ENERMAC
Energías Renovables y Eficiencia Energética
Desarrollo Sostenible de África Occidental e Islas de la Macaronesia

MAC 2014-2020 Cooperación Territorial

Interreg

Blue Economy:

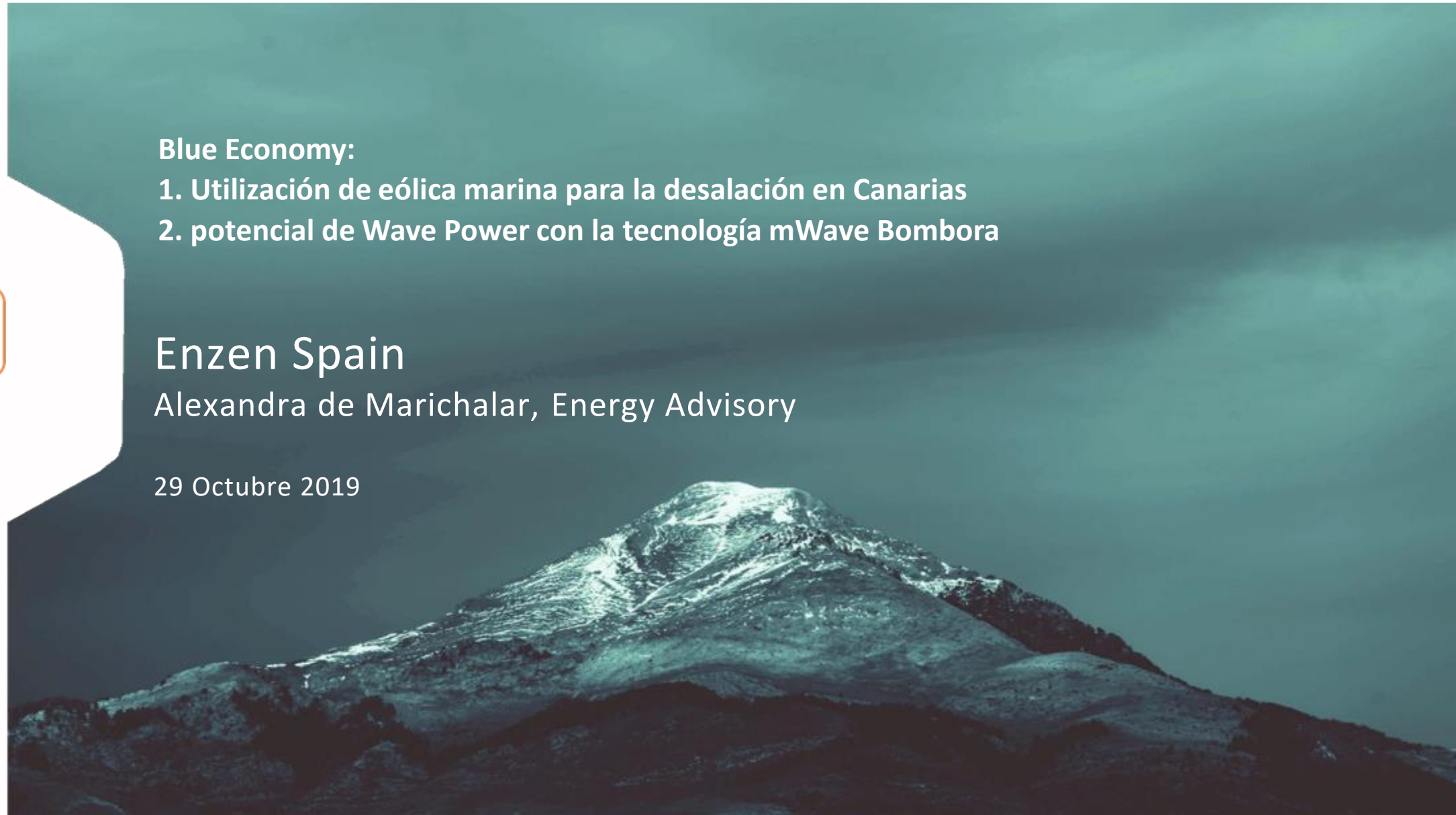
1. Utilización de eólica marina para la desalación en Canarias

2. potencial de Wave Power con la tecnología mWave Bombora

Enzen Spain

Alexandra de Marichalar, Energy Advisory

29 Octubre 2019



An Exclusive Energy, Water and Renewables Expert

Power

Power generation (Coal, Hydro, CCGT)

Transmission & Distribution

Retail/Supply

Water

Desalination, Fresh and waste water treatment

Distribution

Retail/Supply

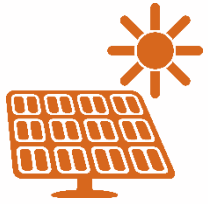
Oil & Gas

Gas production, Primary transport, Interconnectors

LNG Terminals Transmission & Distribution

Retail/Supply

Renewables



Standard wind and solar PV

Concentrated Solar Power

Geothermal

Offshore wind

Storage

Bio-fuels

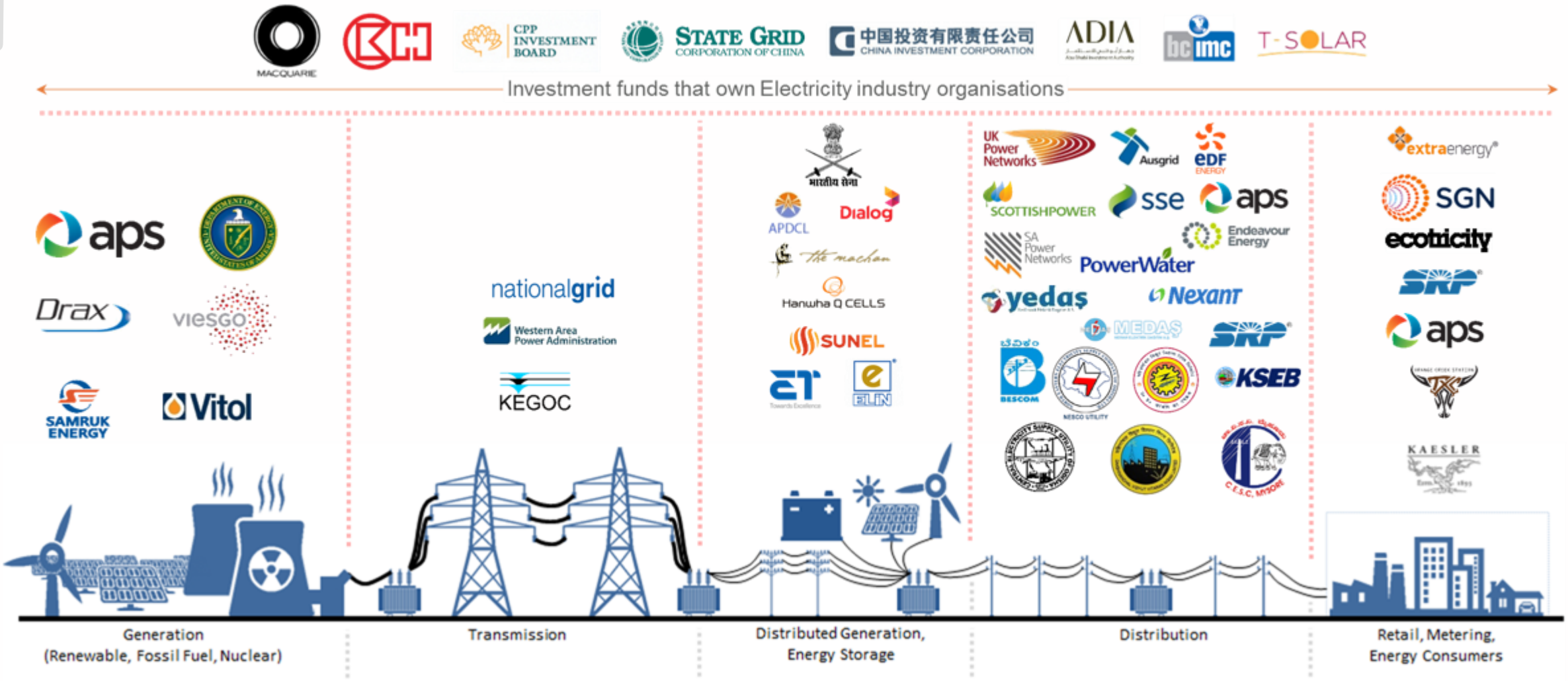
Our Global Presence

Established offices

- UK
- Spain
- India
- USA
- Australia
- Turkey
- Kazakhstan
- Middle East

Our extended portfolio supports outcome delivery

Enzen in Electricity Business



Strategy for Renewable Energy Integration

Based on the collaboration agreement signed between Enzen and the Cabildo de Lanzarote in May 2018 Enzen is developing offshore renewable energy projects

This collaboration agreement is the result of detailed discussions around delivering Lanzarote's 2020 -2040 strategy. It works towards achieving the key objectives of this strategy: achieve a model of development of the island by delivering a balance between the economic, social and environmental concerns.

Wave Power Generation will be developed based on the technology of the Australian company Bombora Wave Power part of Enzen Group

Floating Offshore Wind Pre-commercial Project in the South of the island

Expecting a high-rapid growth in Renewable energies

Over the past 10 years industry experts have been consistently upgrading renewable capacity forecasts. Since 2011-2016 energy bodies (IEA,EIA) and renewable-specific bodies (GWEC, GSC) have been raising their 2030-2035 targets by 100%-200%.

The reasons for this continuously increase in RES capacity are:

1. **The rising support from policies**

- EU has published 2030 targets and is now working towards an 80-95% reduction in greeenhouse gas emissions by 2050.

Emission reduction targets (Eurostat, Goldman Sachs)

Source: Enzen Spain, Goldman Sachs (201

2. The strong decline in cost and an improved supply chain/manufacturing process

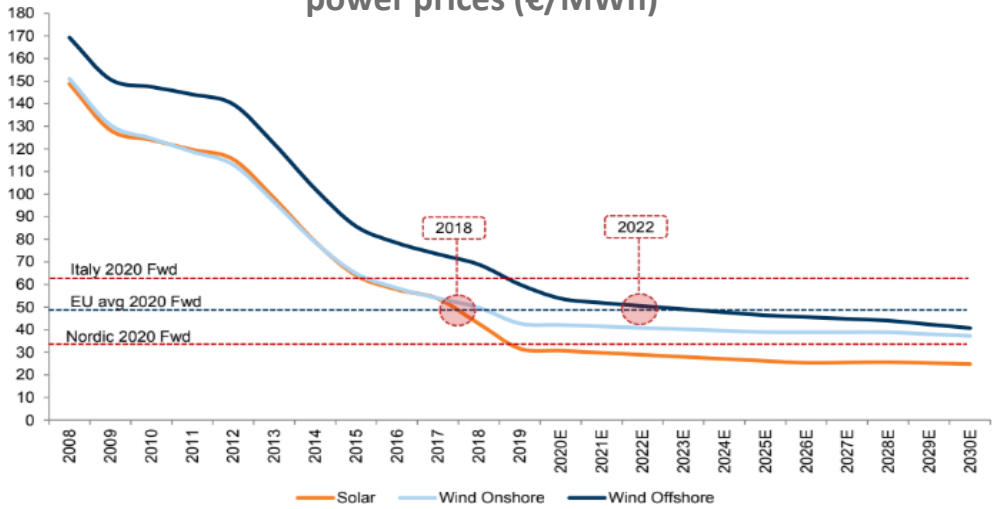
	LCOE €/MWh		
2009	Wind and Solar		
	150-200		
2019	Solar	Onshore Wind	Offshore Wind
	20-30	30-40	45-50

3. The ability to develop capacity under alternative methods

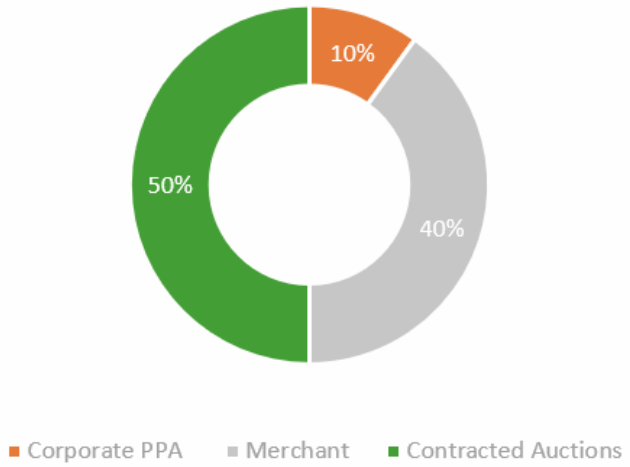
Until now most wind/solar developed has been on the back of (government run) auctions.
Rising relevance of:

- Corporate PPAs
- Merchant

Solar, onshore and offshore LCOEs (GSe) vs European forward power prices (€/MWh)



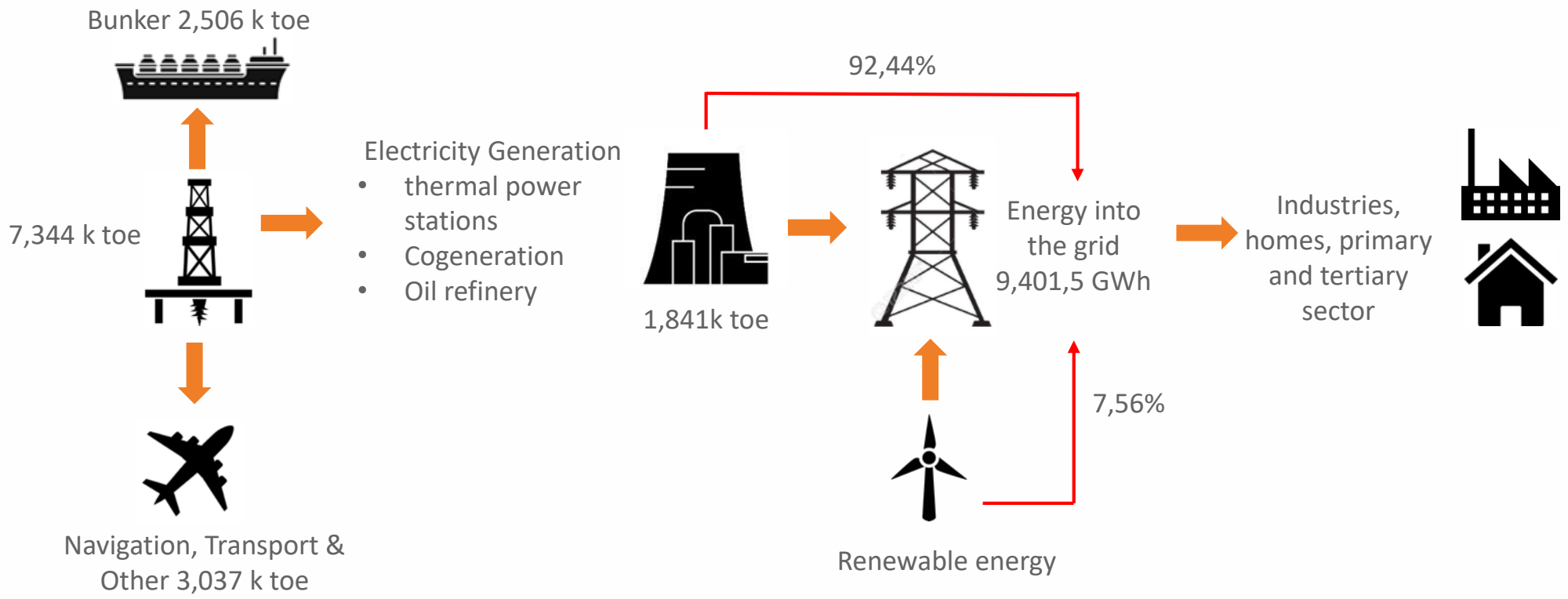
Renewables additions breakdown in Spain between 2020 and 2030



Source: Enzen Spain, Goldman Sachs (201

CANARY ISLANDS

Current Energy Generation Mix in the Canary Islands



- Currently imported oil accounts for 98% of total primary energy in the archipelago and 92,44% in electric power generation.
- The average yearly generation cost in the Canary Islands in 2017 was close to 200 €/MWh. Fossil fuels are Governmental subsidized for the final consumer to have the same price as in the mainland).
- High fuel consumption: 7,344 k toe/ year
- Low level of energy self-sufficiency

Source: Enzen Spain, Gobierno Canarias (2

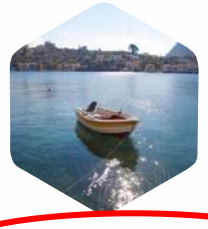
What is The Blue Economy?

- The Blue Economy comprises economic activities that directly take place in the ocean and seas,
- Taking full advantage of ocean´s potential to power sustainable development
- Development of Blue Economy should be accompanied by intelligent management protection of coastal and marine resources.
- An effective Blue Economy strategy must seek to leverage the Island largest resource base, the surrounding ocean.

Ocean Energy

Off-shore wind farms
3,589 turbines
12,631 MW capacity
150,000 jobs

Coastal & Maritime Tourism



Revenue 75 bill €

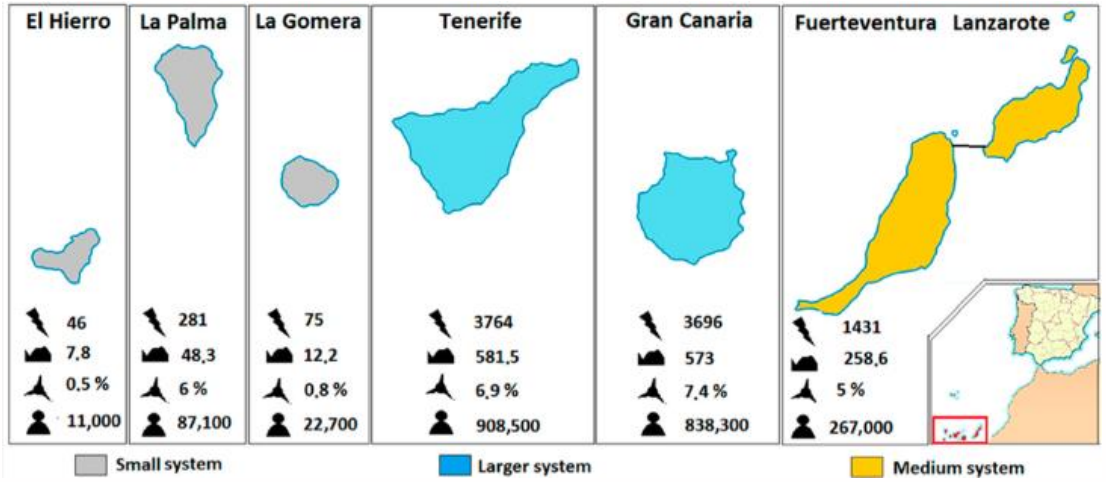
Socio-Economic and Environmental impact of FOW

A Blue Economy should target a balance between the three pillars , economic and social development and environmental protection.

- The Canary Islands can become an innovation hub and a world-reference location for FOW
- Attract investors
- Creation of knowledge centers
- Direct and indirect job creation (research, project management, installation, O&M, decommissioning of the turbines etc.)
- Increase the exchange of know-how
- Boost the local industry
- Creation of professional networks that will improve the information exchange
- Development and support of the supply chain locally
- See the Canary Islands as a platform to chase after some of the more progressive and innovative funding mechanisms

Challenges of penetration of FOW in an Isolated System

Feature	Integrated System	Isolated System
Size of the electrical system	Large	Small and fractioned
Availability of renewable energetic resources	Medium	Very high
Relative capacity of energy storage	Low	Large
Need for flexibility in the electrical system	Medium	Large
Access to fossil fuels	High in natural gas and petroleum	High in oil (refinery) Low in natural gas (liquified only)



- The effect of an imbalance between production and consumption has a greater effect on the frequency of small size isolated grids.
- Smaller systems are more vulnerability to the consequences of outage
- High costs of standby generation
- High system losses
- Reduced reliability

- **Energy consumption (GWh),**
- **Maximum annual peak power (MW),**
- **Renewables share**
- **Population in the Canary Islands**

Source: Canary Island Energy Strategy

Case Study Lanzarote: Desalination as an alternative source of demand

Background Info:

The number of desalination plants in the Archipelago is estimated at 319, with a total production capacity of drinking water, exceeding 660,000 m3 / day as a whole.

75,000 m3/day of water are needed to supply 70%-80% of Lanzarote's population. For a water demand of 75,000 m3/day the pumps consume 11,7 GWh/year

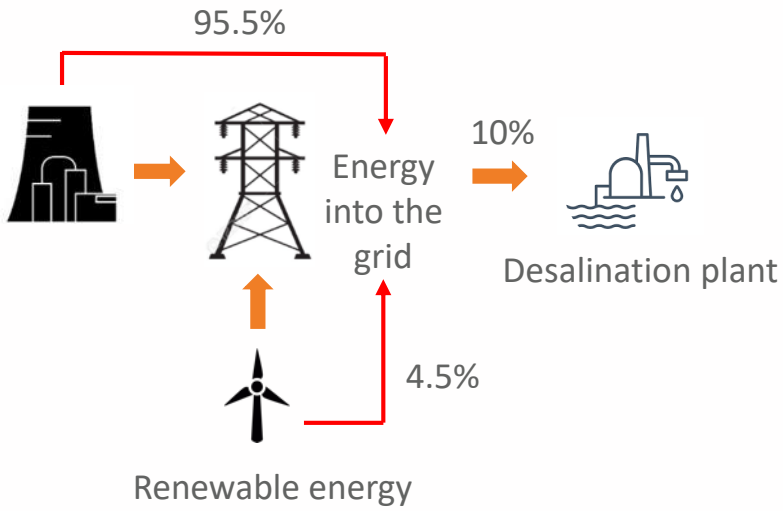
Until 2017 100% of the drinkable water in Lanzarote was produced by the desalination plants which consumed almost 10% of the grid-connected energy.

When looking at the existing energy system it was found that in terms of carbon footprint the desalination plant was a major focus for the Government.

The government's holistic view of a renewable generation system included the desalinating plant as a crucial part of the system that had to be decarbonised.

Renewable integrated system:

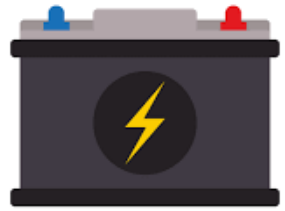
- **Wind turbines (onshore or offshore) can partially supply the power required to run the desalination plant reducing carbon emissions.**
- As we go through a greater degree of renewables the uncertainty to match the customer's demand is greater.
- Storage and flexibility have to be part of the solution in order to achieve a 100% renewable integrated system.



Case Study Lanzarote: Desalination as an alternative source of demand

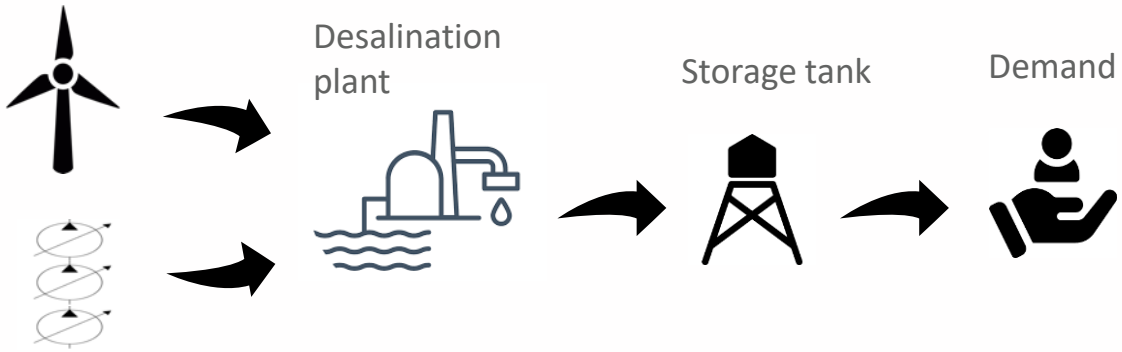
Potential Solutions:

- Up to date there were two wind turbines, total of 4,6 MW, connected to internal Grid of the Plant.
- The desalinization plant has a constant production of fresh water 2.5 kW/m3 and a constant consumption of 12 MW
- If the plant desalinates water at off peak times this can later be stored on water tanks and demand can be reduced on the system during the peak times - the water tank acts as a battery-.
- Instead of using batteries (due to cost and and efficiency losses) to store the excess power generated a water tank can be used on the same manner to achieve the goals of flexibility and meeting the customer's demand.

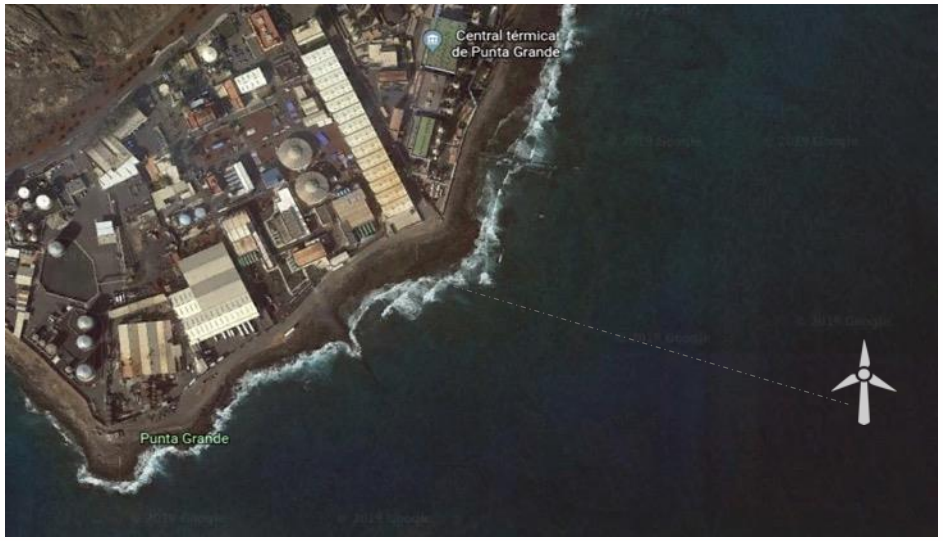


If 2.5kW/h is needed to desalinate $1m^3$ of water.
A 400 m^3 water tank would act as a 1MW/h battery.

Production using FOW



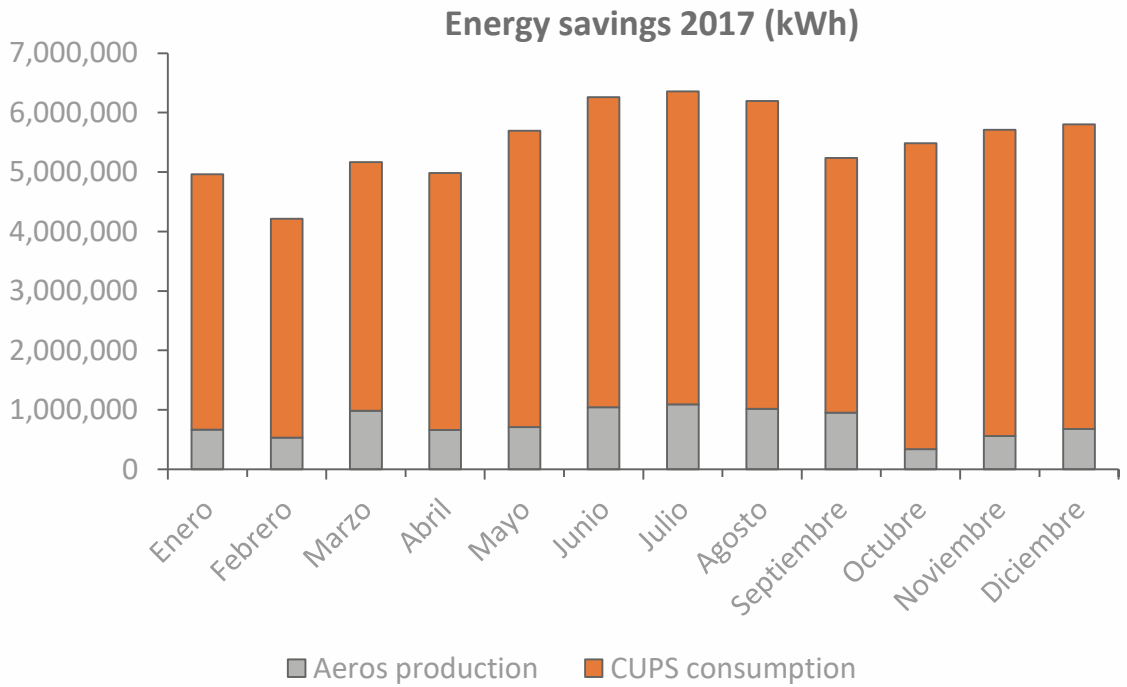
Desalination plant Punta Grande

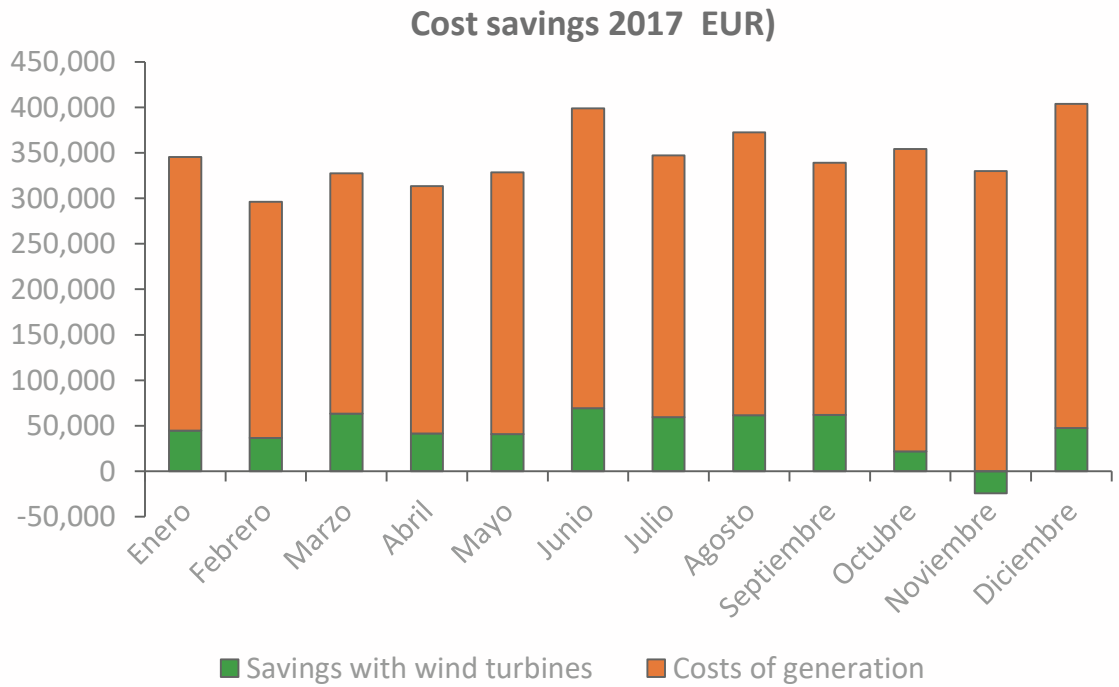


Case Study Lanzarote: Desalination as an alternative source of demand

Potential Outcomes:

- Before it was a one way system in which generation followed demand
- Now demand can be controlled thanks to the deposit and a properly dimensioned wind farm
- Example of Making use of the local renewable generation to help balance supply and demand resulted in benefits such as:
  - reduction of 4.200 tones of CO_2 each year
  - 16% of energy savings
  - 15% cost savings

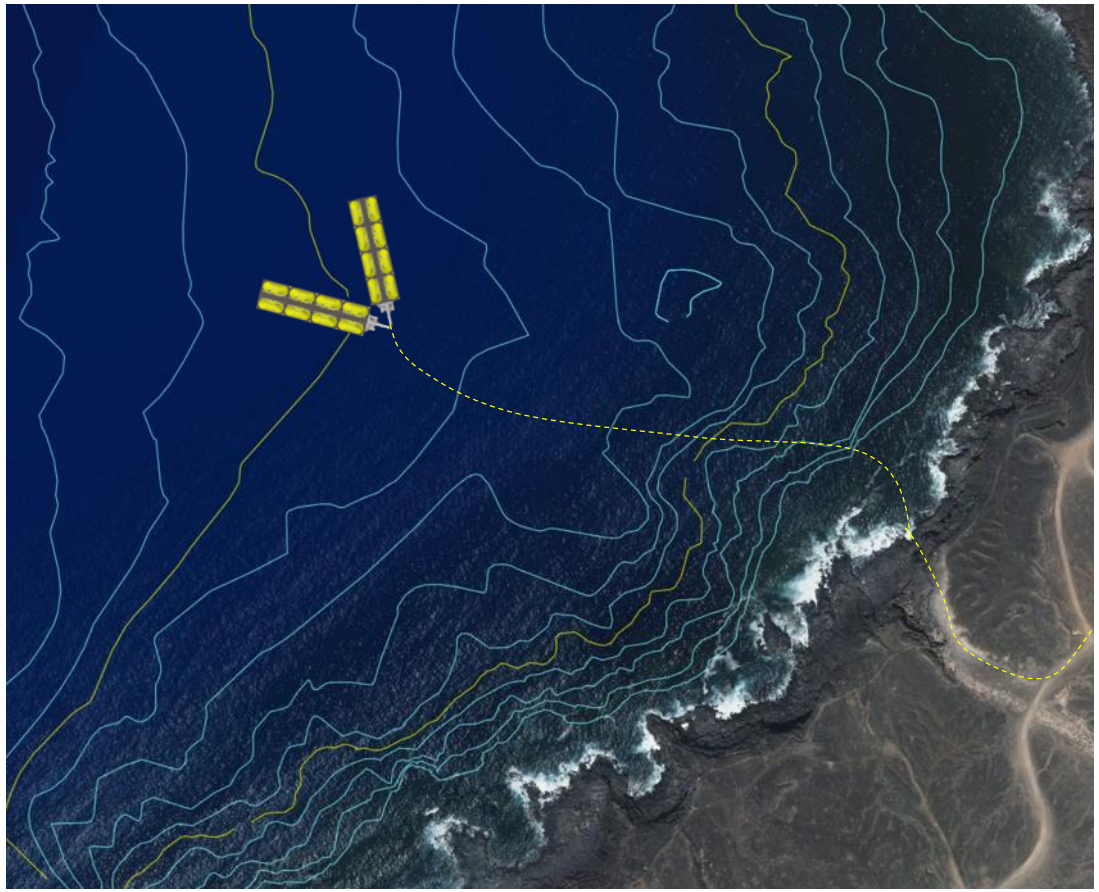




Bombora Wave Power Enzen

mWave Power Project Lanzarote

Lanzarote Wave Park Project



2MW **28kW/m** **North of Lanzarote**

- First grid connected mWave project
- First multi-leg mWave deployment (scalability)
- Alternative to existing diesel power generation

- Framework Agreement between Enzen and Cabildo de Lanzarote
- Consortium team members assembled
- Survey campaign in progress

The Technology mWave Bombora

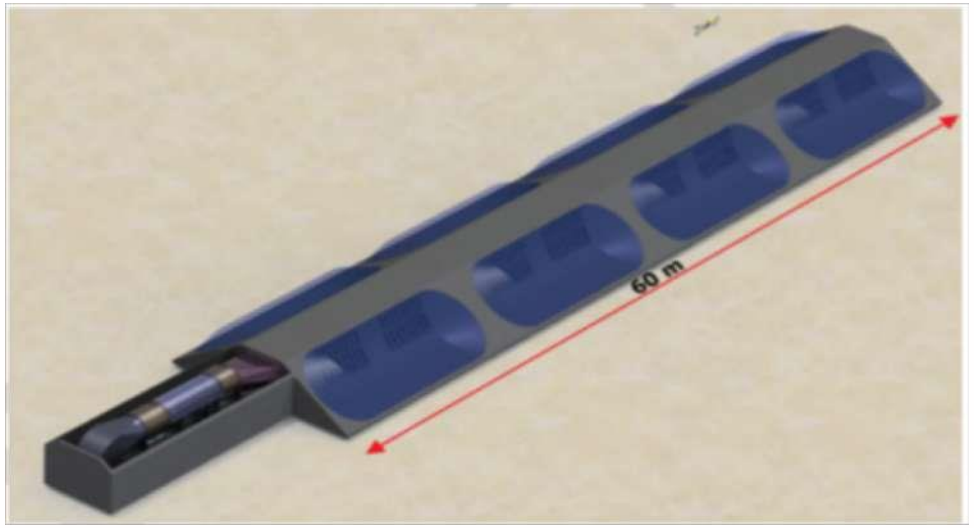
mWave Bombora:

Part of Enzen Group is a company with a long history and proven experience in the marine renewable sector.

Bombora received in 2017 a GBP 10.3 million Grant from the European Regional Development Fund for the technology demonstration in UK.

Simple and Zero Emissions Technology:

Tilted membrane captures wave energy, there are no complex systems.

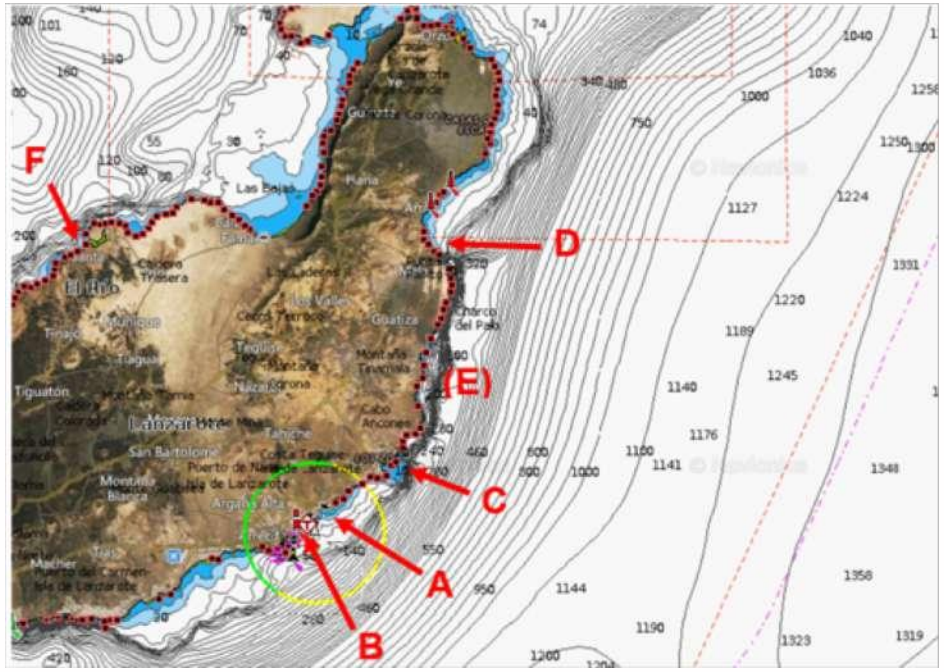


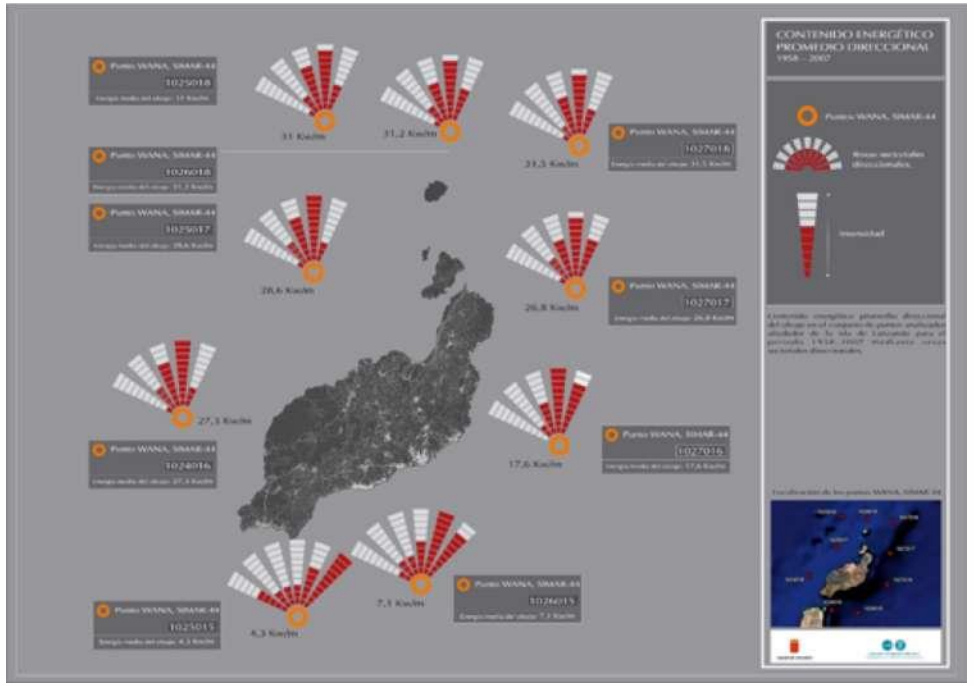
Ecological system:

Working in harmony with ocean eco-systems. No visual impact and no disruptive. Smart combination of simple components with intelligent controls

Capacity (per unit) of the prototype 1, 5 MW

Pre-feasibility Resource Appraisal





Site	Estimated Resource kW/m	Potential Installed Capacity MW	Comments
A	10		Closest to HV grid connection
B	10		Existing breakwater could reduce cost
C	10		
D	17	11	
Northern Site	28	22	Grid connection required to electricity distribution network

Product and Market

2007-2014

Product Development (Wave Tank)

TRL 1-3

2015-2016

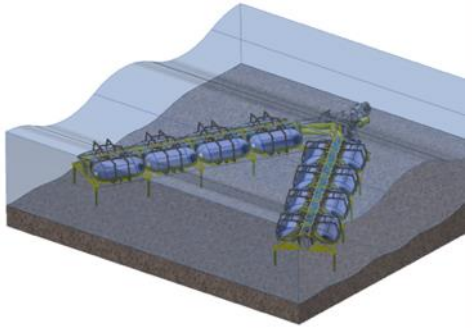
Part Scale Product Validation (Estuary)

TRL 4-5

2017-2020

Large Scale Product Validation (1.5MW Ocean Trial)

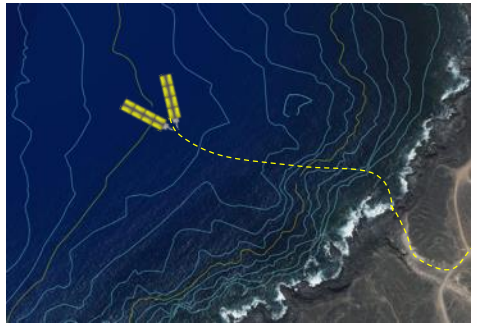
TRL 6-7

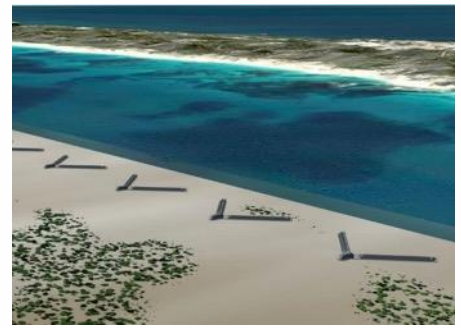


2020-2022

First Wave Farm Deployment (Lanzarote)

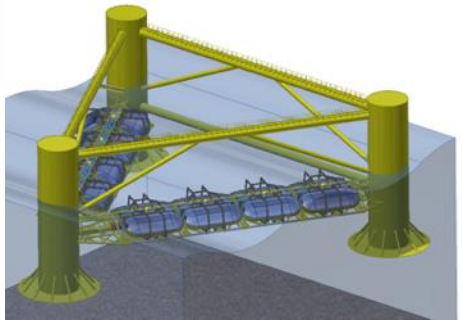
TRL 8-9





2022+

Commercial Wave Farm Deployment



Social Impact

Student lectures and engagement programs

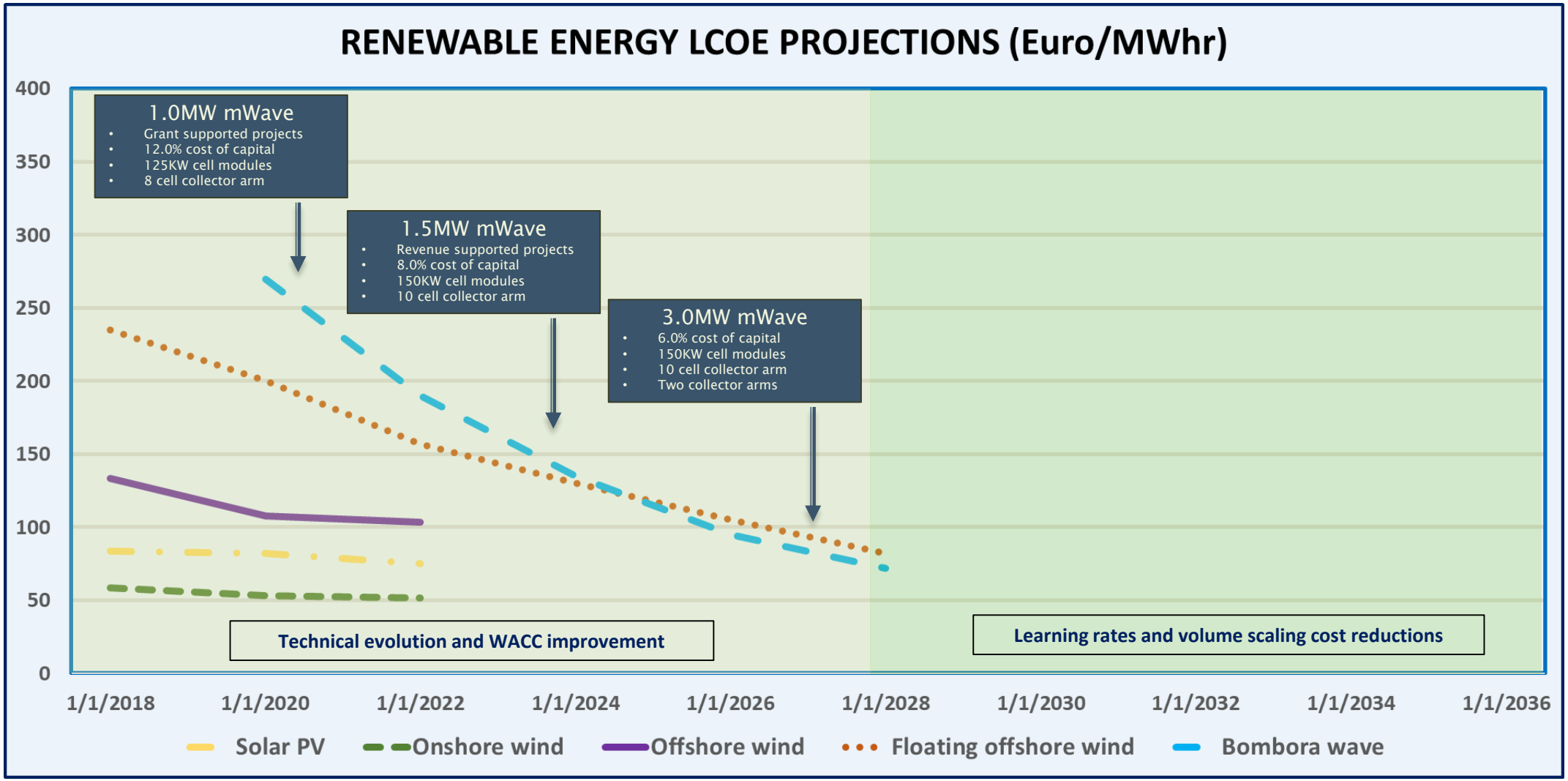
University research linkage programs

Local industrial engagement and apprentice opportunities

Student internships (IST Masters Programmes)

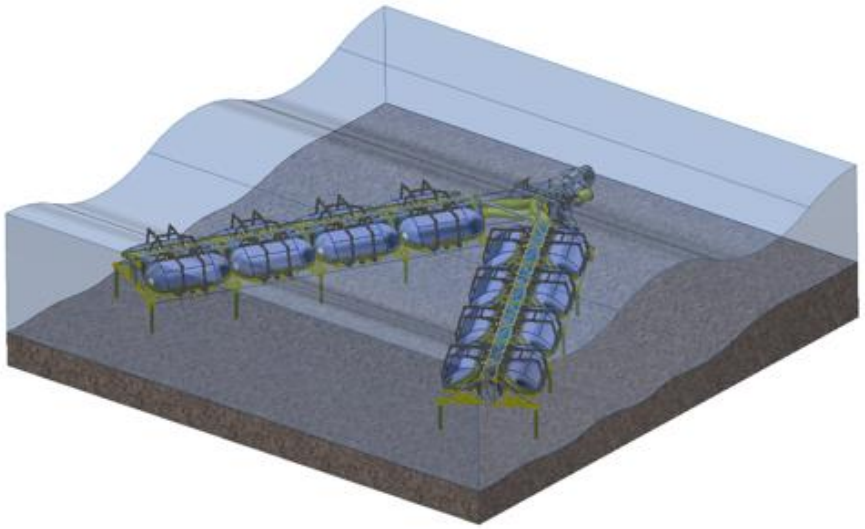
Test facility collaboration opportunities

Expected LCOE Reduction

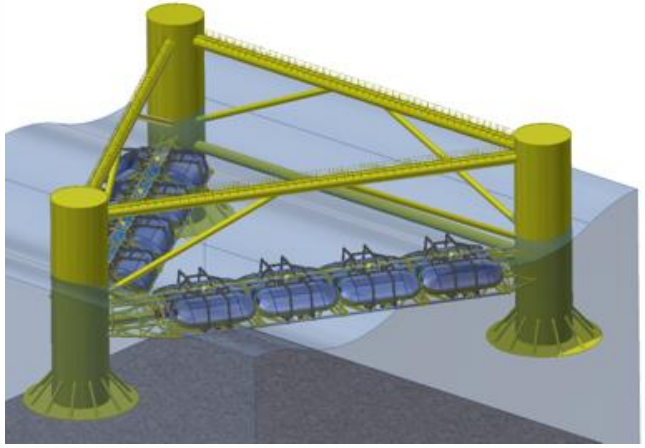


Product and Market

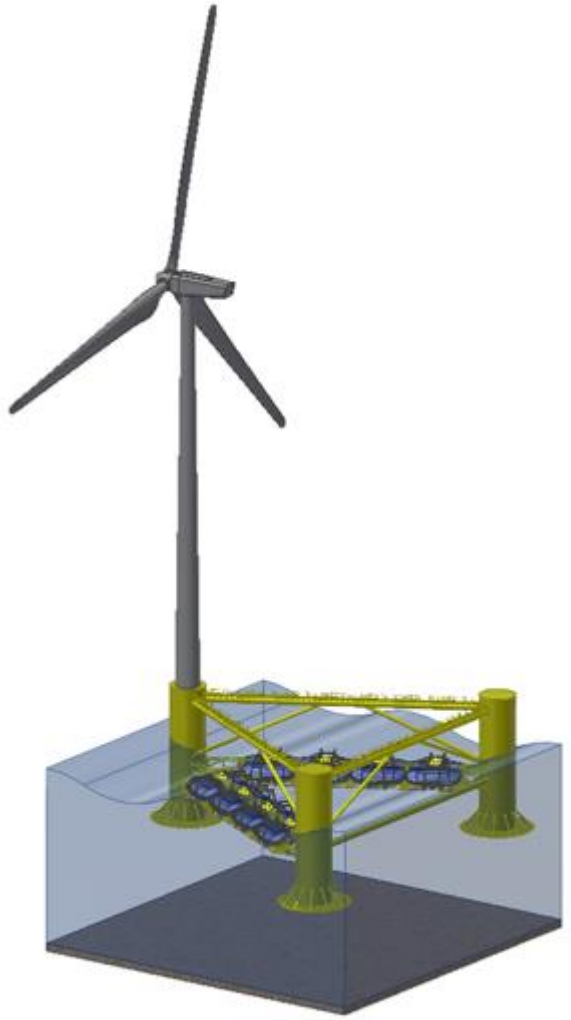
mWave Cell Module



Fixed near shore



Floating offshore



Floating wave & wind

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