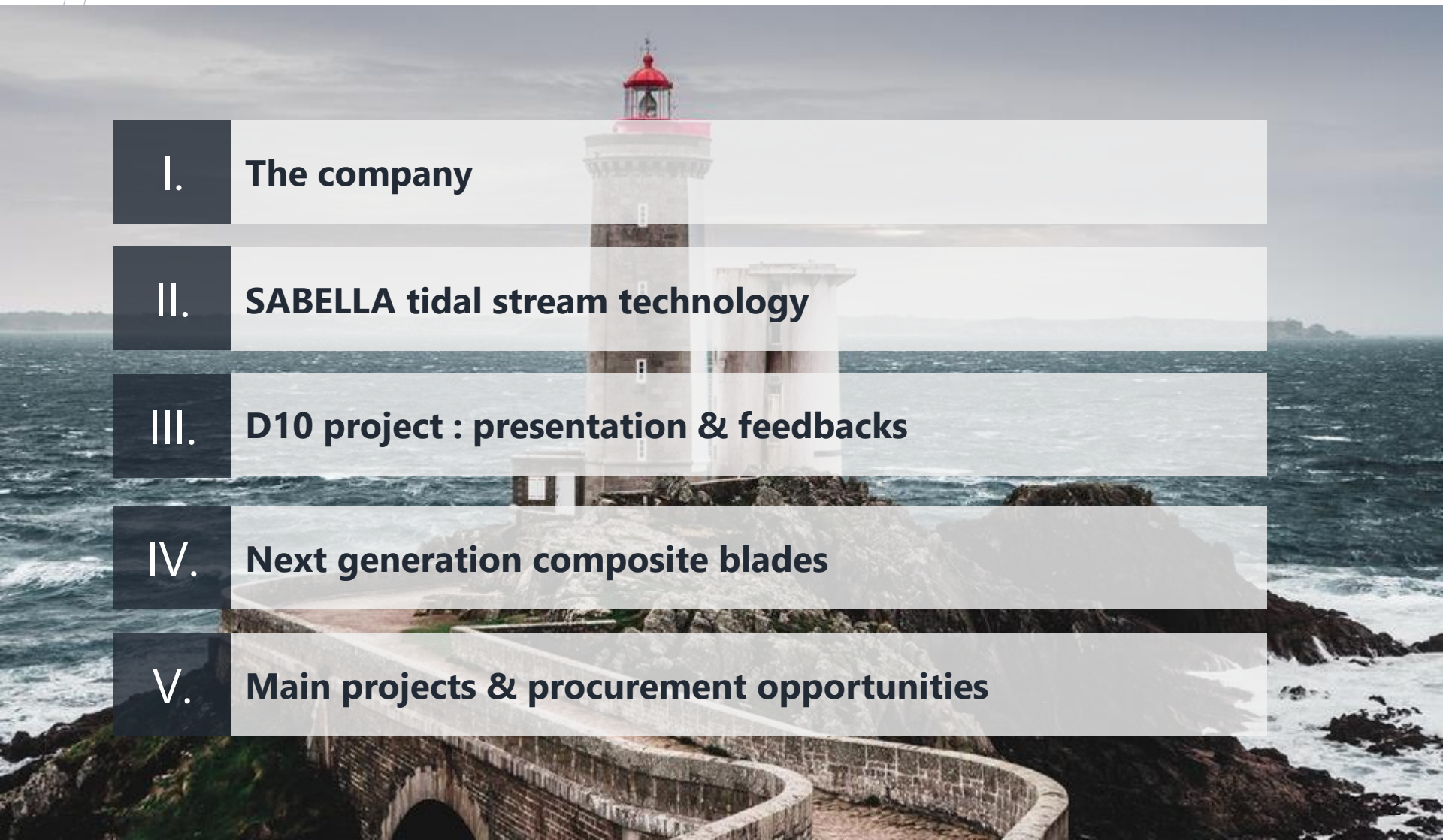
sabella
ride the tide

HARNESSING TIDAL STREAM POWER FOR

A MORE SUSTAINABLE FUTURE

Interreg
EUROPEAN UNION
France (Channel Manche) England
TIGER TIDAL STREAM INDUSTRY ENERGISER

SUMMARY



I. The company

Driving force of the energy transition, 10 years of experience in ocean energy

2008 | D03-30
1st tidal turbine installed in France during 12 months

2015 | D10-1000
1st tidal turbine to supply electricity to the French grid

Key facts

- Created in 2008
- 25 employees
- EPCI (Engineering, Procurement, Construction & Installation)
- ISO9001 certification
- 100% owned subsidiary in Canada (HYDRO-SAB)
- Indonesian consortium (MPS)
- Turnover: €1 million
- Shareholding structure: 25% of industrials, 50% of financials, 20% of founders, 5% of management

II. SABELLA tidal stream technology

A cutting-edge technology for a differentiated solution

Direct drive generator with permanent magnets

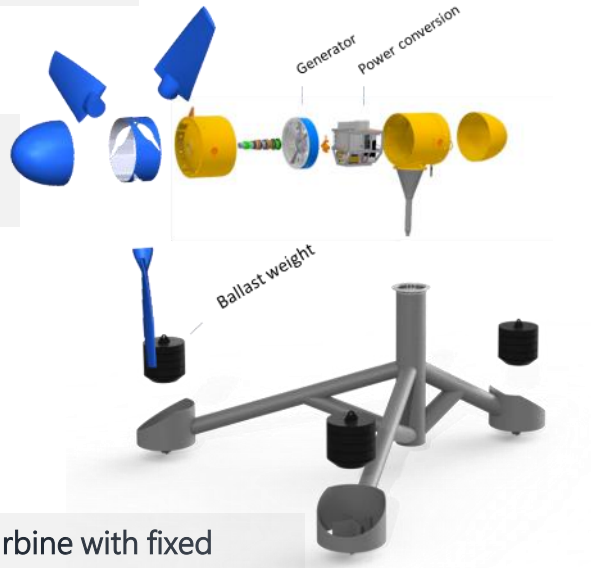
No wearing parts

Onboard conversion chain and transformation with complete redundancy

Increased reliability in case of component failure

Low rotation speed

Marine life friendly



Modular architecture

Installation and O&M costs reduction

Horizontal axis turbine with fixed symmetrical blades and no yaw system

Improve yield, proven design and ruggedness

Gravity-based support structure with ballast weight

Environmental impact

II. SABELLA tidal stream technology

A complete product family to fit with local site characteristics

A range from medium to high power devices

- Rotor diameter depending on available water depth
- Rated power according to marine stream velocity

Main advantages

- Standardized sub-part to benefit the **volume economy** and ease the industrialization
- **Up to 25 meter diameter**
- Gravity-based or monopile foundation
- Rated power **from 250 kW up to 2 MW**

D08-250
Rated speed @ 3 m/s

D10-500
Rated speed @ 3,2 m/s

D12-500
Rated speed @ 2,8 m/s

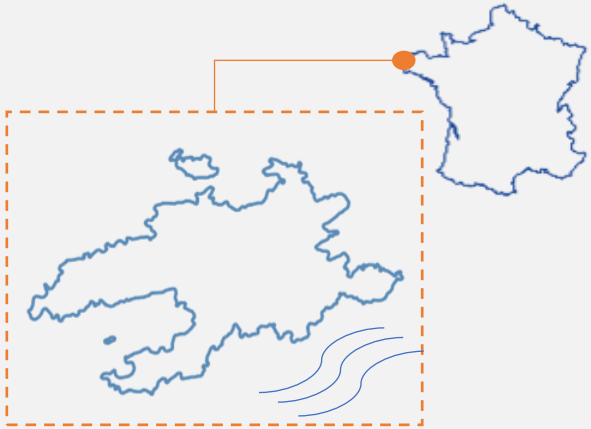
D12-1000
Rated speed @ 3,6 m/s

D16-1000
Rated speed @ 2,9 m/s

D25-2000
Rated speed @ 2,75 m/s

III. D10 project

Ushant: insular, off-grid and autonomous



Ushant island
900 inhabitants – 4 Diesel power gensets,
Peak consumption 2 MW
7,000 MWh/year – 2 millions litres of fuel per year

SABELLA's projects on this island
3 steps from a first deployment in 2015 to the establishment of a tidal turbines array in the Fromveur Passage:

- 55 meters deep
- 2 km off the shore
- Up to 4.5 m/s (9 knots) current velocity

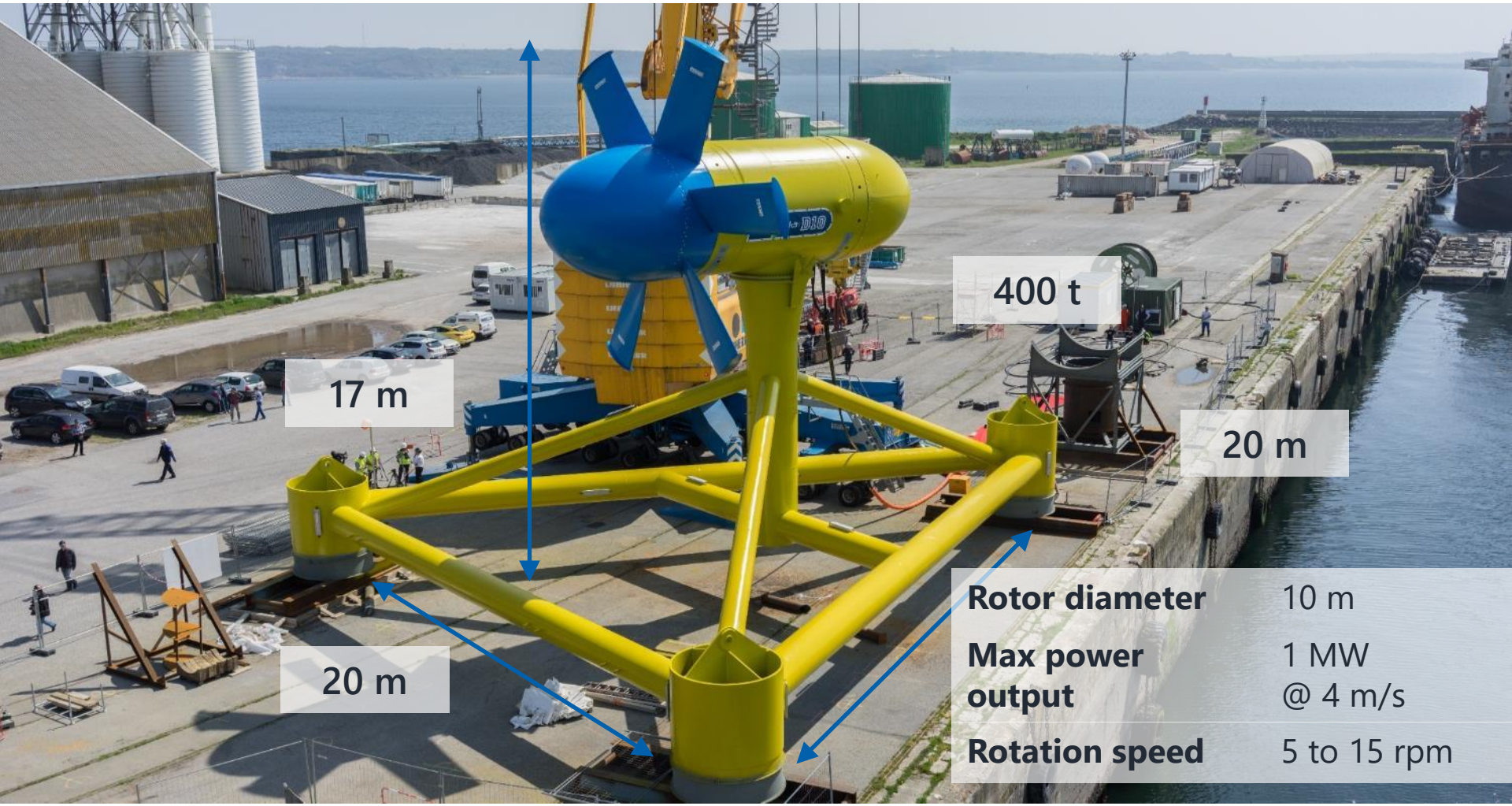
Step 1: D10-1000 mechanical and grid integrity and environmental compatibility ✔

- Supported by the French government and Brittany region
- 1 MW device of 10-meter rotor diameter
- 2015: deployment in the Fromveur Passage and **connection to the electrical network of Ushant Island,** a weak and fragile off-grid network
- **Operation and monitoring** of the turbine during the 12-month authorized period

Environmental compatibility and operability assessed during the operations

III. D10 project

Ushant: insular, off-grid and autonomous



Rotor diameter	10 m
Max power output	1 MW @ 4 m/s
Rotation speed	5 to 15 rpm

III. D10 project

D10 blade design & manufacturing

- **Blade design**
  - **Symmetrical profile** (elliptic) and constant chord
  - Validation of performances with **CFD** and **tank tests**

- **Blade manufacturing**
  - **Monolithic carbon** fiber composite
  - 3 main éléments : spar, blade shape, winglet
  - Fixed to the hub with **steel flange**
  - 2 process used : **pre-preg** for spar, **infusion** for blade shape

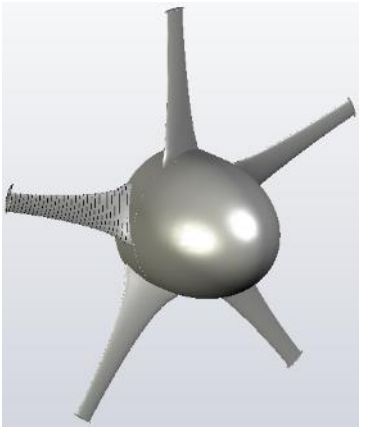
- **Monitoring**
  - **strain gauges** linked to data loggers installed by IFREMER

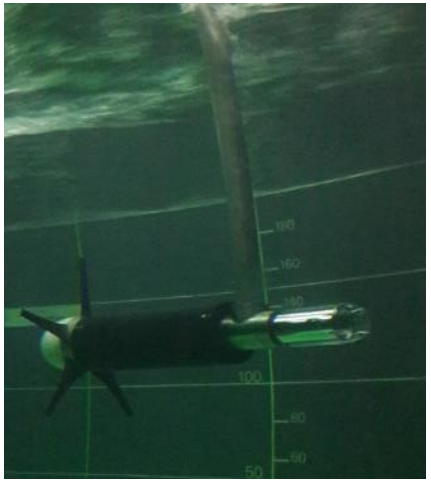
- **State of the art & Feedbacks**
  - **Lack of knowledge** on real **environmental conditions** and on the **behaviour of composites in underwater environments**
  - **Absence of design standards** dedicated to tidal devices
  - Independent design process for the composite blade and the steel flange: difficult convergence at the interfaces, assembly process not adapted to a higher manufacturing volume.

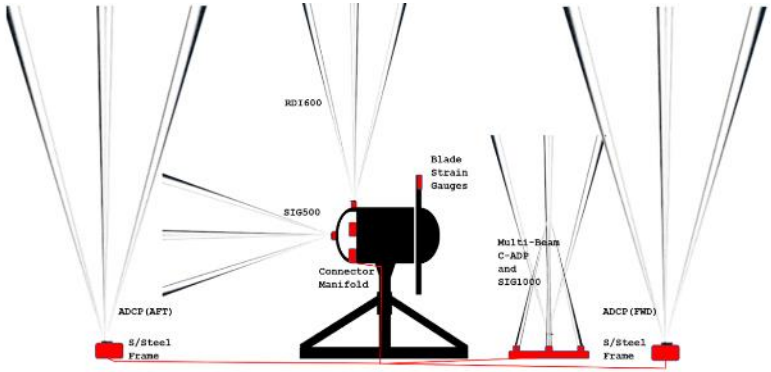
IV. Next generation composite blades

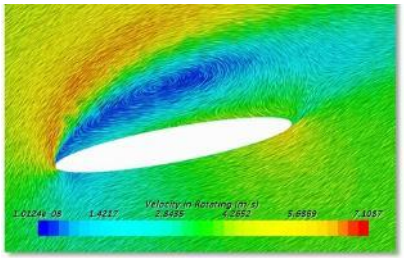
R&D activities for blade design improvement

- Blade shape optimisation using **BEMT tools**
- Validation of performances with **CFD and tank tests**
- **Refined measurement campaign** and study of environmental conditions in Fromveur Strait, including turbulences
- **Analysis of dedicated standards** for load cases definition (IEC 62600, BV NI603, DNV-GL ST0164) for optimisation of safety factors





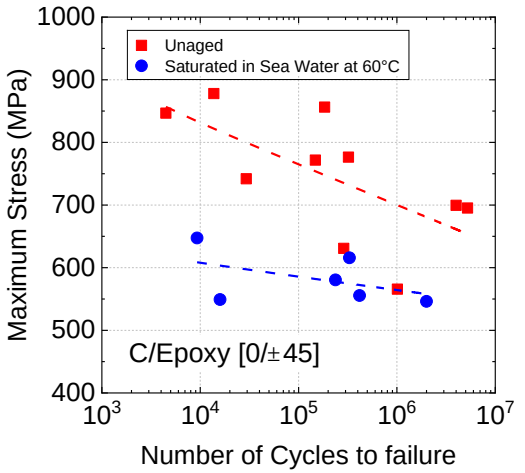




IV. Next generation composite blades

R&D activities for blade design improvement

- **Characterisation of composite behaviour** in underwater environment (IFREMER)
- **Integration of blade fixation** in balade root (inserts in composite)
- Works on **new manufacturing** process to reduce blade cost
- Works on new monitoring methods using **fiber optics** and **cracks detection system**



IV. Next generation composite blades

Next steps

- Characterisation of impact of turbulences on **fatigue behaviour** for composite
- Characterisation and use of **new composite materials**, included « eco-friendly » materials (recyclable/bio-sourced materials)
- **Industrialisation process** for composite blade manufacturing
- Integration of **monitoring systems** in composite

➢ **Reduce cost of blades for tidal turbines**

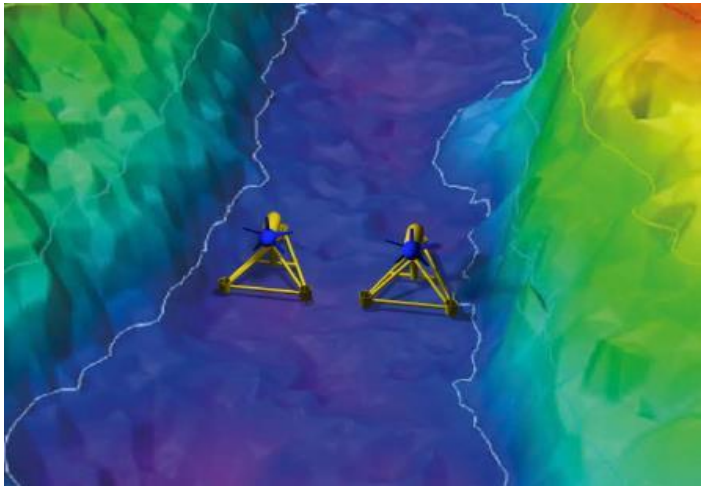
➢ **Improve reliability of composite blades for tidal turbines**

V. Main projects
Morbihan Gulf

Interreg France (Channel Manche) England
TIGER TIDAL STREAM INDUSTRY ENERGISER

Step 1 : TIGER project 2 x D08-250 – Site development and innovation ✔

- Project 60% financed by the **INTERREG Channel** Programme
- **Pilot farm of 2 tidal turbines (250 kW unit power) connected to the onshore grid** and coupled to hydrogen production units
- **Commissioning planned for 2022**, one year's experimentation as part of the TIGER project, then operation for 20 years.
- Integration into the energy mix of the Gulf region for autonomous and carbon-free production
- **Procurement opportunities :**
    - Composite blade design for 8 m diameter rotor
    - Composite blades supply (2 sets of 3 blades)
    - Composite hydrodynamic appendices supply (2 sets of 2 bulbs)



V. Main projects
Morbihan Gulf

Step 2 : Ile longue project 18 x D08-250 – Commercial phase ✔

- **farm of 20 tidal turbines (250 kW unit power) connected to the onshore grid** and coupled to hydrogen production units
- **Commissioning planned for 2026,** operation for 20 years.
- **Procurement opportunities :**
  - Composite blades supply (18 sets of 3 blades)
  - Composite hydrodynamic appendices (18 sets of 2 bulbs)

Step 3 : Berder project 20 x D08-250 – Commercial phase ✔

- **Additional farm of 20 tidal turbines (250 kW unit power) connected to the onshore grid** and coupled to hydrogen production units
- **Commissioning planned for 2030**, operation for 20 years.
- **Procurement opportunities :**
  - Composite blades supply (20 sets of 3 blades)
  - Composite hydrodynamic appendices (20 sets of 2 bulbs)

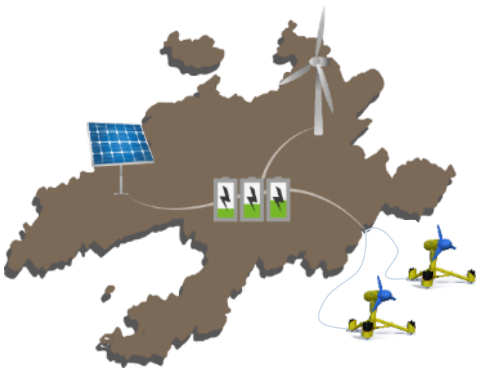
V. Main projects

Ushant: insular, off-grid and autonomous

Step 3: PHARES – 2 tidal turbines – Commercial phase ✔

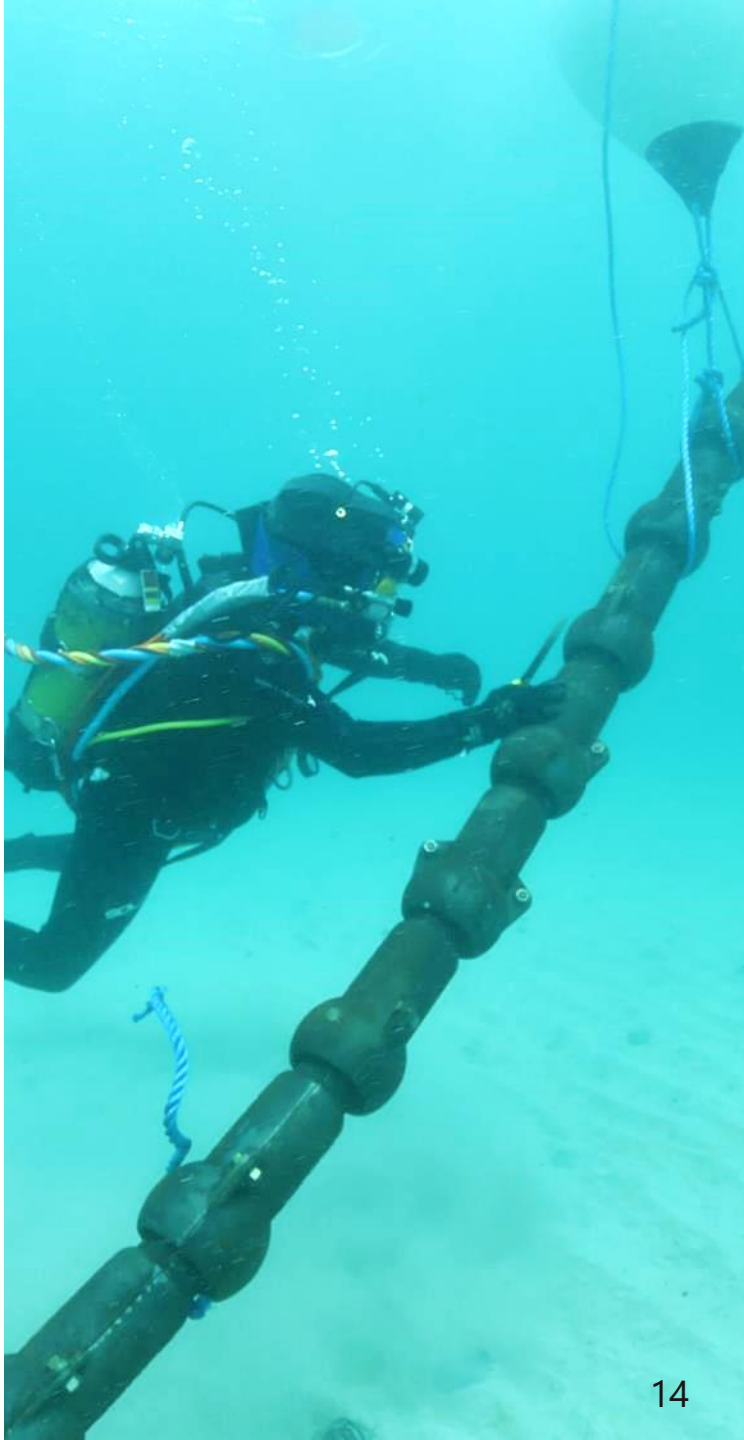
- Showcase for the "Fuel Free Island" energy model
- Led by AKUO Energy, final step of Ushant's energy transition toward a green energy mix
- **Deployment of two tidal turbines, one wind turbine, solar panels and energy storage capacity**
- Commissioning in **2023**, 20-year period operation
- **Procurement opportunities :**
  - Composite blade design for 15 m diameter rotor
  - Composite blades supply (2 sets of 3 blades)
  - Composite hydrodynamic appendices supply (2 sets of 2 bulbs)

The first commercial turbines array in France



Two tidal turbines of 500 kW each, one wind turbine of 900 kW, 500 kW of innovative solar panels solutions and an energy storage (Li-Ion) of 2 MWh.

Total power: 2.4 MW



Thank you for your attention!

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