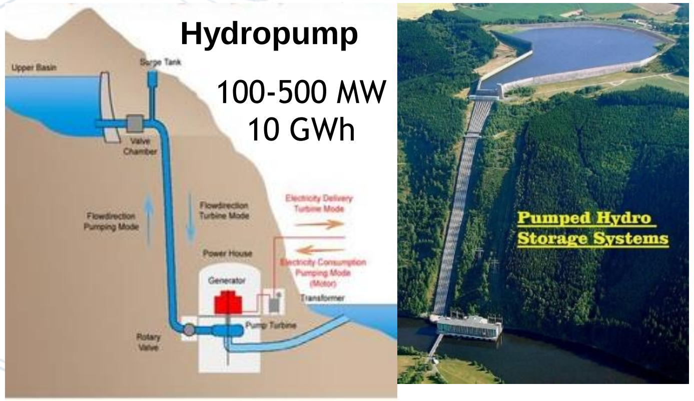
**Electric Grid with small inertia**
Small differences between generated and consumed power produces rapidly frequency deviations.

Frequency evolution after a power generation lost. Inertia effect and primary and secondary regulation. Source: Red Eléctrica de España.

# Energy storage as a solution

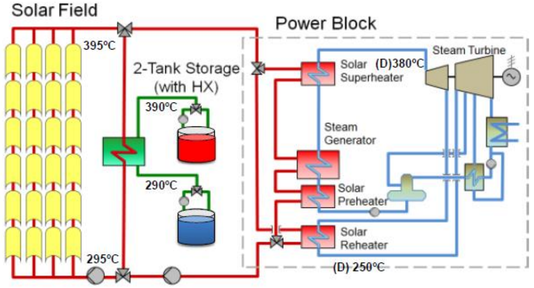
**Hydropump**

100-500 MW
10 GWh




**Thermal Storage**

50-300 MW
0.1- 6 GWh




**Flywheels**


100-1000 kW
10-100 kWh

**Supercacapacitors**

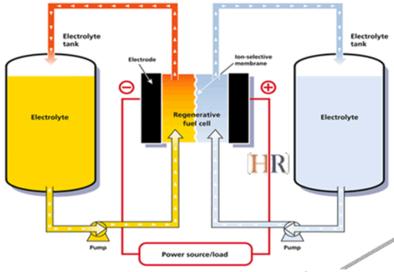

100 kW
1 kWh

**Compressed Air (CAES)**

1.7MW 10 MWh

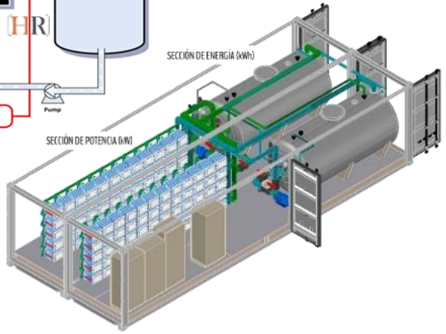
Goderich Project (Canada)

**Storage based on hydrogen**




**Baterías REDOX flujo**

15MW
60MWh



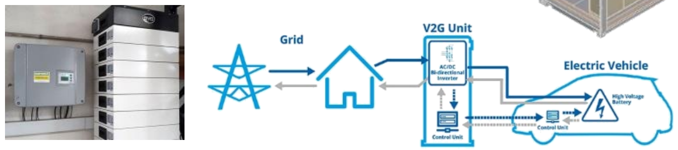

**Lithium batteries**
1MW/1MWh

**SMES**

1 MW, 1 kWh

0.350MW, 2.5MWh

**Liquid Air (LAES)**




**Electric vehicle and domestic storage**

# Energy storage as a solution

| Storage type | Power density (W/kg) | Cost $/kW | Energy density (Wh/kg) | Cost $/kWh | Life cycle |
|---|---|---|---|---|---|
| **Li-ion bat** | 150-500 | 500-4000 | 70-200 | 150-250 | < 10,000 |
| **Supercapacitors** | 1000-10000 | 100-400 | 0.5 - 5 | 500-15000 | 1,000,000 |
| **Flywheels** | 500-4000 | 150-400 | 10 -50.0 | 1000-10000 | > 100,000 |
| **SMES** | 500-2000 | 200-500 | 1-10.0 | 1000-10000 | 20,000 - 100,000 |

Most important technologies (appart from hydro pumping)

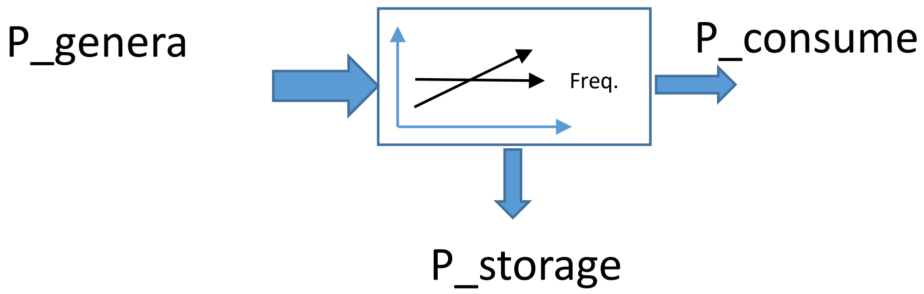
Some already operating systems in the world and the use related to the grid stability.

| *Technology* | *Country* | *Power/Energy* | *Application* |
|---|---|---|---|
| Battery | Australia | 30 MW/8 MWh | Fast frequency response |
| Battery | USA | 8 MW/2 MWh | Frequency regulation |
| Battery | Germany | 8.5 MW/8.5 MWh | Fast frequency response, spinning reserve |
| Battery | Puerto Rico | 20 MW/ 14 MWh | Fast frequency response, spinning reserve |
| Battery | Japan | 34 MW/ 245 MWh | Wind power fluctuations mitigation |
| Battery | USA | 10 MW/ 40 MWh | Spinning reserve, load leveling |
| Battery | Ireland | 2 MW/ 12 MWh | Wind power fluctuations mitigation |
| Supercaps | China | 3 MW/ 17.2 MWh | Voltage sag mitigation |
| Supercaps | Spain | 4 MW/ 5.6 MWh | Frequency stability |
| Flywheels | USA | 20 MW | Frequency regulation, power quality |
| Flywheels | Japan | 235 MW | High power supply to nuclear fusion furnace |
| SMES | Japan | 10 MW | Frequency stability, power quality |

# Energy storage as a solution to increase the inertia (virtual inertia)

Energy storage can provide additional inertia to the grid as "virtual inertia".

A modification of the difference between Pgen and Pcons, including a certain dynamic performance is equivalent to modify the inertia of the system.

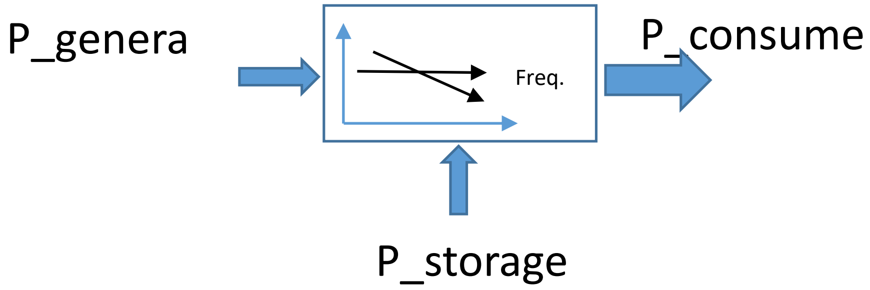



$$2H \cdot f \cdot \frac{df}{dt} = P_{gen} \pm P_{storage} - P_{con}$$

# Energy storage as a solution to increase the inertia (virtual inertia)

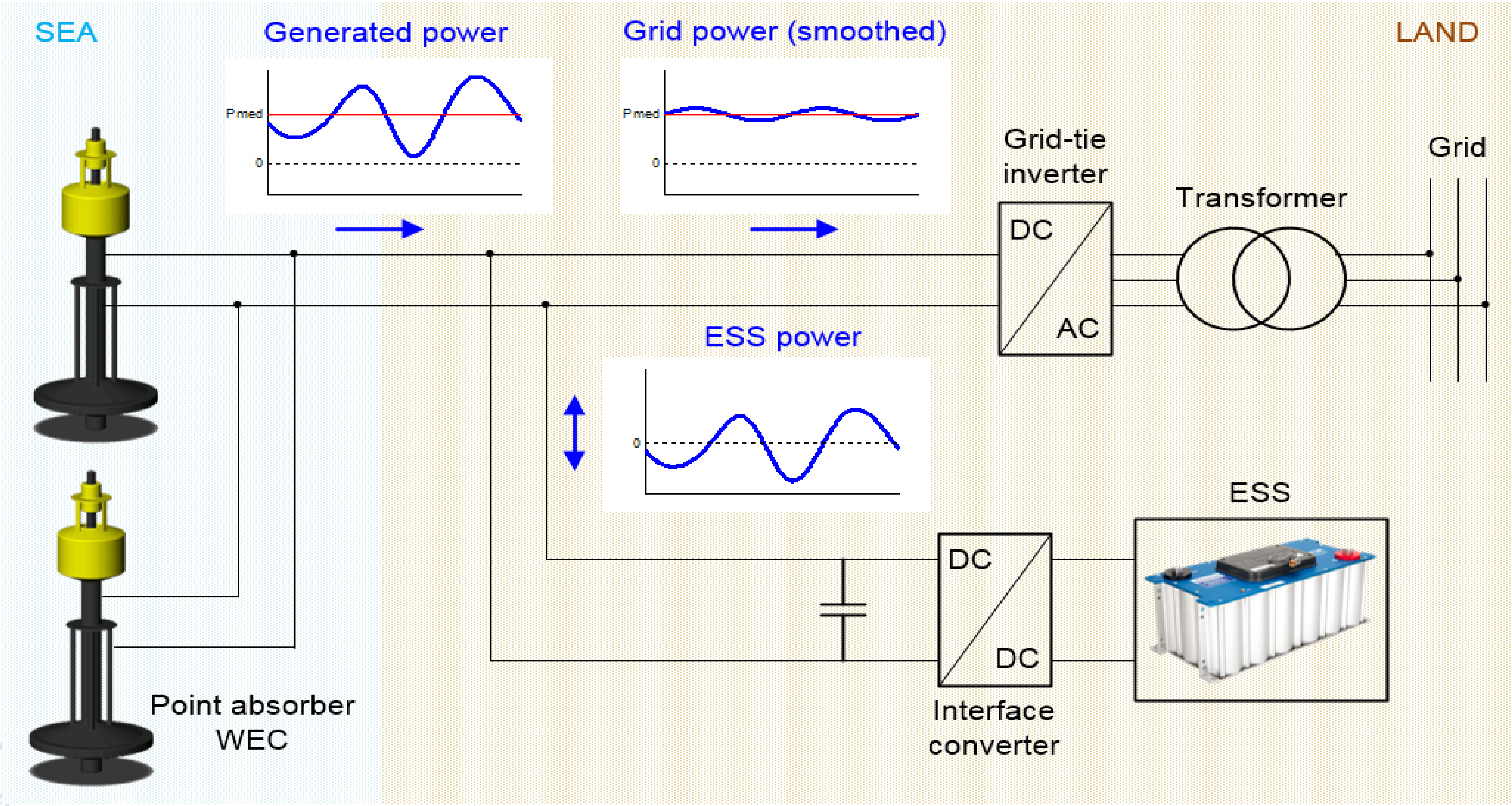
Energy storage can provide additional inertia to the grid as “virtual inertia”.

A modification of the difference between Pgen and Pcons, including a certain dynamic performance is equivalent to modify the inertia of the system.




$$2H \cdot f \cdot \frac{df}{dt} = P_{gen} \pm P_{storage} - P_{con}$$

# Integration of marine renewable energies using energy storage



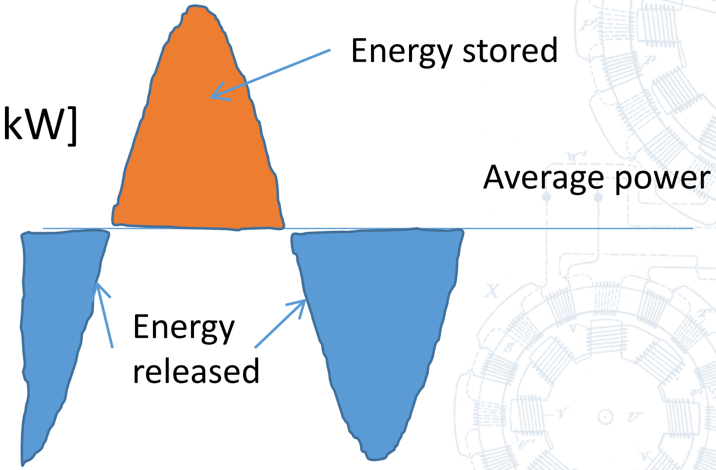
# Integration of marine renewable energies using energy storage

Let’s consider a simple example, considering a Wave Energy Converter which provides a continuous sinusoidal power

**How much energy storage is required to smooth the power?**

Average power is 60kW
Calculate 2 times the first blue area between 0 and T/8

$P = 120sin^2(wt)$ [kW]




$$E = 2 \times \int_0^{\frac{T}{8}} (P_{load} - P_{wave})dt = 2 \times \int_0^{\frac{T}{8}} \left(\frac{A}{2} - A \cdot sin^2(2wt)\right) dt$$

$$E = 2 \cdot \frac{A}{2}\frac{T}{8} - 2 \cdot \frac{A}{2} \cdot \int_0^{\frac{T}{8}} (1 - cos(2wt))dt = A \cdot \frac{T}{8} - A \cdot \frac{T}{8} + 2 \cdot \frac{A}{2} \cdot \frac{1}{2w} sin\left(2w\frac{T}{8}\right)$$

$$E = A \cdot \frac{T}{4\pi} sin\left(2\frac{2\pi}{T}\frac{T}{8}\right) = \frac{A \cdot T}{4\pi}$$

A=120kW
T=63 seg

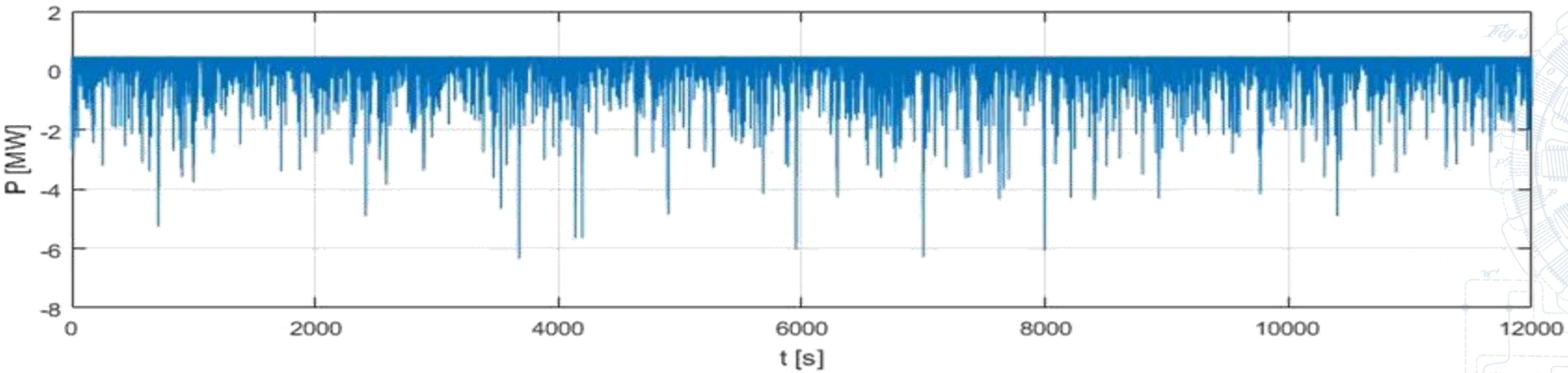
$$E = \frac{120 \cdot 64}{4\pi} = 611{,}15kWh$$

Modifying the wave period to 0.1Hz, E=95,49kWh.

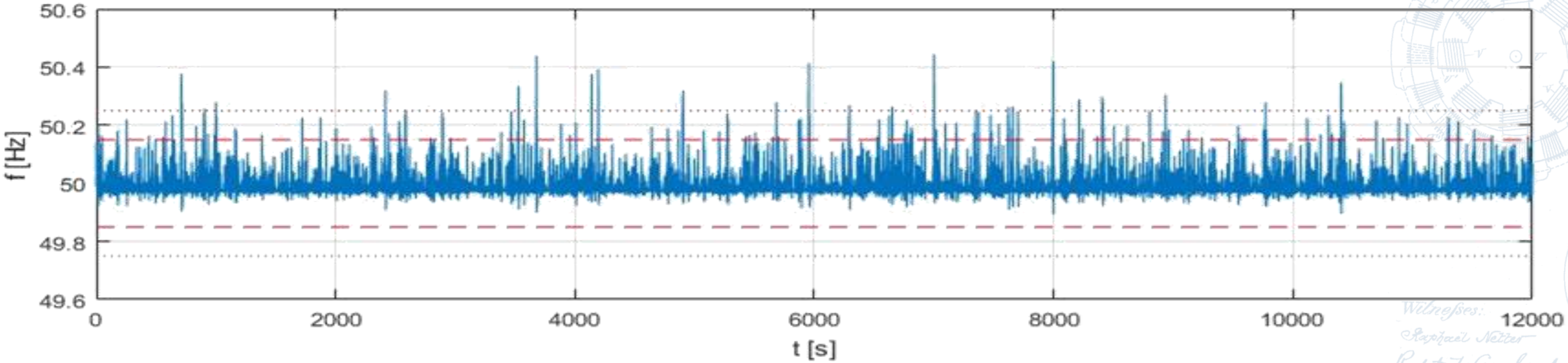
# Integration of marine renewable energies using energy storage

*Simulation study based on the case of the Canary Islands (Spain)*

Power injected to the grid by a wave energy power plant



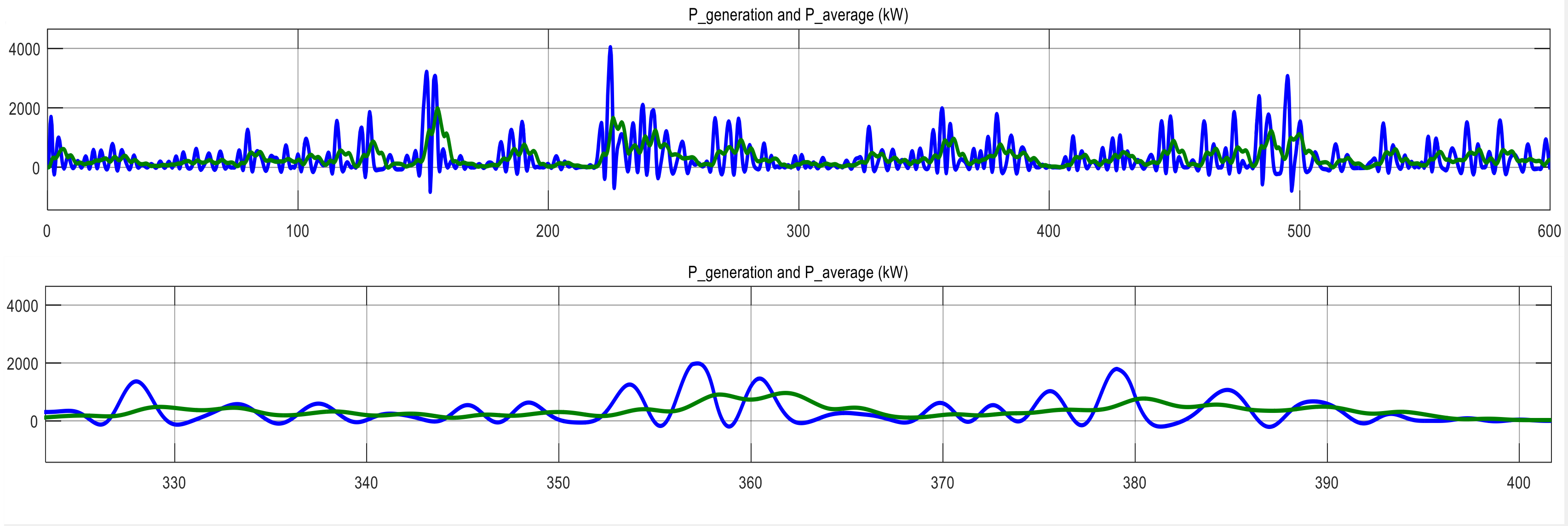

Frequency evolution at the grid



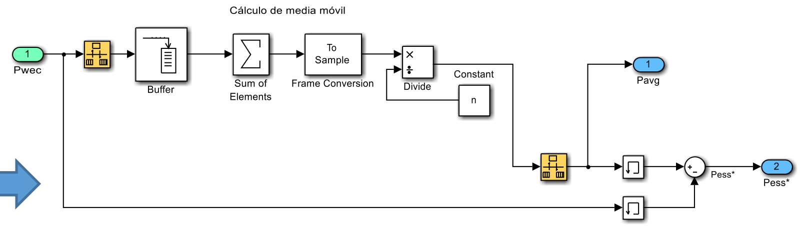
# Integration of marine renewable energies using energy storage

The power introduced in the grid is modified by means of the use of an energy storage system.

Time zoom




Power generation for the grid based on a mobile average window (filter).



# Integration of marine renewable energies using energy storage

➢ Technologies selected for the study as possibilities.

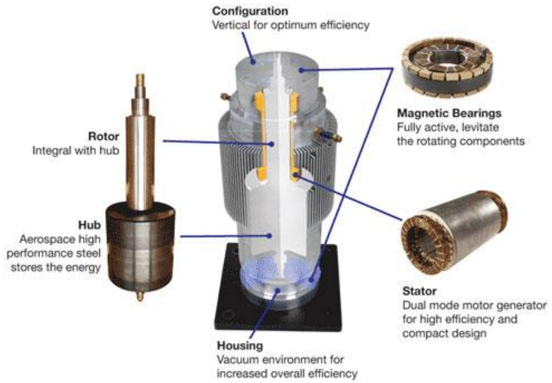
**Batteries**


Batteries $LiFePO_4$: 20Ah, 3.2V.
Reg. continuous at 3C: 60A
Peaks 15seg 10C: 200A
688V rated voltage
( 215 series cells)
Energy: 4.3kWh
Power: 137kW

**Supercapacitors**

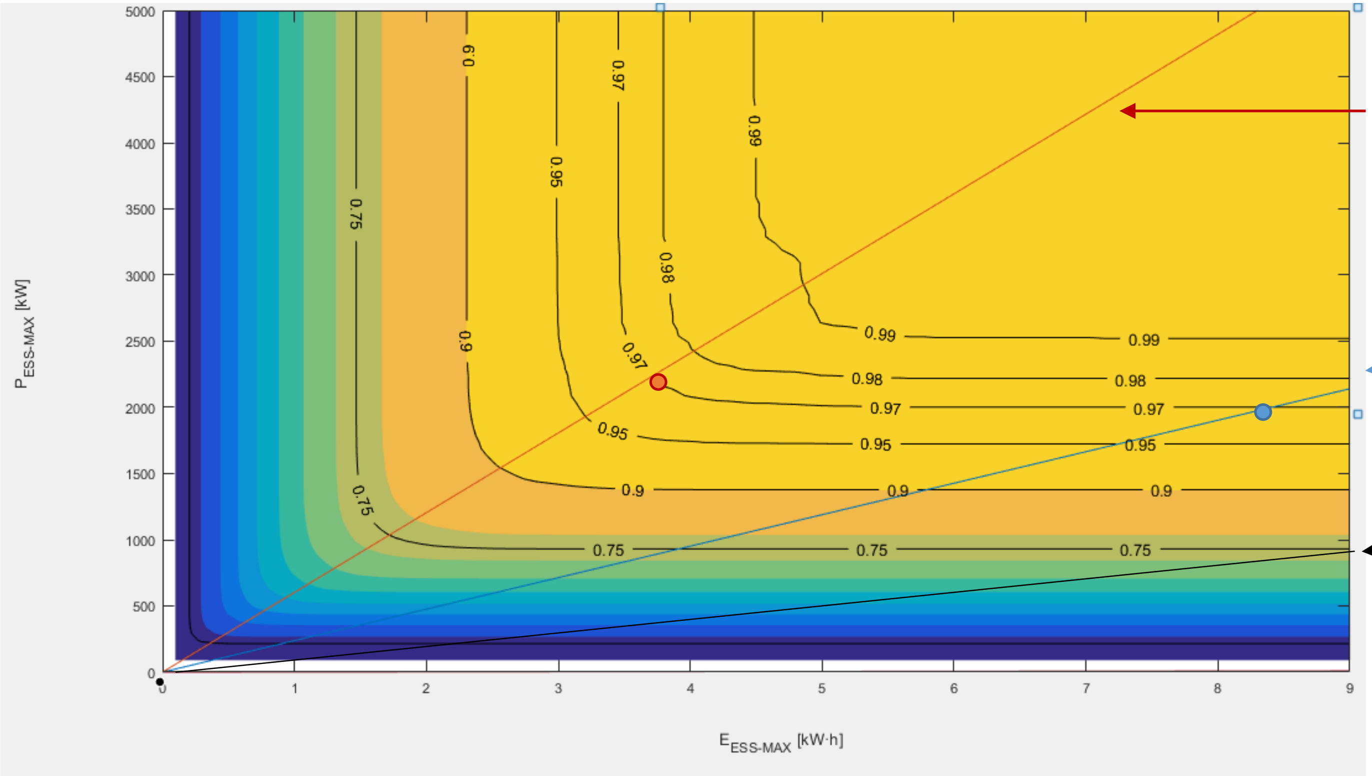

0.727 kWh (256 cells, 690V, 200A)
0.58 kWh (Energy with U min 50%)
Power max: 138kW
690V rated voltage
(256 modules of 2.7V in series)

**Flywheels**




0.83 kWh (Energy until 50% speed)
Power max: 500kW
690V rated voltage

# Integration of marine renewable energies using energy storage




Flywheel Vycon:
500kW, 0.83kWh

Supercapacitor Maxwell:
138kW, 0.58kWh

Baterías GWL Power:
137kW, 4.3kWh

Batteries: 2000/137 -> 15 branches in parallel. 64.5 kWh, 2055kW
Supercapacitors: 8.4 kWh, 2000 kW -> 15 units
Flywheel Vycon: 3.7 kWh, 2300 kW -> 5 units

# Social and environmental perspective and ocean energy grid integration

Dr. Rodrigo Rojas Morales
RRojasM@iec.cr

www.ice.cr

# Main messages

1. The building ocean energy capacity in Latin American, through the lenses of social and environmental requirements.

2. Mandatory integration of actions towards social acceptance and environmental licensing frames.

3. A brief analysis of this topics in the ocean energy supply chain in some selected Latin American countries.

# ¿What is the status of integration of marine energy in Latin America?

¿Kw installed?

¿Projects?

¿Road maps?

¿Consenting process?

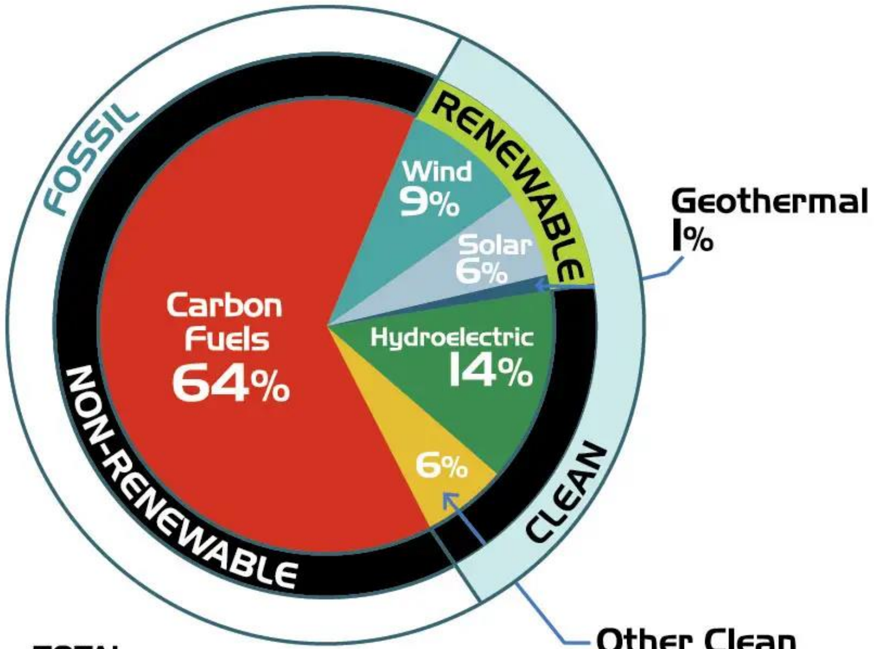

¿Auctions?

¿legal frame?

¿Licensing process?

¿Social acceptance?

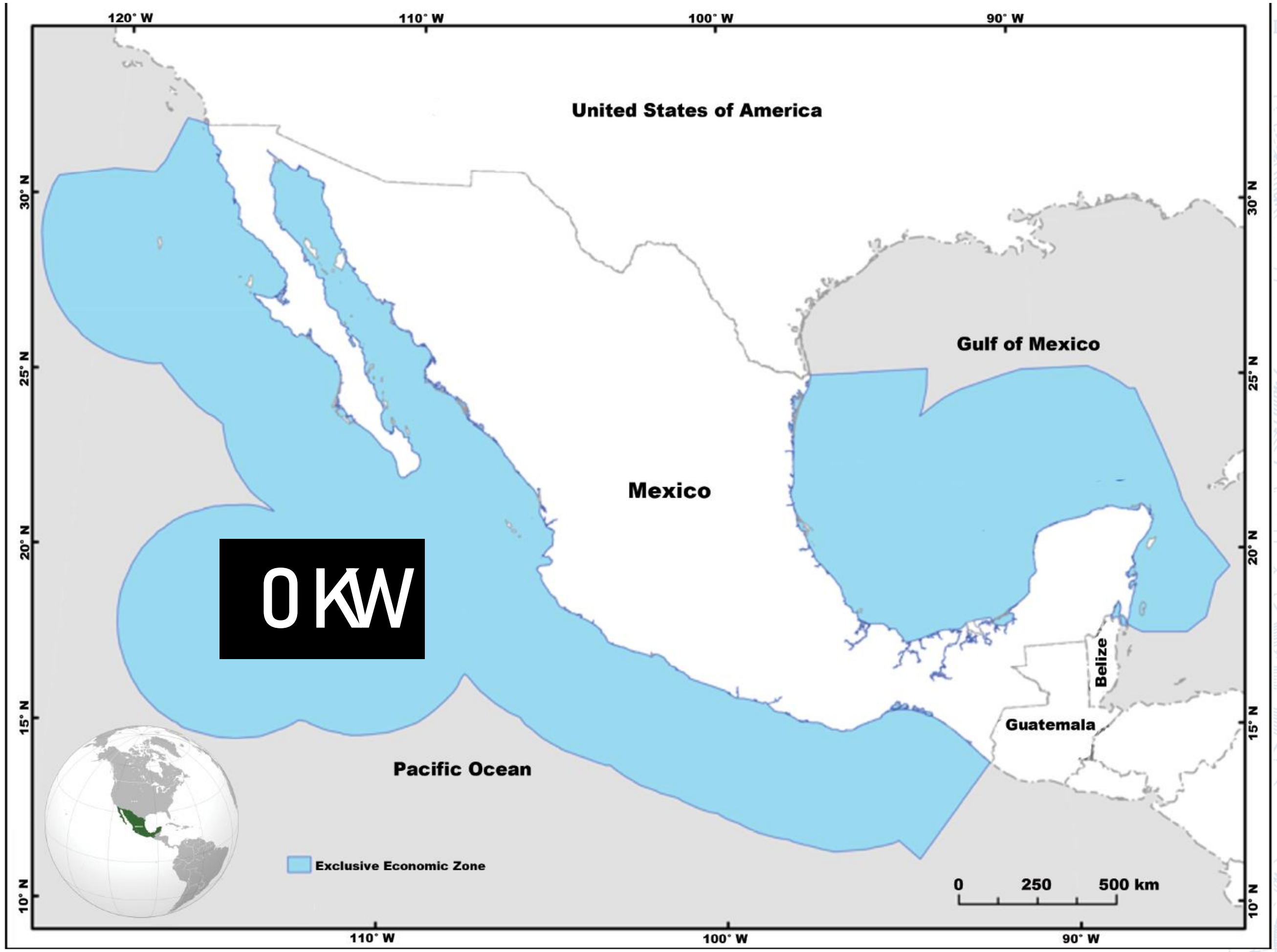
# Mexico
## Electric Energy Installed Capacity Sources (Megawatts-2020)




TOTAL :
88,000 MW
or aprox. 3,700 Petajoules

SOURCE: Ministry of Energy-Prodensen

EXHIBIT 4



## Onshore installed capacity

HIDROELÉCTRICO
65,91%
2.331, 3 MW

GEOTÉRMICO
7,40%
261,9 MW

SOLAR
0,15%
5,4 MW

EÓLICO
11,13%
393,5 MW

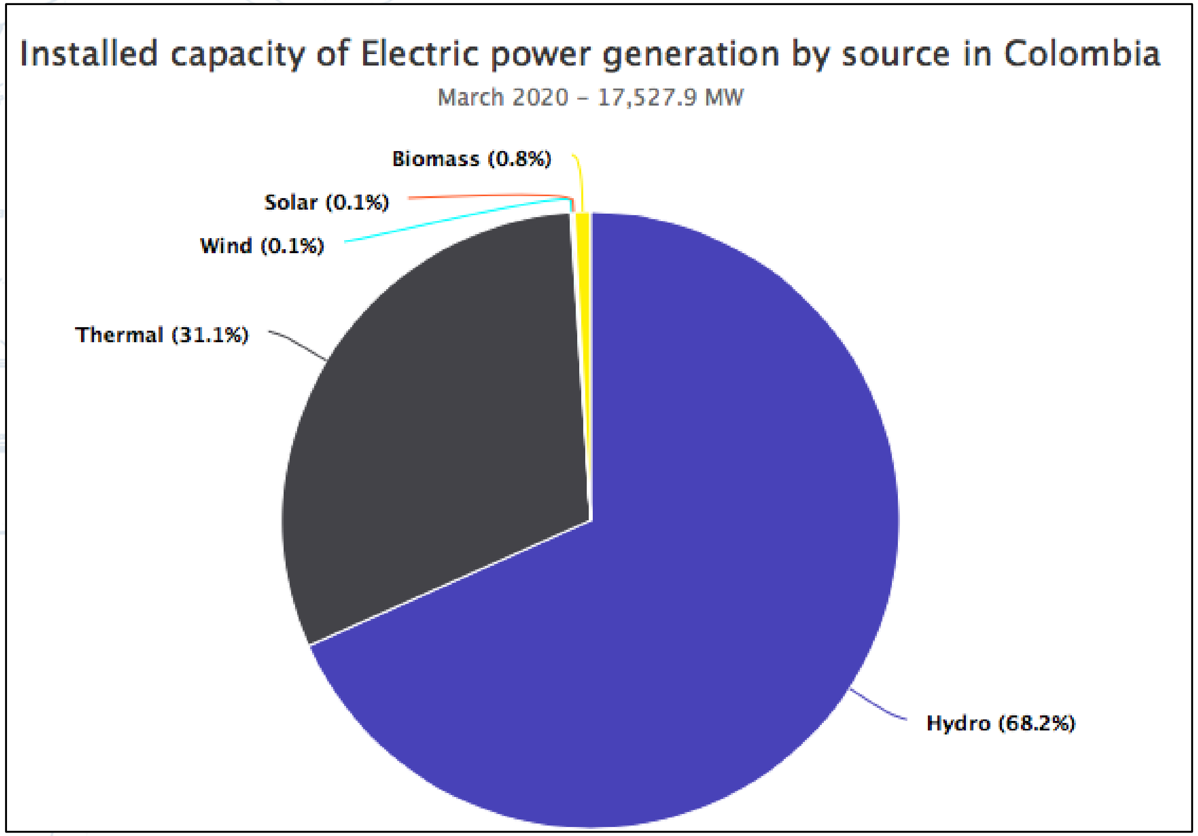
BIOMASA
2,01%
71 MW

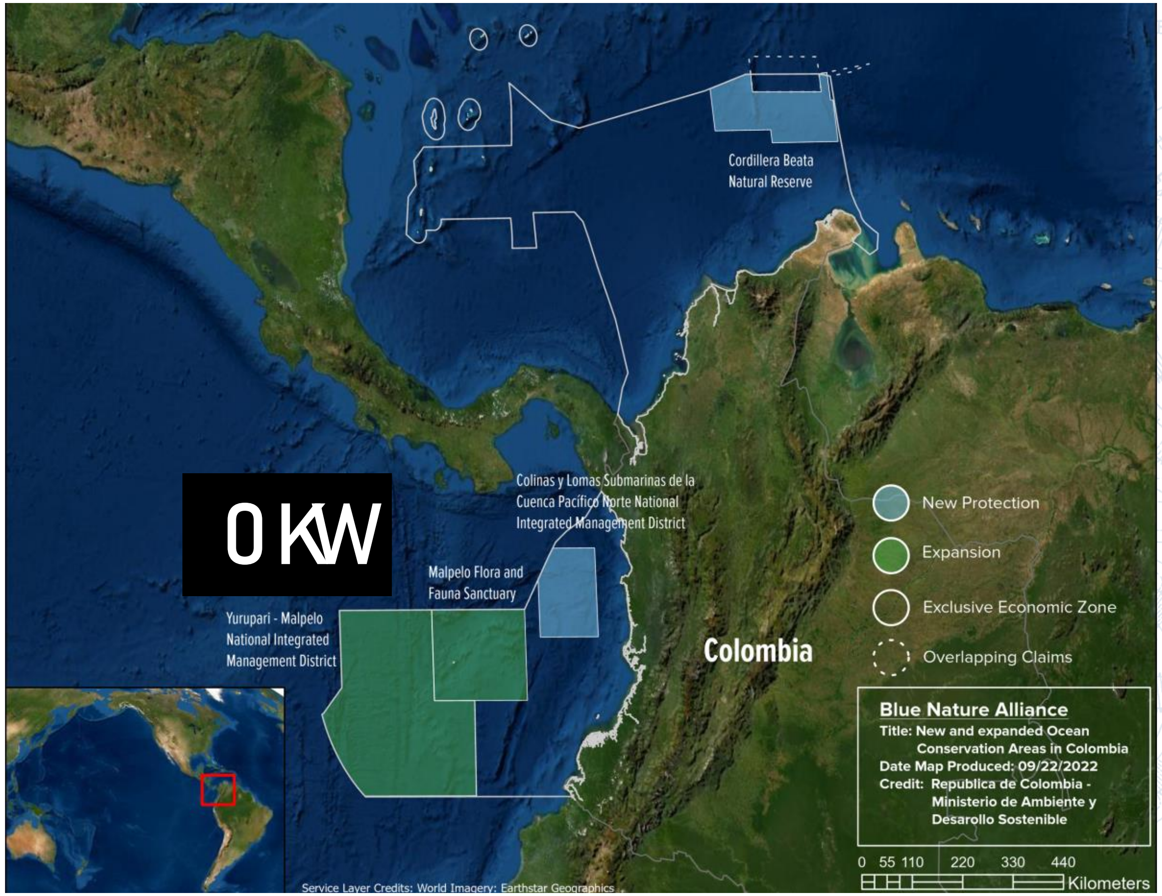
**Onshore vs marine energy capacity.**

**This condition is similar in other LA countries**

## Challenges: ocean capacity

### We are 10 times ocean tan land territories




Colombia’s installed electric power generation Capacity currently stands at 17,771 MW,

| COUNTRY | SOCIAL TOPICS | ENVIRONMENTAL CONDITIONS | REFERENCE |
|---|---|---|---|
| MEXICO | YES | YES | A Review on Environmental and Social Impacts of Thermal Gradient and Tidal Currents Energy. Conversion and Application to the Case of Chiapas, Mexico. Graciela Rivera, Angélica Felix and Edgar Mendoza. Int. J. Environ. Res. Public Health 2020, 17, 7791; doi:10.3390/ijerph 17217791.<br><br>Environmental Assessment of the Impacts and Benefits of a Salinity Gradient Energy Pilot Plant Etzaguery Marin-Coria, Rodolfo Silva, Cecilia Enriquez, M. Luisa Martínez 3 and Edgar Mendoza. Energies 2021, 14, 3252. https://doi.org/10.3390/en14113252. |
| EL SALVADOR | NO | NO | Quintanilla, J. 2021. ESTUDIO NUMERICO DEL POTENCIAL ENERGETICO DEL OLEAJE EN LA ZONA DEL PUERTO DE ACAJUTLA TRABAJO DE GRADO PARA OBTENER EL TITULO DE LICENCIADO EN F FISICA. UNIVERSIDAD DE EL SALVADOR. FACULTAD DE CIENCIAS NATURALES Y MATEMATICA.ESCUELA DE FISICA |
| COSTA RICA | No specific for Marine energy | | Foresight analysis of supply chain for development of offshore wind in Costa Rica. José Rodrigo Rojas M.1, Karla Chaves Martínez2. Repertorio Científico. ISSN 2215-5651. Vol. 24, N.º 1:Junio 2021: 57-78 |
| PANAMA | NO | NO | AN OCEAN ENERGY ROAD MAP AND STRATEGY FOR PANAMAINVESTIGADORES. José Rogelio Fábrega Duque. Job Osvaldo Noel Amaya y Alejandrina Batista. UTP, 2022. |
| COLOMBIA | YES | YES | The Renewables Consulting Group. Roadmap for the Deployment of Offshore Wind Power in Colombia; Report for Consultation [Hoja de Ruta Para El Despliegue de La Energía Eólica Costa Afuera En Colombia—Reporte Para Consulta]. Technical Report. Ministry of Mines and Energy, Colombia. 2022 |
| CHILE | YES | YES | Henriksen, J. Key Principles in Implementing ILO Convention No. 169. In Programme to Promote ILO Convention No. 169;Programme to Promote ILO Convention: Paris, France, 2008. |
| BRAZIL | YES | YES | Xavier, T.W.d.F.; Caetano, A.G.N.; Brannstrom, C. Parques Eólicos Offshore no Brasil e os Potenciais Impactos Sociais: Aplicação de Matrizes SWOT; Arquivos de Ciências do Mar: Fortaleza, Brazil, 2020<br><br>Hernandez C., O.M.; Shadman, M.; Amiri, M.M.; Silva, C.; Estefen, S.F.; La Rovere, E. Environmental impacts of offshore wind installation, operation and maintenance and decommissioning activities: A case study of Brazil. Renew. Sustain. Energy Rev. 2021, 144, 110994. |

# Consenting processes México

**MARINE SPATIAL PLANNING POLICY**

Although there is not a clear Marine Spatial Planning (MSP) policy, there are legal instruments to the matters related to the sea.

1. The Mexican Constitution
2. General Law of National Assets
3. Federal Law of the Sea
4. Marine Sector Programme
5. Law of National Waters
6. Law on the Use of Renewable Energy and Energy Transition Financing (LAERFTE)
7. General Law of Ecological Balance and Environmental Protection

**AUTHORITIES INVOLVED**

According to the actual legal framework of the marine and energy sectors, the authorities that have the faculty to be involved in the licensing process are:

Secretariat of Environment and Natural Resources
Secretariat of Energy (SENER)
National Commission of the Efficient Use of Energy (CONUEE) –Energy Regulatory Commission (CRE
Federal Commission of Energy (CFE
National Commission of Water (CONAGUA)
Secretariat of Communications and Transport (SCT)

# Consenting processes Costa Rica

**Due to the fact that ocean energy is a renewable energy that has not been developed in Costa Rica, there is not a specific law to regulate it. Instead, the coastal and marine zone is regulated by a complex set of laws concerning public and private land ownership. The legal and institutional framework for Costa Rica's coastal zone covers a range of areas including land use planning, conservation, construction, and environmental impact and control.**

**MARINE SPATIAL PLANNING POLICY**

Similar to Mexico, in Costa Rica, there are legal collections of instruments to the matters related to the governance of the sea.

1. The Constitution of the Republic
2. Law of Rights of the Sea
3. Law of National Waters
4. Maritime Terrestrial Zone
5. Marine Protected Areas
6. Urban Planning law

**AUTHORITIES INVOLVED**

Ministry of Environment An Energy
Costa Rican Tourism Institute
Ministry of Public Infrastructure and Transport
National Technical Environmental Agency
Municipalites of local goverments
Costa Rican Institute for Electricity

# Politic constitution

- **Sovereign rights for exploration and exploitation, conservation and management of the natural resources, both living and non-living, of the waters superjacent to the bed and of the bed and subsoil of the sea, and with respect to other activities such as the production of energy derived from water, currents and the winds.**

# Concessions in the Maritime Terrestrial Zone

***Maritime Zone concessions only exist on properties within coastal regulatory plans and according to their location***

# Steps for offshore permitting in Costa Rica

Like any other renewable energy project, the developer has to make a feasibility study and determine the scope of the project they want to develop. Once this is done, permits and studies need to be requested.

# Steps for concessions for offshore energy projects

**Request for construction permit to Costa Rica Engenieers Corporation**

**Construction permit for land use and planning**

**Local Municipality**

**Viability and control of social and enviromental Impact Assessment (EsIA)**

**SETENA has three instruments that have to be used to create the EIA**

**Studies for a renewable energy project**

# Consenting processes Colombia

MARINE SPATIAL PLANNING POLICY
Now is in progress the first offshore wind farm project

1. The Colombian Constitution (article 101)
2. Economic exclusive marine zone
3. The CONVEMAR, United Nations Convention on the Law of the Sea
4. Marine policy law (DIMAR)
5. National agency for environmental licence ANLA

# Challenges for marine energy policy: Iberoamerica, Latam and Caribbean


**Dr. Andrés Fernando Osorio Arias**
**afosorioar@unal.edu.co**

https://cemarin.org/

# Renewable Energy Regulation and regional integration

**LEY 1715 DE 2014**

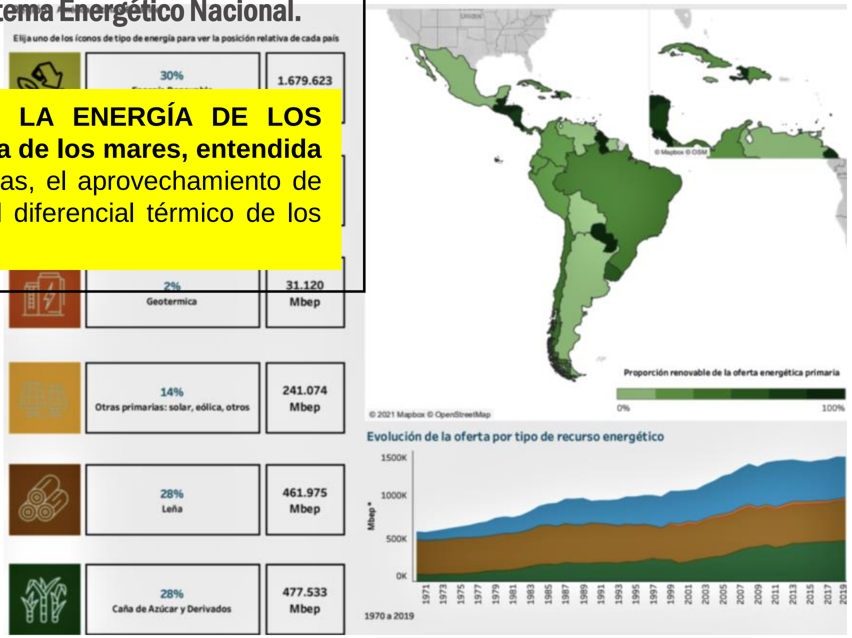
(mayo 13)

Diario Oficial No. 49.150 de 13 de mayo de 2014

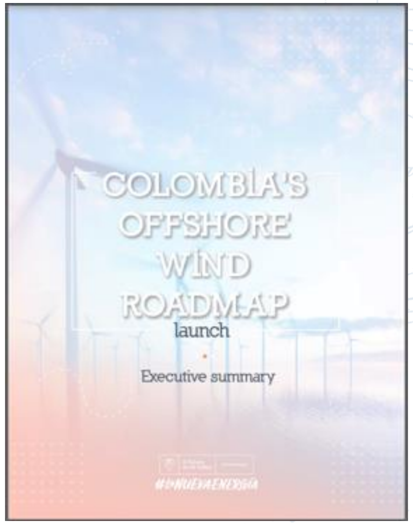
**CONGRESO DE LA REPÚBLICA**

**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



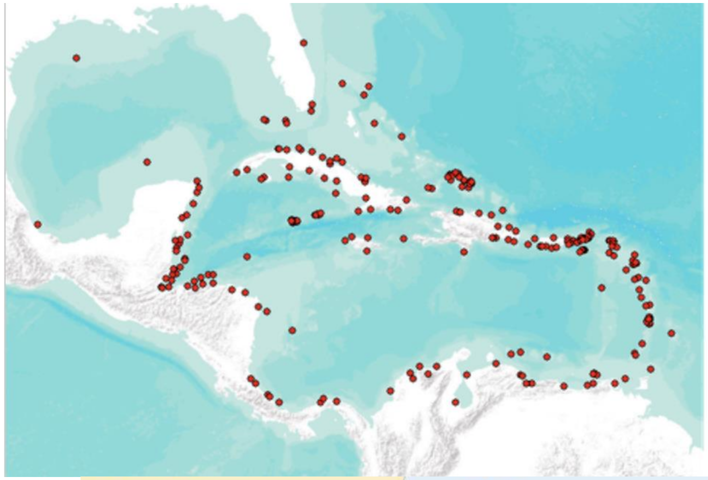

Countries should not only formulate robust domestic policies but also engage in **regional integration initiatives**. Collaborative efforts can lead to shared resources, knowledge exchange, and collective problem-solving.



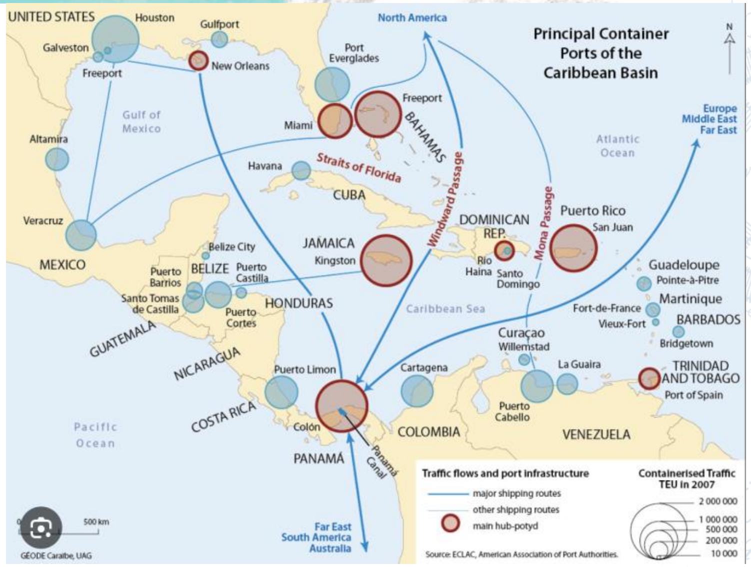
# Sector regulation vs environmental regulation

Balancing sector-specific regulations with environmental concerns is crucial for achieving sustainability. While sectorial **regulations focus on economic growth** within specific industries, **environmental regulations ensure** that development remains within ecological boundaries. Striking this balance requires a holistic approach, where policies promote green technologies, eco-friendly practices, and sustainable resource management across industries.

Caribbean Marine Protected Areas (points)
World Resources Institute, 2004



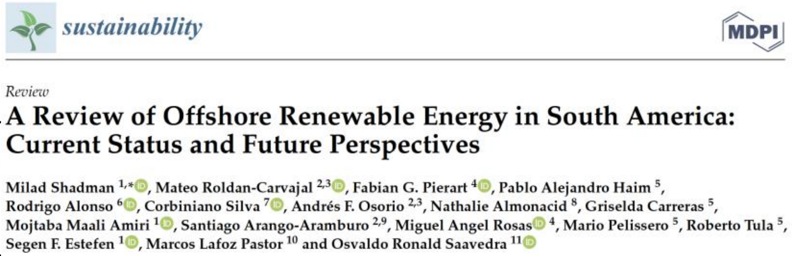
Principal Container Ports



# Sector regulation vs environmental regulation

**Table 1.** ORE's specific regulatory frameworks and possible conflicts/synergies in SA.

| Country | Possible Conflicts/Synergies in Hotspot Areas | Regulatory Framework | Auction Bids |
|---|---|---|---|
| Argentina | Environmental protected areas, commercial activities (navigation, fishing) and recreational activities (boating, surfing) | Not yet | Not yet |
| Brazil | High importance biological area, O & G activities | IBAMA Reference Term (Environmental licensing), Decreto N° 10.946, de 25 de Janeiro de 2022 (Concession authorization) | Being planned |
| Chile | Fishing coves, indigenous communities, environmentally protected areas, marine mammals routes, aquaculture, marine traffic/island and remotes areas | Not yet | Not yet |
| Colombia | Protected areas, biosphere reserves, oil and gas concessions, artisanal fishing areas and shipping routes | Not yet | Not yet |
| Uruguay | Fishing, hydrocarbon exploration, shipping line and high importance biological areas | Not yet | Not yet |


sustainability MDPI

*Review*

**A Review of Offshore Renewable Energy in South America: Current Status and Future Perspectives**

Milad Shadman [1,*], Mateo Roldan-Carvajal [2,3], Fabian G. Pierart [4], Pablo Alejandro Haim [5], Rodrigo Alonso [6], Corbiniano Silva [7], Andrés F. Osorio [2,3], Nathalie Almonacid [8], Griselda Carreras [5], Mojtaba Maali Amiri [1], Santiago Arango-Aramburo [2,9], Miguel Angel Rosas [4], Mario Pelissero [5], Roberto Tula [5], Segen F. Estefen [1], Marcos Lafoz Pastor [10] and Osvaldo Ronald Saavedra [11]

# Policy of Education to Develop and Incorporate National Capacities

Investing in education is central to developing and incorporating national capacities. Through education, a nation can empower its citizens with the skills and knowledge needed to contribute to sustainable development. Curriculum enhancements that prioritize environmental awareness, innovation, and problem-solving can prepare the workforce for the challenges of the future

## Technical paper production



MDPI
sustainability
Review
A Review of Offshore Renewable Energy in South America: Current Status and Future Perspectives
Milad Shadman, Mateo Roldan-Carvajal, Fabian G. Pierart, Pablo Alejandro Haim, Rodrigo Alonso, Corbiniano Silva, Andrés F. Osorio, Nathalie Almonacid, Griselda Carreras, Mojtaba Maali Amiri, Santiago Arango-Aramburo, Miguel Angel Rosas, Mario Pelissero, Roberto Tula, Segen F. Estefen, Marcos Lafoz Pastor and Osvaldo Ronald Saavedra

# ISOLATES or non-connected zones - NEEDS

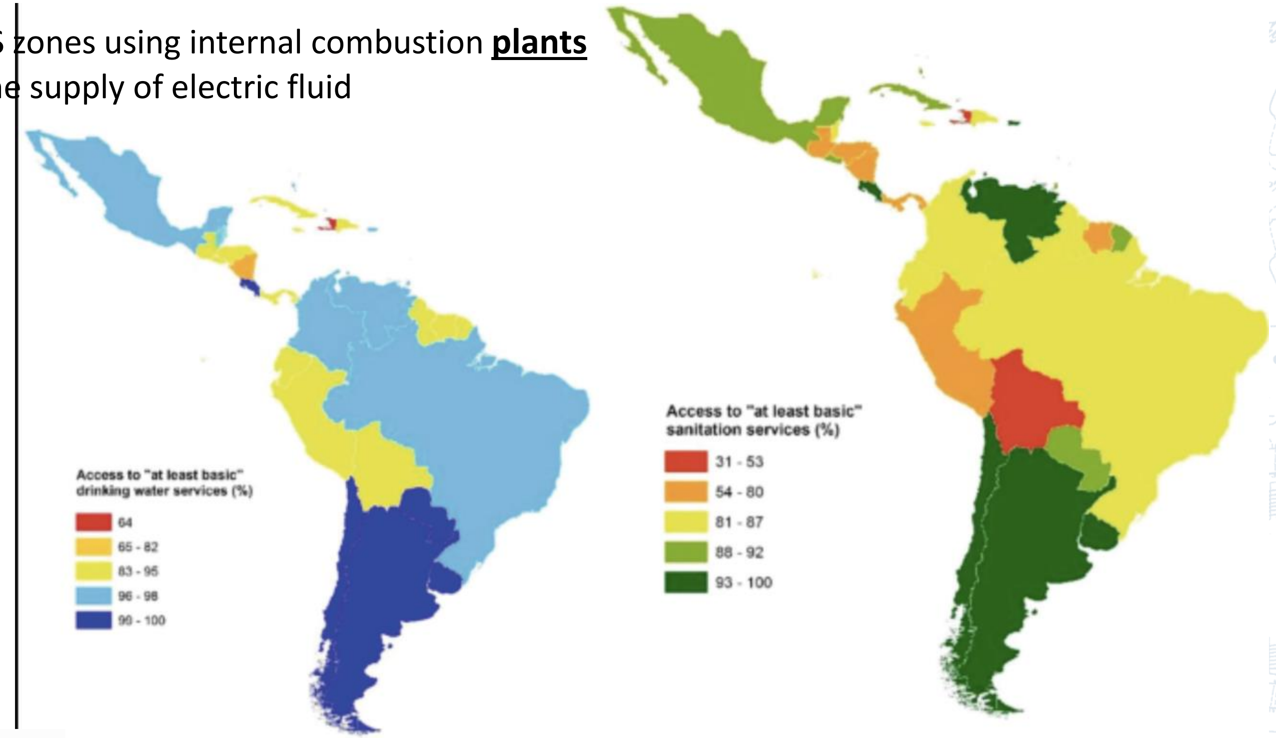
Goal of guaranteeing safe, affordable and clean energy, contemplated in the Sustainable Development Goals (SDGs).


The Objectives of Sustainable Development of Water and Sanitation in Latin America

Teofilo Carlos N. Monteiro, Hildegarde Venero, Rosa M. Alcayhuman & Rodrigo Coelho de Carvalho

Chapter | First Online: 30 June 2022

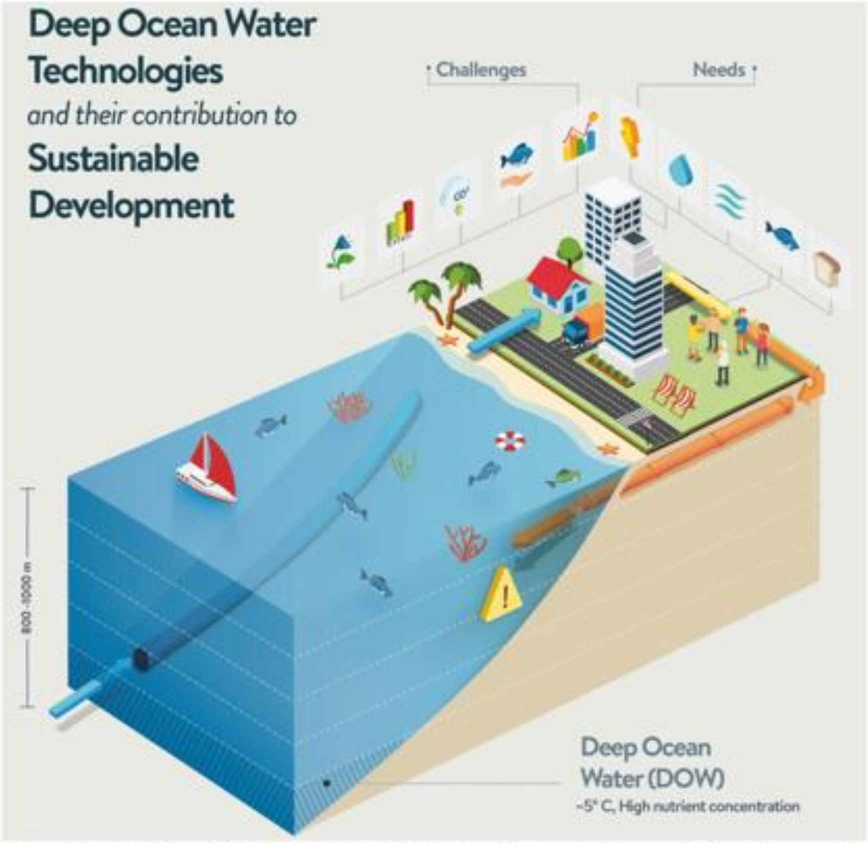
In many ISOLATES zones using internal combustion **plants with diesel** for the supply of electric fluid




Many of these homes without electricity are located in rural and ISOLATES areas where poverty affects the sustainable development – NOT ACCESS to DRINK WATER

# In Isolated Micro-Grids agree with local resources

New Business models –
Blue Economy
Ocean Technology Parks

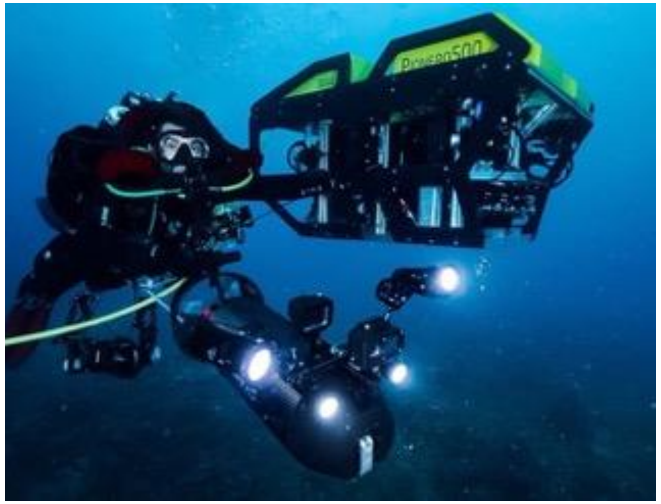


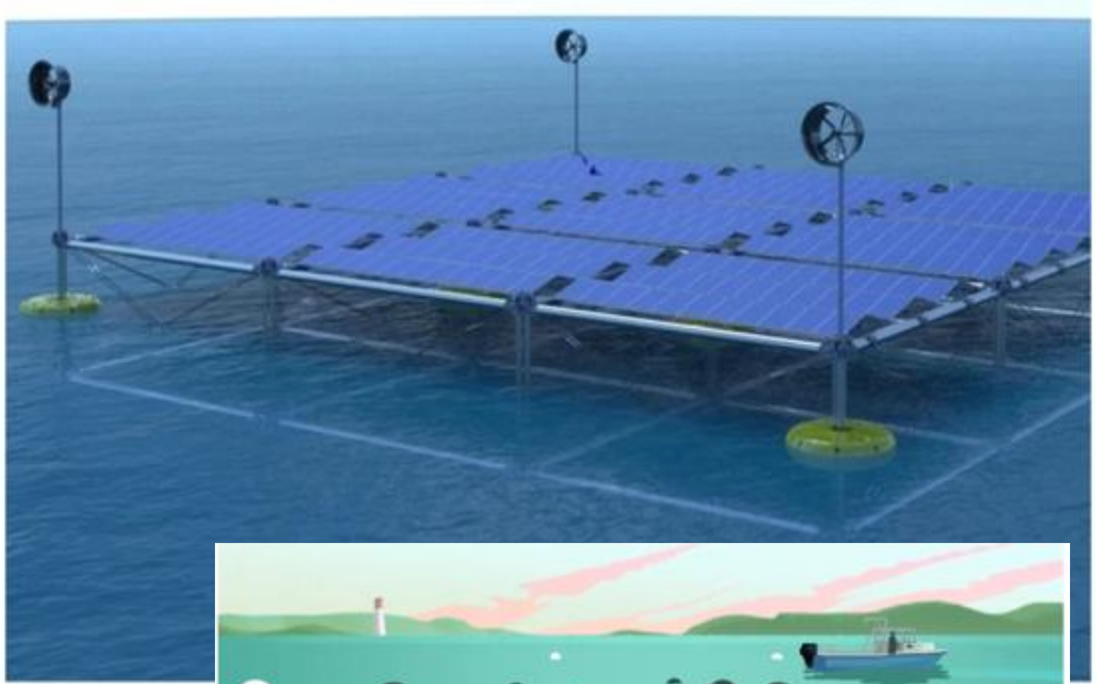

Fuente: Jessica Arias-Gaviria (2019) Deep Ocean Water Technologies and their contribution to sustainable development in the Caribbean. Referencia: Laura Lucia Torres, www.holalula.com

- Energy (IRENA, 2014b)
- District Cooling (SWAC) (Makai., 2011)
- Desalination (Kalogirou, 2005)
- Greenhouse conditioning
- Aquaculture. (Yoza et al., 2010)
- Algae cultivation for biodiesel, cosmetic products, etc.
- Nutrients based industries (pharmaceutic and cosmetic).

# Energy for what? INTEGRATION with Desalination, Aquaculture, Hydrogen…

Policy of tax exemption and suppliers for companies and spin-off (reduce CAPEX and OPEX)



Sinn Power ha co
diversas fuentes


*Still from an animation of GreenWave's general ocean regenerative farming set up. Seaweed, like sugar kelp (Saccharina latissima), hangs from long lines attached to buoys along with scallops and mussels; cages with oysters and clams hang on the seafloor beneath. (Credit: The Water Brothers, all rights reserved)*

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

INTEGRACIÓN EN REDES ELÉCTRICAS IBEROAMERICANAS DE LAS ENERGÍAS DEL MAR
REMAR

PROGRAMA IBEROAMERICANO
CYTED
CIENCIA Y TECNOLOGÍA PARA EL DESARROLLO

Ciemat
Centro de Investigaciones Energéticas, Medioambientales y Tecnológicas

ice

CEMarin
Corporation Center of Excellence in Marine Sciences

# Local Community Science
# Marine Ecosystem Monitoring

## MANGROVES
## Punta Soldado (Btra)
## y Tribugá (Choco)


CORNELL UNIVERSITY FOUNDED A.D. 1865
CONSERVATION, FOOD & HEALTH FOUNDATION

# ¿What about the world and iberoamerican?

22 countries are actively participating in the IEA Ocean Energy Systems (OES) programme. Achievements:

Methodologies to estimate jobs generated by the sector.

Methodologies and cooperation to estimate environmental impact.

Standards for certifying technologies: IEC Technical Committee (TC) 114.

Larger scale projects.

OES OCEAN ENERGY SYSTEMS


# Challenges for Marine Energy - REMAR

Country policy regulation and regional integration

- **Sectorial** Regulation vs **Environmental** regulation

- Policy of **education** to develop and incorporate national capacities .
- Integrate energy solutions with nature-based solutions –
  Carbon Sequestration - **Blue Economy**
  And actively involve **communities in solutions**.
- Policy of **tax exemption** for companies and spin-off
  - Policy of suppliers
- Policies and route map for **energy transition / Green hydrogen / ..**
- Develop real test cases **integrating other needs** (e.g. Desalination)
- Annual REPORTS


# 30 min

# Topics for the debate at the round tables

1. What future trends and challenges in terms of technology of grid integration are coming in the near future related to the marine renewable energies?
2. What environmental challenges do you find related to the marine renewable energies?
3. What changes in government support would enhance the effectiveness of marine energy integration in our region?
4. How are the outcomes of research in marine energy being integrated into local and national policies related to energy transition?
5. Are there any challenges or opportunities identified in aligning energy transition with existing policies?

# Final ideas from the debate at the round table

- The technical issues related to the integration of renewables will be a problem (hopefuly) in a near future. TRL, equipment with more specific characteristics, energy management, coupling with other sectors, … will be key.
- No specific materials or technologies are ready for marine energies or are too expensive.
- In 40 years of marine energy development nobody paid attention to grid integration (at least in some countries).
- The reality of Ibero-American countries (also in other regions) is that renewables integation is not a reality yet.
- Why should government support marine renewable energy beyond other renewables?. Important to increase the energy matrix and some regions or countries have the main resource in offshore areas. Use the strength with other RE.
- Although some countries like Costa Rica have a 100% renewable energy matrix, climate change, transport, industry transformation and increase of population requires a further integration.
- Integration with desalination, aquaculture, hydrogen (Blue economy) in order to reduce CAPEX and OPEX.
- Local communities need to be integrated as part of the question.
- Standarized frame is esential for the marine energies integration. Standards as previous step for regulation.
- Esential participationon in associations – OES and standarization groups (TC-114).
- Coupling with demand control in arquitectura, climatization, …
- Hydrogen has some issues related to social acceptance (ammonia) due to safety. Electrolizers directly connected to RE.
- Regulatory certainty – regulatory path is not still clear.
- Ocean energy not ready for commercialization. Policy strategy can motivate the investors and developers.

# Thank you for your attention


marcos.lafoz@ciemat.es

RRojasM@ice.go.cr

afosorioar@unal.edu.co