



Classification & Certification on Offshore Marine Renewable Energy



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Summary



- ▶ Overview of natural resources and marine energy
- ▶ Context and projections of energy sources
- ▶ Market and business aspects
- ▶ Bureau Veritas experience & on-going projects
- ▶ International standards & Bureau Veritas Rules
- ▶ Bureau Veritas software package



Overview of natural resources and marine energy



Marine energy resources : a major challenge for the XXI century



The oceans restore accumulated thermic energy under various forms : kinetic energy, potential energy, chemical energy,...

► Global Natural Resources* *(estimated)*

- Ocean Thermal Energy : 456.10^3 PWh/year
- Tidal : 29,4 PWh/year
- Wind : 537.10^3 TWh/year
- Waves (tidal + wind) : estimated to about 550.10^3 TWh/year









► Technically exploitable energy *(estimated, extracted from developers' publications)*

- Ocean Thermal Energy : 100 PWh/year
- Tidal : 800 TWh/year
- Wind : 18450 TWh/year
- Waves : 19 850 TWh/year

Nota : 1 PW (PetaWatt) = $10^{15}W$
1 TW (TeraWatt) = $10^{12}W$

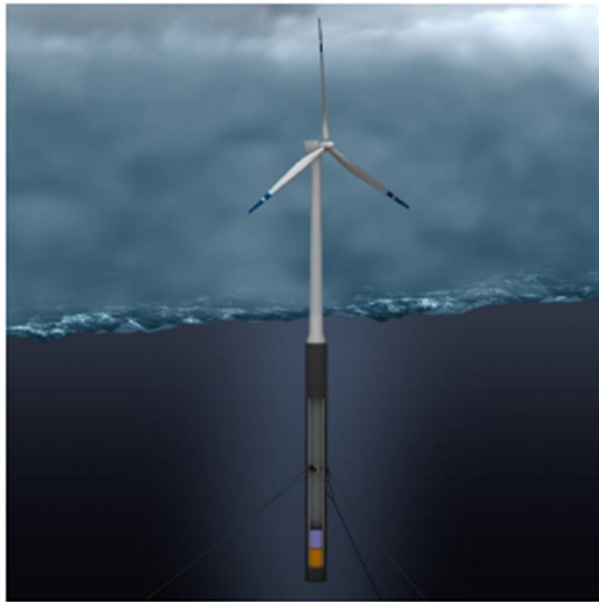
Resource type & technology associated

Tidal & wave converters

DEVICE TYPE	HORIZONTAL AXIS TURBINES	VERTICAL AXIS TURBINES	OSCILLATING HYDROFOIL	OSCILLATING WAVE SURGE CONVERTER (OWSC)
DIAGRAM				
DEVICE TYPE	ATTENUATOR	OVERTOPPING	OSCILLATING WATER COLUMN (OWC)	POINT ABSORBER
DIAGRAM				

Resource type & technology associated

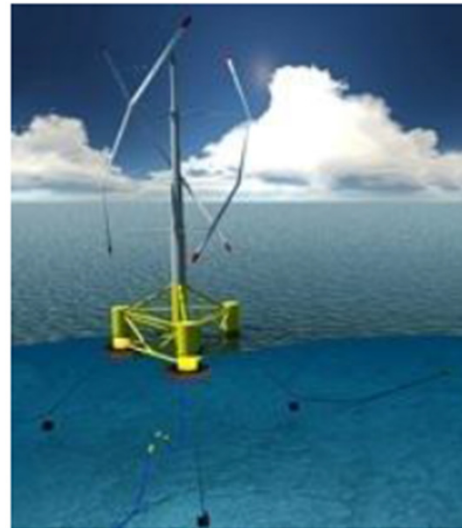
Windmill



HyWind (Statoil, Norvège)
www.statoil.com 2.3 MW



WINFLO (France)
nassetwind.com

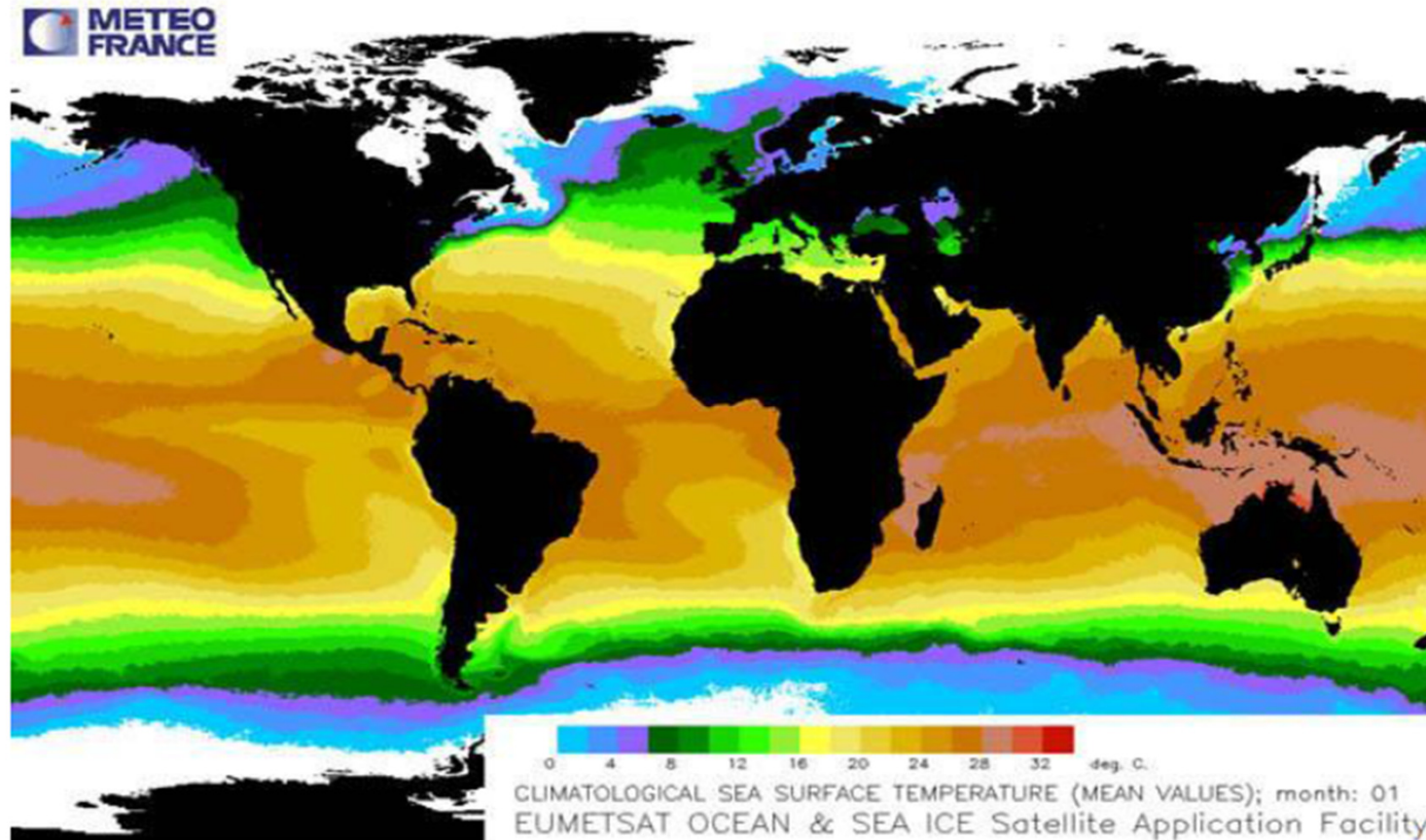


Nenuphar (France)
www.nenuphar-wind.com



Windfloat (USA)
www.principlepowerinc.com/products/windfloat.html

Resource type & technology associated



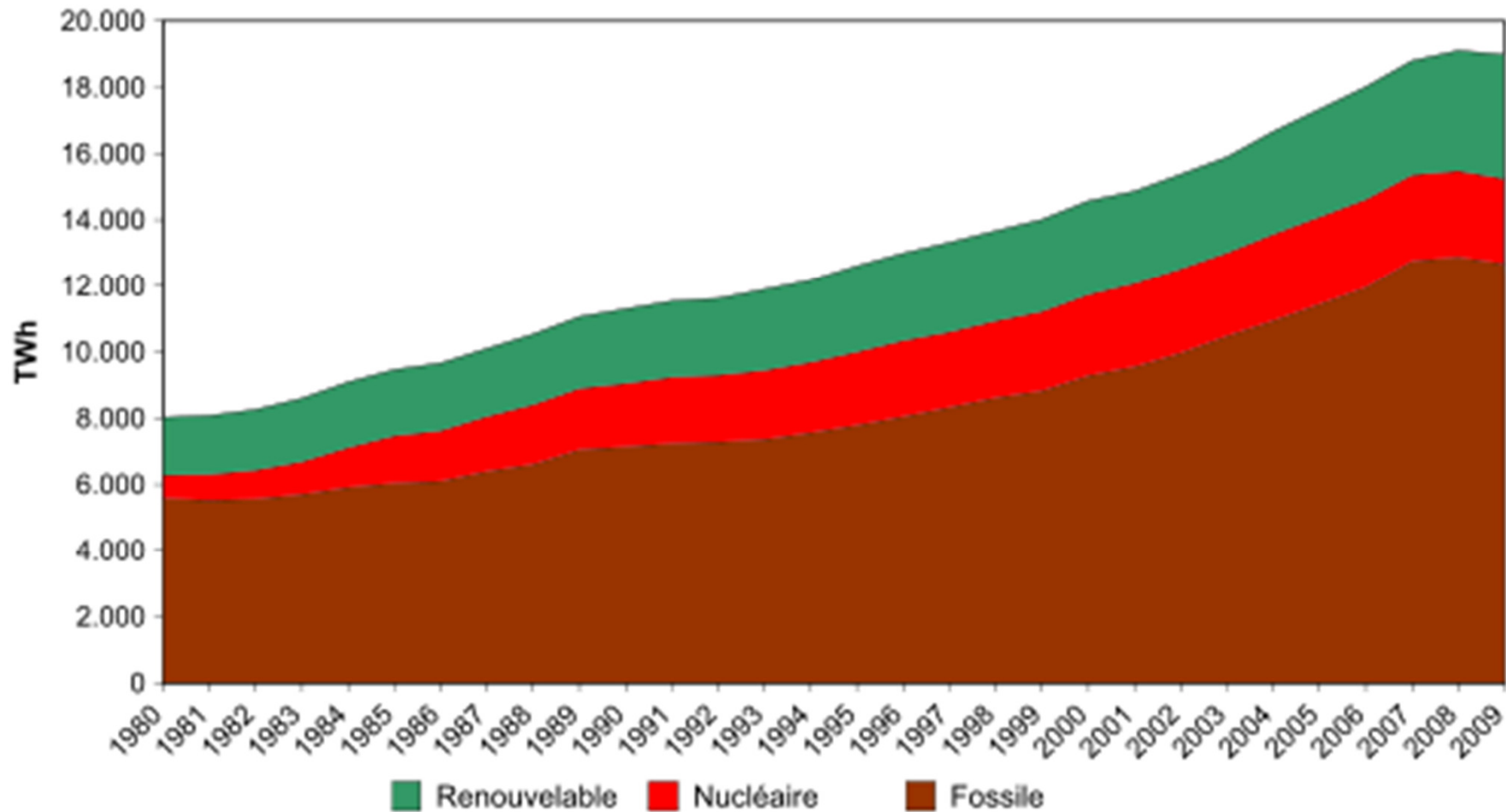
Ocean Thermal Energy



Context and Projections

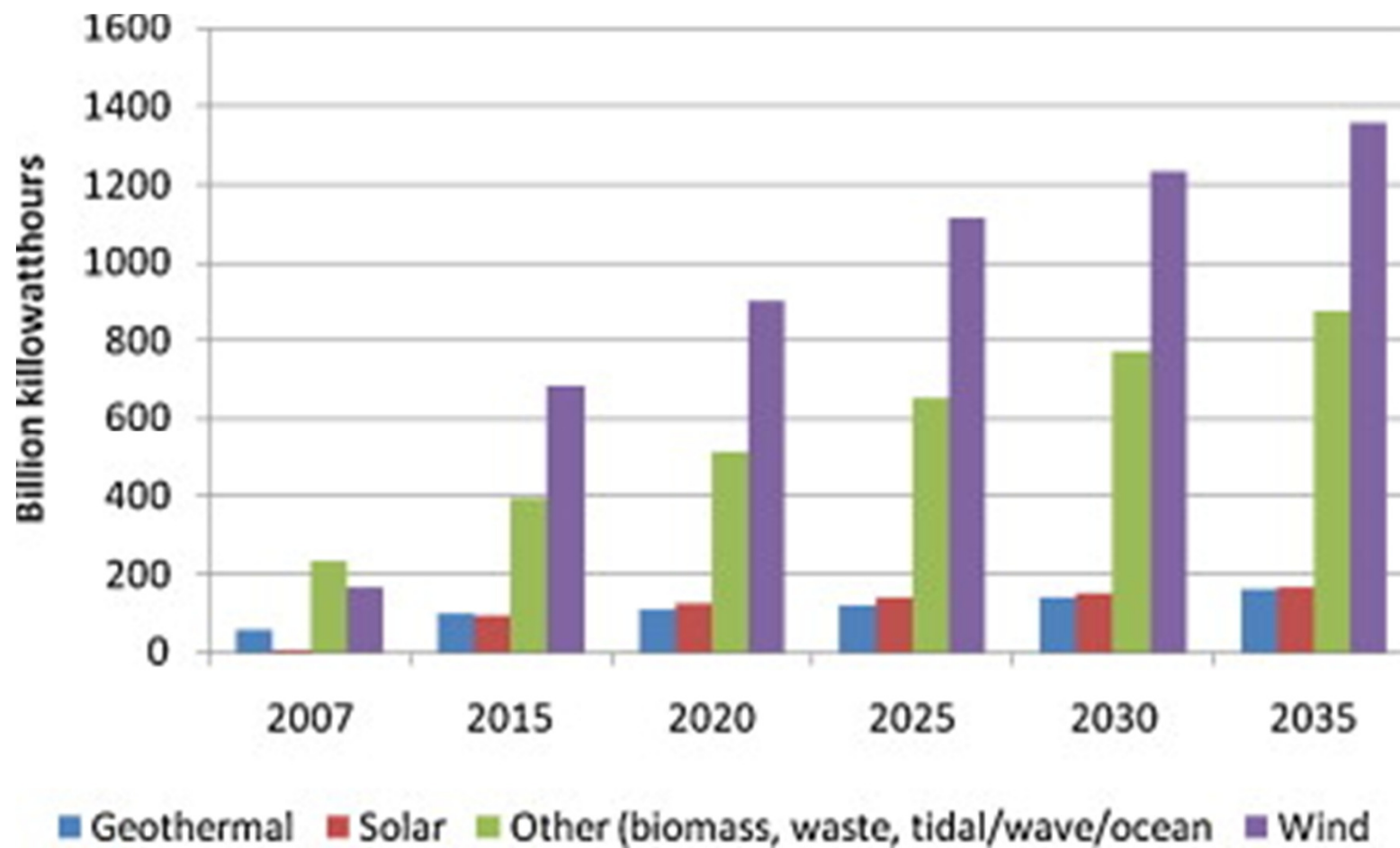


Evolution of the world annual electricity production



**Source : EDF - 2010*

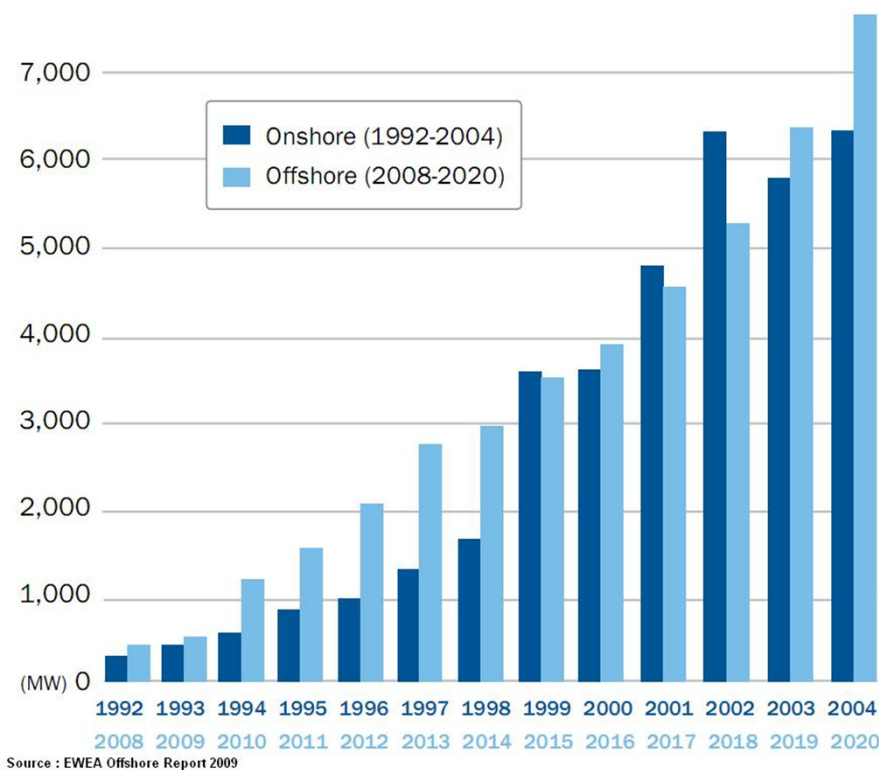
World net renewable electricity generation projections



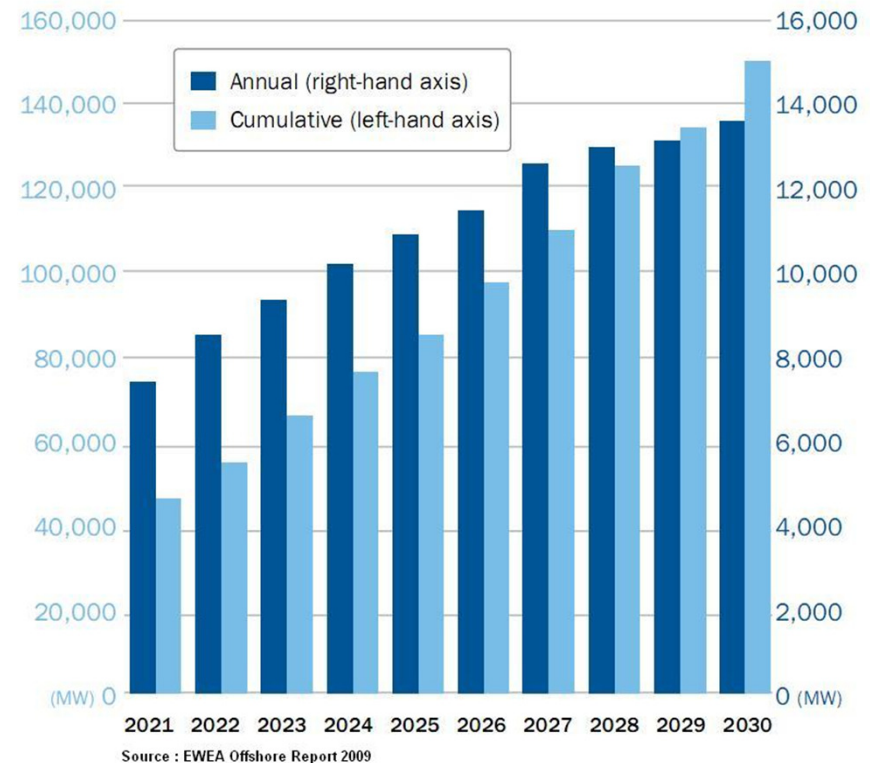
Source : US EIA (<http://www.eia.doe.gov/oiaf/ieo/>)

European Wind Energy Association projections

Historical onshore growth 1992-2004 compared to EWEA's offshore projection 2008-2020 (MW)



Offshore wind energy annual and cumulative installations 2021-2030 (MW)





Market and Business Aspects



Marine Renewables-Engineering : a new industry

- ▶ Technical studies (geotechnical, geophysical, impacts, risks ...)
- ▶ Construction of factories and assembly
- ▶ Manufacturing masts, blades, sub-structures
- ▶ Assembling of the rotor-nacelle sets
- ▶ Upgrading of harbor infrastructure
- ▶ Connections to the electricity grid
- ▶ Offshore implementation
- ▶ Development of a fleet of ships (ship building, service, maintenance)



1% of the market represents 70 to € 80 million for Bureau Veritas, between 2014 and 2022

Offshore windfarms (MW)

Source : GBI Research, PwC analysis (data gathered April 2011)

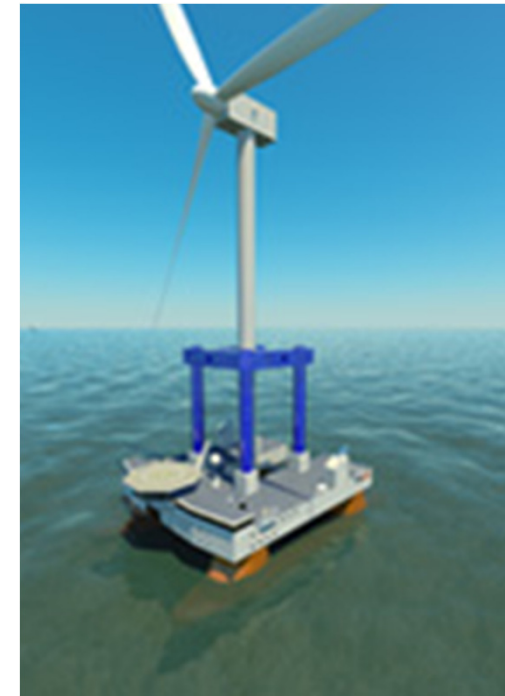
	In operation	Under construction	Planned
Canada	-	-	1,750 MW
United States	-	-	23,865 MW

	In operation	Under construction	Planned
China	110 MW	1,200 MW	28,691 MW
Hong Kong	-	-	300 MW
Japan	25 MW	-	-
South Korea	-	-	3,827 MW
Taiwan	-	-	600 MW

	In operation	Under construction	Planned
Albania	-	-	1,259 MW
Belgium	195 MW	-	1,594 MW
Denmark	876 MW	12 MW	873 MW
Egypt	-	-	1,200 MW
Estonia	-	-	1,700 MW
Finland	30 MW	-	3,736 MW
France	-	-	3,000 MW
Germany	185 MW	335 MW	25,105 MW
Ireland	25 MW	-	1,828 MW
Italy	1 MW	-	2,147 MW
Malta	-	-	200 MW
Netherlands	247 MW	-	5,423 MW
Norway	2.3 MW	-	10,435 MW
Poland	-	-	299 MW
Romania	-	-	500 MW
Spain	10 MW	-	500 MW
Sweden	163 MW	-	2,857 MW
United Kingdom	1,341 MW	2,238 MW	43,652 MW

Service Vessels

- ▶ **STX**
 - Poseole project (Bureau Veritas partner)
 - Vinci project – Bureau Veritas following design
 - EDF project – Bureau Veritas following design
- ▶ **Socarenam**
 - Bureau Veritas supporting shipyard
- ▶ **Samsung HI**
 - Class Request answered and followed up
- ▶ **Mitsubishi**
 - HO / Japan meeting in February
- ▶ **SAIPEM**
 - Project Castoro Vento – Bureau Veritas follow design
- ▶ **Seajack / Gusto MSC / Bluewater**
 - Bureau Veritas discussion for new design class
- ▶ **Swiber / Keppel**
- ▶ **Turkish Shipyards?**
 -



Shipping - Wind & MRE – Projects

► *Shipyards / Designers*

- Chantier Allais : WFSS with Tug Thomas (Bureau Veritas France)
- Meyer Werft : WTIV & WFSS (Bureau Veritas Germany)
- Nordic Yard : WFSS (Bureau Veritas Germany)
- Damen : WFSS (Bureau Veritas Netherlands)
- Socarenam : WFSS (Bureau Veritas France)
- Piriou : WFSS (Bureau Veritas France)
- Baltec : WFSS (Bureau Veritas Germany)
- CNIM : WFSS (Bureau Veritas France)
- DSME : WTIV jack-up (Bureau Veritas South Korea)
- Samsung : WTIV jack-up (Bureau Veritas South Korea)
- STX France : WTIV jack-up a WFSS (Lorient) (Bureau Veritas France)
- Navantia : WFSS and small jack-ups (Bureau Veritas Spain)



Shipping - Wind & MRE – Projects

► Owners / operators

- A2SEA : **WindTurbineInstallationVessel** Project of jack-up (by BV Denmark)
- ALSTOM : WTIV ORCA launched (GL) – Sistership with Bureau Veritas
- EDF-EN / STX : WTIV project of jack-up (Bureau Veritas StNazaire & DTO)
- FREYSSINET - Project SEANERGY : fully assembled turbine transportation
- Jan-de-Nul : WTIV project of Jack-up (Bureau Veritas Belgium & DTO)
- Saipem : CASTORO VENTO : WTIV fully assembled turbine transportation
- Jifmar : **WindFarmServiceShip** (Direct)
- LDA : WFSS (Direct)
- Tug Thomas : WFSS
- C-Truk : WFSS (Bureau Veritas UK)
- Gardline : WFSS (Bureau Veritas UK)

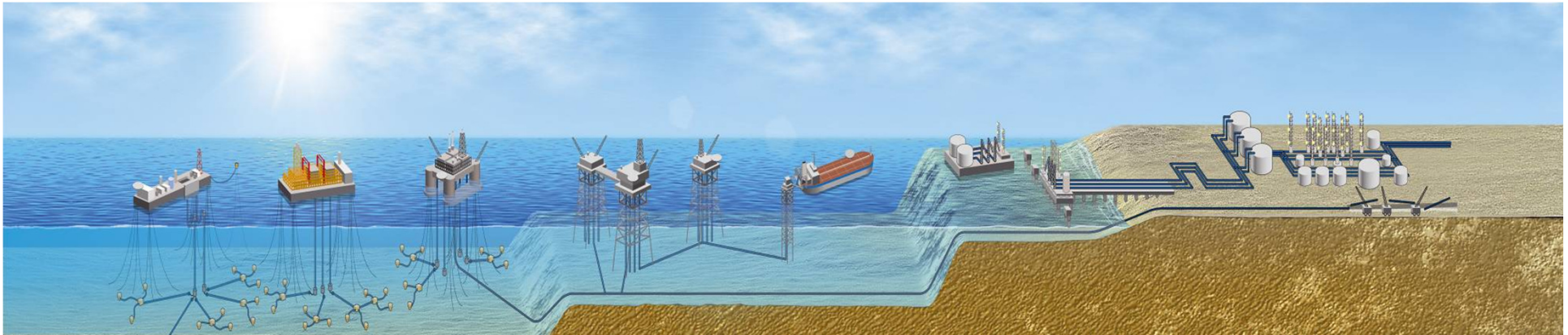




Bureau Veritas experience & on-going projects



Bureau Veritas experience from Oil & Gas...



► Deepwater facilities

- Floating units: FSO, FPSO, semisub, TLP and SPAR
- Mooring systems
- Offloading facilities (export lines, buoys)
- Flexible or rigid flowlines
- Pipelines and subsea equipment

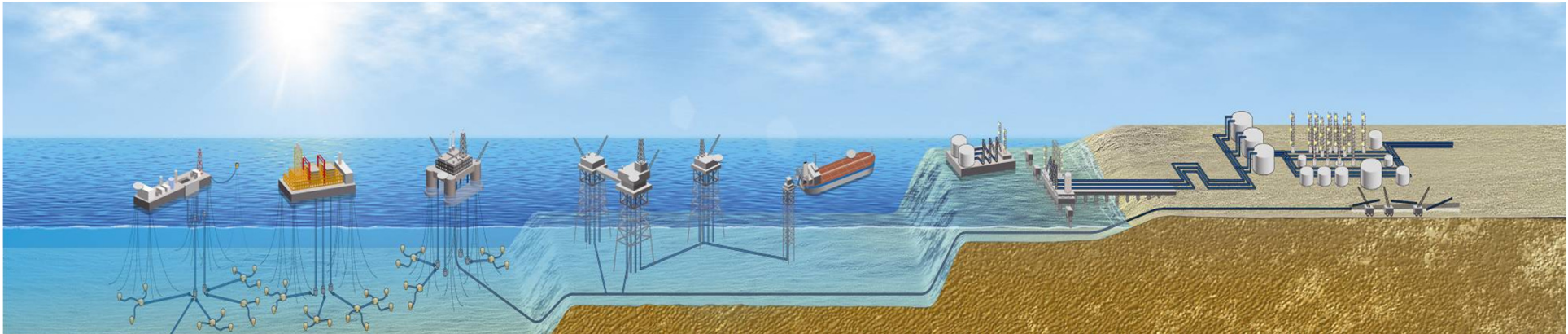
► Offshore facilities

- Fixed platforms & loading units
- Offloading facilities and flexible or rigid flowlines
- Pipelines and subsea equipment
- Concrete gravity based structures
- Offshore plants & terminals

A world leader in Fatigue Analysis of Floating units

More than 95 FSOs & FPSOs studied by BV (about 50% of world fleet)

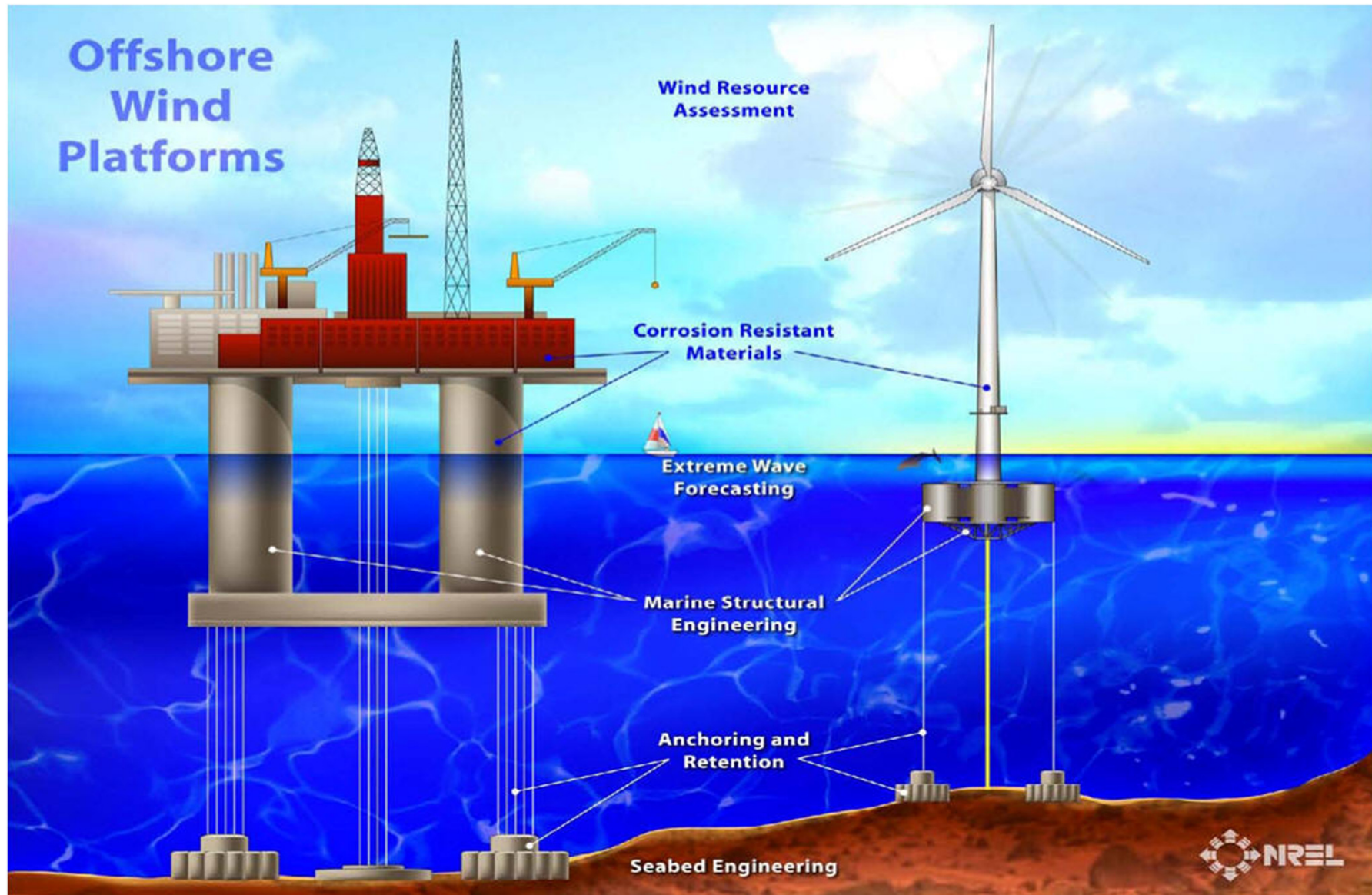
Bureau Veritas experience – ...to Renewables



- ▶ Many similarities in many technical fields with strong synergy



BV Experience - similarities



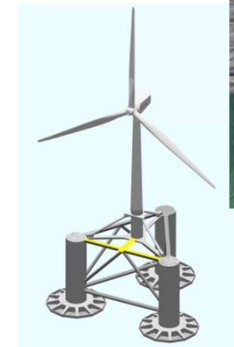
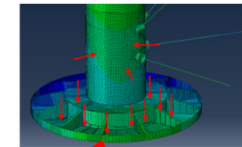
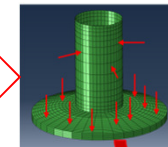
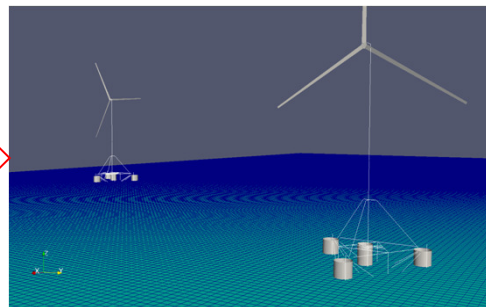
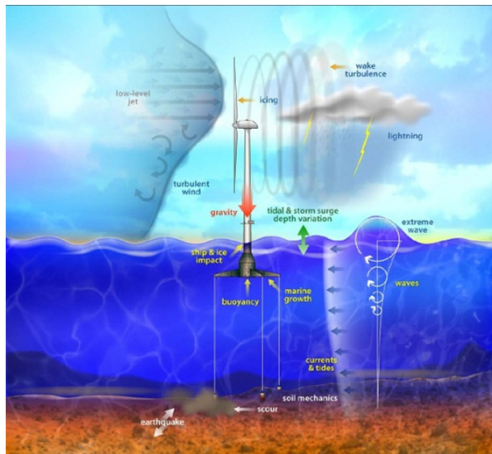
Floating Offshore Wind Turbine

► Industrial projects:

- Vertiwind – 3 MW - Technip, EDF-EN, Nenuphar, Oceanide,...
- Winflo – 1 MW to 5 MW - Nass&Wind, DCNS, PRINCIPIA,...
- HiprWind - 2 MW - Acciona, Fraunhofer, Technip, ABB, Olav Olsen, Vicinay Cadenas,...

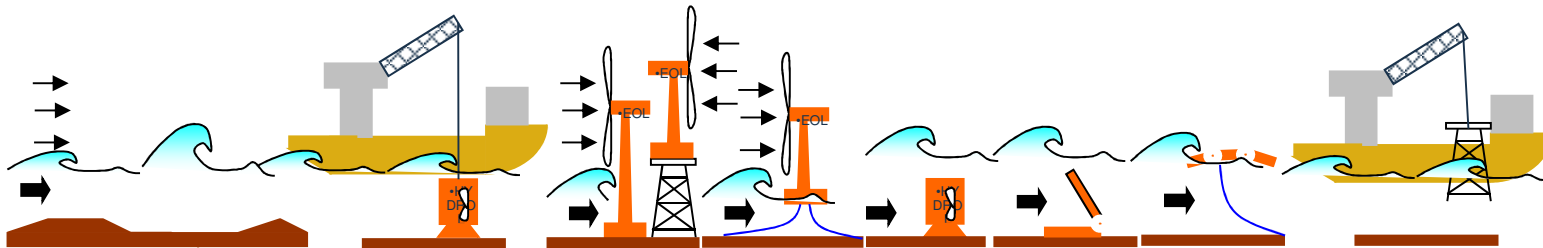
► Technical issues : multi-physics phenomena

- Bureau Veritas's specific tools



Multi-Marine Renewable Engineering

- ▶ Institut de Recherche Technologique-Jules Verne – HYSMAR
 - Numerical simulations of loading, towing and installation procedures
 - Fixed offshore and floating wind turbines
 - Water turbines
 - Tidal converters
 - Electrical stations



stx Europe



ALSTOM



Shipping – Wind & MRE dedicated Vessels



Classical Classification interlocutors

► Ships by type

- Barges / Semi-sub with Heavy / High Lift
- Jack-ups
- OSV / MPSV (DP, Multi Purpose)
- Floating Hotels
- Crane Vessels
- Cable-layers
- High Speed Vessels for transfers

► Designers

- Gusto / MSC
- SHI
- Offshore Ship Design
- Ulstein
- STX (OSV, Solution, Canada)
- Wartsila
- Rolls Royce
- BMT Nigel Gee
- Mauric
- ...

► Shipowning / chartering

- LDA
- Bourbon
- Jifmar Offshore
- Seajacks
- Technip
- SAIPEM
- MPI Offshore
- Houlder
- Jumbo Shipping
- A2SEA
- Swire Blue Ocean
- GeoSea / DEME
- MISC
- Workfox
- Vroon
- Fugro
- ...

► Shipyard

- STX
- Swiber
- Damen
- Socarenam
- SHI
- DSME
- Mitsubishi
- IHC MerWede
- Abeking & Rasmussen
- Keppel
- Swiber
- Piriou
- ...



International standards & Bureau Veritas Rules



Bureau Veritas Marine Involvements – Rules



- ▶ Ships and Offshore units classification (NR467: Ships / NR445: Offshore)
- ▶ **NR 579: Wind Turbines IMR Vessels**
- ▶ **NI 589: Wind Farms Service Ships**
- ▶ NR 526: Classification of lifting systems on ships and offshore units
- ▶ **Materials** (NR216 steels / NR546 composites / NR561 aluminium alloys)
- ▶ NI 493: Guideline on anchor systems for permanent offshore units
- ▶ **NI 572: Classification/Certification of Floating Offshore Wind Turbines**
- ▶ NI 603 : Guidance Note for the Design, Fabrication, Installation and Operations of Tidal current energy converters

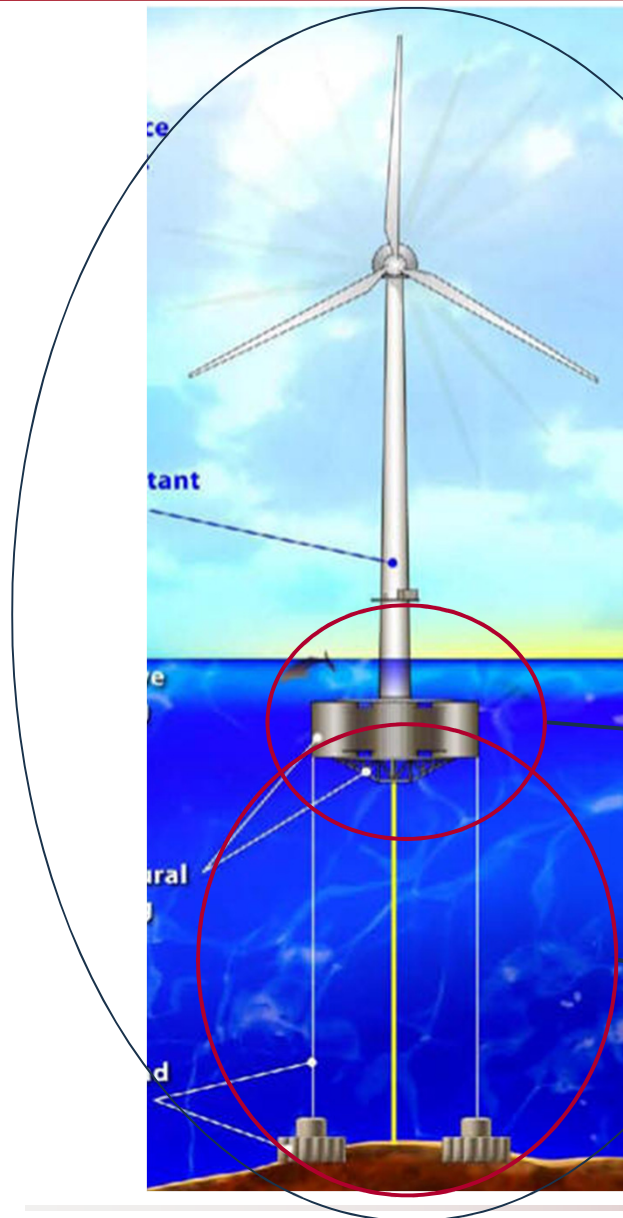


Few standards dedicated to MRE...



Reference	Title	Year
IEC 62600	<i>(under construction)</i> Marine energy - Wave, tidal and other water current converters	2011-...
EMEC	Marine Renewable Energy Guides (series of 12 guidelines)	2009
BV NI 603	Current and Tidal turbines	2013
BV NI 572	Classification of F loating O ffshore W ind T urbines	2010
DNV OS J101	Design of Offshore Wind Turbine Structure <i>(including FOWT)</i>	2013
DNV OSS 312	Certification of Tidal and Wave Energy Converter	2012
GL	<i>(draft)</i> Guideline for the Certification of Ocean Energy Converters - Part 1: Ocean Current Turbines	2005
ABS	Guide for building and classing floating offshore wind turbine installations	2013
Lloyds	Guidance on offshore wind farm certification <i>(including FOWT)</i>	2012

Example with Fixed Offshore Wind Turbine



IEC 61400-3-2

From TC88 WG documents:

88//379/NP & 88/397/RVN

**BV is an active member of
this TC WG**

**Existing BV
Offshore Rules
NR445 / NI572**

**Existing BV
Offshore Rules
NI493 / NI572**

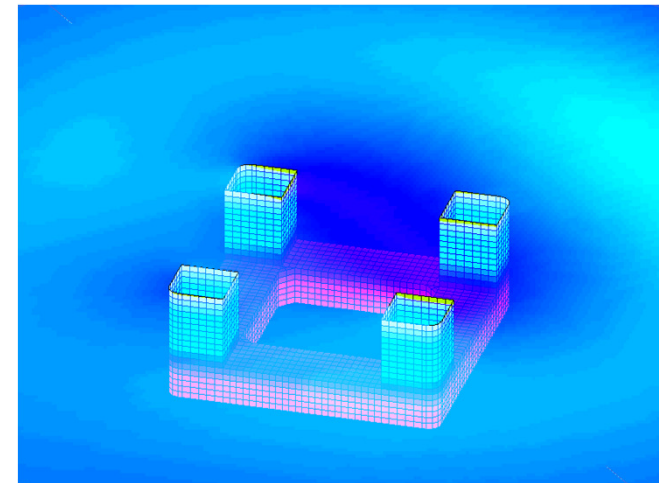


Bureau Veritas Software package



► **HYDROSTAR** (hydrodynamic)

- 3D diffraction/radiation software for 1st and full 2nd order wave loads
- Powerful software using efficient and most advanced logarithms, enhanced by advanced functionalities:
 - Visualization / Animation
 - Multi-bodies interaction
 - Quadratic viscous damping for the roll motion.
 - Analysis in frequency domain/time domain
 - Elimination of irregular frequencies
 - Mixed Diffraction / Morison model
 - Wave-current interaction
 - Fully interface with NSO and FEMAP/NASTRAN
 - Forward speed...

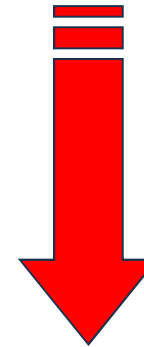
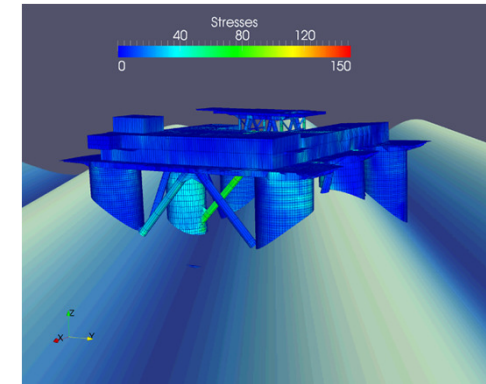


BV software

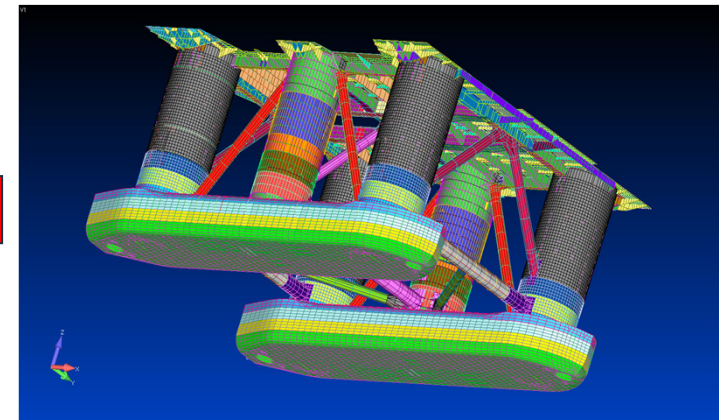
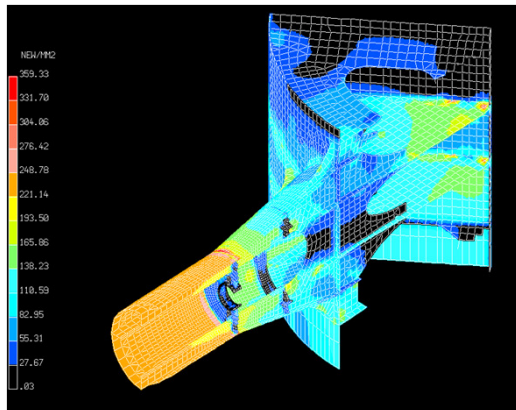


► **HOMER** (Hydro-structure interactions)

- Direct calculation of wave pressures forces
- Direct calculations of Hydrodynamic forces and motions
- Direct calculations of Forces and stress responses
- Extreme condition and Fatigue analyses



► **WindSTAR** (hydro/mooring/aero fully-coupled response)



VeriSTAR HLC Asset Integrity Management System

Objectives

- ▶ Follow-up of the condition of an offshore wind farm
- ▶ Software package for decision making in the remote control centre of these wind turbines
- ▶ Maintenance optimization and improvement of the operational productivity

Our services

- ▶ Integrated software platform
- ▶ Continuous measures (constraint gauge, etc.)
- ▶ Occasional inspections (crack detection, non destructive testing)
- ▶ 3D Model for each wind turbine
- ▶ Risk-Based Inspection (RBI)
- ▶ Parametric finite elements calculations
- ▶ Automated decision making module



Take into account the specificities “numerous objects” of the farm
Open to future measurement and repairing techniques



Move Forward with Confidence