



Maine Marine Composites

# Offshore Wind 101

Maine Offshore Research Array Project

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# Parts of an Offshore Wind Farm



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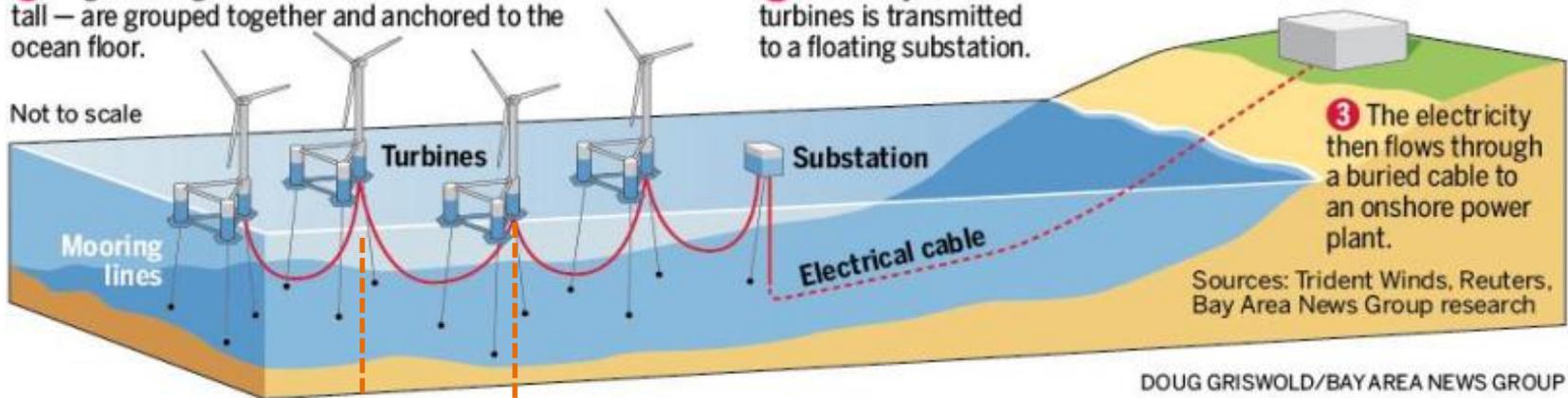
San Jose Mercury News (2015)

## How offshore floating wind farms work

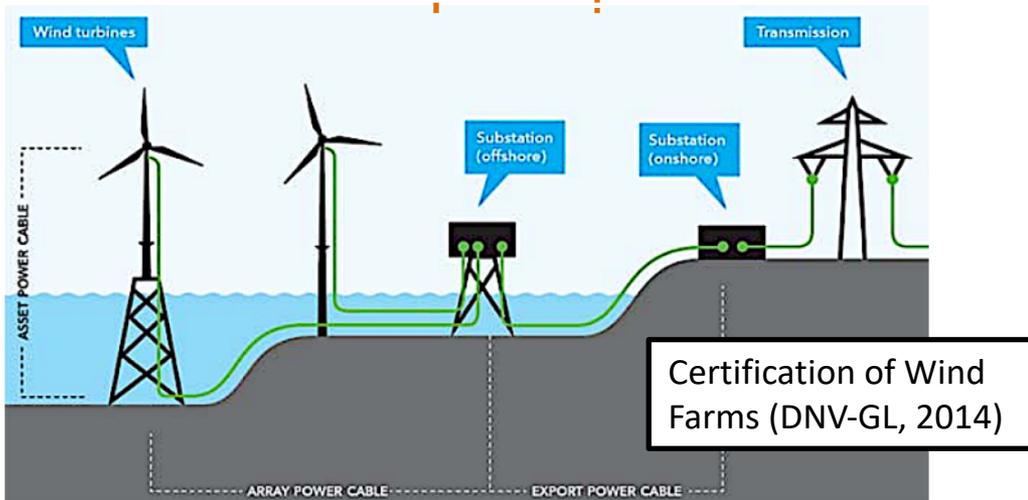
1 Huge floating wind turbines — each about 600 feet tall — are grouped together and anchored to the ocean floor.

2 Electricity from the turbines is transmitted to a floating substation.

Power station



MIN:  $7 \times \text{Rotor Diam} = 7 \times 220\text{m} = 0.96 \text{ miles}$



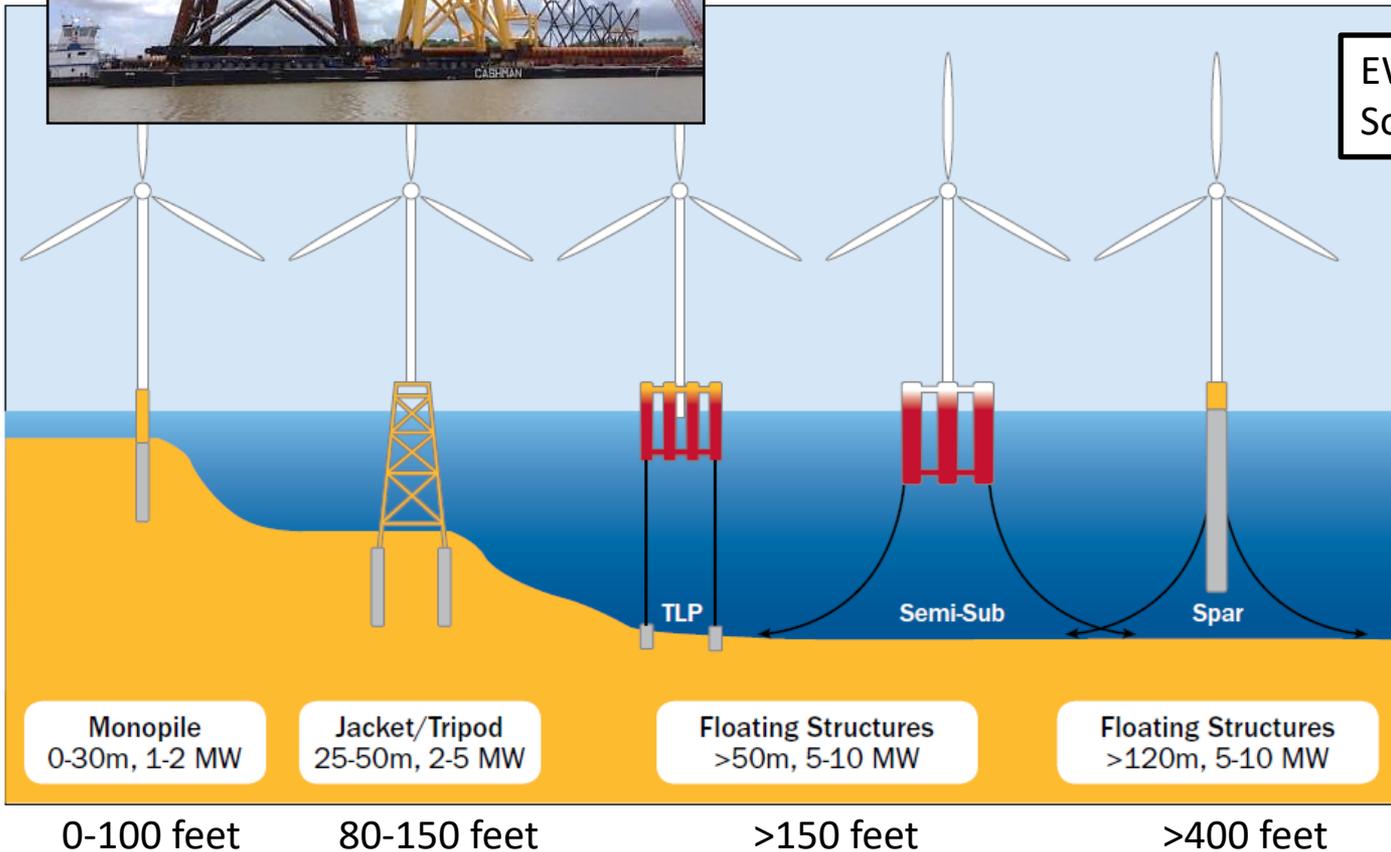
- Wind farms north of Cape Cod will be floating, not fixed
  - Floating can be more economical than fixed because FOWTs can be constructed shoreside
- Growth Rate: 10MW prototype → 50MW test field → 300MW to 500MW wind farm (Hall, 2020)

# Offshore Wind Turbine Foundations



Jacket foundations for Block Island Wind Farm (*Providence Journal, 2015*)

EWEA (2013)  
Source: Principle Power



## Fixed Foundations:

- Monopile
- Tripod/jacket

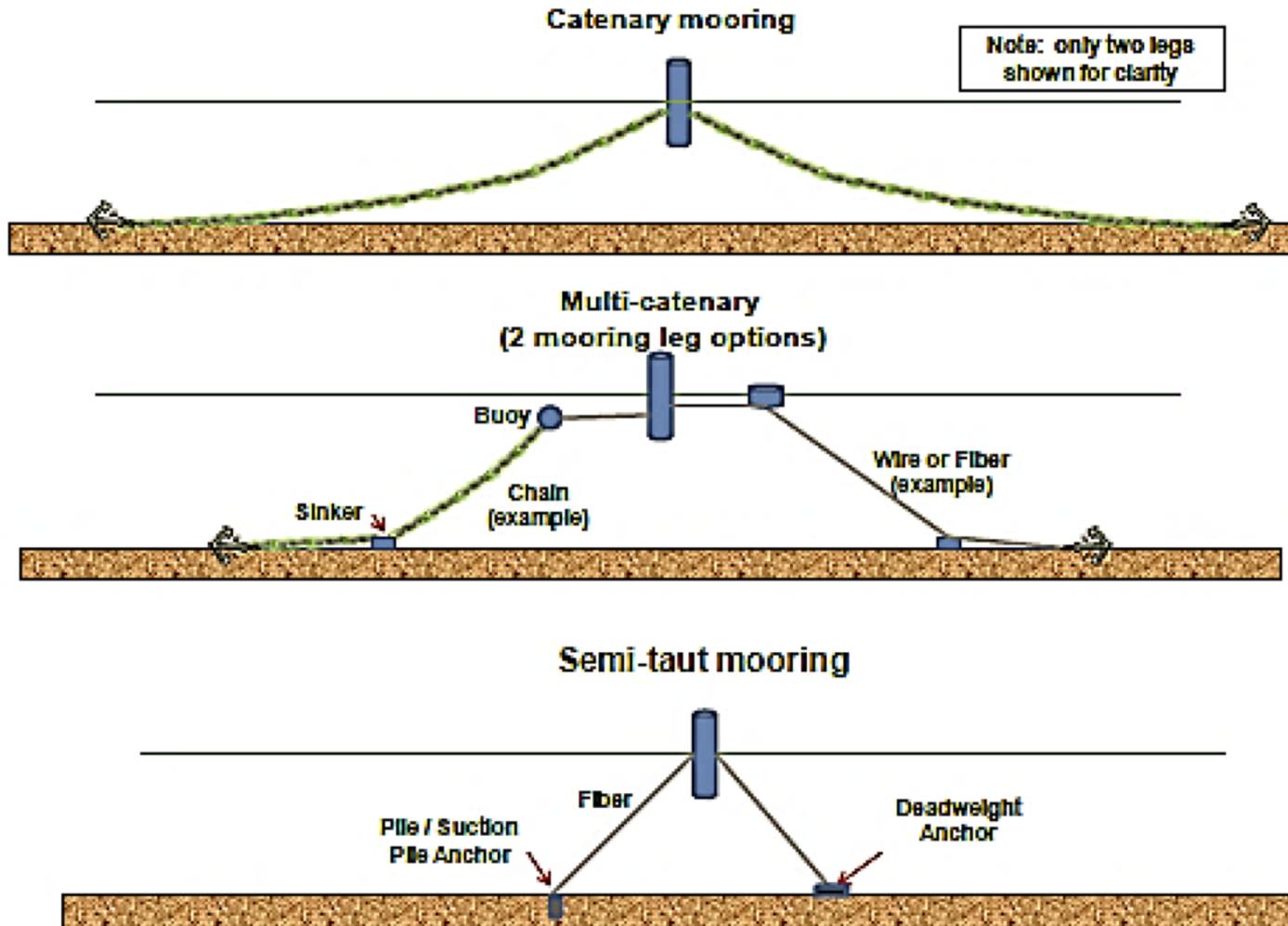
## Floating Foundations:

- Tension Leg Platform (TLP)
- Semi-submersible (Semi-sub)
- Spar Buoy (Spar).

# Mooring Components



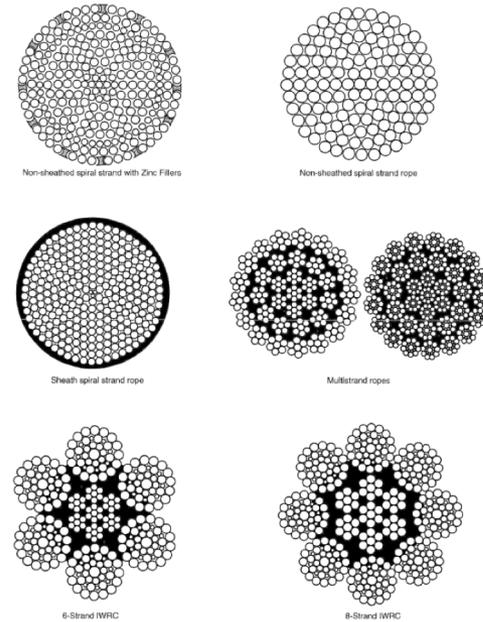
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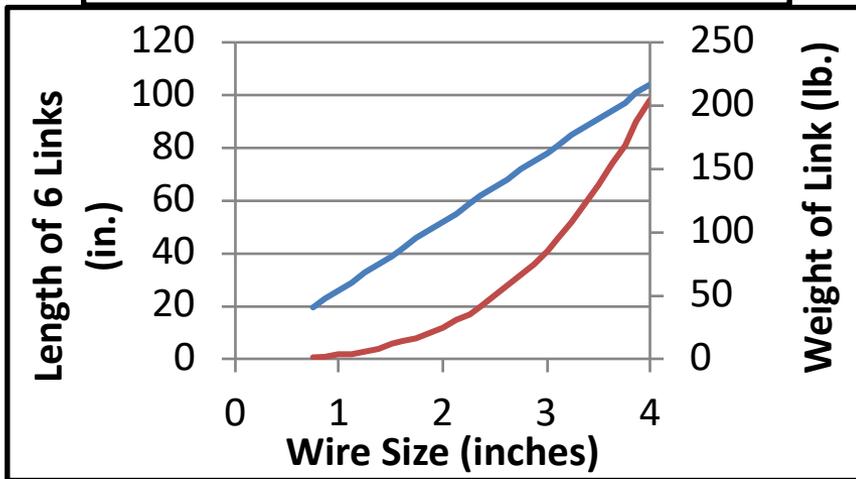
*Sound & Sea  
Technology, 2009*

Figure 35 Spread Mooring Configuration Options

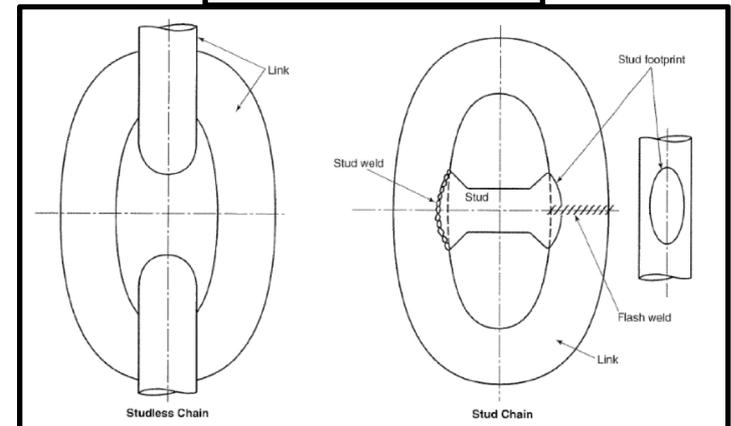
# Mooring Materials: Chain, Wire & Synthetic Rope



Stud Link Chain Properties (*Paduca, 2020*)



Source: API RP 2SK





# Anchor Types

DEA - Surface



DEA - Deep



Gravity block



Pile ( $\uparrow L, \downarrow D$ )

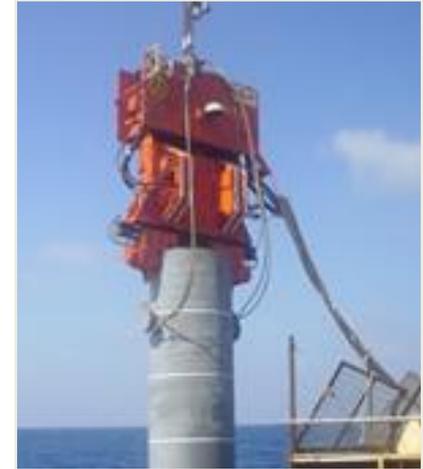
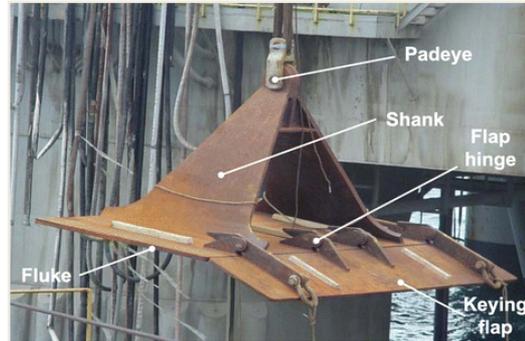
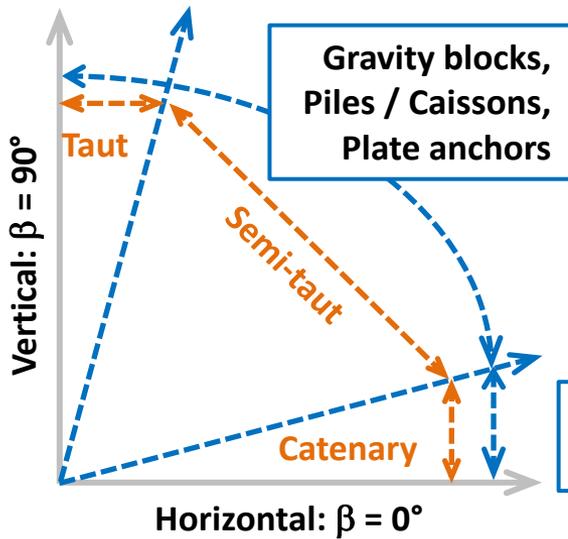


Plate anchor



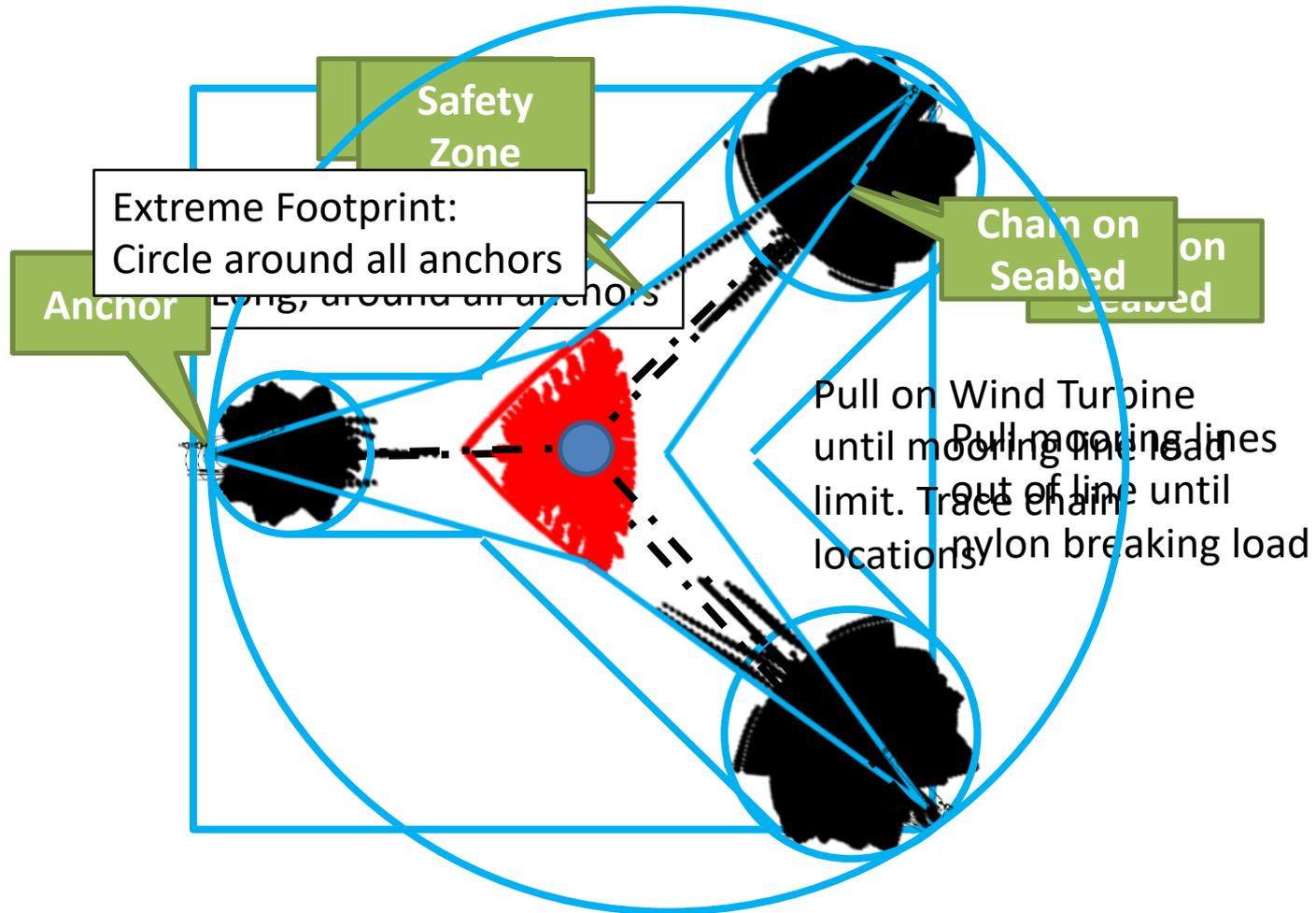
Suction caisson ( $\downarrow L, \uparrow D$ )



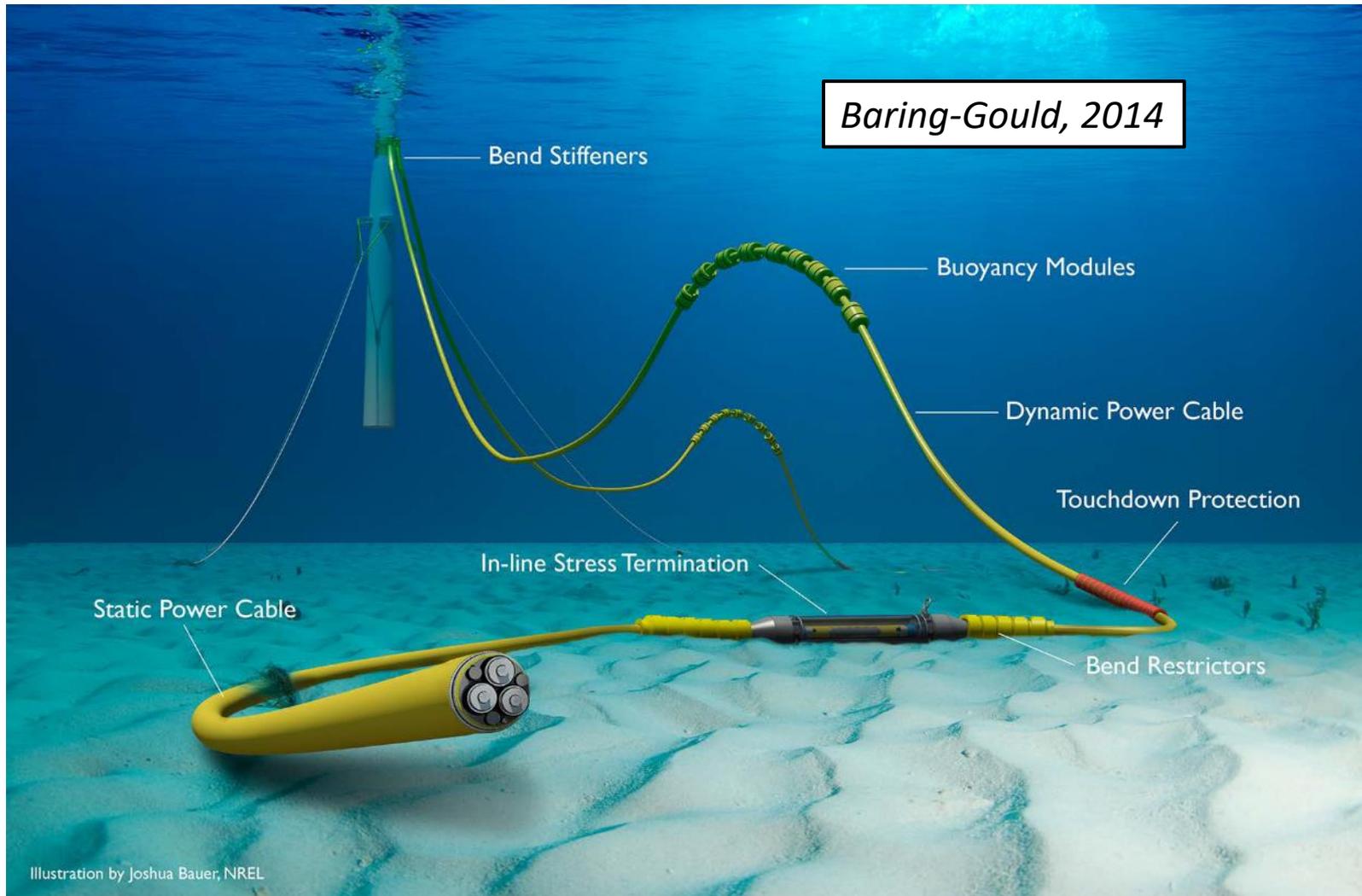
Drag embedment anchors (DEAs)  
Gravity blocks, Piles/Caissons

(Landon, 2019)

# What is a Wind Turbine's Footprint?



# Electrical Connection

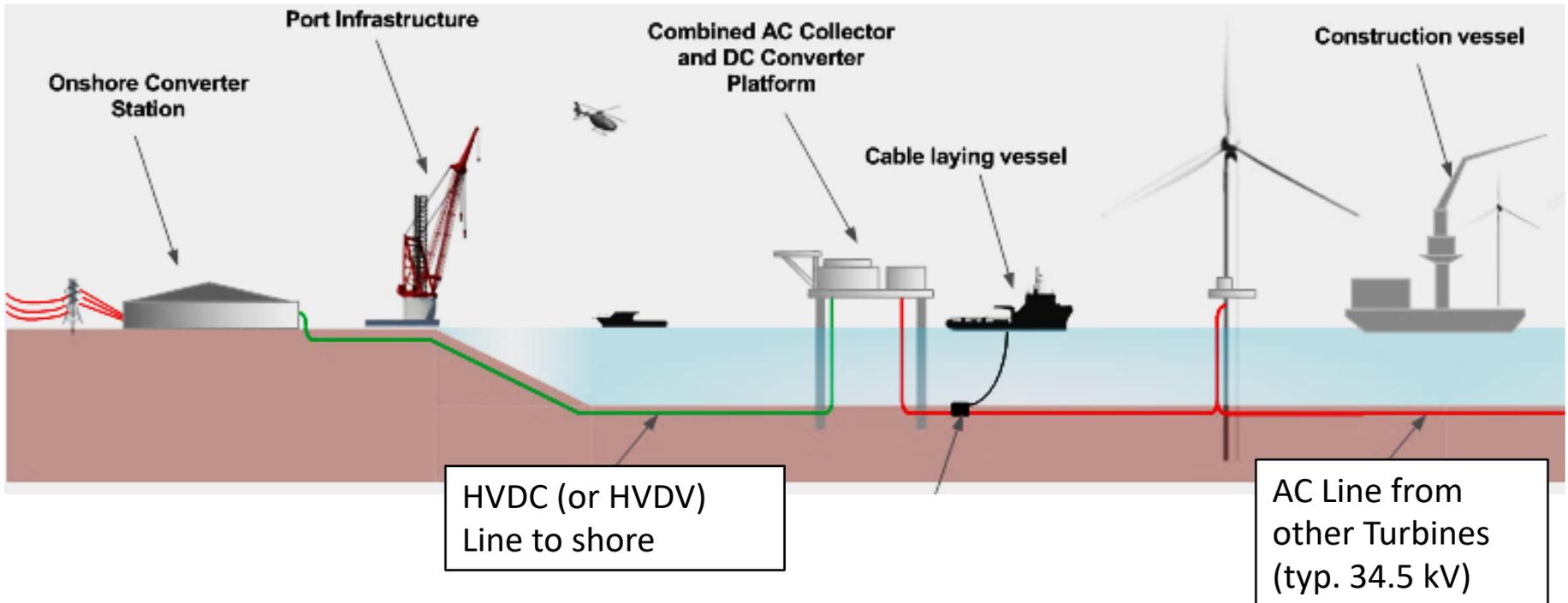


# Power Lines to Shore

- Typical shore cable
  - 6"-7" diameter
  - Buried 6-feet deep



Approx. 5.5" diameter  
34.5 kV, three  
conductors with fiber-  
optic communications  
cable (Plourde, 2017).



# Trenching the Power Cable



Jet plow on Town Beach in preparation for connecting Block Island to Wind Farm. Photo by K. Curtis (*Shuman, 2016*)

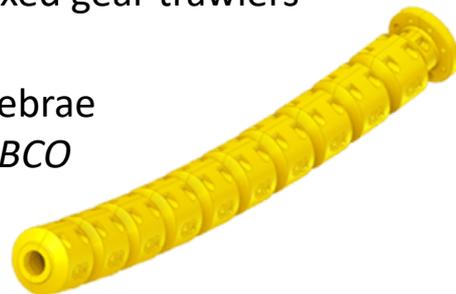


Block Island Cable Installation (*Henrikson, 2017*)

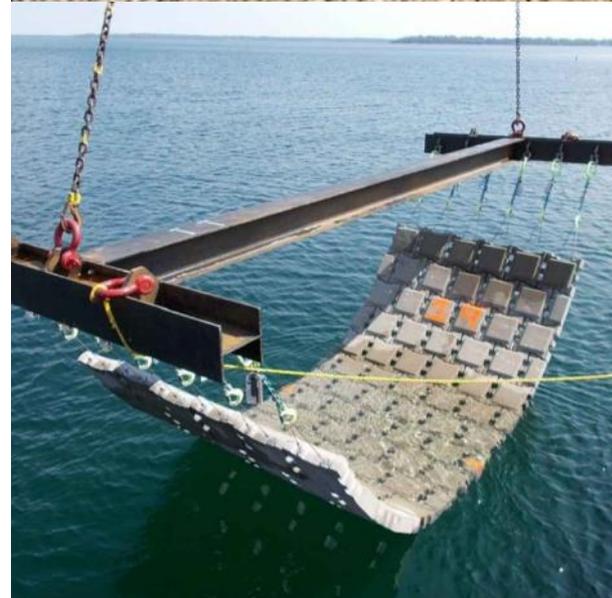
# Protecting the Power Cable

- Cables are trenched and laid in place
  - Jet the trench, then drop cable in behind jet
  - 6' underground (2M)
  - Use mechanical plow to minimize impact in sensitive areas
- If trenching not feasible (or near shore) use cast iron armor, 10" to 12" diameter
  - Small anchors won't catch, heavy anchors won't damage
- Use polyurethane bend restrictors for dynamic cable
- Trenches allow lobstering
  - Only precludes fixed gear trawlers

Polyurethane Vertebrae Bend Restrictor (*ABCO Subsea, 2020*)



Cast iron, articulated bend restrictor. (*PCS Italiana, 2017*)



Articulated concrete mat. (*Kokosing, 2018*)

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**QUESTIONS?**