North American Offshore Wind Projects

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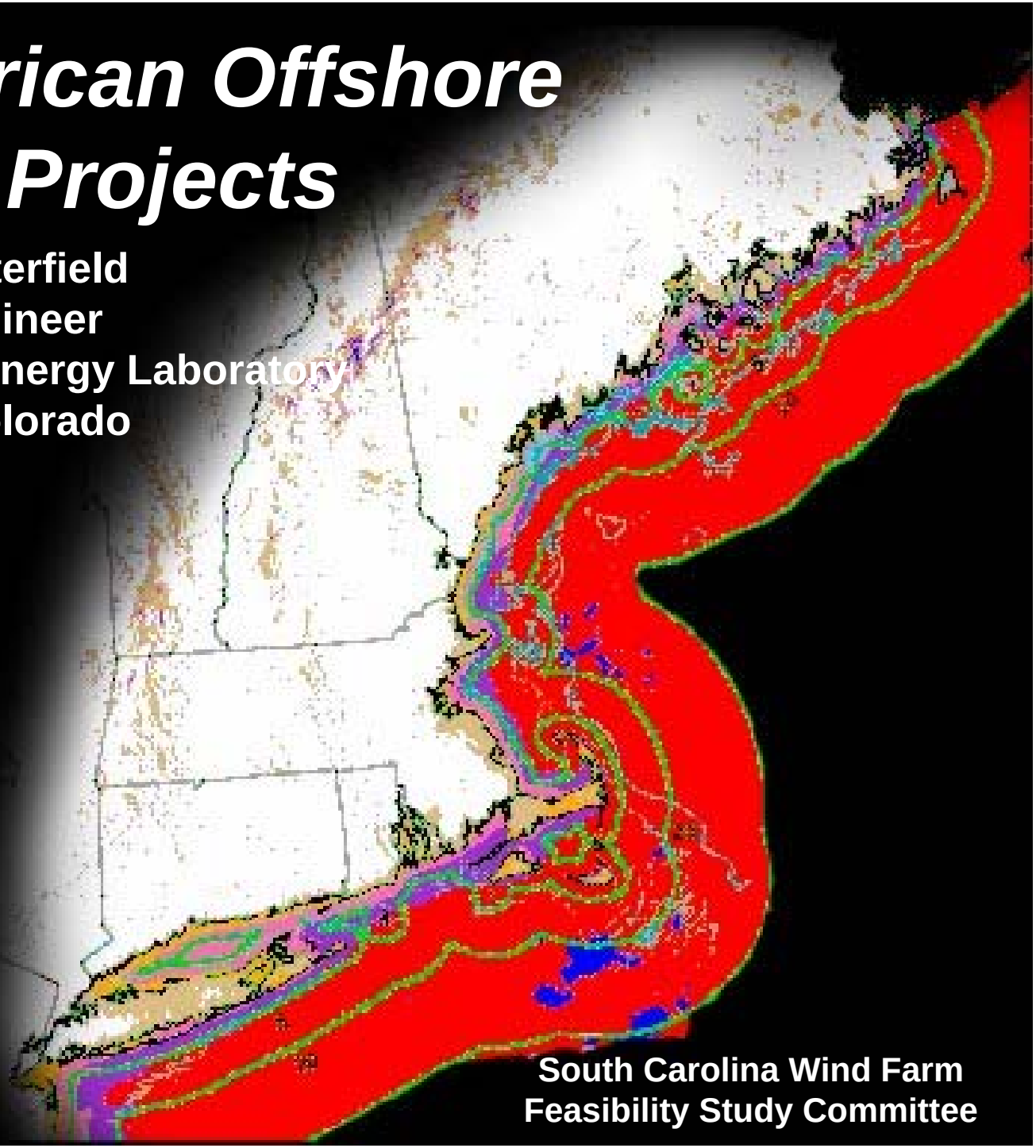
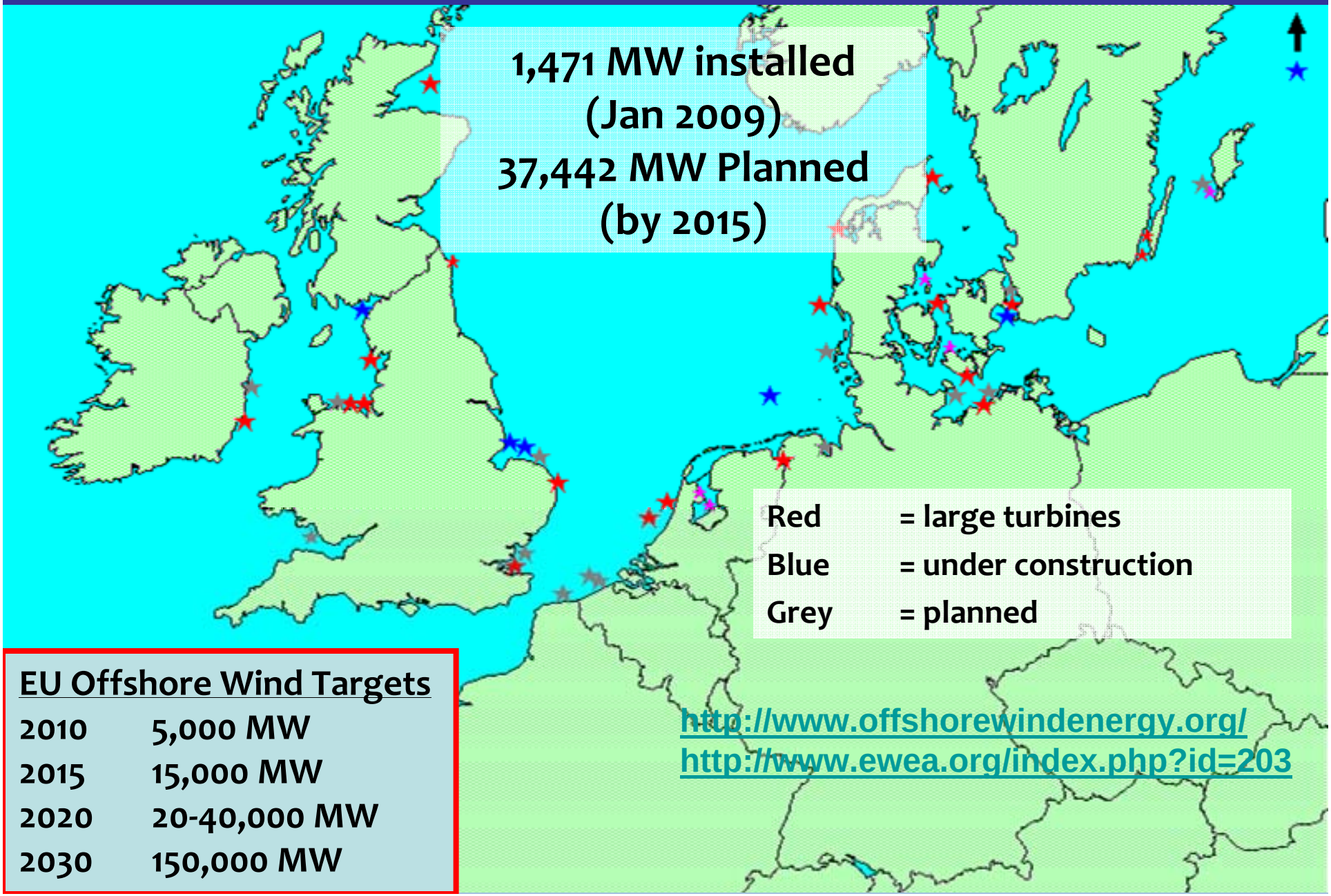


South Carolina Wind Farm Feasibility Study Committee

Offshore Wind Projects

European Activity Offshore Wind

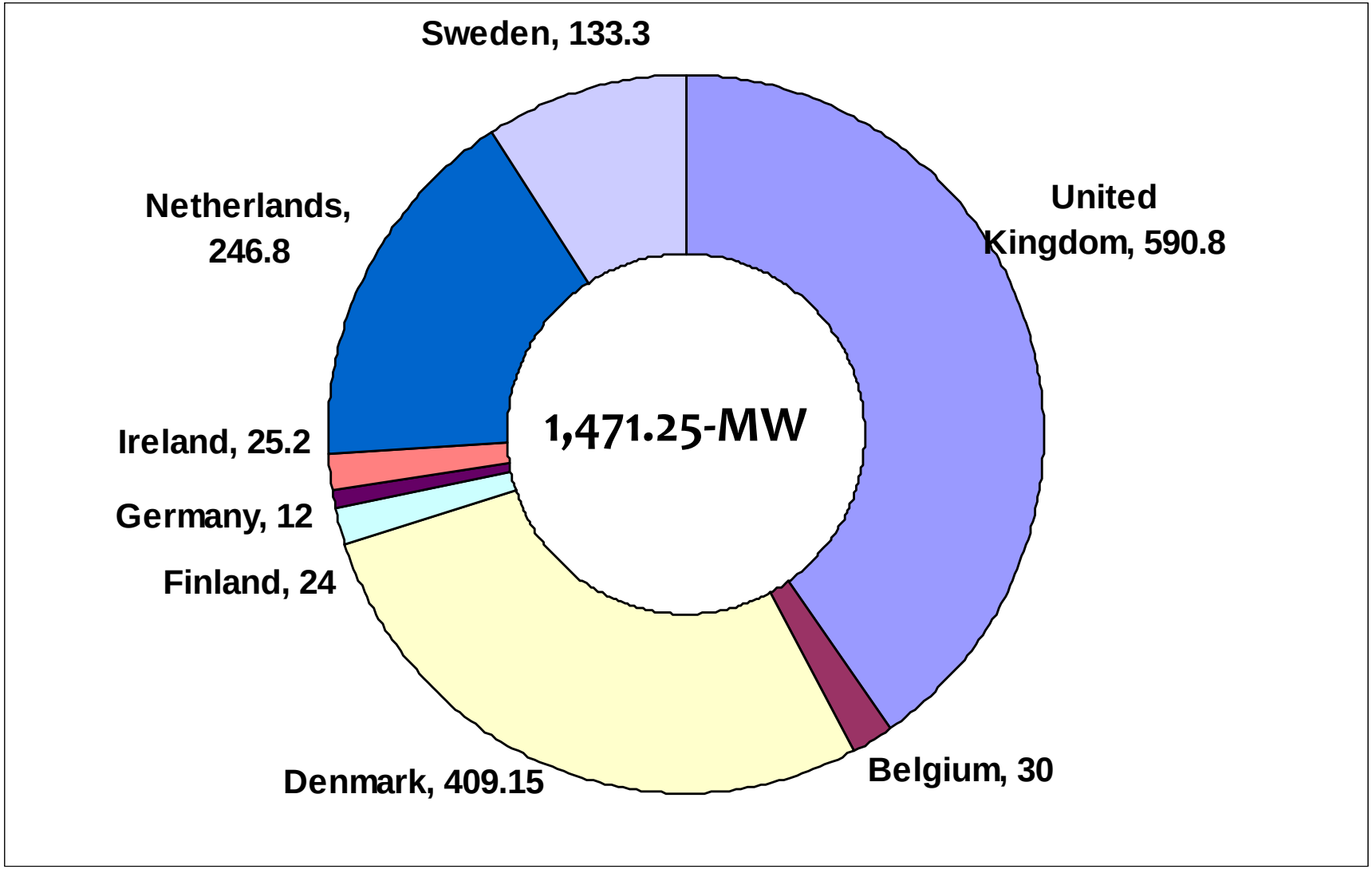


EU Offshore Wind Targets

2010	5,000 MW
2015	15,000 MW
2020	20-40,000 MW
2030	150,000 MW

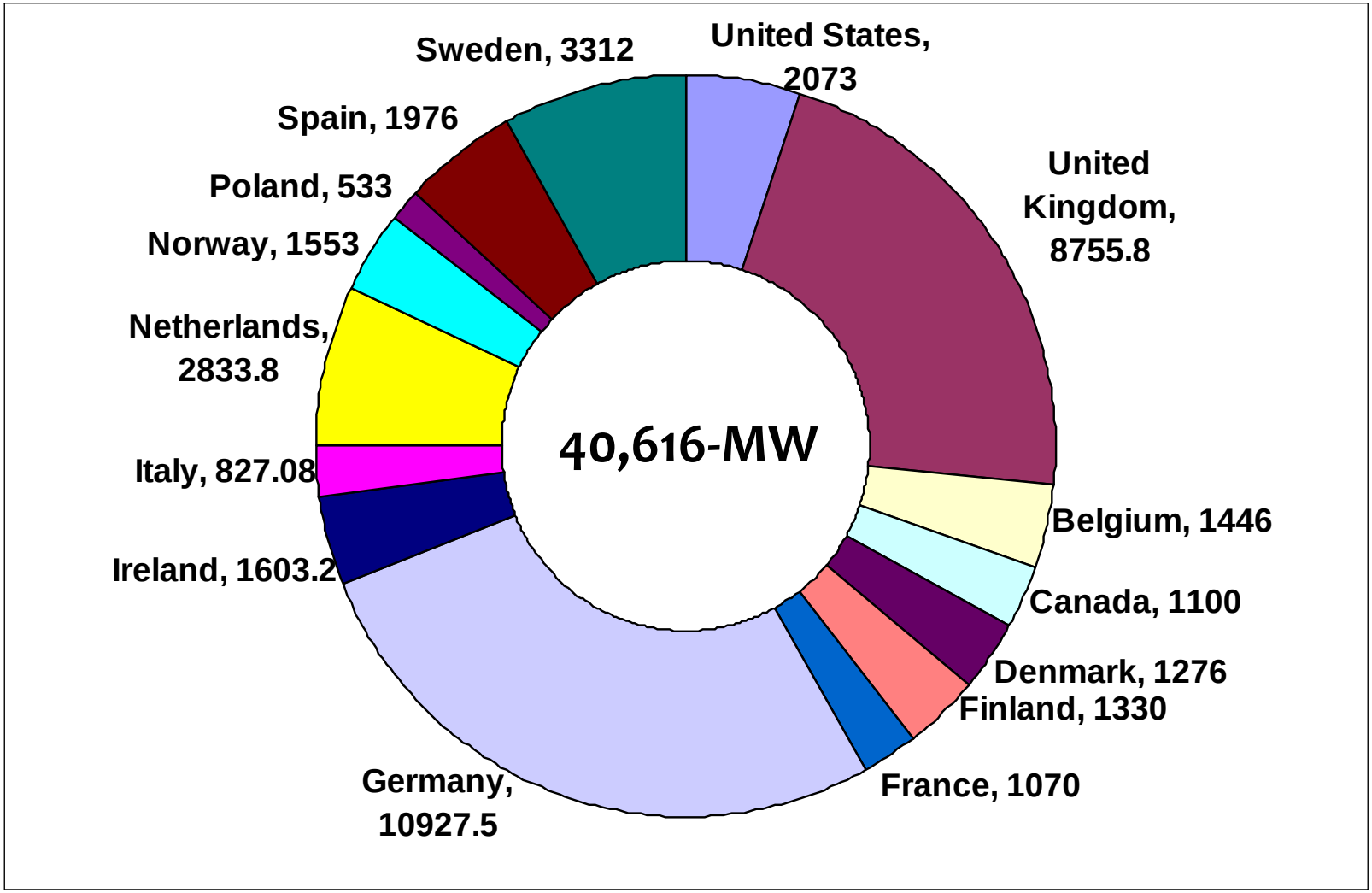
http://www.offshorewindenergy.org/
http://www.ewea.org/index.php?id=203

Current Installed Offshore Capacity
(Country, MW Installed at the end of 2008)



http://www.ewea.org/index.php?id=203

Projects Planned by 2015
Europe and North America



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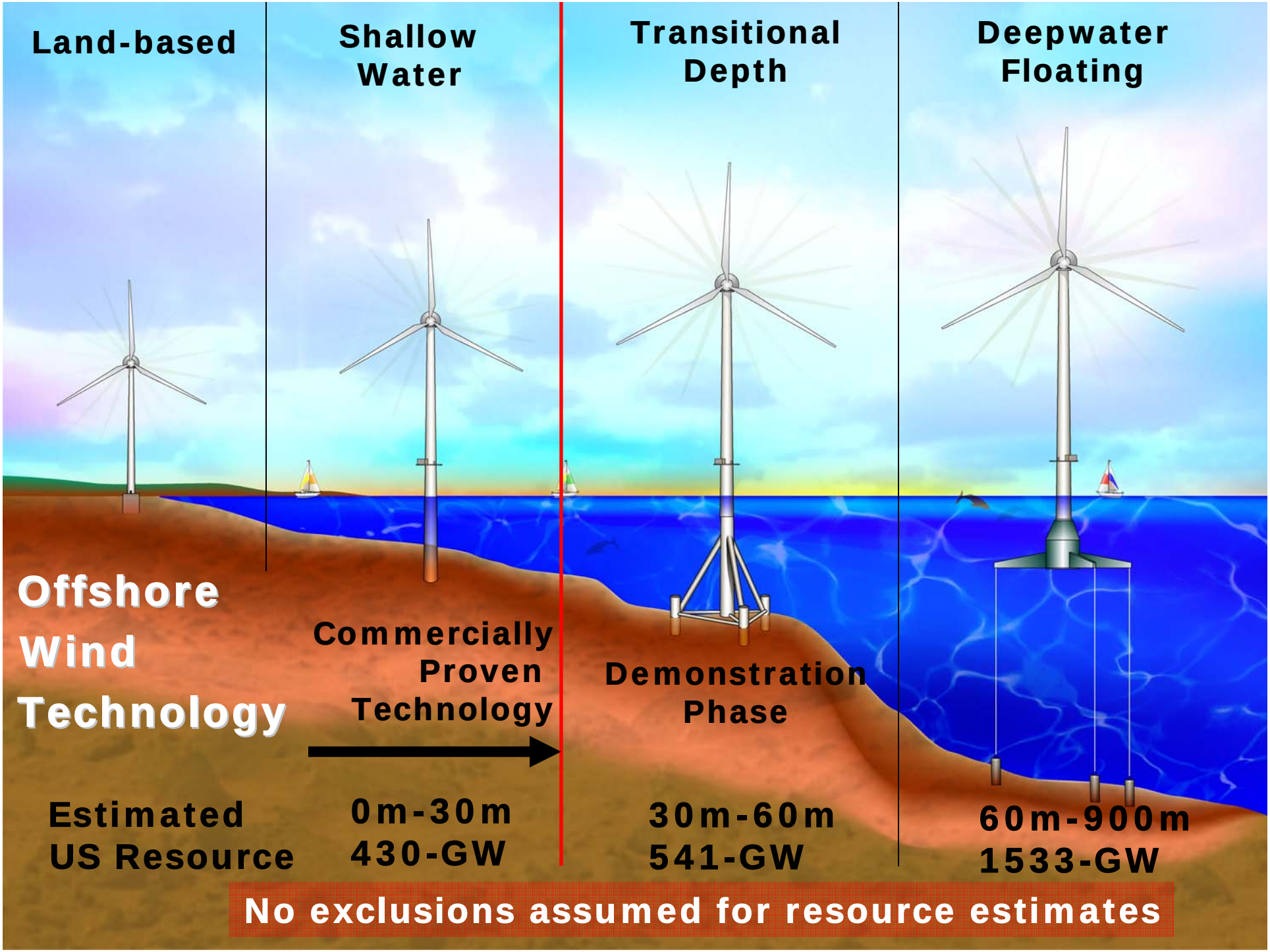
Presentation Scope

- *"Approximately 30 offshore wind projects have been announced in North America".*
- *"This presentation will provide brief overviews of the projects announced to date in various regions".*


Land-based
Shallow Water
Transitional Depth
Deepwater Floating
Offshore Wind Technology
Commercially Proven Technology
Demonstration Phase
Estimated US Resource
0m-30m 430-GW
30m-60m 541-GW
60m-900m 1533-GW
No exclusions assumed for resource estimates

Commercial Offshore Wind Technology

Vestas 2.0 MW Turbine
Horns Rev, DK

Talisman Energy:
Repower 5-MW
Beatrice Fields,
Scotland

GE 3.6 MW Turbine
Arklow Banks

Seimens 2.3 MW Turbines
Middlegrunden, DK

- Initial development and demonstration stage; 22 projects, 1,471 MW installed
- Fixed bottom shallow water 0-30m depth
- 2 – 5 MW upwind rotor configurations
- 70+ meter tower height on monopoles and gravity bases
- Mature technology for submarine power cable
- Existing oil and gas experience is essential
- Reliability problems and turbine shortages have discouraged early boom in development.
- Cost are not well established in the US.

Monopile Foundations

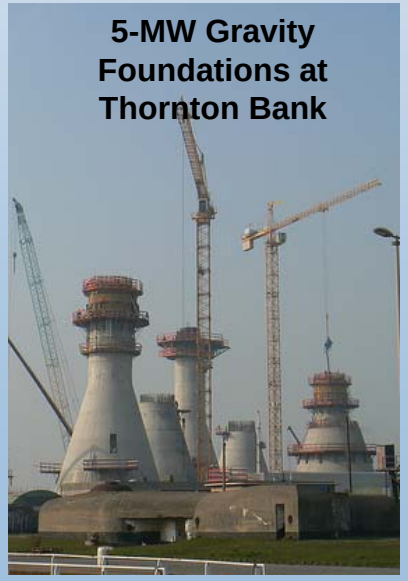
Pile Hammer
Credit: DONG Energy

- Most common type
- Driven or drilled 25-30m embedment
- Stiff soils only (e.g. sand)
- 4.5 - 5 m diameter steel tube typical
- Wall thickness 30 - 60 mm
- Minimal Footprint
- Water depth experience to 28-m

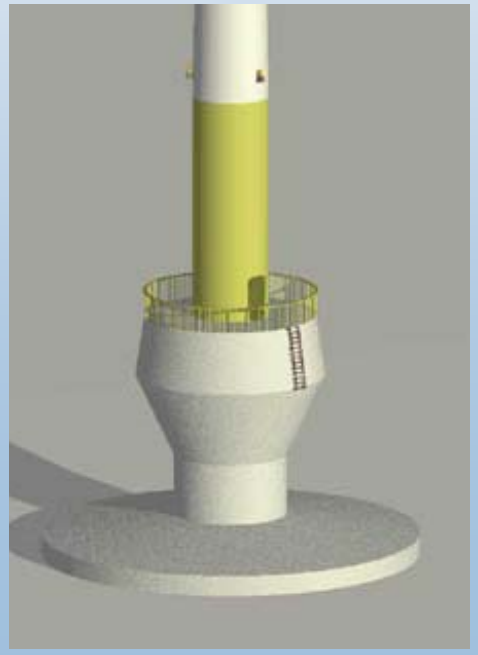
Transition Pieces
Credit: DONG Energy

Credit: GE Energy

Gravity Base Foundations



5-MW Gravity Foundations at Thornton Bank



- Steel or concrete
- Relies on weight of structure to resist overturning
- Ballast added after placement
- Seabed preparation essential
- Examples: Siemens turbines at Nysted and Samsø.
- New project underway at Thornton Bank in Belgium.
- Depth experience to 30-m

5-MW Gravity Foundations at Thornton Bank

Commercial Offshore Wind Turbines

Turbine Manufacturer	Turbine model & rated power	Date of availability	Offshore Operating Experience
Siemens	SWT-2.0 - 2.0 MW	2000	Commercial
Vestas	V80 - 2 MW	2000	Commercial
General Electric	GE – 3.6-MW	2003	Commercially inactive
Siemens	SWT-2.3 - 2.3 MW	2003	Commercial
Vestas	V90 - 3 MW	2004	Commercial
Siemens	SWT-3.6 - 3.6 MW	2005	Commercial
RePower Systems (Suzilon)	5M - 5 MW	2005	45-M Demonstration Offshore Commercial
Multibrid (Areva)	M5000 - 5 MW	2005	Onshore 2005 Borkum West Pilot

Progress Toward Commercial Viability and Technical Maturity

Floating Wind Systems

Multi-pile Foundation Technology in 30-45m depths with Commercial Turbines

Multi-pile Foundation Technology in depths >45 m with Commercial Turbines

Commercial Offshore Turbines on Monopiles and Gravity Foundations <30M depths

Concept Development

Proof of Concept

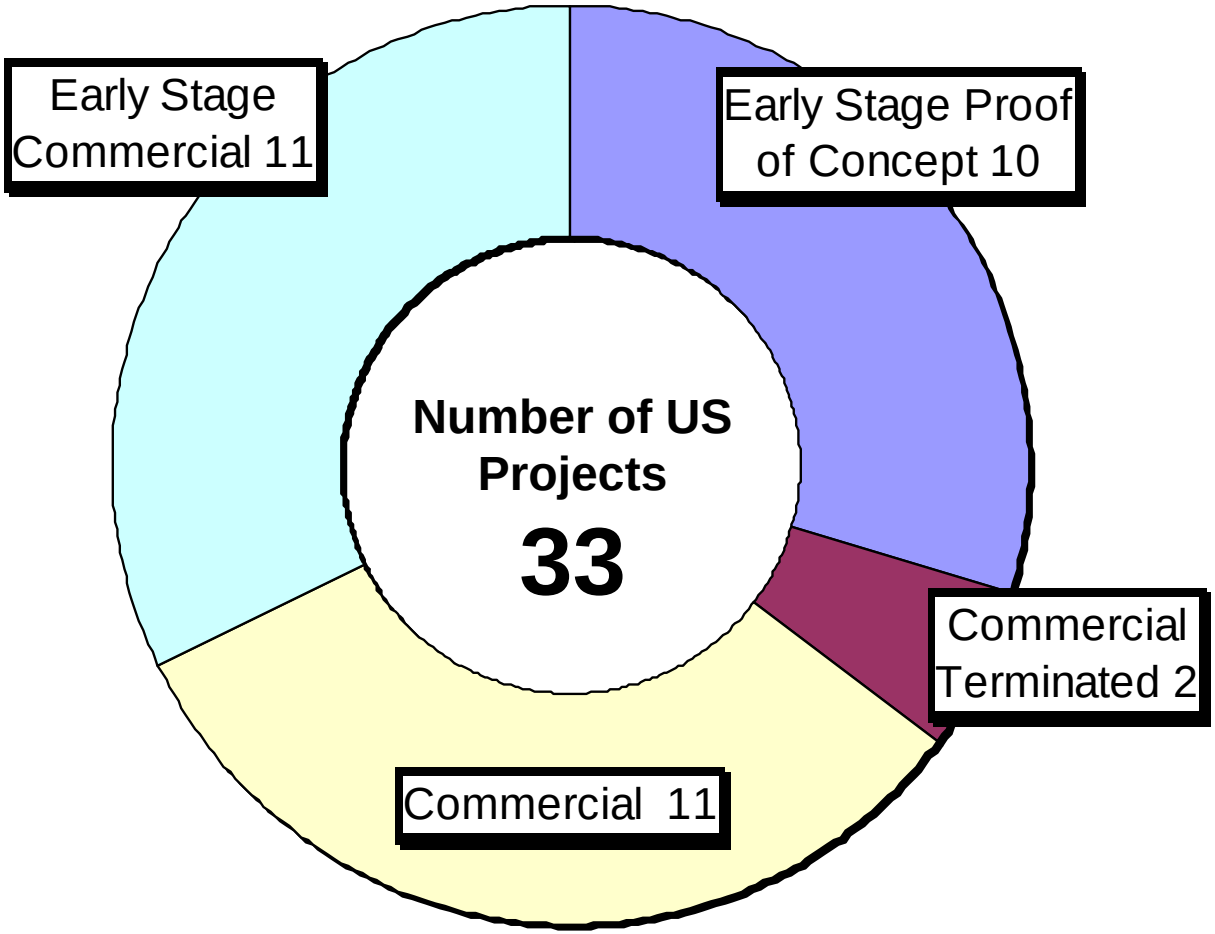
Prototype Development

Commercial Development

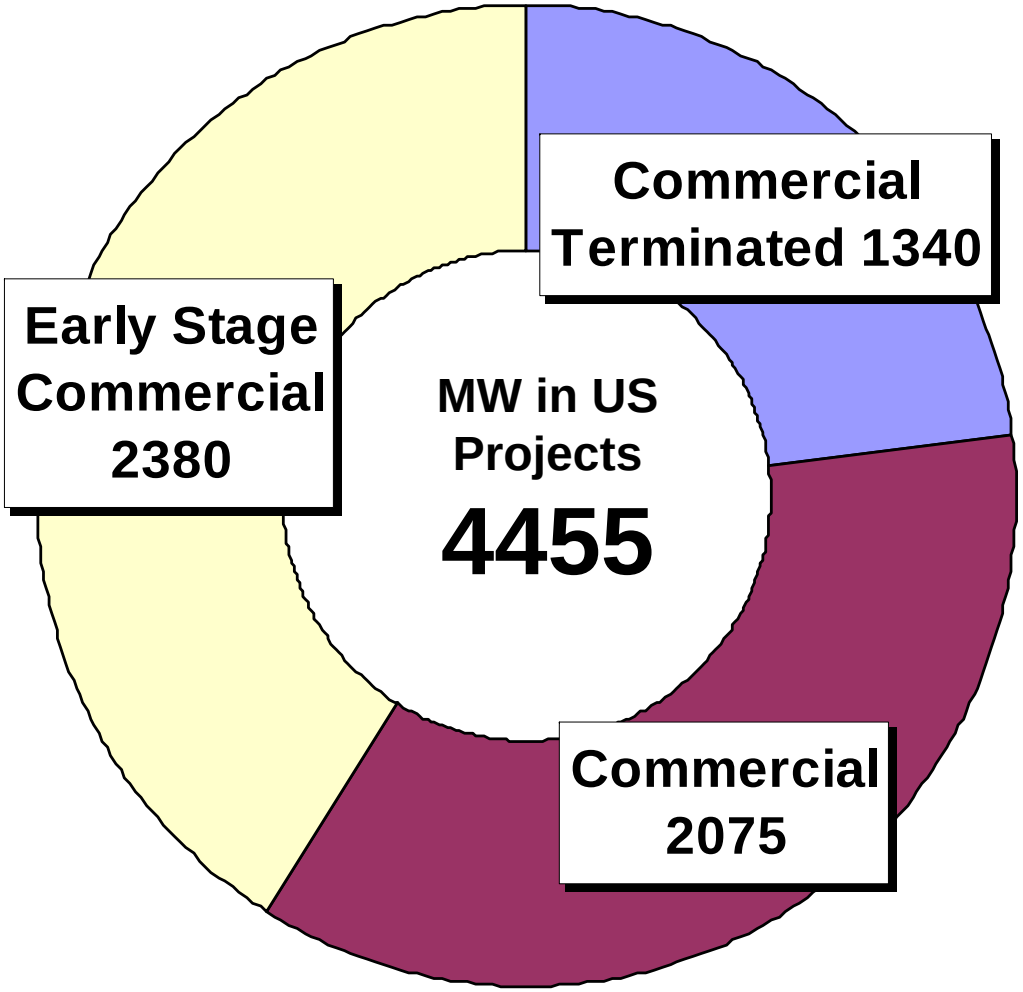
Criteria for Commercial Projects

- ✓ Commercially available wind turbines.
- ✓ System technology has been proven in other commercial offshore wind applications.
- ✓ Potential to generate sustained electricity to the grid.
- ✓ Can be completed before 2015.
- ✓ Technology is recognized by the current regulatory process, offshore wind standards, and certification bodies.
- ✓ Specific site and capacity is defined.
- ✓ Metocean, micrositing, environmental, and other risk impact feasibility studies have been performed.

U.S Projects by Development Status



US Projects by Rated Power Capacity (MW)



US Offshore Wind Commercial Projects

US Offshore Wind Initiatives		
Project	State	MW
Capewind	MA	468
Hull Municipal	MA	15
Buzzards Bay	MA	300
Rhode Island (OER)	RI	400
Winergy	NY	12
New Jersey (BPU)	NJ	350
Delmarva	DE	350
Southern Company	GA	10
W.E.S.T.	TX	150
Cuyahoga County	OH	20
Total MW		2075

No Offshore Wind Projects Installed In North America Yet

Description of Individual Commercial Projects

Project	Developer	Jurisdiction	State	MW
Capewind	Cape Wind Associates	MMS	MA	468
Hull Municipal	Town of Hull MA	MA State	MA	15
Buzzards Bay	Patriot Wind	MA State	MA	300
RIWinds	Deepwater Wind	RI State	RI	20
RIWinds	Deepwater Wind	MMS	RI	380
Winergy Plum Island	Deepwater Wind	NY State	NY	12
New Jersey (BPU)	Deepwater Wind	MMS	NJ	350
Delmarva	Bluewater Wind	MMS	DE	350
Savanna GA	Southern Company	MMS	GA	10
Galveston Offshore Wind	W.E.S.T.	TX State	TX	150
Cuyahoga County	Cuyahoga CO. Task Force	OH State	OH	20
Total				2075

Canadian Offshore Wind Projects

Project	Developer	Status	Province	Size (MW)
Nai Kun	Nai Kun Wind	Commercial Track	British Columbia	396
Trillium Power Wind	Trillium Power Wind Corp.	Commercial Track	Ontario	710
Lake Ontario (3 Sites Under Consideration)	Toronto Hydro	Preliminary Planning/ Commercial Track	Ontario	200
Amherst Island Offshore Wind Farm	Gilead Power	Preliminary Planning	Ontario	NA
Prince Edward County Offshore Wind Farm	Gilead Power	Preliminary Planning	Ontario	NA
Salmon Point Offshore Wind Farm	Gilead Power	Preliminary Planning	Ontario	NA
Southpoint Wind Power Leamington	Leamington	Preliminary Planning	Ontario	30

Multi-pile Foundations

Moving into Deeper Water

Wind Industry Experience is Limited
Jackets (welded truss towers) are the Oil and Gas Standard

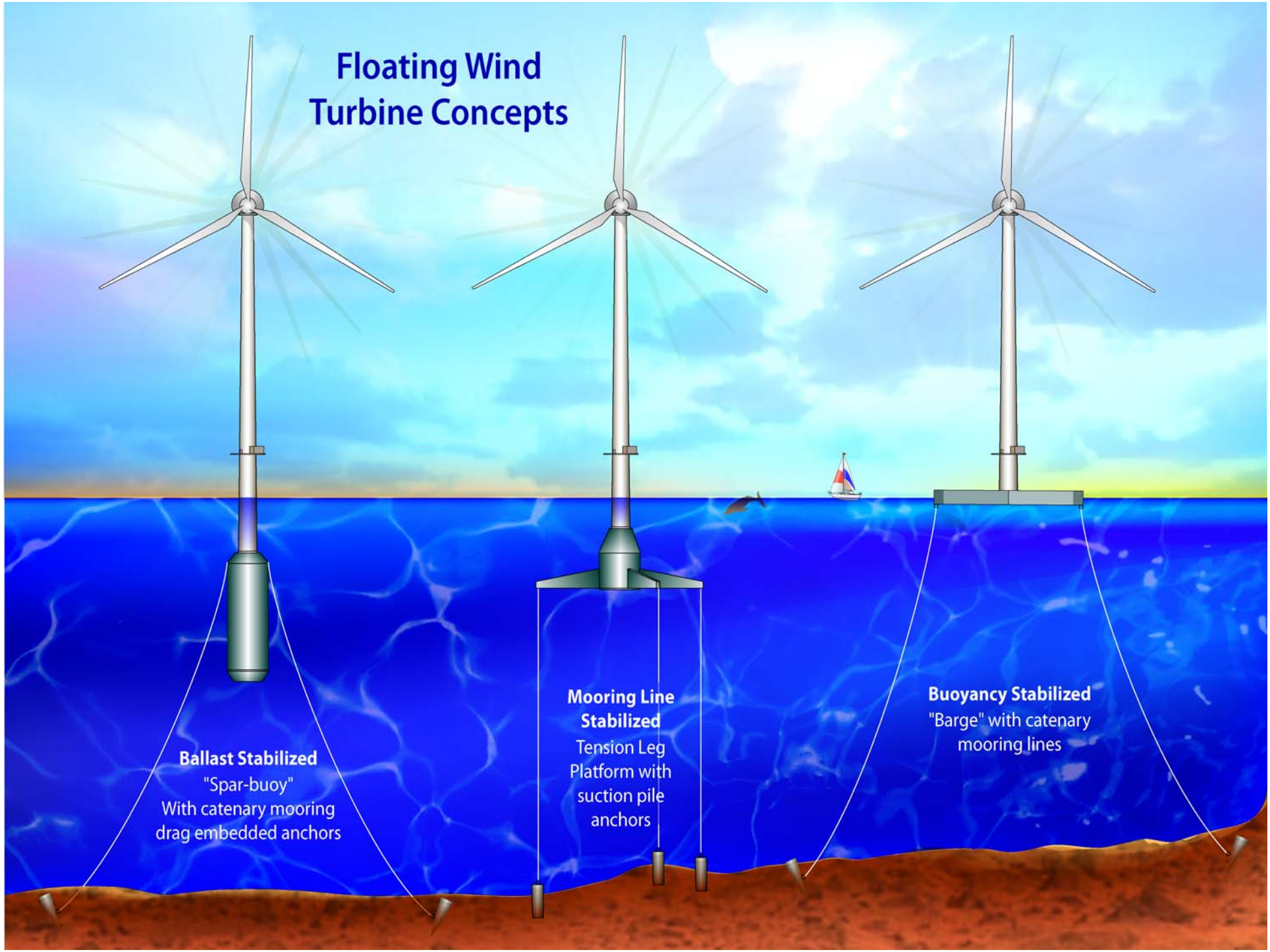
Bard Engineering Tripod Variation

Multibrid M5000 Prototype on Tripod

Repower 5MW Demonstration at Beatrice Four-pile jacket

Offshore Wind Turbines Under Development

Turbine Manufacturer	Turbine model & rated power	Date of availability	Technology Status
RePower Systems (Suzilon)	6M – 6MW	2009	Prototype Assembled
Bard Engineering	VM - 5 MW	2009	Onshore prototype 2008
Nordex	N90 - 2.5 MW	2006	Offshore Demo 2003
Clipper Windpower	Liberty 2.5 MW	-	Commercial Onshore
Clipper Windpower	Britannia 7.5 MW	-	Prototype Design Underway


Floating Wind
Turbine Concepts
Ballast Stabilized
"Spar-buoy"
With catenary mooring
drag embedded anchors
Mooring Line
Stabilized
Tension Leg
Platform with
suction pile
anchors
Buoyancy Stabilized
"Barge" with catenary
mooring lines

Innovative Offshore Wind Systems Under Development

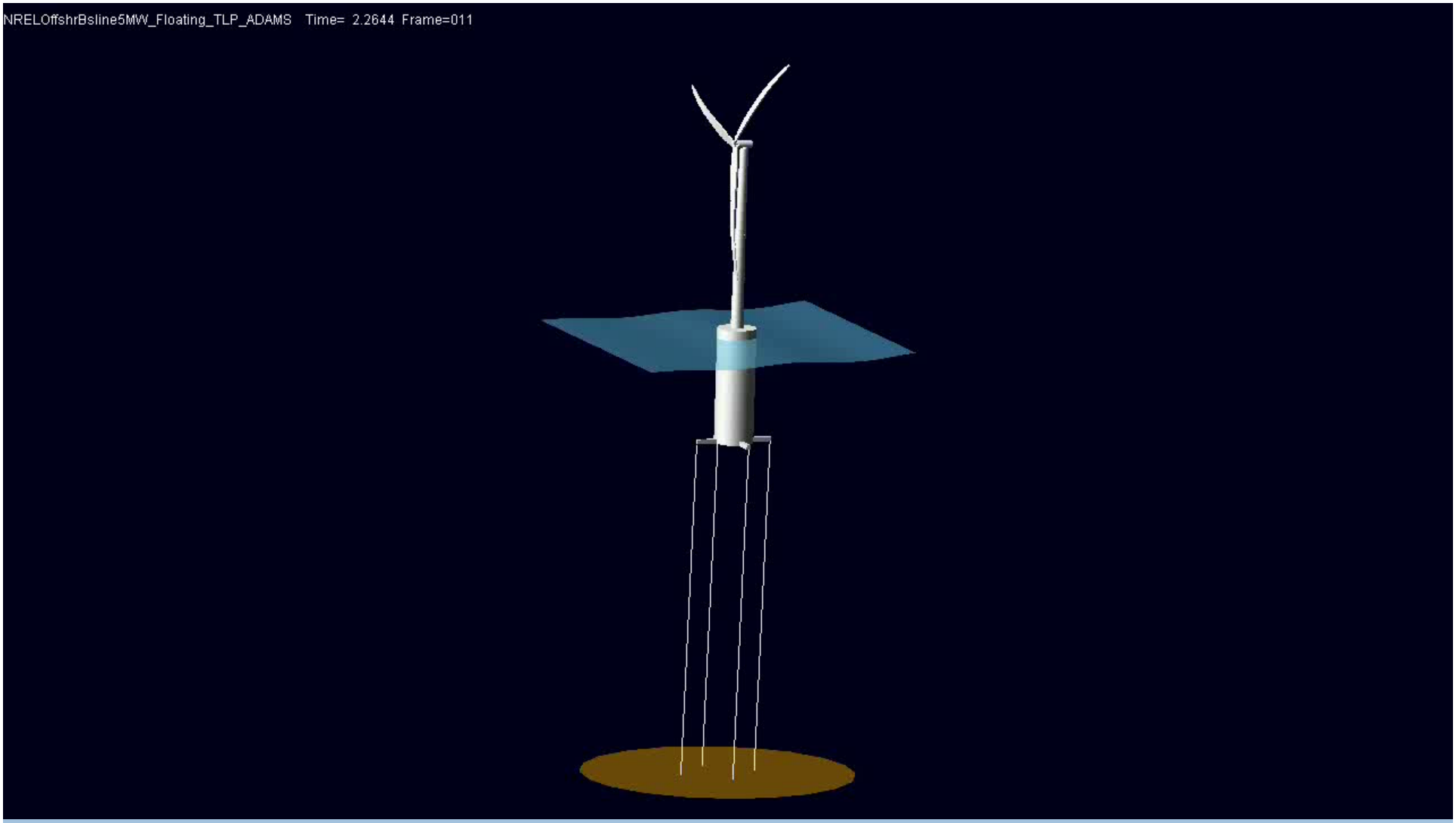
Developer	System Model and rating	Type	Technology Status
Statoil/Norske Hydro	HyWind – 2.3 MW POC	System	Proof of Concept Underway
Blue H Group	80-kw 2.5-MW / 5-MW planned	System	Proof of Concept Underway
Principal Power	2-MW	Platform / System	Concept development
Statoil/Norske Hydro	SWAY	System	Concept development
Offshore Windpower Systems of Texas	Triton	Platform	Proof of concept
Grey's Harbor	-	Wind/Wave Hybrid	Concept development
Ecopower	Vertical axis 300-kW	System	Concept development

Fundamental Technology Challenges for Commercial Floating Offshore Wind Turbines

- ✓ Develop new design tools to minimized loads.
- ✓ Understand deepwater external conditions and develop new design basis to account for open ocean conditions.
- ✓ Redesign turbine/platform systems to withstand new deflections and load regimes.
- ✓ Optimize lower weight systems for floating design space.
- ✓ Update offshore regulations, certification, and standards to account for floating systems.

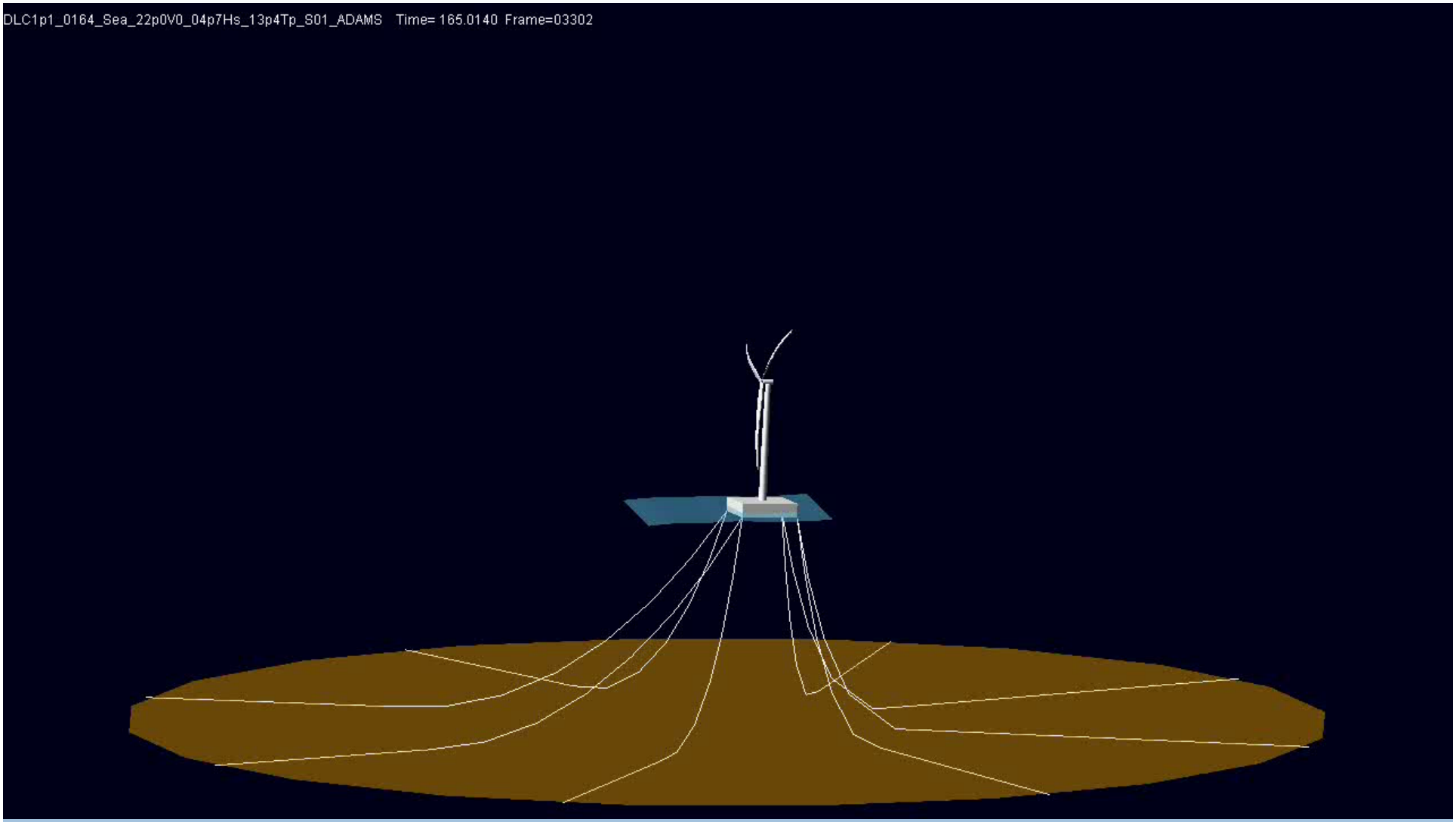
NREL simulation of MIT tension leg platform

slack lines under extreme loading



NREL simulation of barge type platform

high loads and extreme deflections under extreme loading



Floating Wind Turbine Pioneers

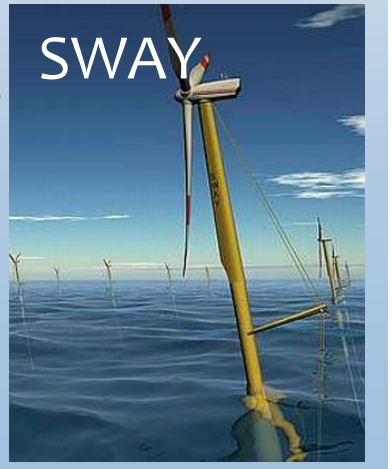
- HyWind is Under development by StatoilHydro – Norway
- Needs 100-m+ depth to operate.
- Announced a $78MM proof of concept demonstration project near Norway.
- Partnering with Siemens using their 2.3MW turbine.
- Costs estimated about where solar is today.
- Expectations to compete with conventional wind energy long term.

- BlueH is the first company to claim "in-the-water" floating wind turbine status.
- Deployed tension leg platform near Italy in late 2007.
- 80-kW Proof of concept is underway.
- Recently Awarded a Grant from UK pursue 5MW demonstration.

- WindFloat
- Platform Technology from Principal Power
- Planning proof of concept demonstration project.

- Ecopower
- Darrius Vertical Axis
- Phase 1 is 45-MW demonstration project in China – shallow water

- SWAY technology is under development by StatoilHydro – Norway
- Needs 100-m+ depth to operate.



Offshore Projects Summary

- Over 1400-MW deployed in Europe but none yet in the USA.
- Offshore wind resources are abundant in the USA and Canada.
- 33 projects have been announced in USA. 11 are on a commercial track for near-term energy supply.
- Over 2000-MW of offshore projects are in the permitting pipeline in USA and approximately 1100-MW are underway in Canada.
- Atlantic states with transmission constrained load centers are leading development.
- Most projects await completion of regulatory process.
- All commercial projects and technology are in shallow water (>30-m)
- Floating systems are beginning to emerge and several concepts are advancing to a proof of concept stage.
- No significant environmental impacts so far.

Questions?

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