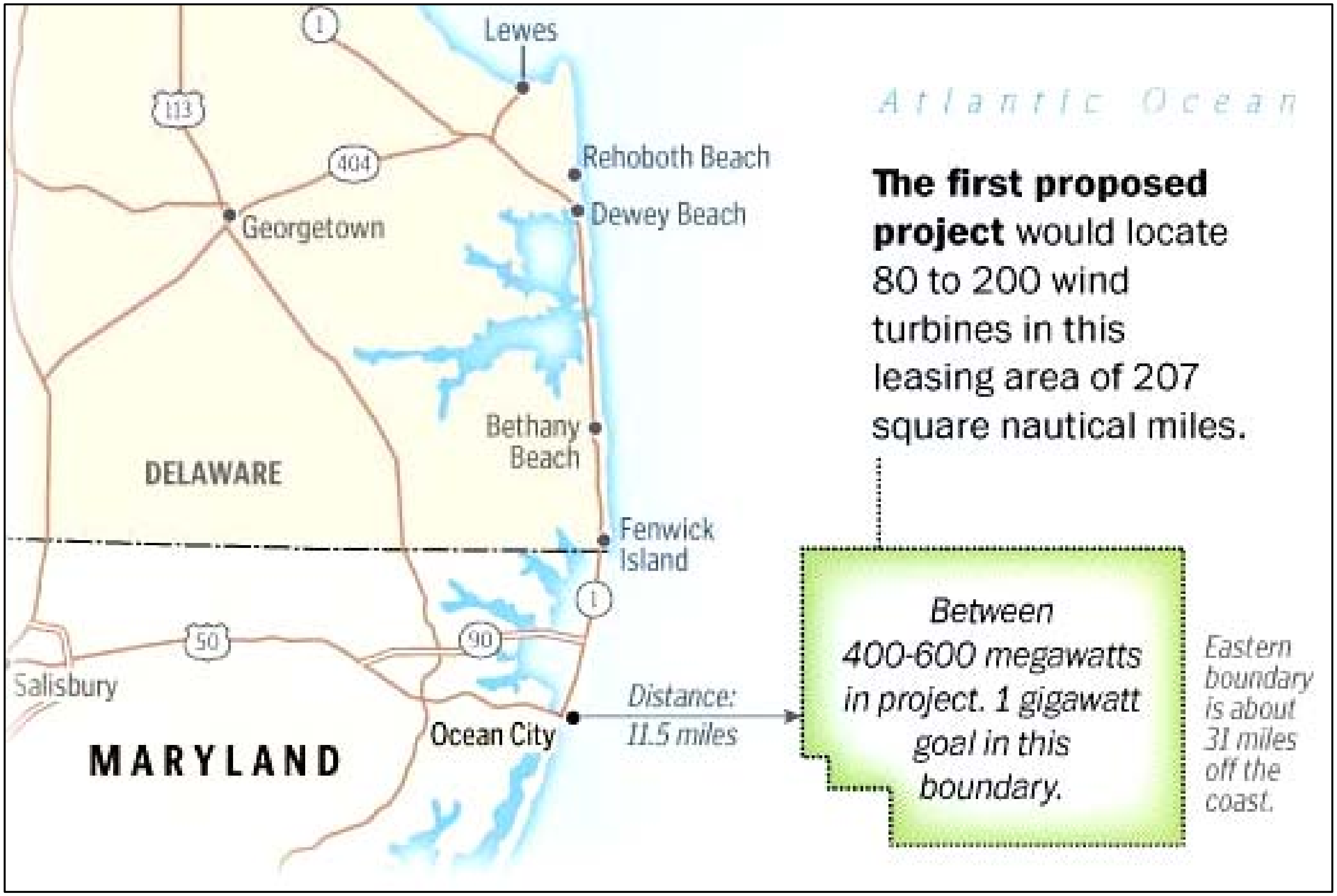
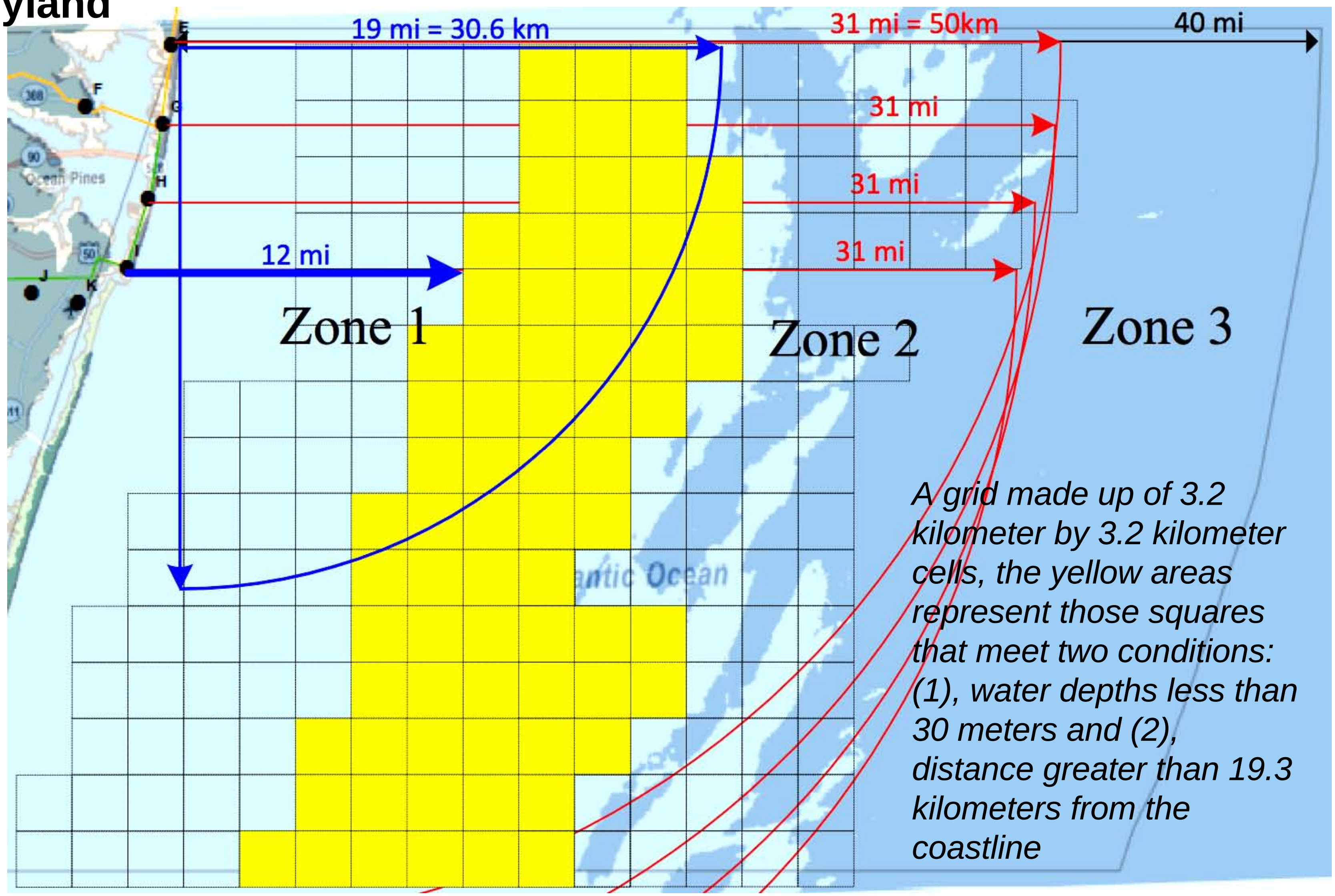
Proposed offshore wind project - a $1.5 billion field of giant turbines about 11 1/2 miles off Ocean City



Maryland Public Service Commission; Maryland Energy Administration; Maryland governor's office; Department of Legislative Services; staff reports, *The Washington Post* - Mar. 3, 2011

Bathymetric Map: Water Depths of the Atlantic Ocean adjacent to Maryland



Blohm, A., Peichel, J., Ruth, M., Shim, Y., Williamson, S., and Zhu, J., "Maryland Offshore Wind Development: Regulatory Environment, Potential Interconnection Points, Investment Model, and Select Conflict Areas," Center for Integrative Environmental Research (CIER) University of Maryland, October 2010

Atlantic Offshore Wind Projects

- The vast wind resources of the Atlantic Ocean have not been tapped. In contrast, European countries have 948 turbines installed at **43 offshore wind farms** and are producing over 2.3 gigawatts (GW), enough electricity to power **450,000 — 600,000 homes** . China recently completed its first major offshore wind farm, totaling 102 megawatts (MW). Not a single offshore wind turbine is spinning off the Atlantic coast of the United States.
- The European Union and China's offshore wind goals dwarf those of the United States. The European Union and the European Wind Energy Association have set a target of 40 GW of offshore wind by 2020 and **150 GW by 2030**. China has established a target of 30 GW of offshore wind by 2020. The United States Department of Energy (USDOE) recently proposed the development of 10 GW of offshore wind by 2020 and **54 GW by 2030**.
- According to NREL, the Atlantic States would generate **$200 billion in new economic activity** and create more than **43,000 permanent, high-paying jobs** if 54 GW of the 212.98 GW of available offshore wind resources were utilized.

Fisher, C., Patel, S., Bowes, C. and Allegro, J., "*OFFSHORE WIND IN THE ATLANTIC*, Growing Momentum for Jobs, Energy Independence, Clean Air, and Wildlife Protection," the National Wildlife Federation, 2010

U.S. Offshore Wind Potential

	Depth			
Region	0-30 m	30 - 60 m	> 60 m	Total
New England	100.2	136.2	250.4	486.8
Mid-Atlantic	298.1	179.1	92.5	569.7
South Atlantic Bight	134.1	48.8	7.7	190.6
California	4.4	10.5	573.0	587.9
Pacific Northwest	15.1	21.3	305.3	341.7
Great Lakes	176.7	106.4	459.4	742.5
Gulf of Mexico	340.3	120.1	133.3	593.7
Hawaii	2.3	5.5	629.6	637.4
Total	1071.2 GW	628.0 GW	2451.1 GW	4150.3 GW

Offshore wind potential for areas up to 50 nautical miles from shore with average wind speeds 7 m/s or greater at 90 m elevation (W. Musial 2010)

A National Offshore Wind Strategy: Creating an Offshore Wind Energy Industry in the United States. U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, Wind & Water Power Program U.S Department of the Interior, Bureau of Ocean Energy Management, Regulation, and Enforcement, February 2011

Atlantic Offshore Wind Projects

Proposed Projects

Proposed projects have been publicly announced and are at a variety of initial stages in the planning process. MW is listed nameplate capacity.

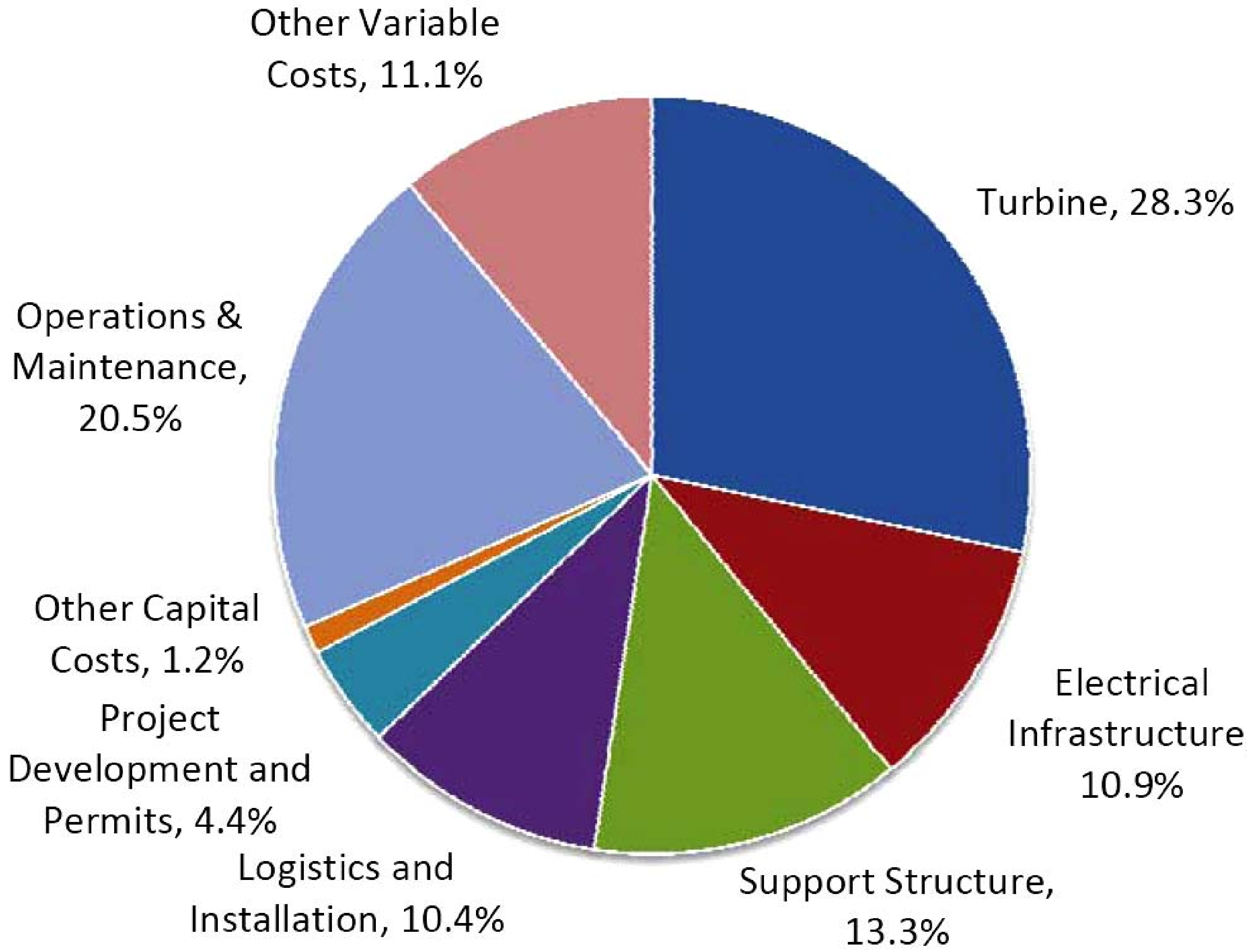
Advancing Projects

Advancing projects meet all of the criteria for proposed projects, and have taken additional steps, including leasing, permitting, power contracts, and other concrete steps toward project completion.

State	Proposed Project	Capacity	Advancing Project	Capacity
MAINE			Demonstration Offshore Wind Farm	25 MW
			Monhegan Island deep water testing site	110 KW
NEW HAMPSHIRE	1 test turbine	10 KW		
MASACHUSETTS	Hull Offshore Wind Energy Project	12 MW	Cape Wind	468 MW
RHODE ISLAND	Rhode Island Sound Wind Farm	384 MW	Block Island Wind Project	28.8 MW
NEW YORK			Long Island-NYC Offshore Wind Project	350 - 700 MW
NEW JERSEY	OffshoreMW	350 MW	Garden State Offshore Energy Project	350 MW
			Fisherman's Energy Atlantic City	20 MW
			Fisherman's Energy Wind Farm	330 MW
			NRG Bluewater Wind Project	350 MW
			OffshoreMW	350 MW
DELAWARE			NRG Bluewater Wind Park	200 - 600 MW
VIRGINIA	Apex Hampton Roads Wind Project	500 MW		
	Seawind Renewble Energy Corp. Wind Farm	400 - 800 MW		
	Hampton Roads Demonstration Project 3 test turbines			
NORTH CAROLINA	Outer Banks Ocean Energy Project	600 MW		
MARYLAND	Ocean City Wind Farm	600 MW		
		3.05 GW		2.82 GW

Fisher, C., Patel, S., Bowes, C. and Allegro, J., "*OFFSHORE WIND IN THE ATLANTIC*, Growing Momentum for Jobs, Energy Independence, Clean Air, and Wildlife Protection," the National Wildlife Federation, 2010

Cost Breakdown



Estimated life-cycle cost breakdown for a typical offshore wind project (W. Musial 2010).

A National Offshore Wind Strategy: Creating an Offshore Wind Energy Industry in the United States. U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, Wind & Water Power Program U.S Department of the Interior, Bureau of Ocean Energy Management, Regulation, and Enforcement, February 2011

Loads Leading to Structural Failure

a) Dead loads
   i) Self Wt, Plant, Equipment, TR/Accommodation.
b) Live loads
   i) Process & other inventory, laydown, general
c) All environmental loads:
   i)Hydraulic pressure
   ii)Wave
   iii)Current
   iv)Wind
d)Earthquake
e)Accidental loads
   i)Fire
   ii)Explosion
   iii)Gas release
   iv)Vessel impact
   v)Dropped object

Birkinshaw, M., “Providing an Outline of Information Expected to be provided In Safety Cases,” UK Health and Safety Executive, OSD 4.2, Basingstoke UK, June 2009.

Foundation Design Considerations

Foundation Design Loads:

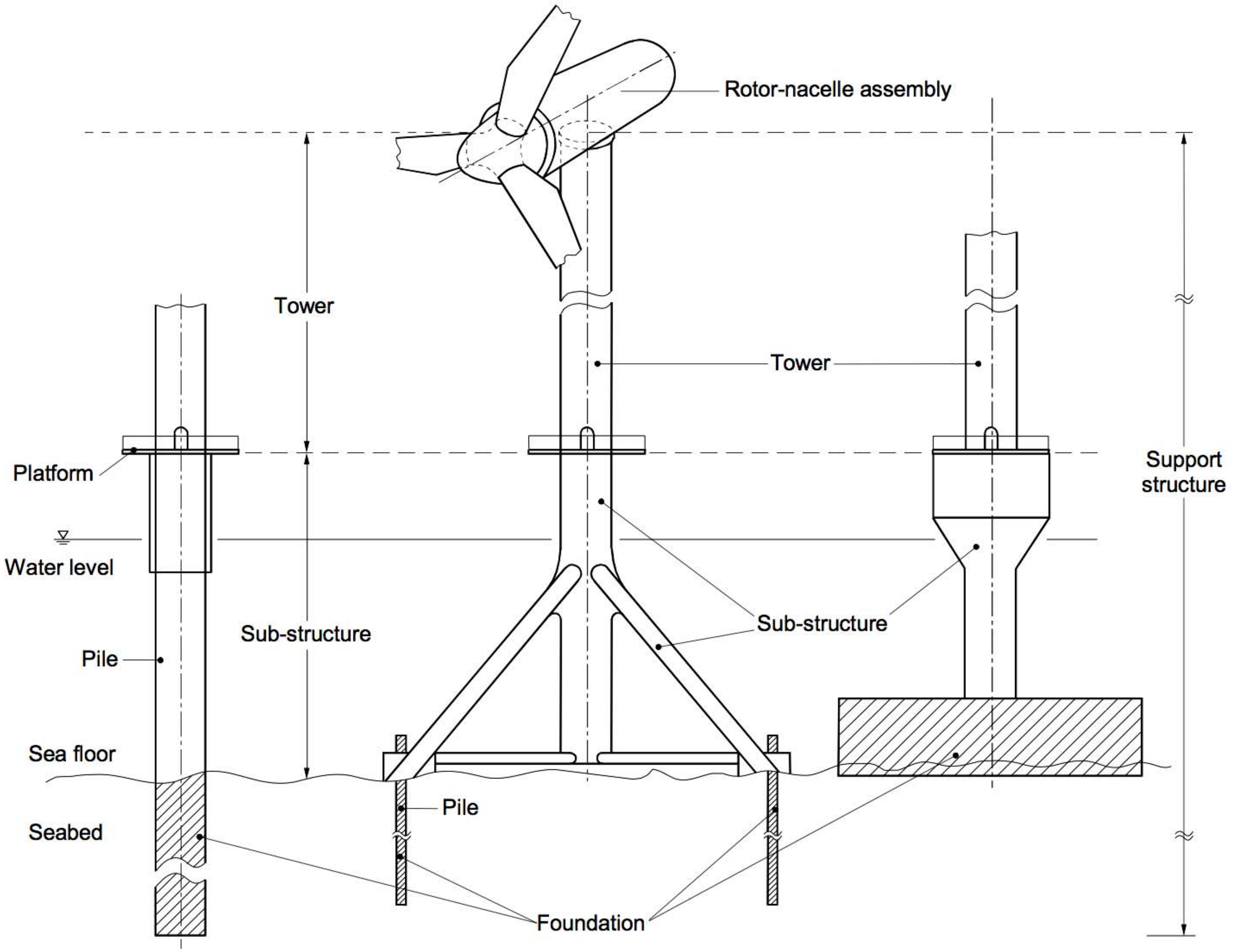
- soil conditions,
- depth,
- current,
- wave climate,
- turbine or wave energy type,
- access,
- local environmental impacts,
- and supply chain issues such as vessels and manufacturing.

Musial, W. 2011. E-mail Communication, Walt Musial, U.S. Department of Energy, National Renewable Energy Laboratory, Golden, CO. February 18, 2011.

Referenced ISO Standards

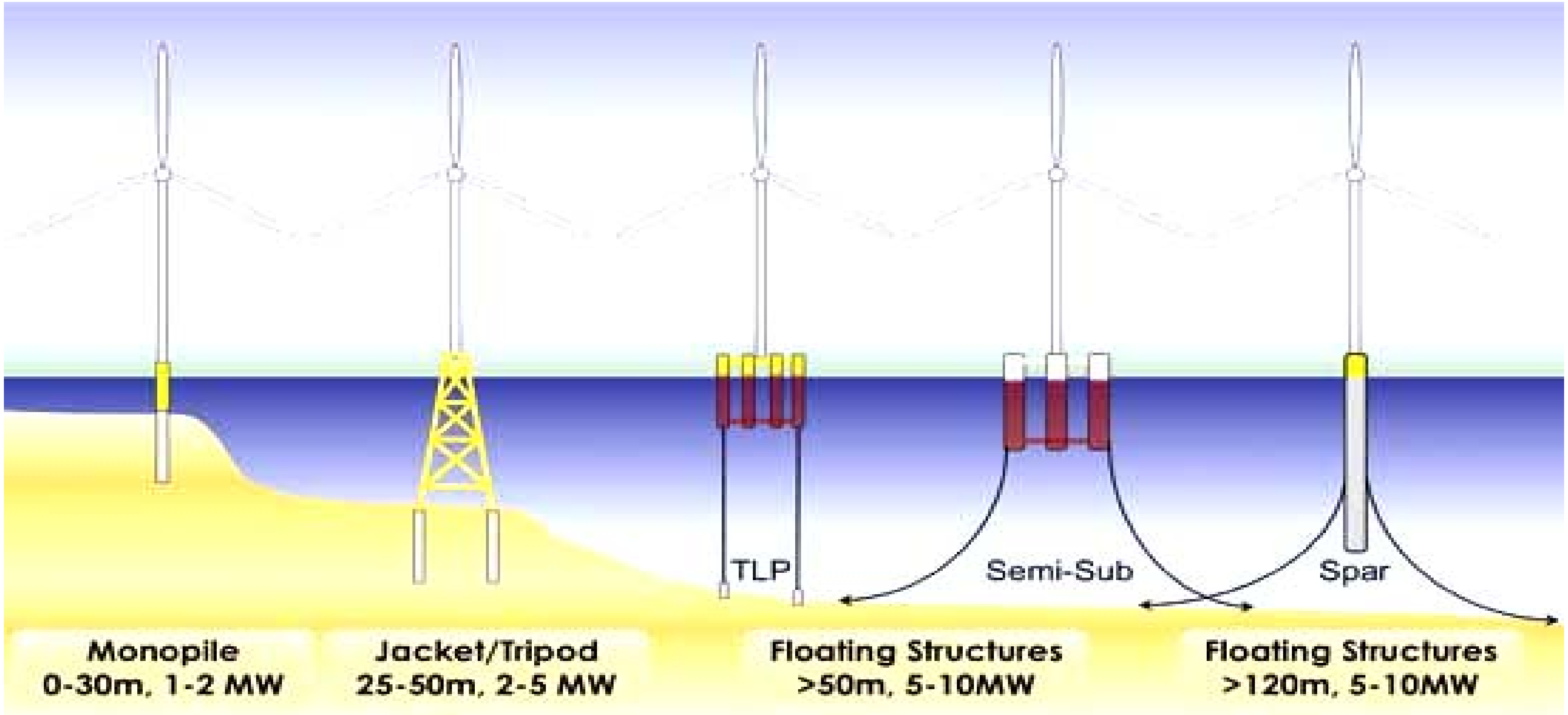
General Requirements for Offshore Structures	ISO 19900
Metocean Requirements	ISO 19901 -1
Seismic Requirements	ISO 19901 - 2
Topsides Requirements	ISO 19901 - 3
Foundation Requirements	ISO 19901 - 4
Weight Engineering	ISO 19901 - 5
Marine Operations	ISO 19901 - 6
Stationkeeping	ISO 19901 - 7
Marine Soil Investigation	ISO 19901 - 8
Fixed Steel Structures	ISO 19902
Fixed Concrete Structures	ISO 19903
Floating – MSS	ISO 19904 - 1
MOUs - Jackups	19905 - 1

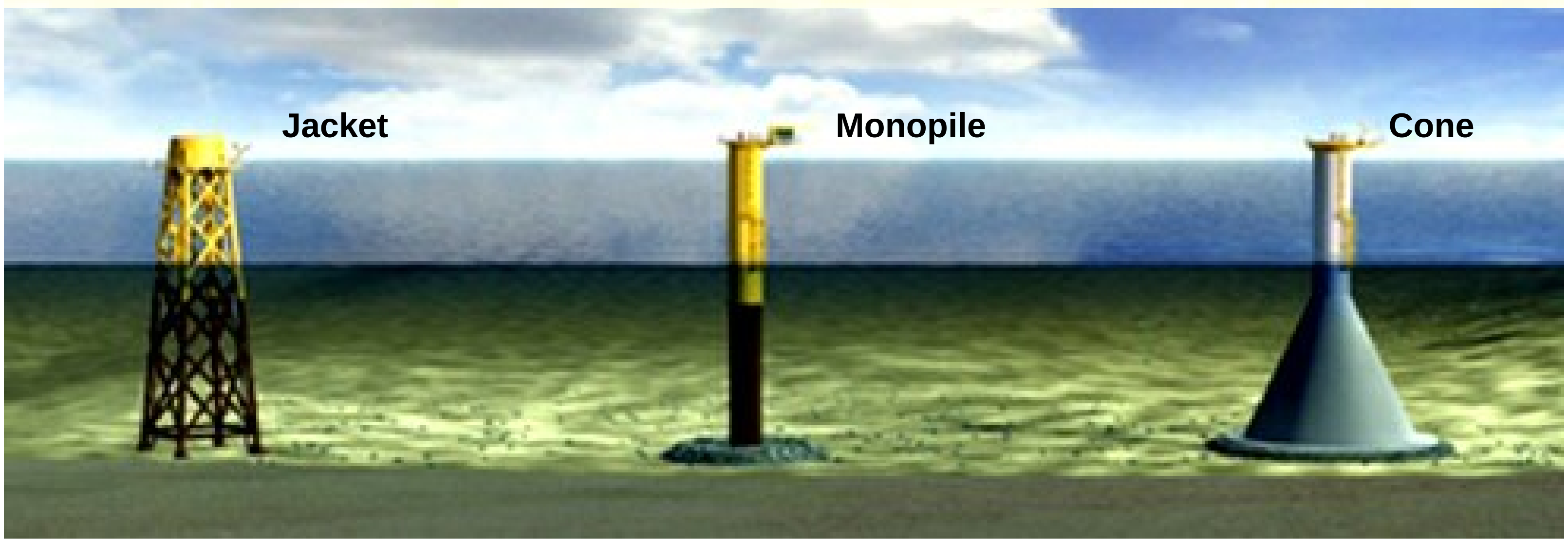
Parts of an offshore wind turbine



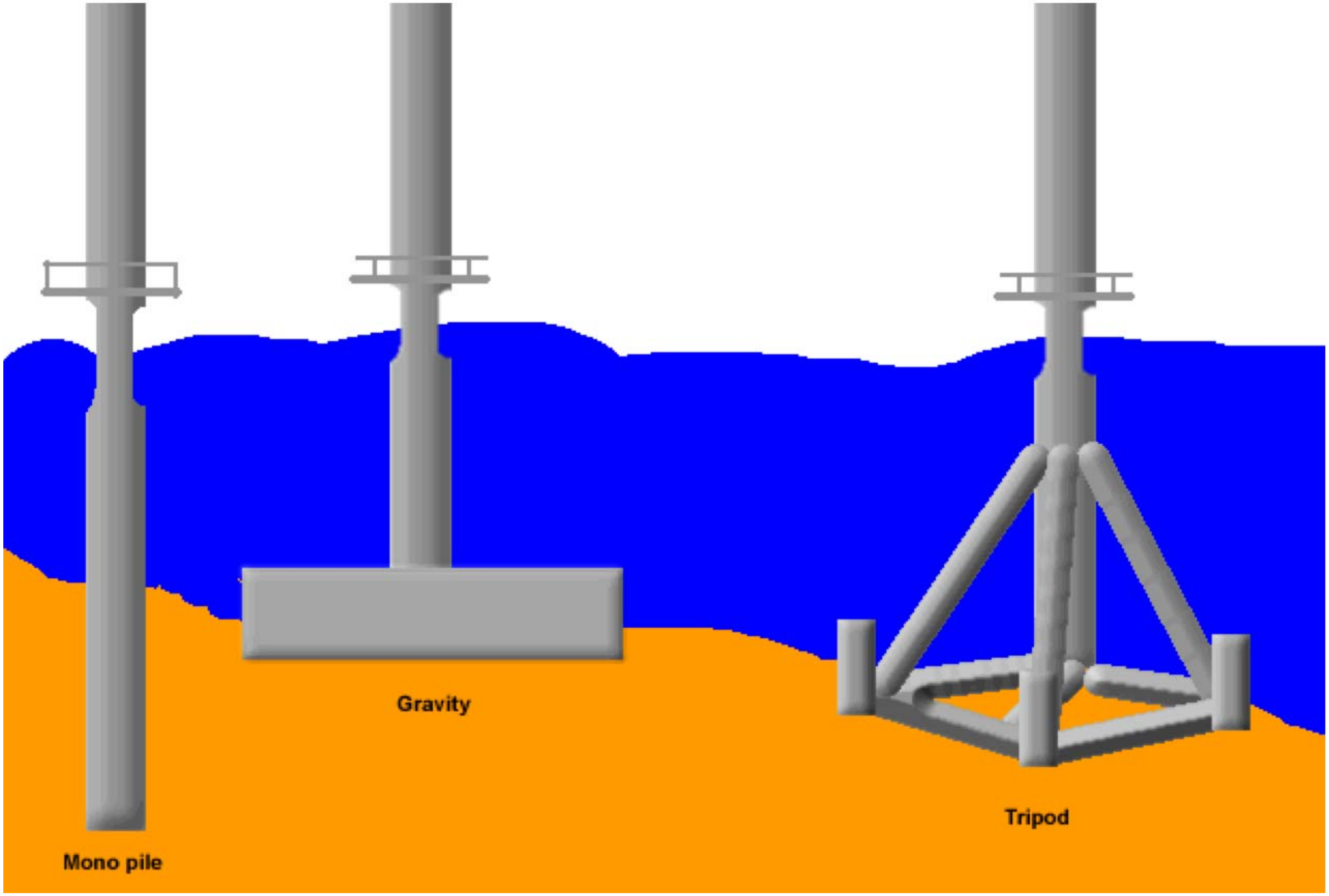
IEC 61400-3, INTERNATIONAL STANDARD, Wind turbines – Part 3: Design requirements for offshore wind turbines, International Electrotechnical Commission, 2009

Types of offshore wind turbine foundations

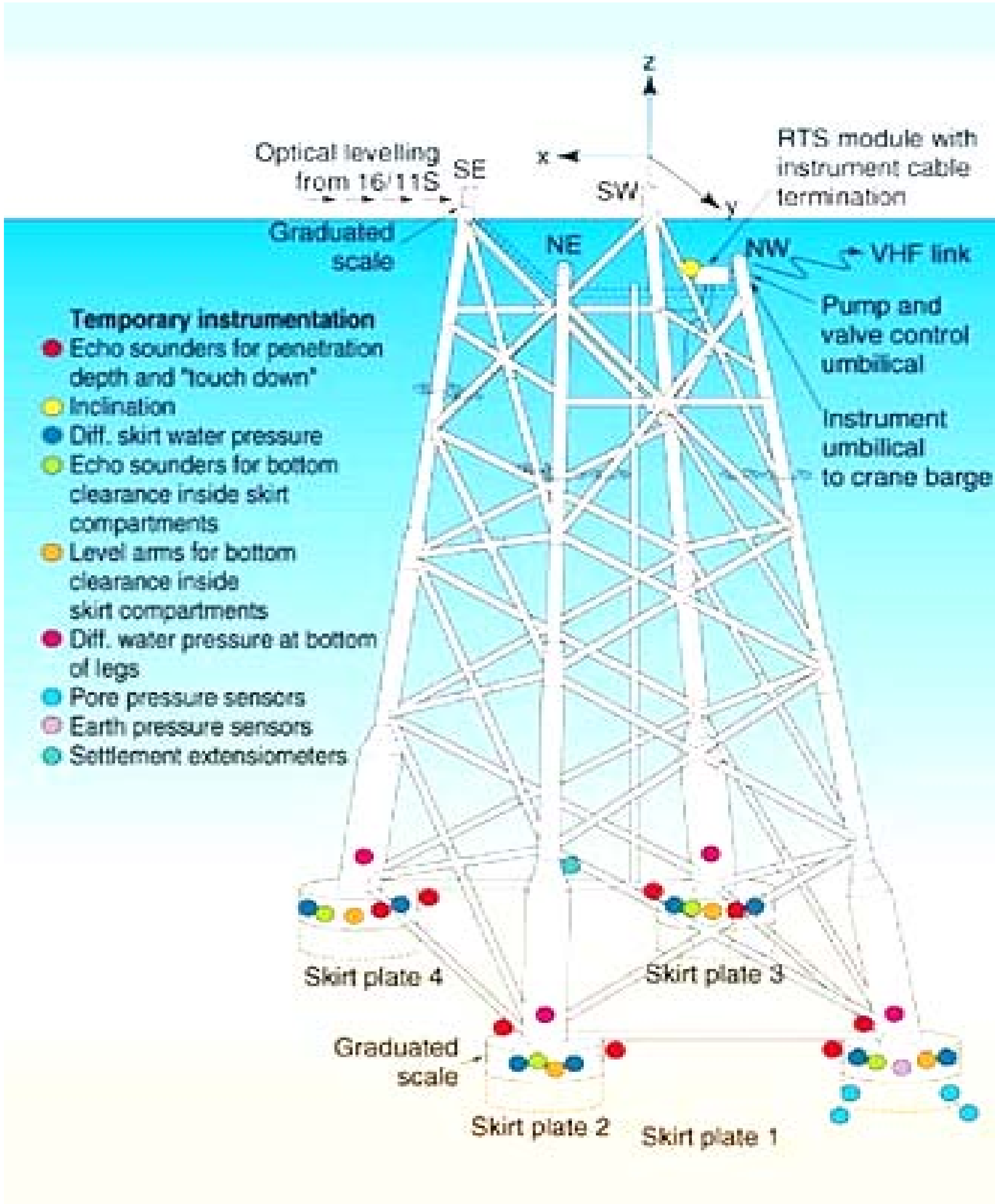




Fixed Platforms



Fixed Platforms

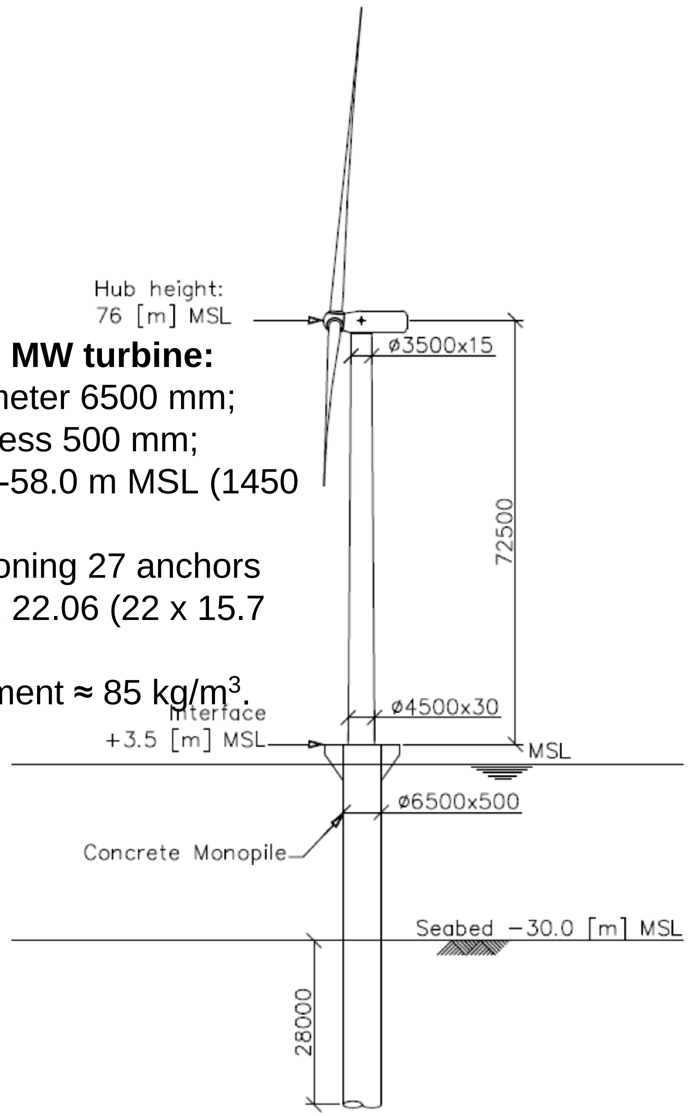


Drilled Concrete Monopile

Vattenfall study project “Foundation Concepts for the Kriegers Flak Wind farm”, Ballast Nedam Offshore and MT Piling have studied Drilled Concrete Monopile

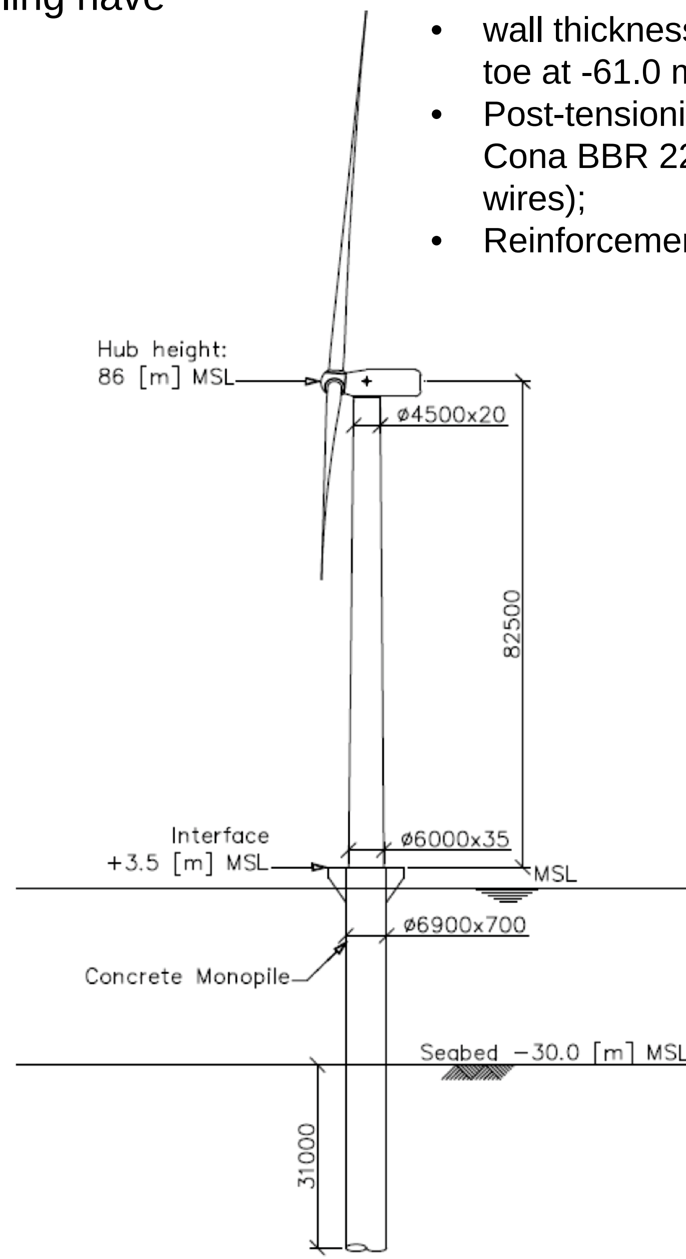
Monopile for 3.6 MW turbine:

- Outer diameter 6500 mm;
- wall thickness 500 mm;
- pile toe at -58.0 m MSL (1450 ton);
- Post-tensioning 27 anchors Cona BBR 22.06 (22 x 15.7 wires);
- Reinforcement ≈ 85 kg/m^3.



Monopile for 5.0 MW turbine:

- Outer diameter 6900 mm;
- wall thickness 700 mm; pile toe at -61.0 m MSL (2200 ton);
- Post-tensioning 37 anchors Cona BBR 22.06 (22 x 15.7 wires);
- Reinforcement ≈ 65 kg/m^3.



Drilled Concrete Monopile

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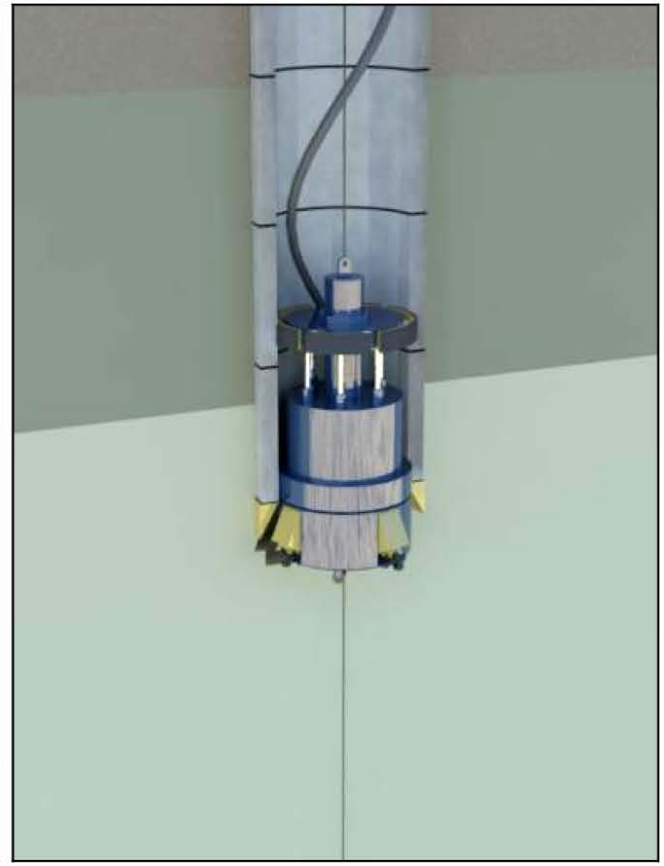
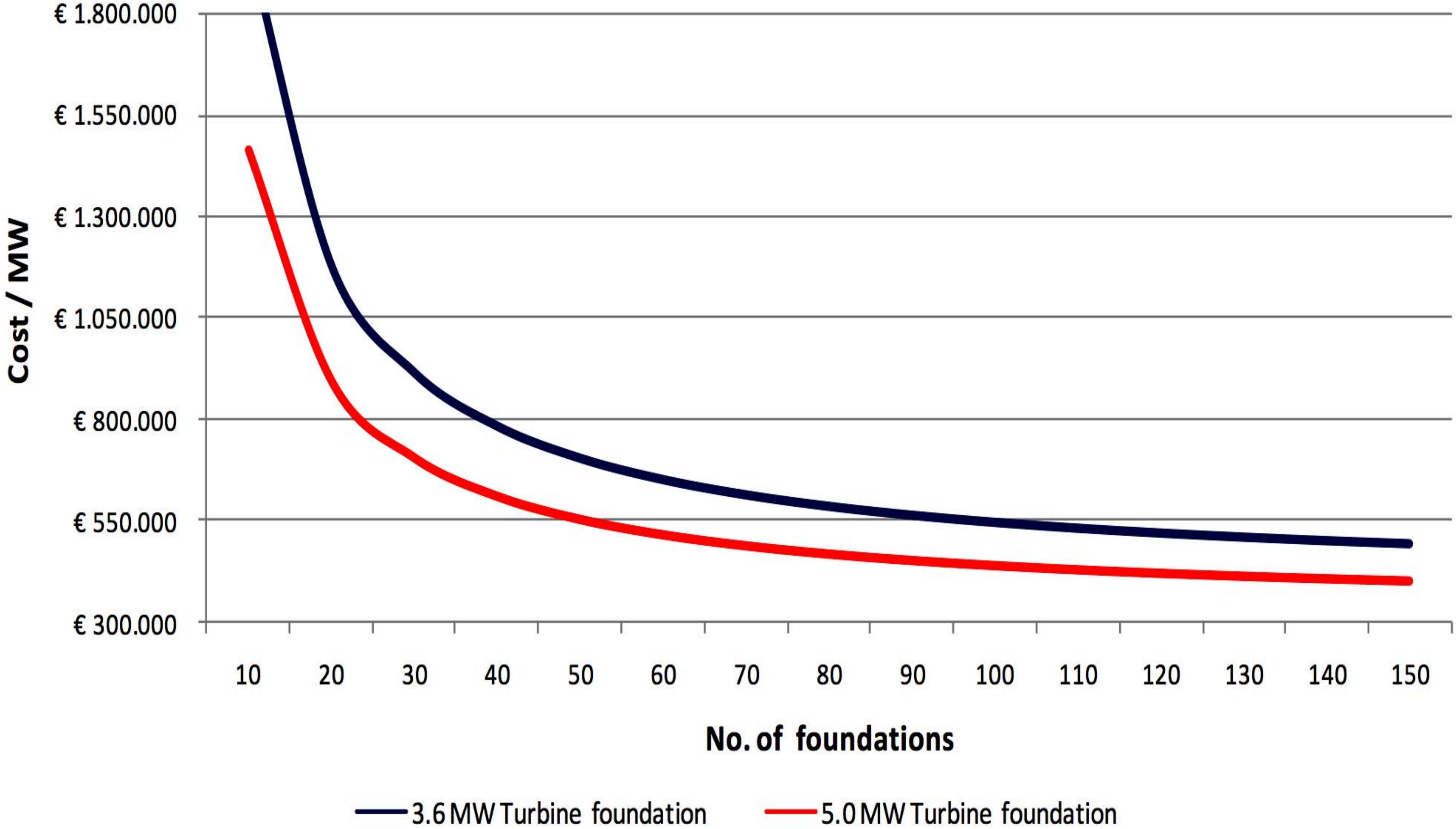


The drilling machine is lowered into the monopile and hydraulically clamped; Drilling starts inside the monopile and after settling stops drilling will continue underneath the monopile until final depth is reached. During settling a self hardening lubrication fluid will be injected in the overcut; After completion of the drilling process, the drilling machine is lifted out of the monopile

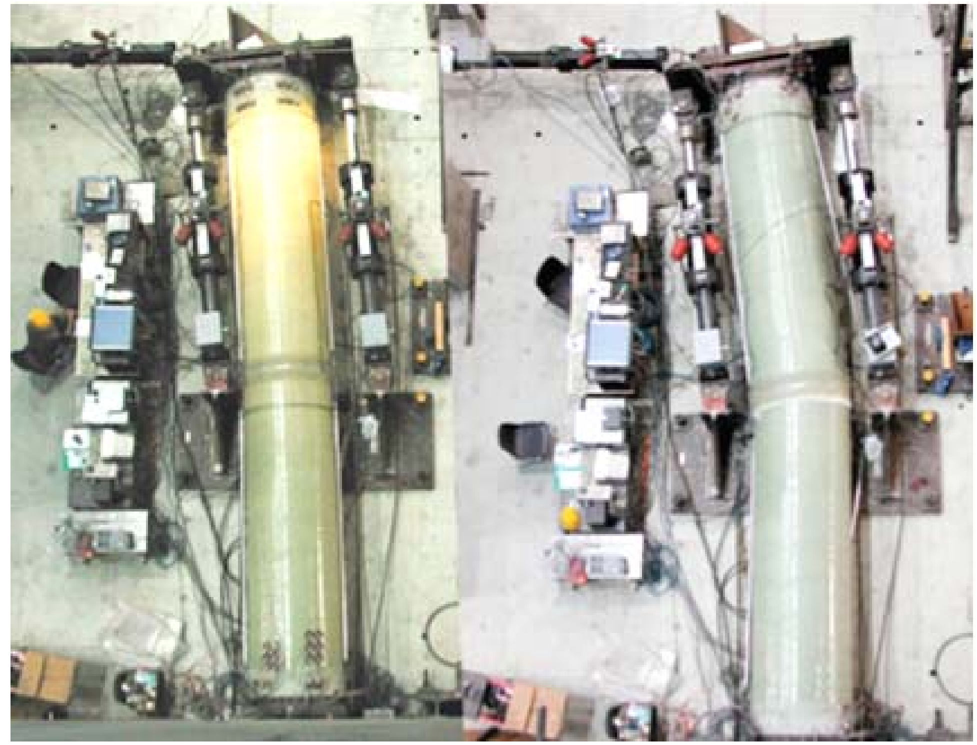
Est. Drilled Concrete Monopile Installation Cost

Ballast-Nedam Offshore



Platform Foundations

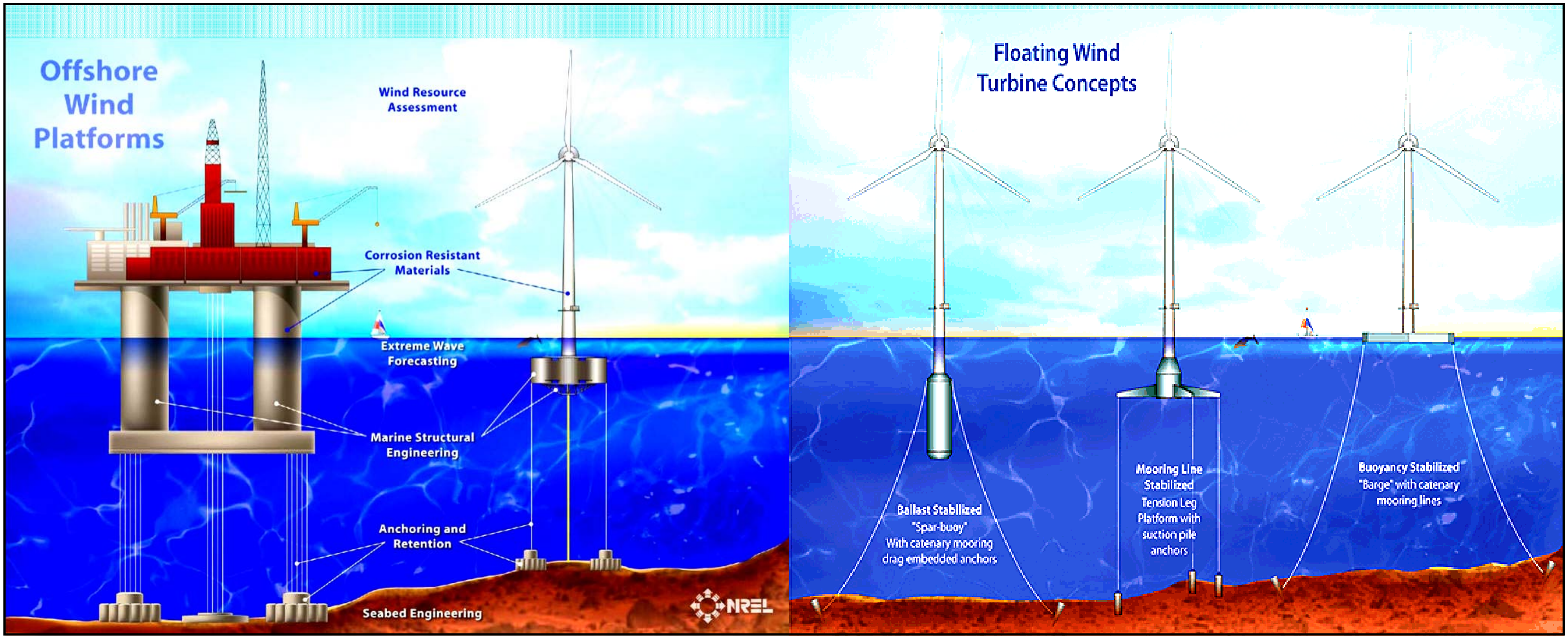
Floating Power Plant has a 37 meter model for a full off-shore test off the coast of Lolland in Denmark.



During the MEGAWIND project, testing of this one-third-scale, filament-wound, monolithic-shell tower was conducted at the ELSA laboratory of the JRC, European Commission, Ispra, Italy.

The Flat Faced Tripod needs three large 96-inch (243 cm) diameter piles but no cast components

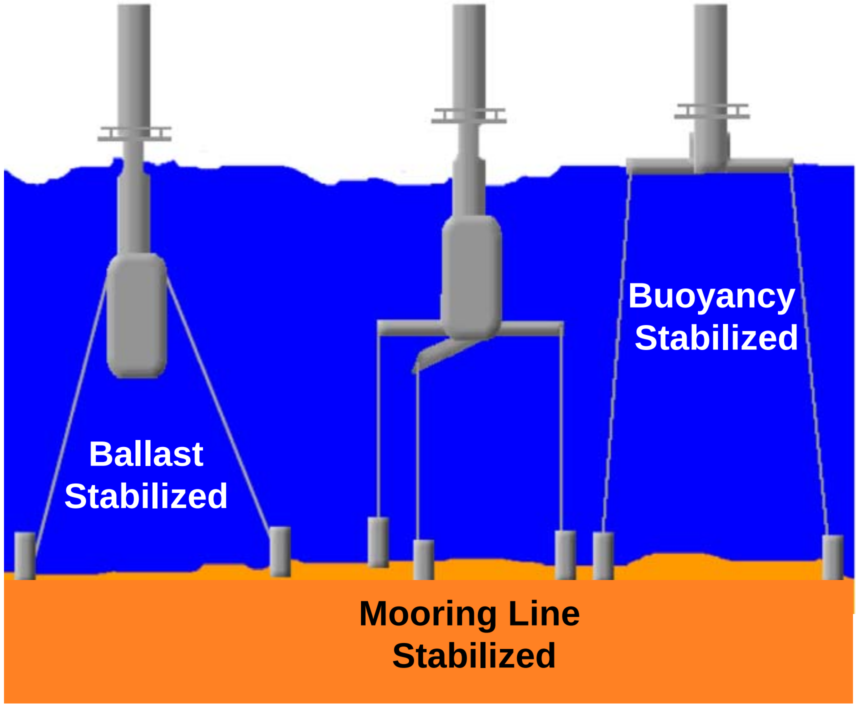
Floating Platforms

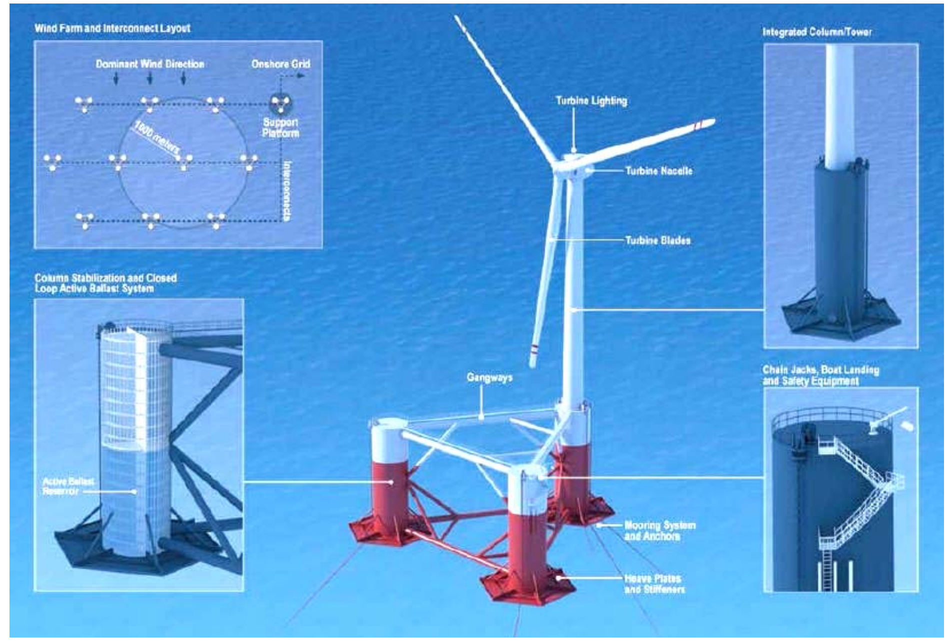


Semi-Submersible Platforms | **Ballast Stabilized** | **Mooring Line Stabilized** | **Buoyancy Stabilized**

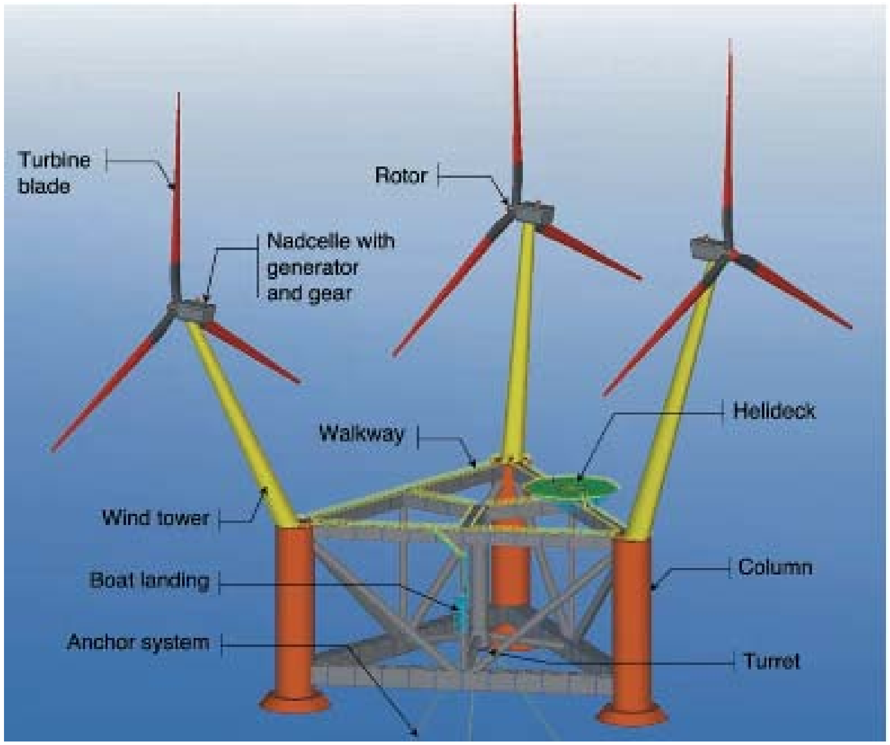
courtesy of National Renewable Energy Lab, Boulder, CO

Floating Platform Concepts





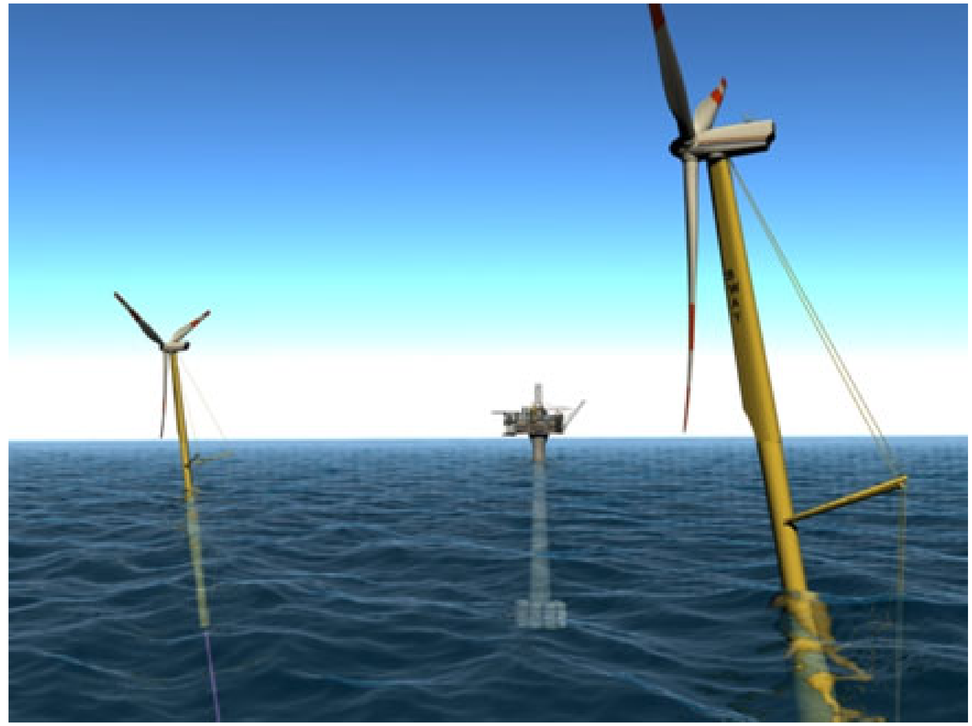
Semi-Submersible Platforms



WindSea is a three-sided semi-submersible vessel with corner columns, each supporting one wind turbine.

- All construction is performed at yard, including turbine installation
- The floater is tugged to the mooring lines offshore
- Self orientating towards the wind
- Easy access for inspection and maintenance
- Easily disconnected from the turret and tugged to the yard for modification or more extensive maintenance

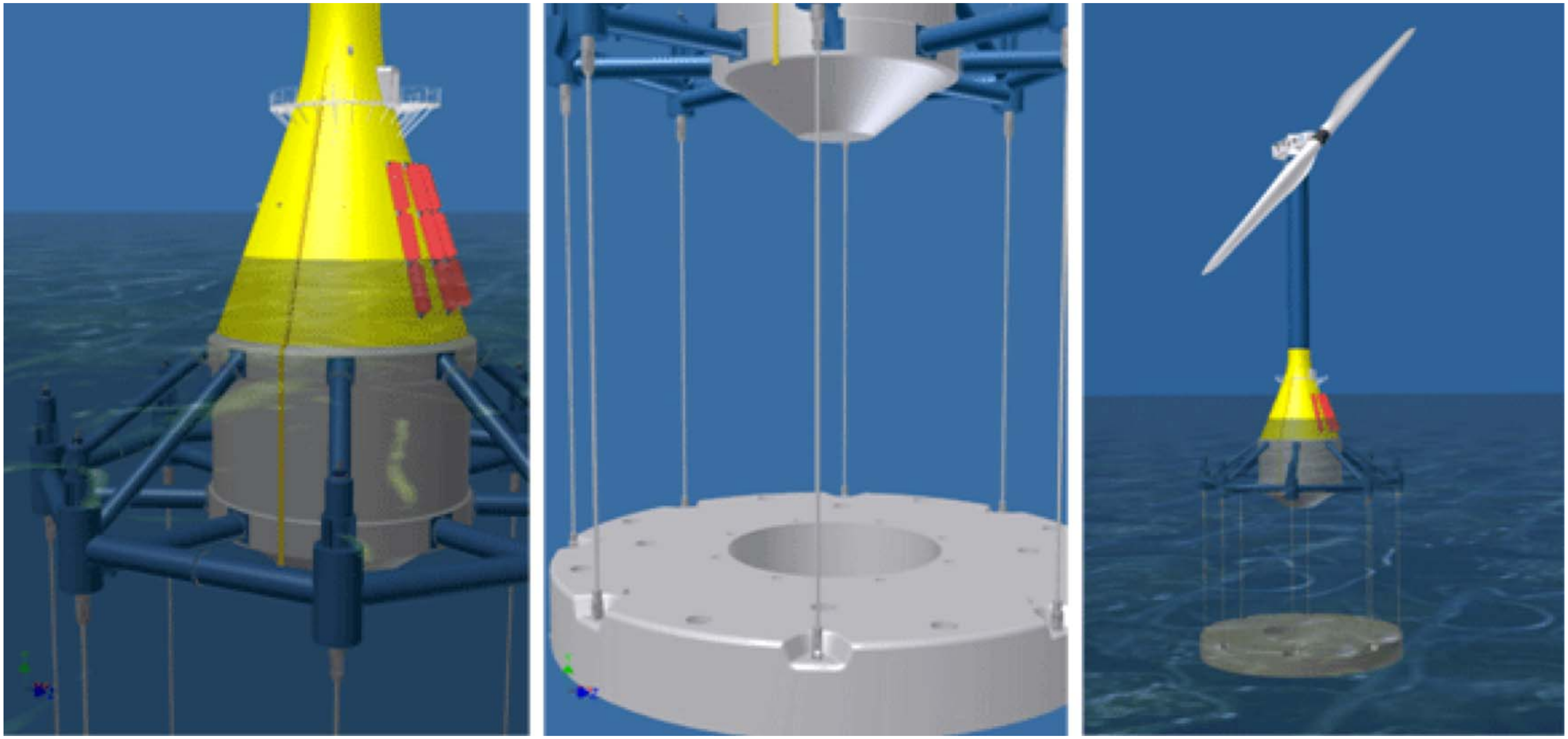
Ballast Stabilized Floating Platforms



The SWAY technology utilizes a “downstream” turbine design with aerodynamic turbine housing and support spar.

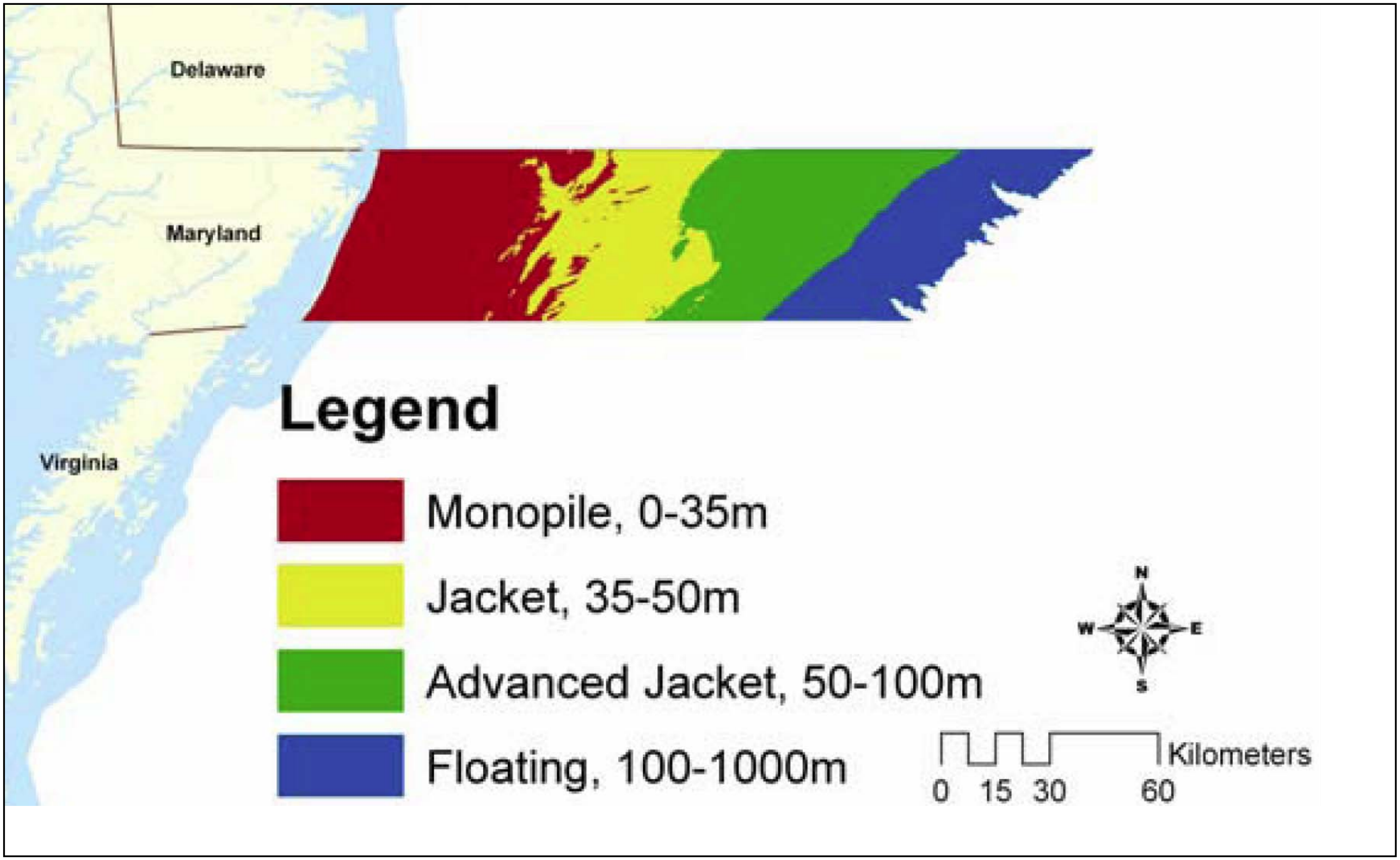
StatoiHydro (Norway) is investing $79M to build a 2.3 MW offshore windmill. The floating wind turbine can be anchored in water depths from 120 to 700 meters.

Submerged Tension Leg Platforms



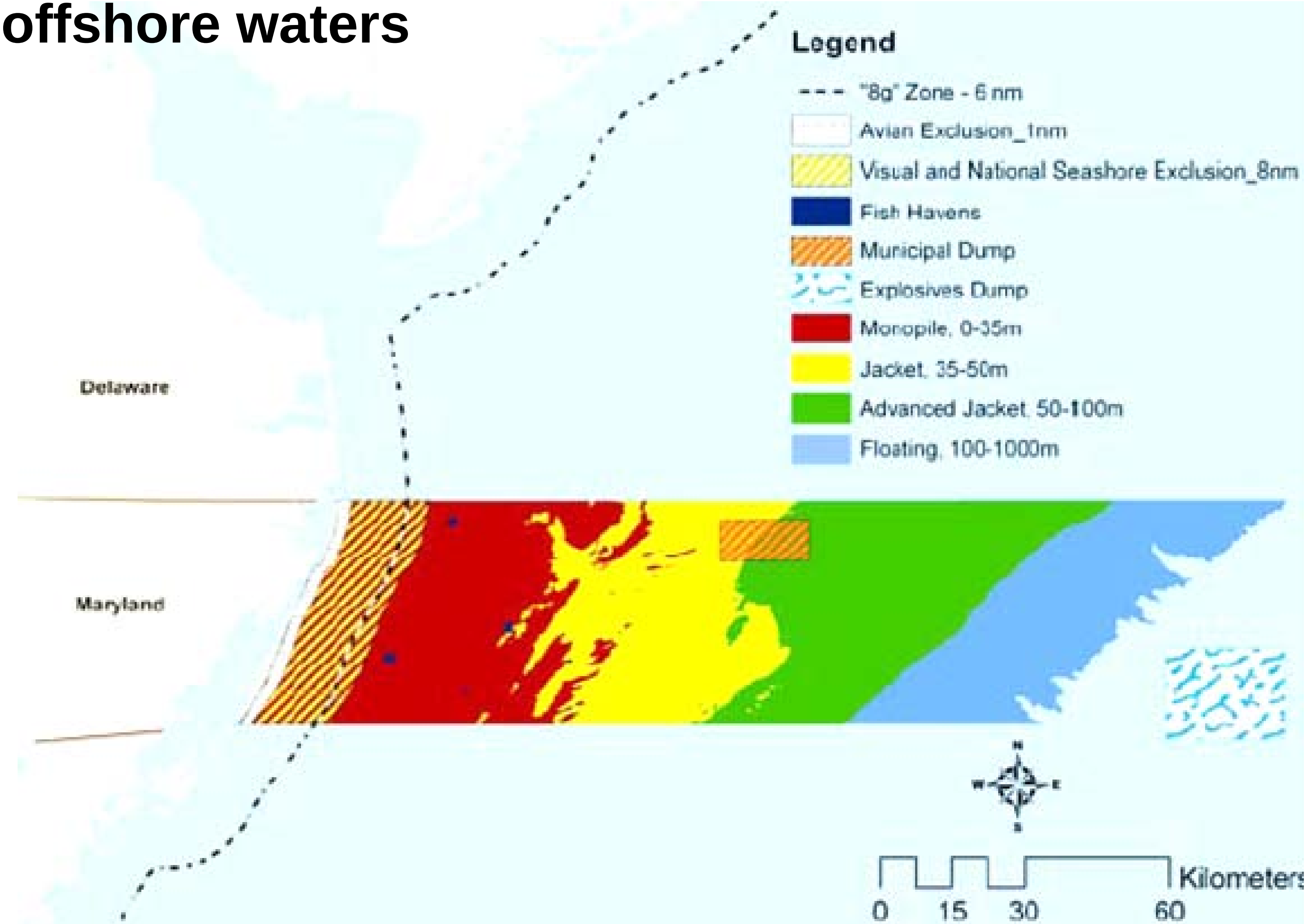
Blue H’s patented Submerged Deepwater Platform (“SDP”). Each SDP consists of a hollow body, which provides the buoyancy, which is held “semi-submerged” under water by chains or tethers which connect the buoyant body to a counterweight which lies on the sea bottom.

Maryland foundations by bathymetry regions



Firestone, J., Kempton, W., Sheridan, B., and Baker, S., “Maryland’s Offshore Wind Power Potential,” sponsored by the Abell Foundation, University of Delaware’s Center for Carbon-free Power Integration, College of Earth, Ocean, and Environment, February 2010.

Activities and possible foundations for Maryland's offshore waters



Firestone, J., Kempton, W., Sheridan, B., and Baker, S., "Maryland's Offshore Wind Power Potential," sponsored by the Abell Foundation, University of Delaware's Center for Carbon-free Power Integration, College of Earth, Ocean, and Environment, February 2010.