


MANUFACTURE & TESTING OF LARGE COMPOSITE STRUCTURES

Tomás Flanagan, CEO

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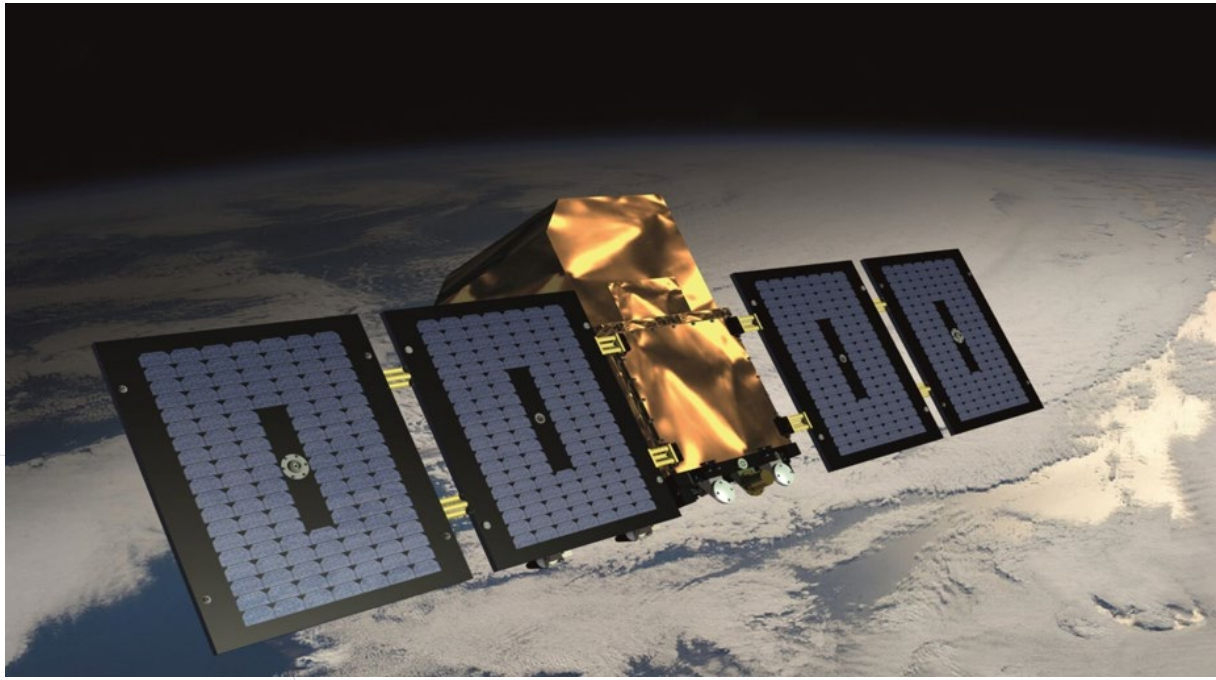
ÉIRECOMPOSITES

OVERVIEW

- Company Background
- Production of wind blades
- Powder Epoxy Technology
- PowderBlade – Powder epoxy technology
- Other research on large composite structures

EIRECOMPOSITES: COMPANY BACKGROUND

- Composites Design, Manufacturing & Testing for Aviation, Space and Renewable Energy
- AS/EN 9100 and NADCAP approved
- Proven track record of research with the European Space Agency and Horizon 2020 program
- Manufacturer of wind blades
  - 14m Blades – for a derivative of the 225kW Vestas V29
  - SD Wind Energy Blades – Glass-fibre reinforced polypropylene (Twintex) thermoplastic wind turbine blades for 6kW and 15kW machines
- Manufacturer of tidal blades, aviation structures and satellite components



RESEARCH PARTNERS

ABB
SIEMENS Ingenuity for life
eDF
sonaca
SKF
Fraunhofer IFAM
WestBIC
OHB
tfi MARINE
TECNARO The Biopolymer Company inside
tecnalia Inspiring Business
STOKES LABORATORIES FLUID DYNAMICS
Science Foundation Ireland sfi For what's next
SE BLADES
POLITECNICO MILANO 1863
Πανεπιστήμιο Ιωαννίνων
ITCF DENKENDORF
Institut für Verbundwerkstoffe
innovalia ASSOCIATION
IDEC
harland and wolff heavy industries ltd
FILL YOUR FUTURE
EXOM engineering
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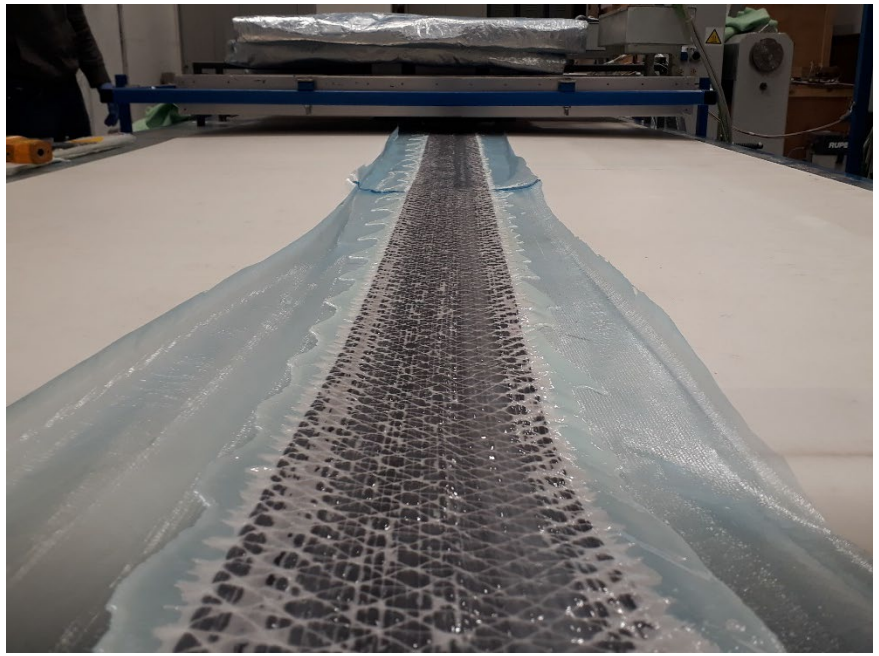
EMEC ORKNEY THE EUROPEAN MARINE ENERGY CENTRE LTD
dralon a step ahead in acrylic fibers
DP ENERGY
DFKI German Research Center for Artificial Intelligence
DATAPIXEL QUALITY CONTROL ENGINEERING
C-Tech INNOVATION
CRF
COMAU
coexpair Composites Expertise for Aircraft
cidetec
CENTEXBEL
cecimo
cea
Brainport Industries
Bernal Institute
ARTTIC a PNO international management services company
Altair
ALBÉA packaging and more
TopSolid
TNO
VDL
Technology Transfer System
SWISS SMART FACTORY
SWITZERLAND INNOVATION
smartFactory
sculpteo
SCHALTAG Unser System ist Partnerschaft
PHILIPS
NIT New Infrared Technologies
LMS Laboratory for Manufacturing Systems & Automation
INNOVATION PLASTURGIE COMPOSITES
aimen TECHNOLOGY CENTRE
INTRASOFT INTERNATIONAL
invent!
5M

PRODUCTION

- ÉireComposites blades are made using the company's patented MechTool®, which allows high-temperature processing of materials
- **13m Blades –** for the Vestas V27 machine from glass fibre and epoxy resin
- **14m Blades –** for a derivative of the 225kW Vestas V29
- **SDWinds Blades –** Glass-fibre reinforced polypropylene (Twintex) thermoplastic wind turbine blades for 6kW and 15kW Kingspan machines

POWDER EPOXY TECHNOLOGY



- Neary all wind blades made with liquid epoxies or polyesters
- Powder-epoxy resins have properties that make them suitable as a matrix for the production of composite wind blades
- Technology has been demonstrated on 14m wind blades
- ÉireComposites has developed a production line specifically for powder epoxy prepreg:
  - Can process glass and carbon fibre fabrics from 300 g/m2 to 1800 g/m2
  - Up to 55% FVF demonstrated on both glass and carbon

POWDER EPOXY ADVANTAGES

- Excellent fibre wet-out, even in thick sections
- Reduction in post-processing requirements
- Reduction in material wastage and overall part cost
- Reduction in transportation and storage costs
- Potentially a good matrix material for use with carbon fibre (which are difficult to infuse)

POWDERBLADE

POWDERBLADE

- PowderBlade is a €2.7m Horizon 2020 project to develop large wind blades (50m-100m)
- The project is based on a novel process for manufacturing blades from powder epoxy
- Project focused on blade roots and spar caps
- Project partners are: Eire Composites, Suzlon, WestBIC & the University of Edinburgh

ÉIRECOMPOSITES

WestBIC

SUZLON

THE UNIVERSITY of EDINBURGH

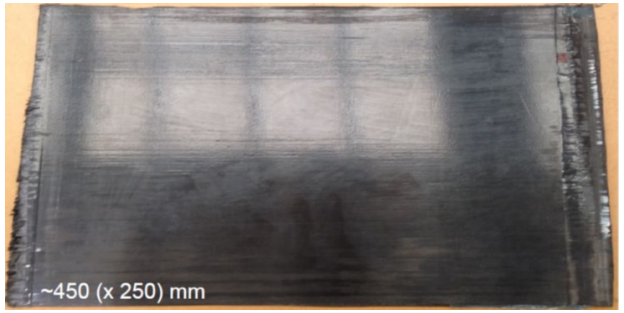
European Commission

HORIZON 2020

POWDERBLADE

Objectives:

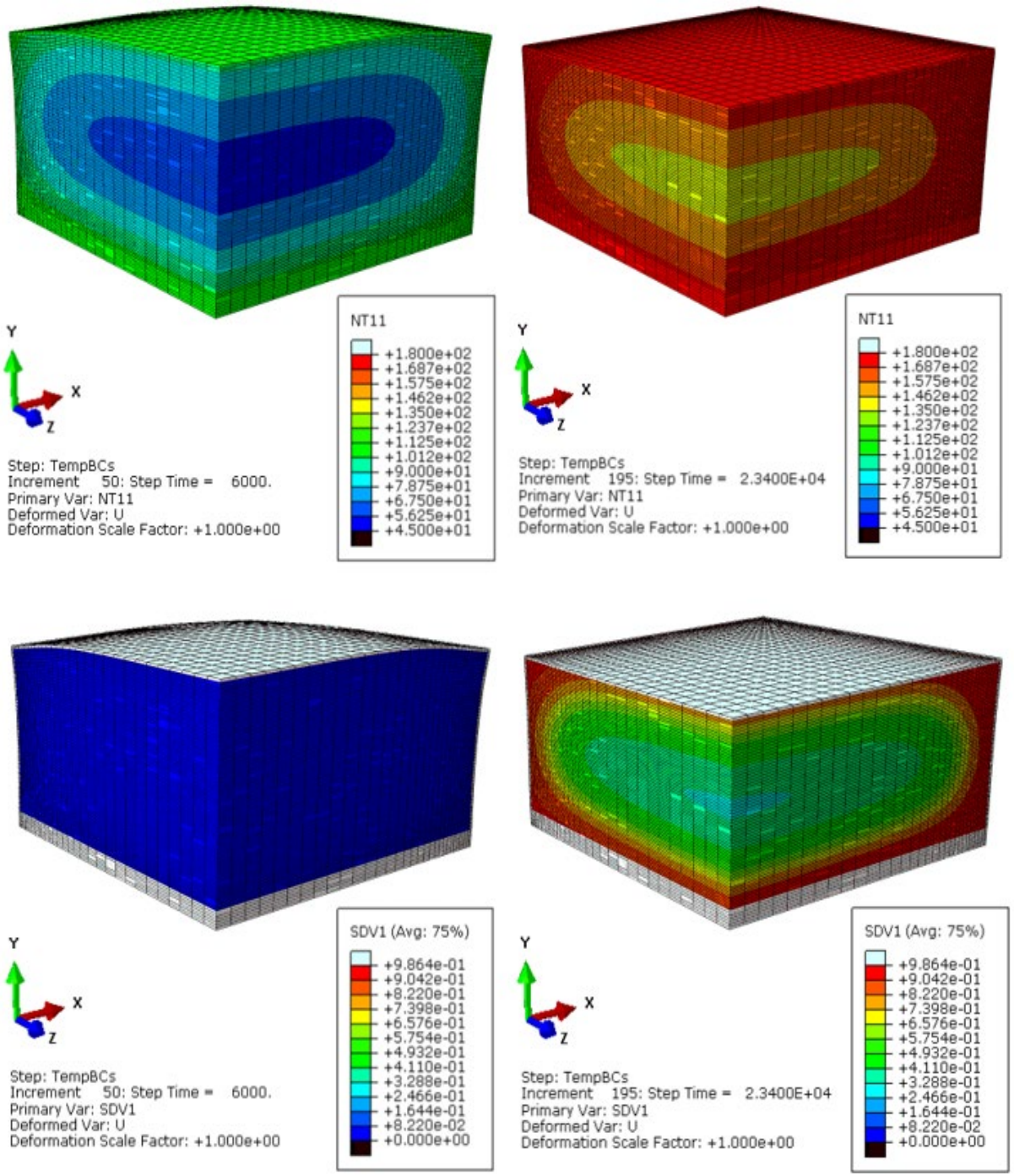
- Design and manufacture a carbon fibre spar and glass fibre root for a full-scale hybrid blade
- Develop a computation model of the cure cycle
- Design and test a torsion box representative of a full-scale wind blade
- Reduce cycle time for blade production
- Commercialise the composite manufacturing technology for large wind blades



POWDERBLADE

Results: Computational modelling

- 3D simulation, in Abaqus, for the processing of a 96-ply thick laminate made from glass-fibre/epoxy-powder
- Temperature within the laminate after 100 mins (top left) and 390 mins (top right)
- Degree Of Cure in the laminate after 100 mins (bottom left) and 390 mins (bottom right)
- Modelling led by the University of Edinburgh
- Processing time of 6 hours achieved

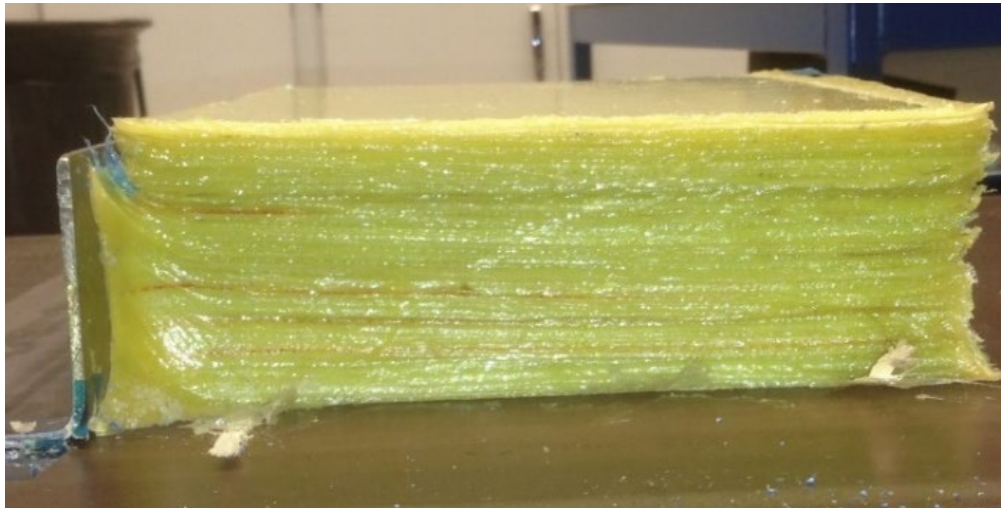


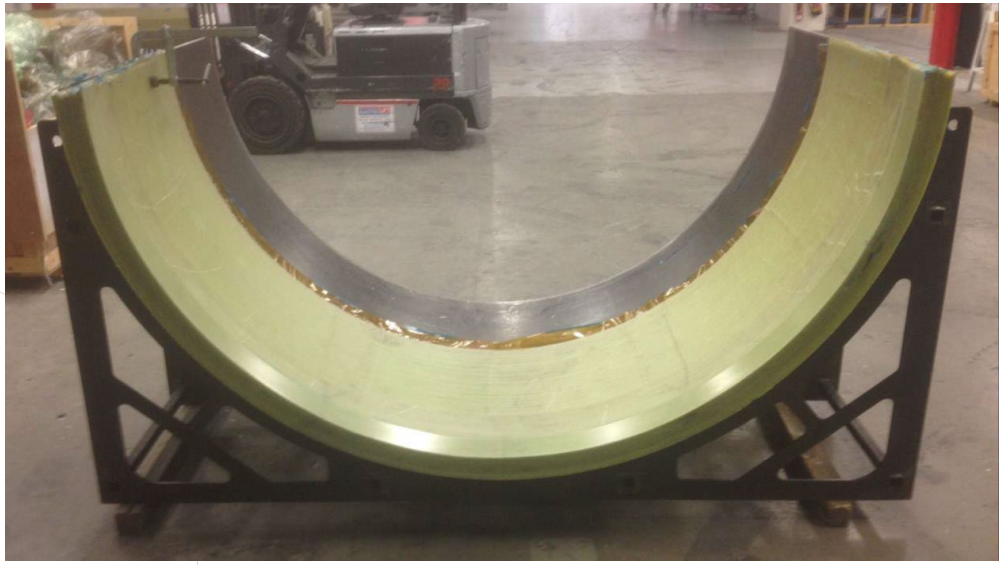
THE UNIVERSITY of EDINBURGH

POWDERBLADE

Results: Glass fibre root

- Lot of testing of powder epoxy laminates
- Laminates manufactured and tested to establish mechanical and fatigue properties
- Several trials performed on 96-ply thick laminates – excellent wet-out achieved
- Temperature probes used to validated numerical model
- Blade root sections manufactured for a 54m wind turbine blade





POWDERBLADE

Results: Carbon fibre spars

- Laminates manufactured and tested to establish mechanical and fatigue properties
- First 13-metre demonstrators manufactured but problems found with fibre-alignment
- Second 13-metre demonstrators manufactured and fibre-alignment issue resolved
- Work ongoing to compare powder epoxy costs as to alternative manufacturing methods

POWDERBLADE

Results: Torsion Box

- Testing of glass-carbon interface on 75cm test pieces – broke several test machines
- Design of torsion box – glass/carbon interface – for a 60m blade
- Manufacture of 6-metre torsion box
- Testing of the glass/carbon interface within the torsion box

LEAPWIND

MOTIVATION FOR LEADING EDGE PROTECTION

- Erosion can reduce annual energy production of a wind turbine by between 4% and 20%
- Offshore blade repairs are expensive and dangerous
- Production losses and maintenance costs as a result of leading edge erosion are a major challenge in the wind sector
- Problem will be worsened due to larger blades with higher tip-speeds
- Blade erosion causes a loss in productivity worth between $168m and $842m a year across European offshore wind sector

THE SOLUTION

- Protective coating for blade leading-edge
- Thermoplastic material
  - Recyclable
  - UV resistant
  - Good energy absorption
  - Thermoformable to blade geometry
- Solution demonstrated through lab-scale rain erosion testing
- Excellent performance from initial operational trials

TEST RESULTS

- Following a 2 month operational trial in Shetland, Scotland. All three test blades were inspected
- Operational environment harsh and representative of real life conditions to be experienced offshore
- On Inspection only the unprotected blade showed signs of damage
- Both the TPU and 3M protected blades showed no signs of damage, delamination or pitting of coated surfaces
- Only slight discolouration occurred on TPU coating

Uncoated Blade

TPU LE Protection

3m LE Protection

CONCLUSIONS FROM LEAPWIND

- There is a massive, growing market for Leading Edge Protection
- The LEAPWind project has developed a novel solution to address this market
- The solution has been tested in a laboratory and in operational trials and shows excellent results
- The technology is disruptive and can place Europe in a globally leading position in terms of offshore wind
- It will also decrease delivery cost LCoE while providing a more sustainable solution

OTHER PROJECTS

TIDAL ENERGY: H2020 CRIMSON

Aims to bring to market an innovative marine power system at reduced cost and increased reliability:

- De-risk the use of recycled carbon fibre material (rCF) in the marine environment
- Design and manufacture a new sustainable Marine HydroKinetic (MHK) turbine
- Prove the structural integrity of the new sustainable MHK turbine
- Perform operational trials at full-scale

ÉIRECOMPOSITES

NUI Galway
OÉ Gaillimh

ORPC

MITSUBISHI CHEMICAL ADVANCED MATERIALS

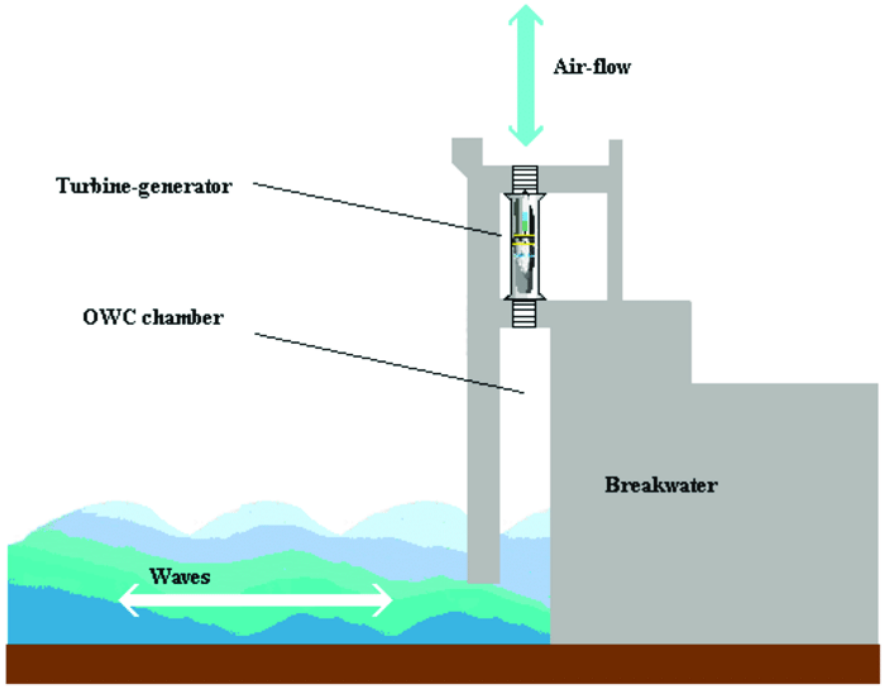
Consiglio Nazionale delle Ricerche

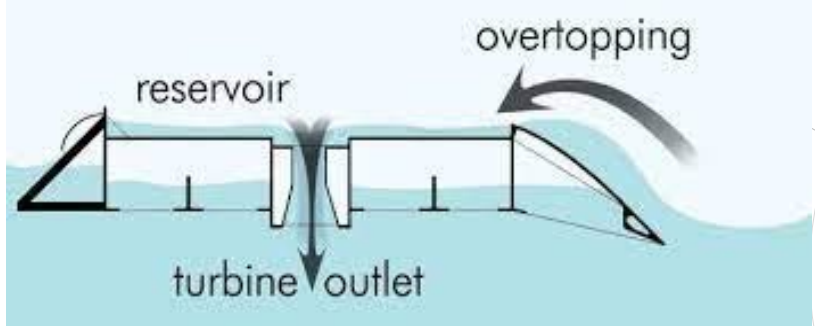
RELATED RESEARCH

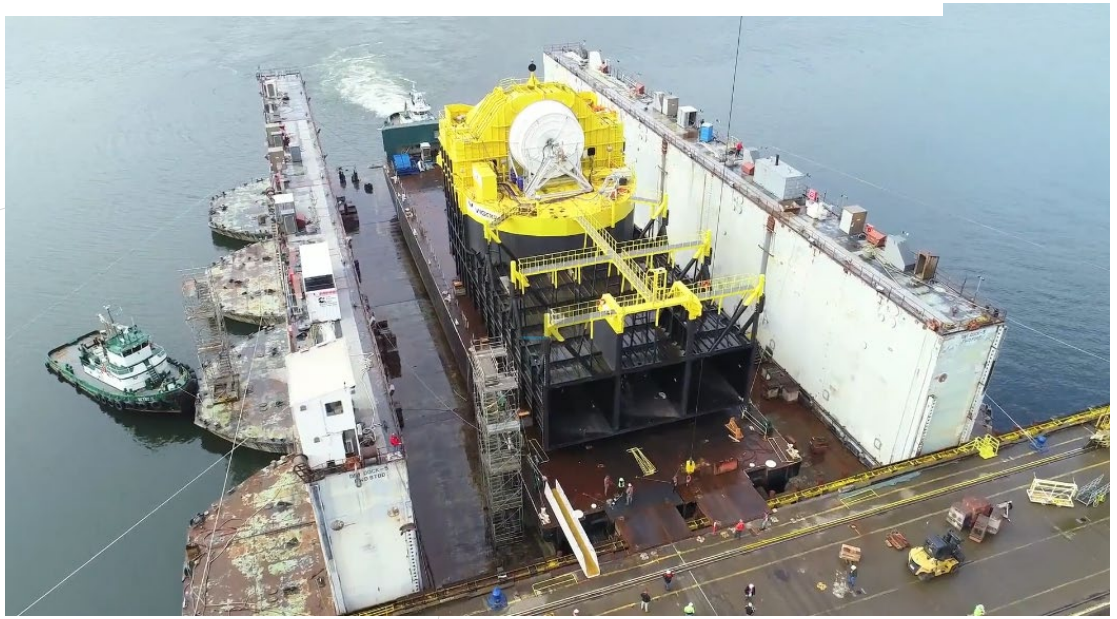
- FloTEC - Floating Tidal Energy Conversion, H2020 LCE, €9.8m, www.scotrenewables.com/projects/flotec
- SEABOAT - Sustainable Environmentally-friendly Advanced-Composite Zero-Emission Boats, H2020, €1.65m, www.seaboat.eu
- MAREWIND - MAterials solutions for cost Reduction and Extended service life on WIND off-shore facilities, H2020, €8m, https://www.marewind.eu/

WAVE ENERGY

- WEC4Ports
  - Hybrid WEC
  - Oscillating column
  - Overtopping device
- Ocean Energy (CTL project)
  - https://oceanenergy.ie/oe35/
  - Oscillating column
  - Large device in Hawaii







THANK YOU

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