Meeting the Anchoring Challenges for Floating Wind

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ACTEON

Organized by FWE Quest Offshore

FWS

The Marriott Marquis, Houston 1-3 March 2022

ACTEON

Oil and gas

From pre-development to decommissioning, we maximise cost efficiencies by providing our customers with all-in-one project support and reducing project footprint while minimising environmental impact.

Offshore renewable energy

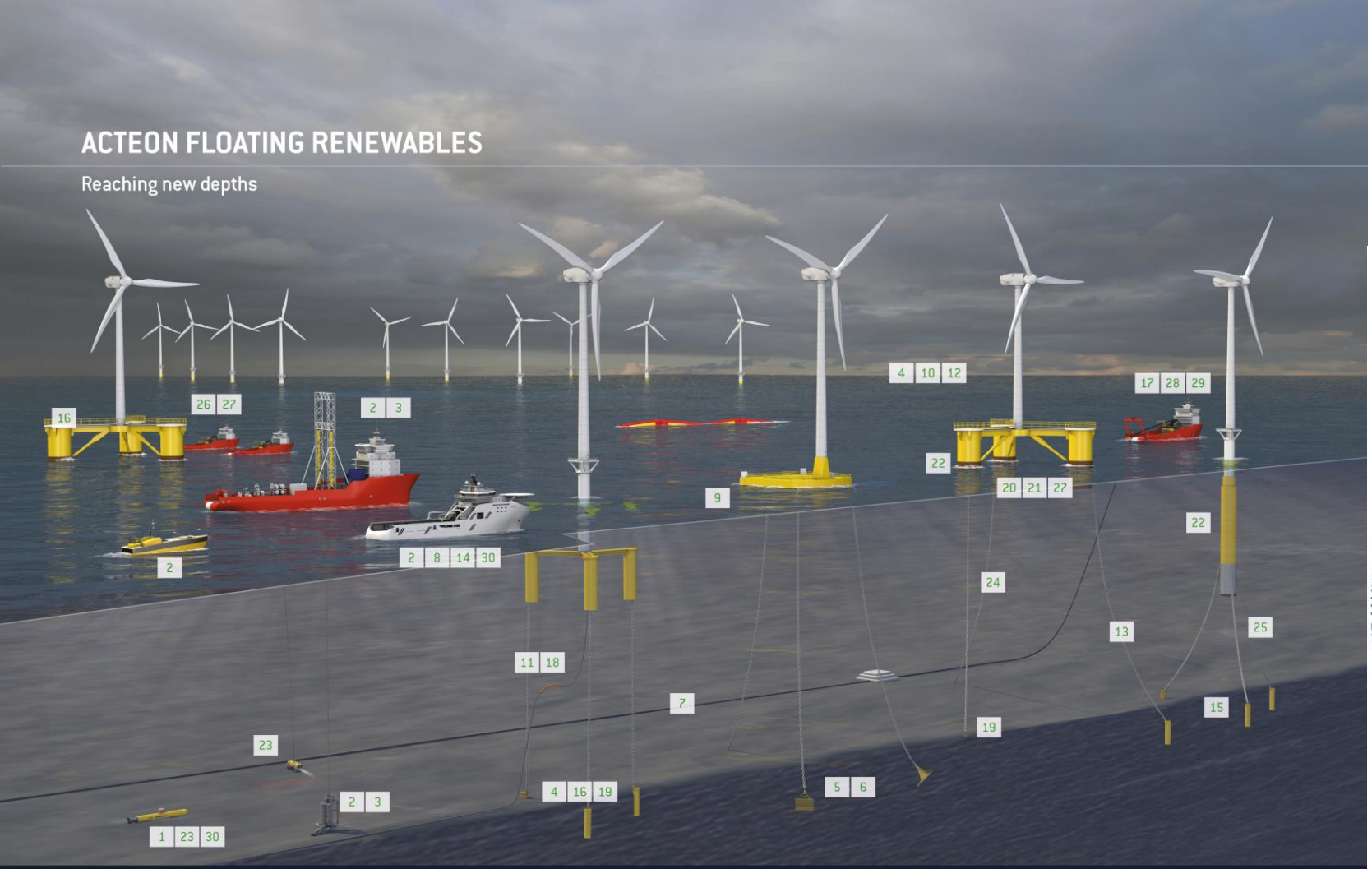
Our integrated engineering solutions optimise capital and operating expenditure to lower the life-cycle levellised cost of energy, and include large and floating structures.

Nearshore construction

Our deep domain knowledge leads to innovative nearshore construction installation methods, increased efficiencies and decreased costs.

ACTEON FLOATING RENEWABLES

Reaching new depths



Site characterisation

1/ ROV and AUV surveys
2/ Geotechnical and geophysical surveys
3/ Geotechnical consultancy

Engineering

4/ Global coupled performance analysis
5/ Mooring system design
6/ Anchor design
7/ High-voltage cable specification, design and integrity
8/ Pre-construction and route surveys
9/ Installation engineering
10/ Logistics and cost analysis
11/ Hydrogen flowline design

Installation

12/ Logistics and base port services
13/ Mooring component provision (chain, rope and connectors)
14/ Survey and positioning
15/ Prelay mooring installation
16/ Floating platform tow and hookup
17/ Cable installation
18/ Hydrogen flowline installation
19/ Anchor procurement (drag, SEPLA, suction, driven, drilled and grouted piles)

Operations

20/ Asset integrity and digital twins
21/ Structural monitoring
22/ Corrosion prevention
23/ ROV and AUV surveys
24/ Mooring and cable inspection, maintenance and repair
25/ Predictive performance monitoring devices

Decommissioning

26/ Floating platform disconnection
27/ Towing
28/ Mooring and anchor recovery
29/ Cable recovery
30/ Final site surveys

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Presentation Contents

- Why is anchor selection important?
- Current anchor types for floating wind
- Anchor sizes and weights
- Anchor total installed cost
- New anchor concepts
- Take aways

Why is anchor selection important?

Cost of the anchor

- Can be 50%+ the cost of a mooring system

Installation time

- For a commercial scale wind farm can be many months

Complexity

- Changing seabed conditions across the wind farm
- Hard bottoms / rock
- Logistics for large anchors

ANCHOR TYPES FOR FLOATING WIND

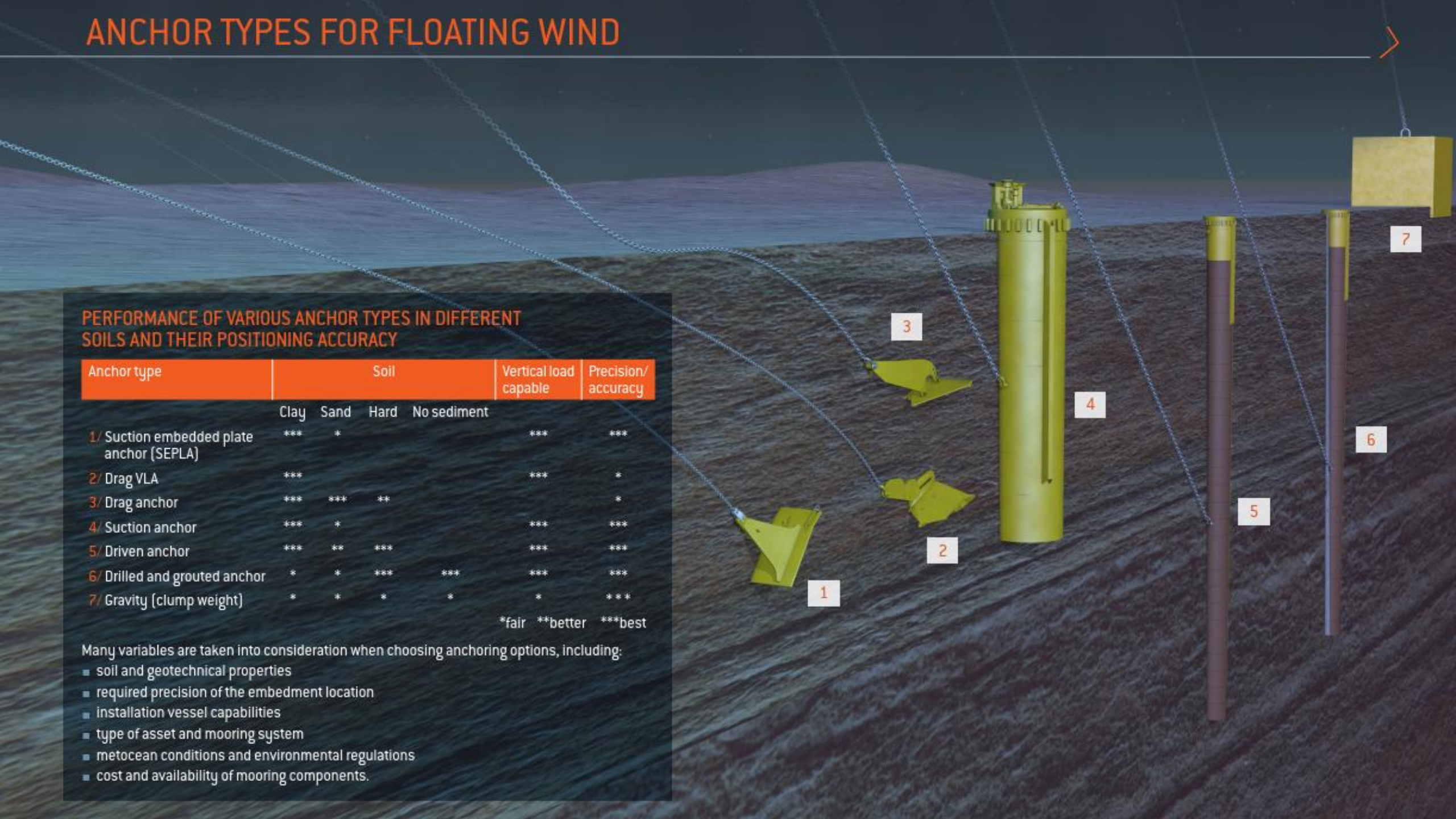
PERFORMANCE OF VARIOUS ANCHOR TYPES IN DIFFERENT SOILS AND THEIR POSITIONING ACCURACY

Anchor type	Soil				Vertical load capable	Precision/ accuracy
	Clay	Sand	Hard	No sediment		
1/ Suction embedded plate anchor (SEPLA)	***	*			***	***
2/ Drag VLA	***				***	*
3/ Drag anchor	***	***	**			*
4/ Suction anchor	***	*			***	***
5/ Driven anchor	***	**	***		***	***
6/ Drilled and grouted anchor	*	*	***	***	***	***
7/ Gravity (clump weight)	*	*	*	*	*	***

*fair **better ***best

Many variables are taken into consideration when choosing anchoring options, including:

- soil and geotechnical properties
- required precision of the embedment location
- installation vessel capabilities
- type of asset and mooring system
- metocean conditions and environmental regulations
- cost and availability of mooring components.



Case Study Parameters

Anchors studied:

- Drag anchors
- Suction anchors
- Suction Embedded Plate Anchors (SEPLAs)
- Driven piles
- Drilled and grouted piles
- Gravity anchors

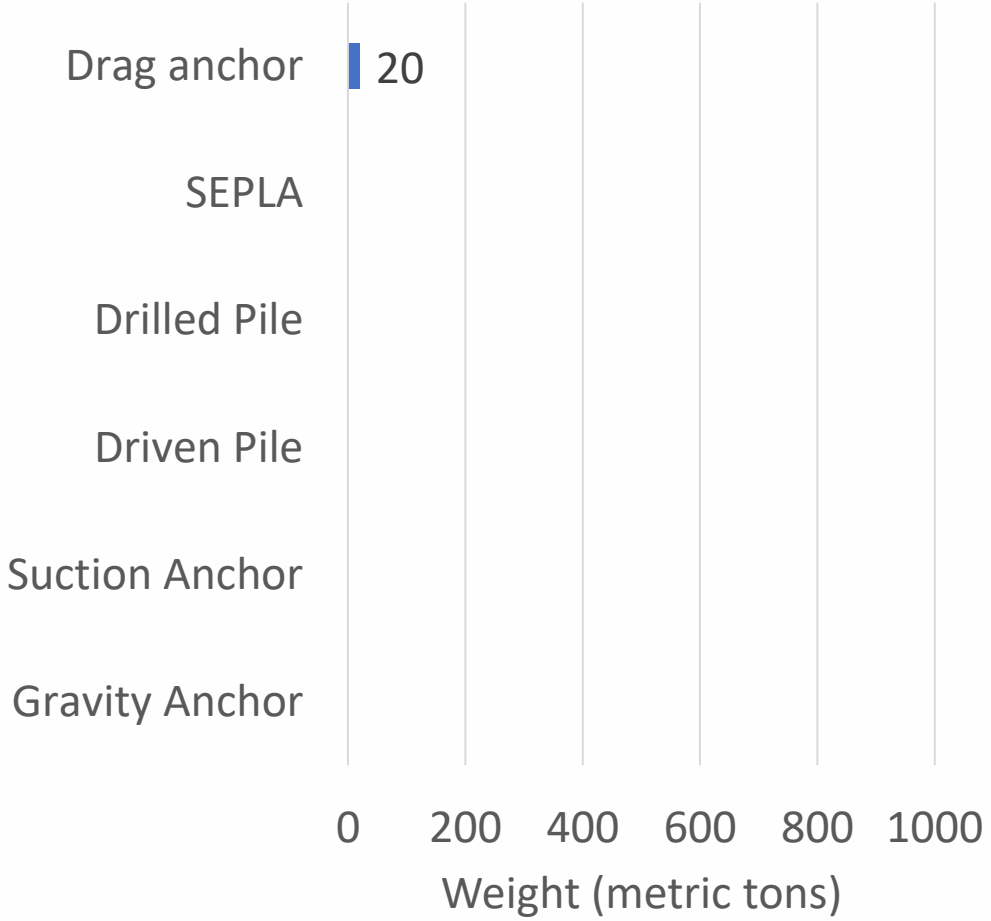
Anchor load: 1,000mt at 25°

- Except drag anchors – no angle

Soil type: Medium clay

- Except drilled pile - rock

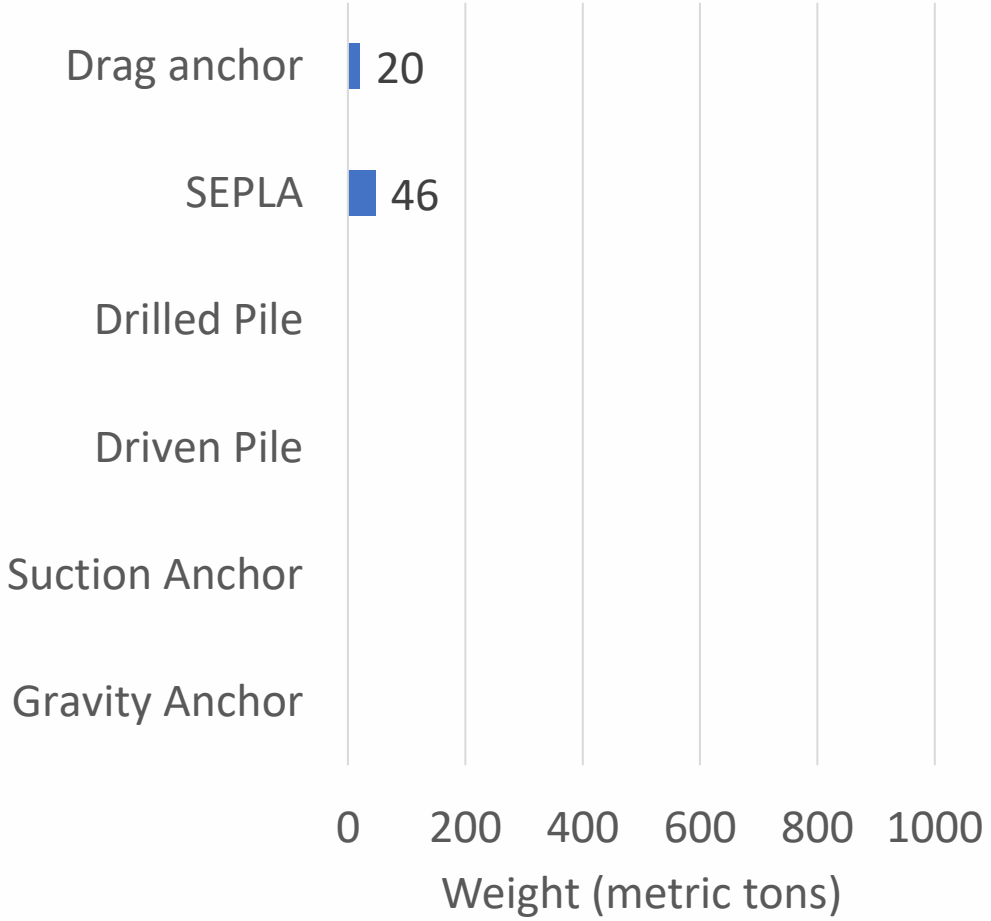
Size and weight comparison



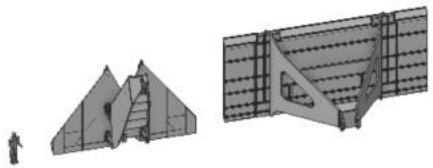
Drag Anchor
7.3m x 6.6m

Floating Wind *Solutions*

Size and weight comparison



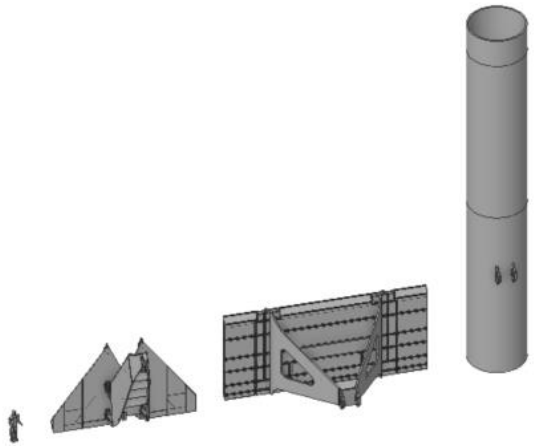
SEPLA
10m x 5m

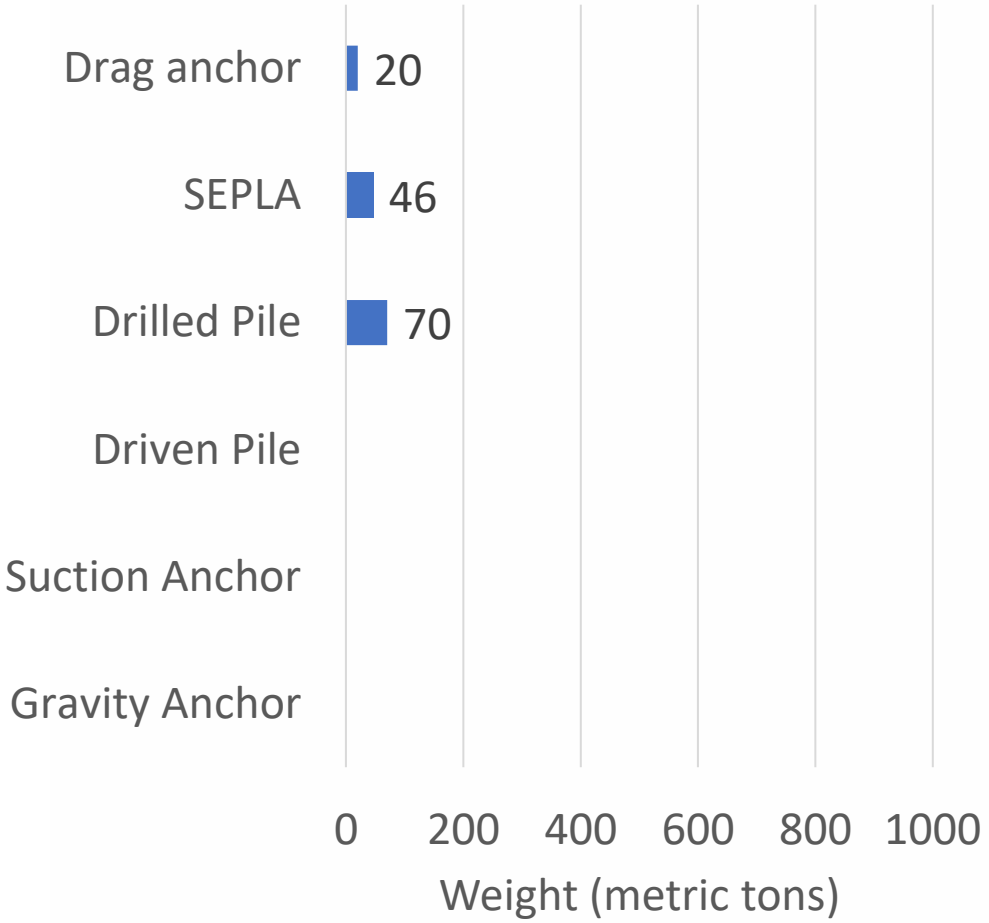


Floating Wind *Solutions*

Size and weight comparison

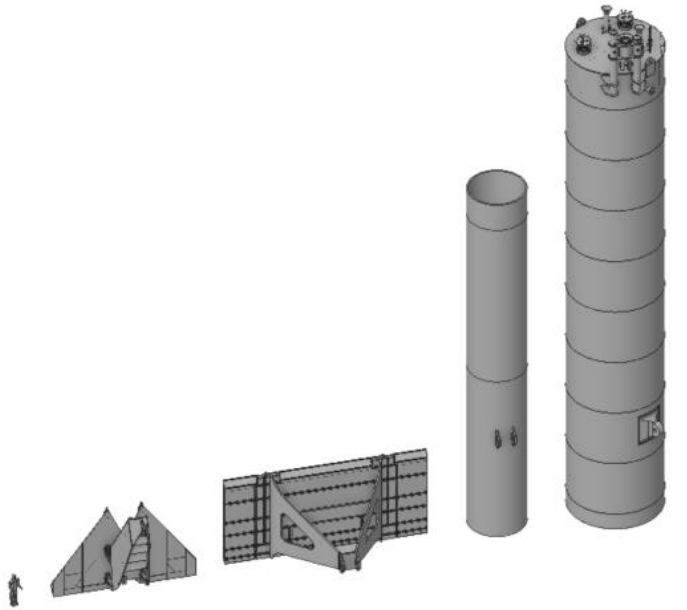
Drilled Pile
3m dia x 20m

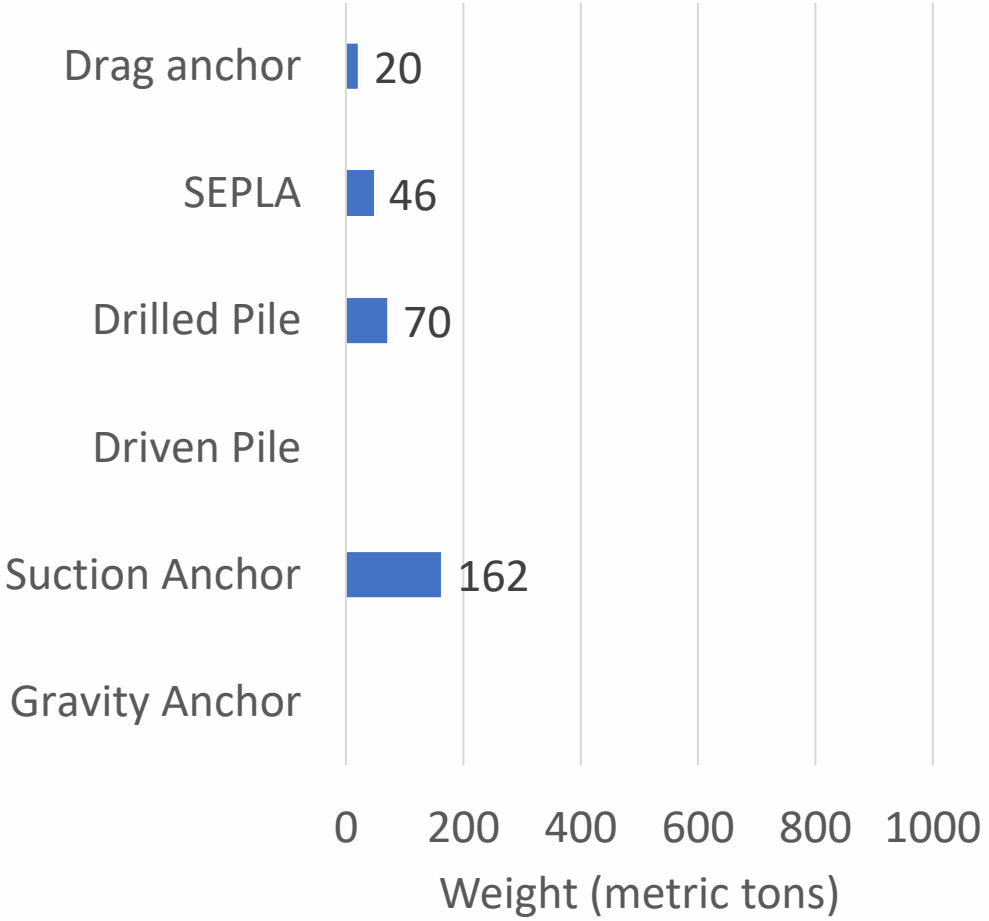




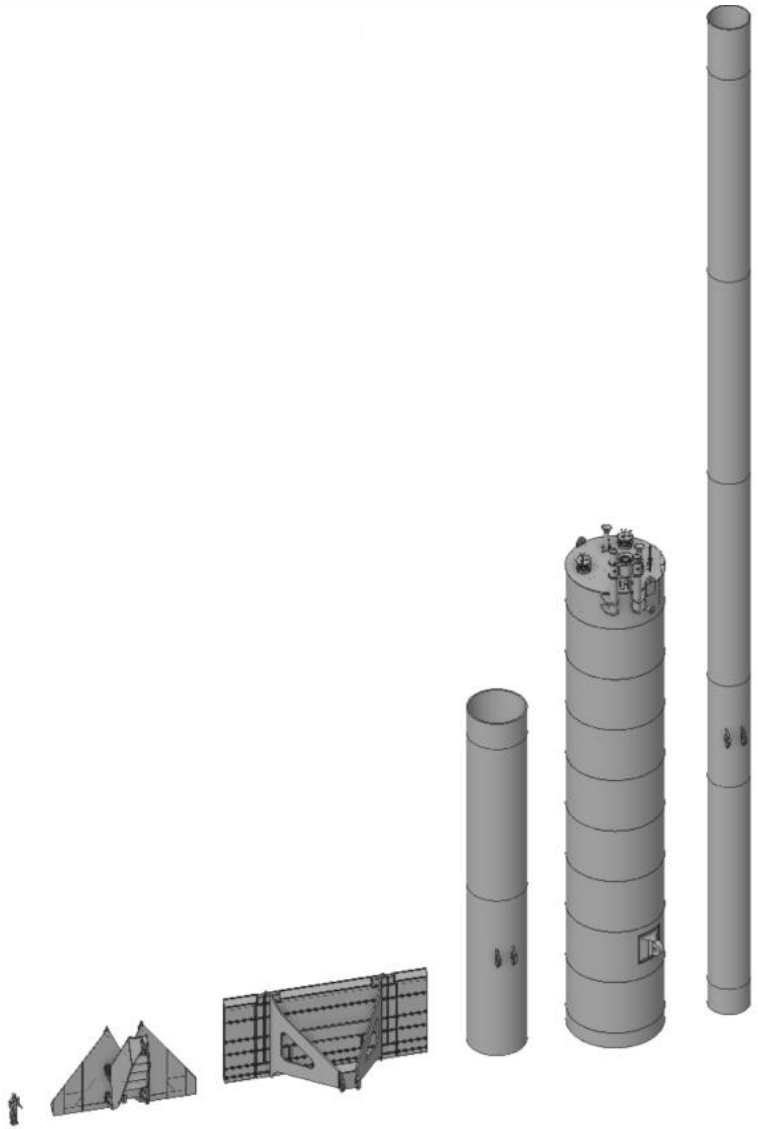
Size and weight comparison

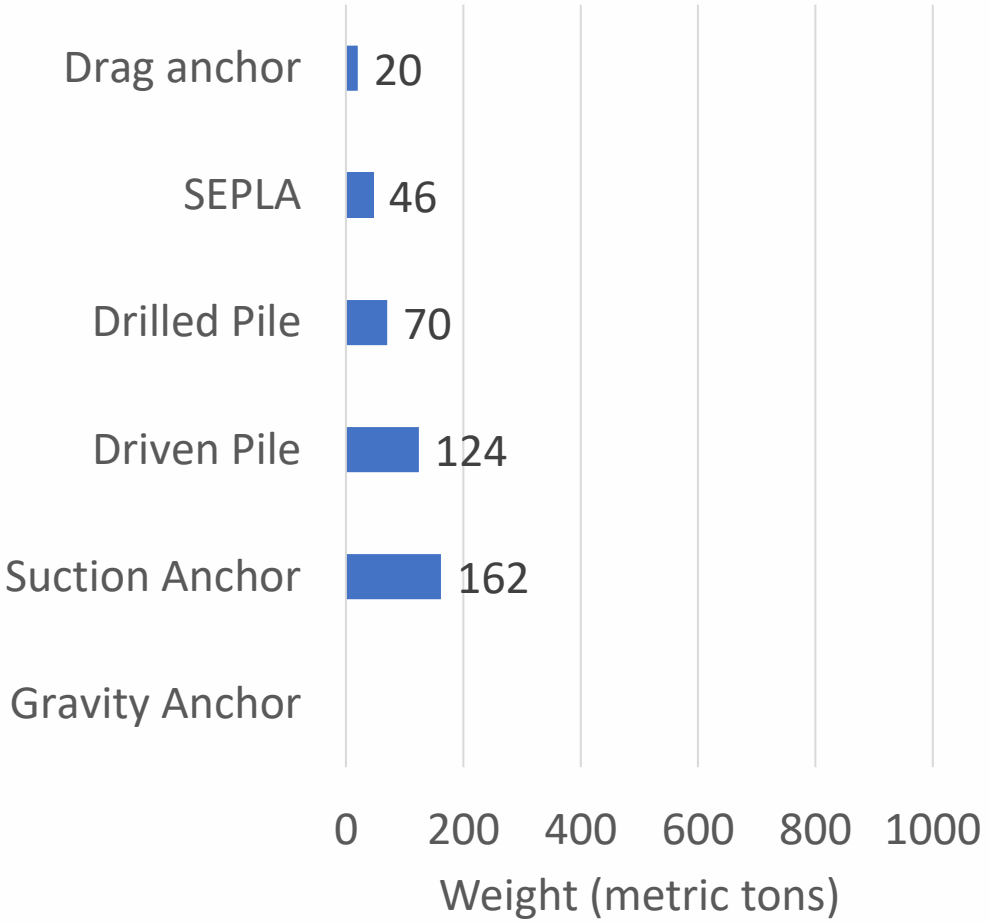
Suction Anchor
5m dia x 27m





Size and weight comparison





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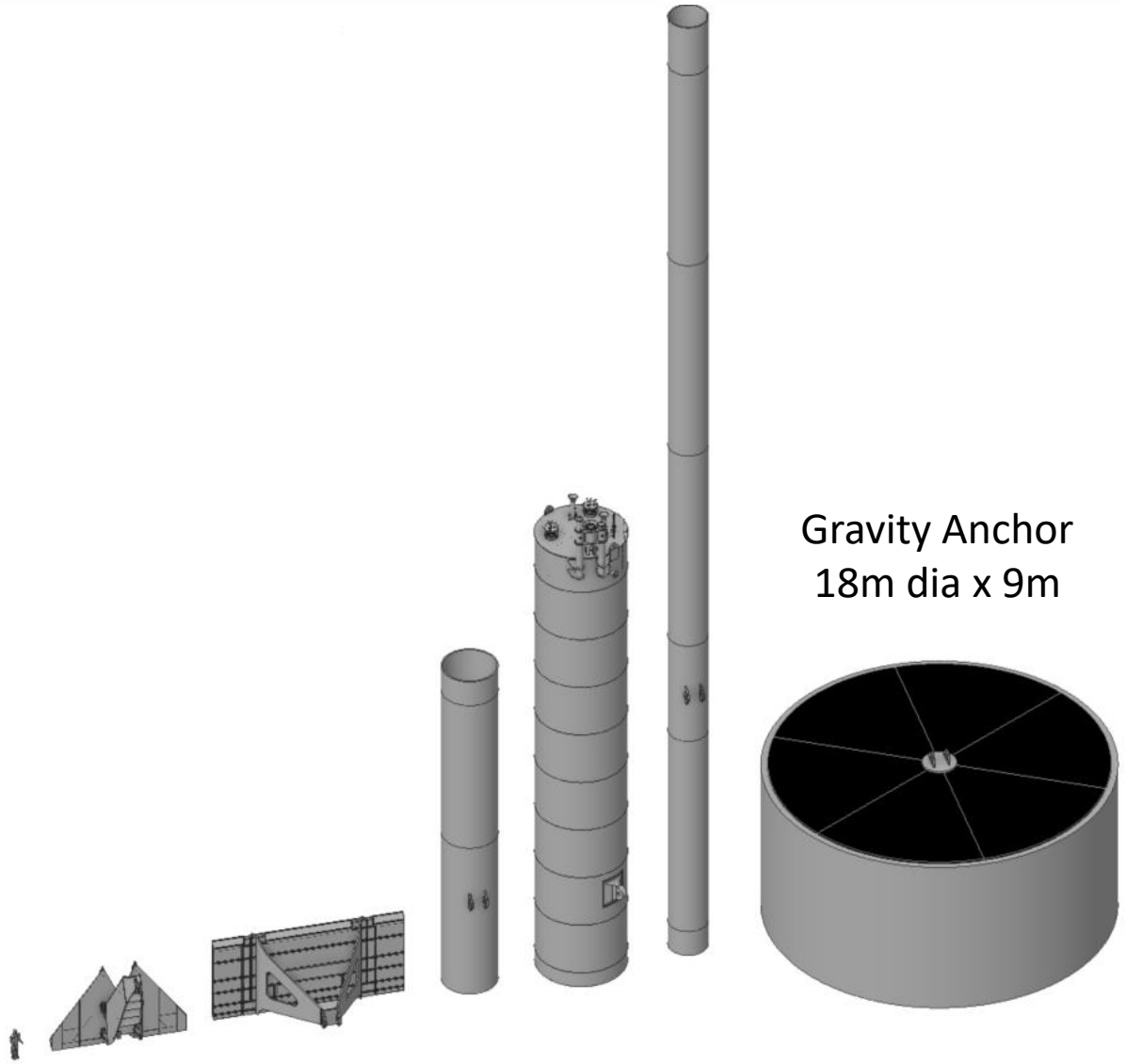
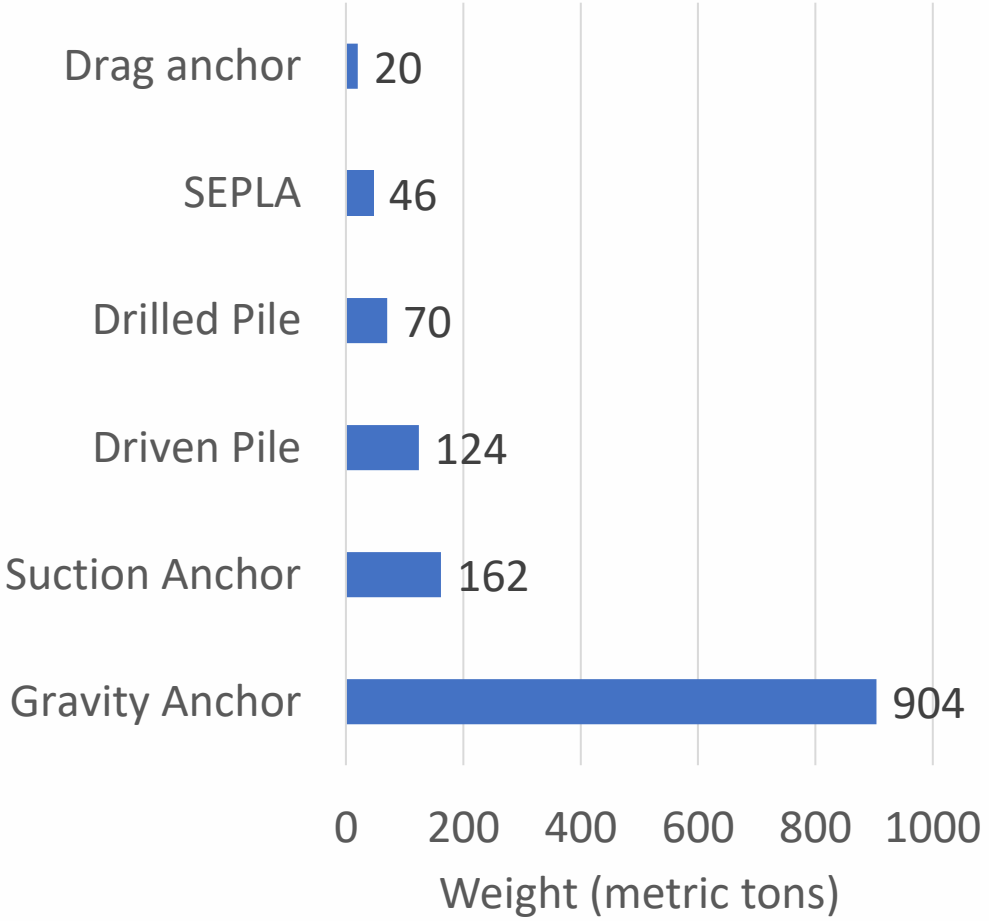
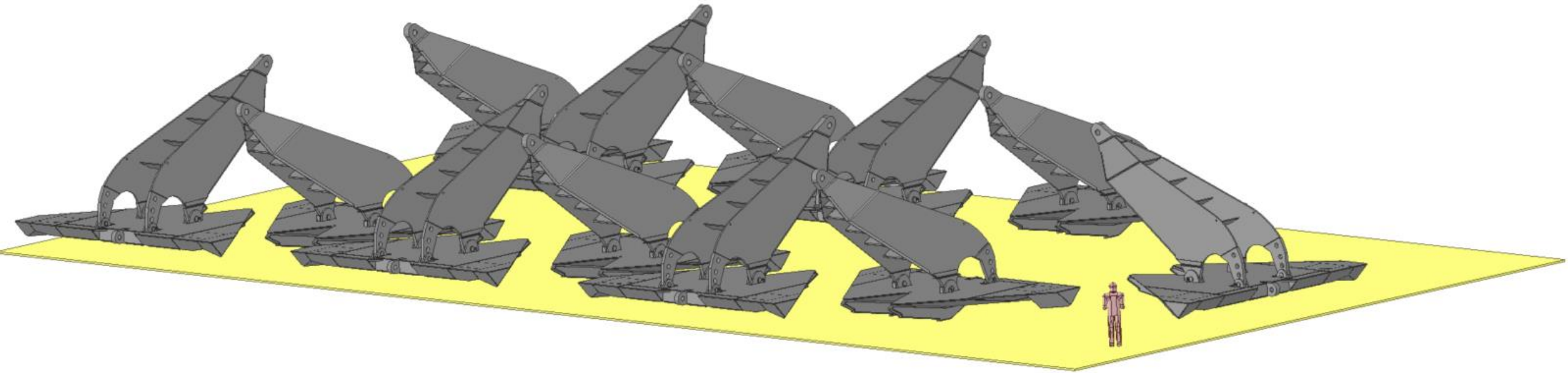


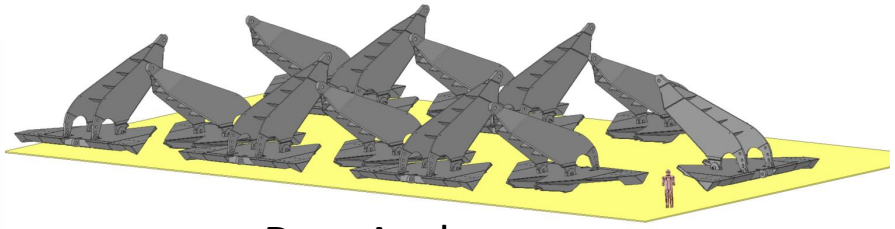
Gravity Anchor
18m dia x 9m



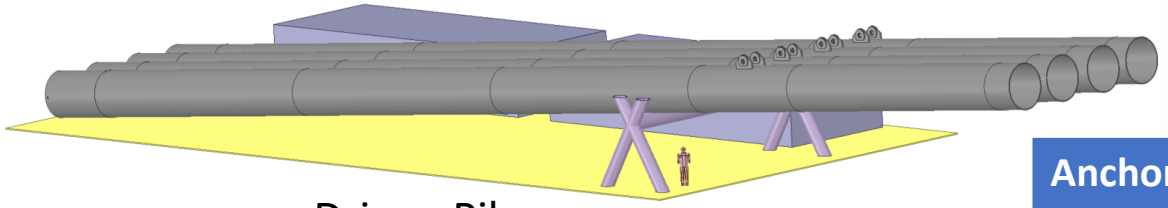
How many fit on a 40m x 20m deck?



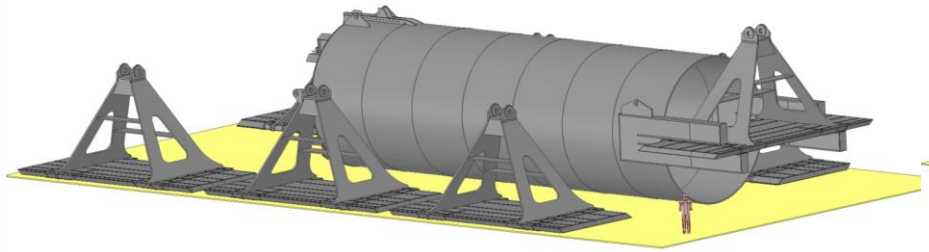
How many fit on a 40m x 20m deck?



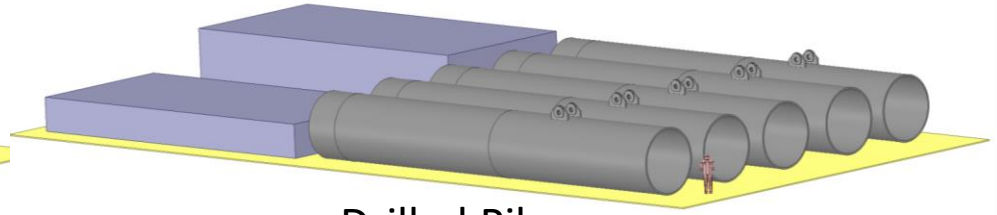
Drag Anchors



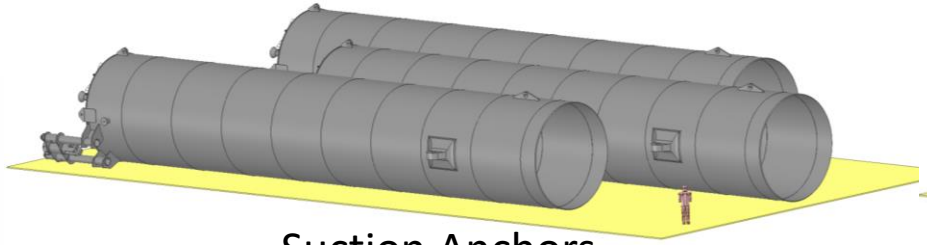
Driven Pile



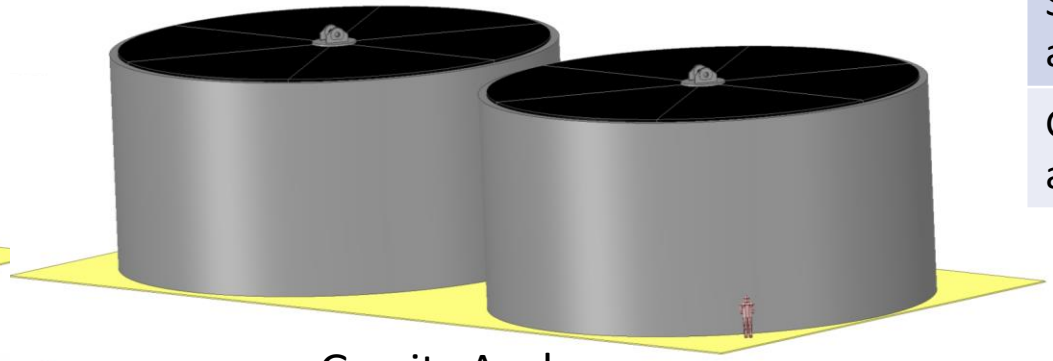
SEPLAs



Drilled Pile



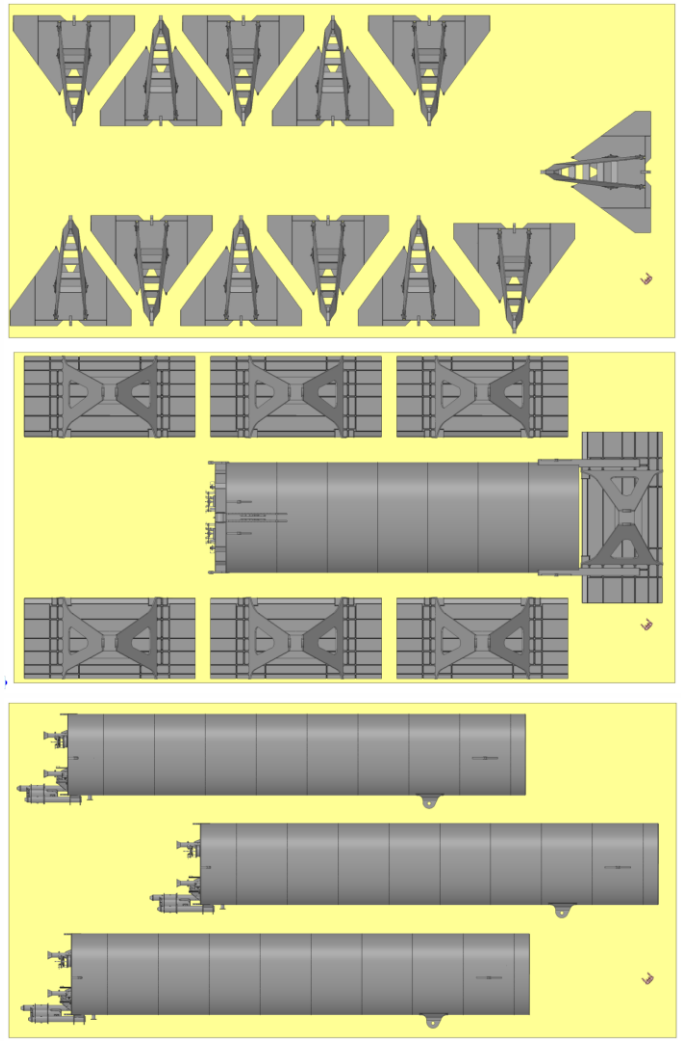
Suction Anchors

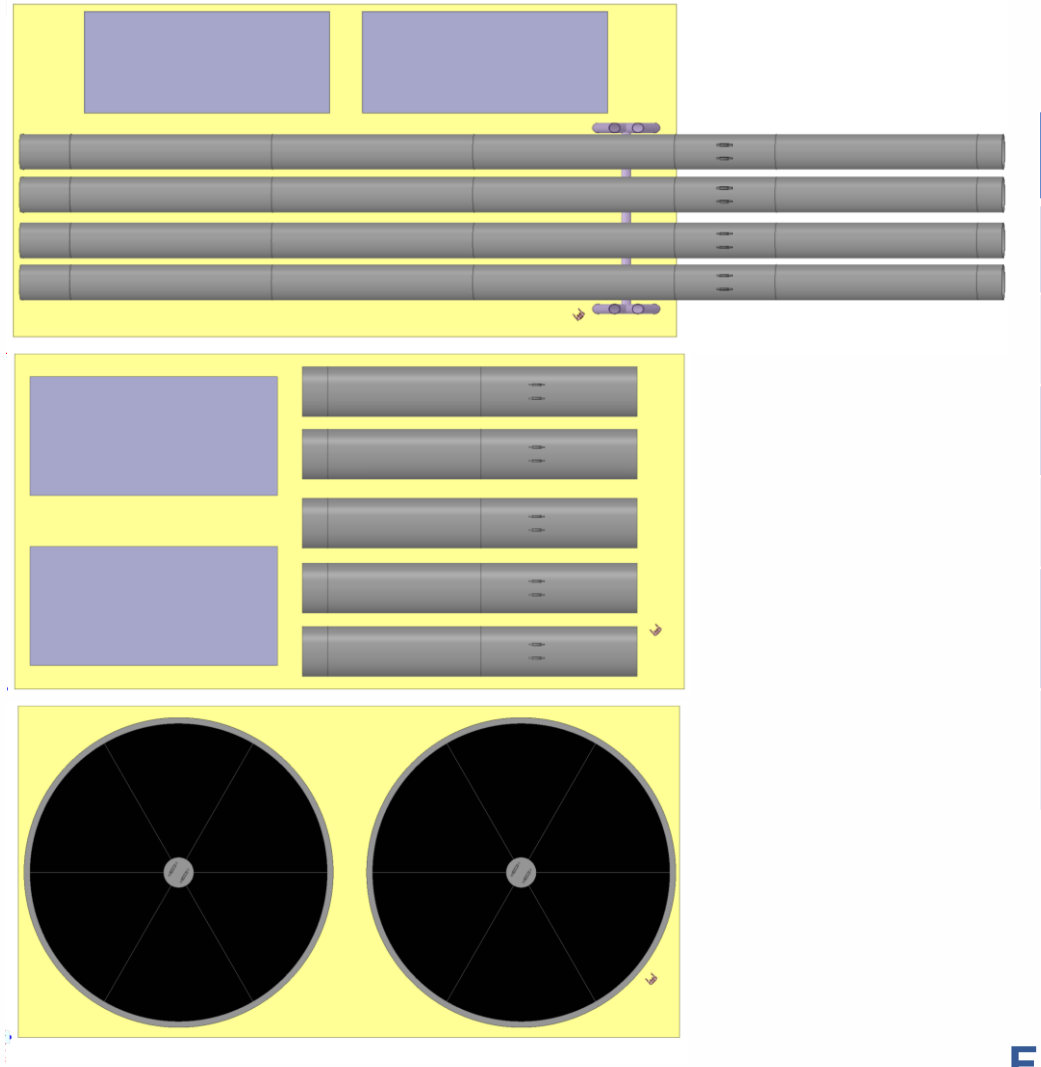


Gravity Anchor

Anchor	No. on deck
Drag anchor	12
SEPLA	7
Drilled pile	5
Driven pile	4
Suction anchor	3
Gravity anchor	2

How many fit on a 40m x 20m deck?





Anchor	No. on deck
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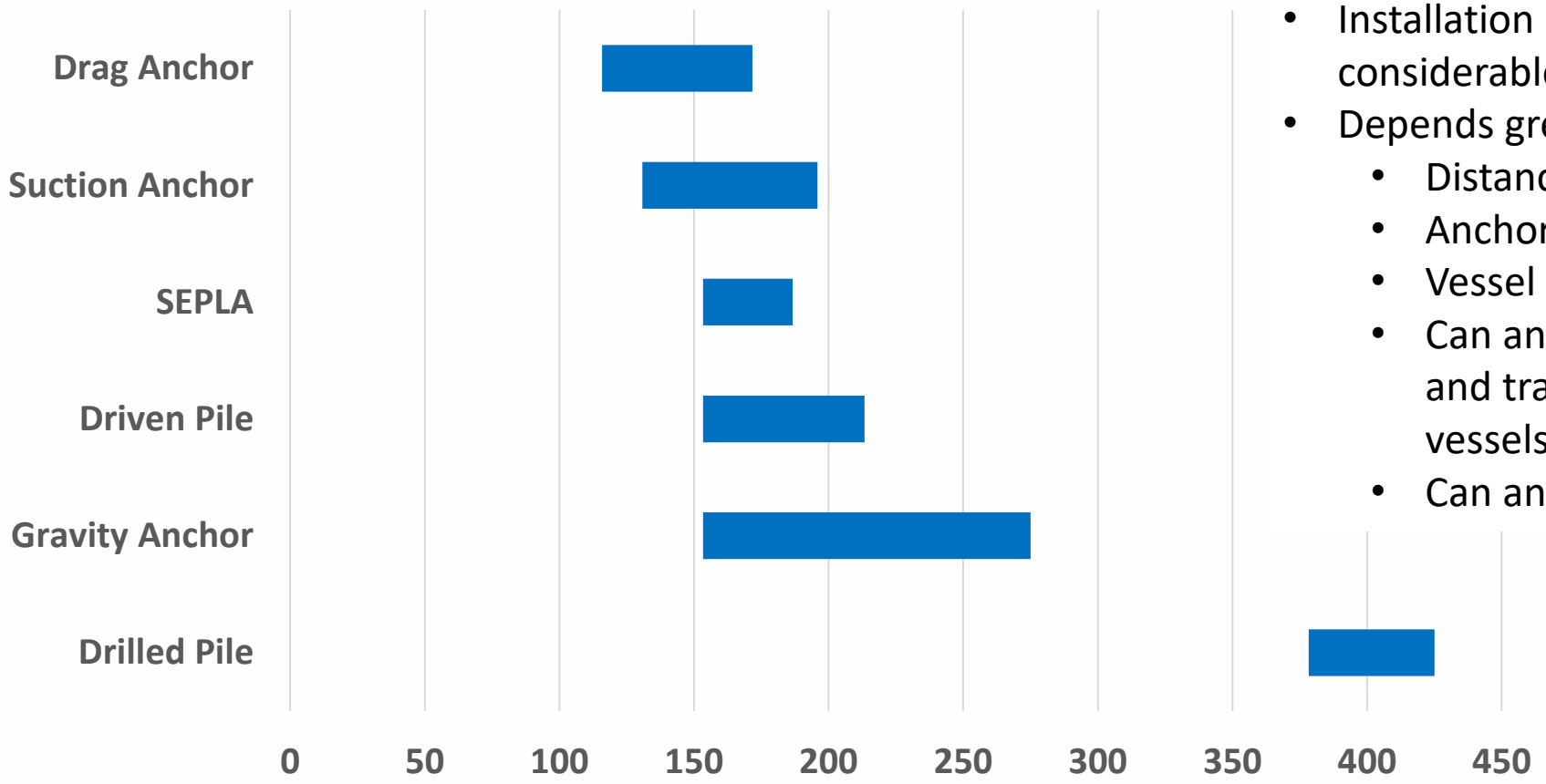
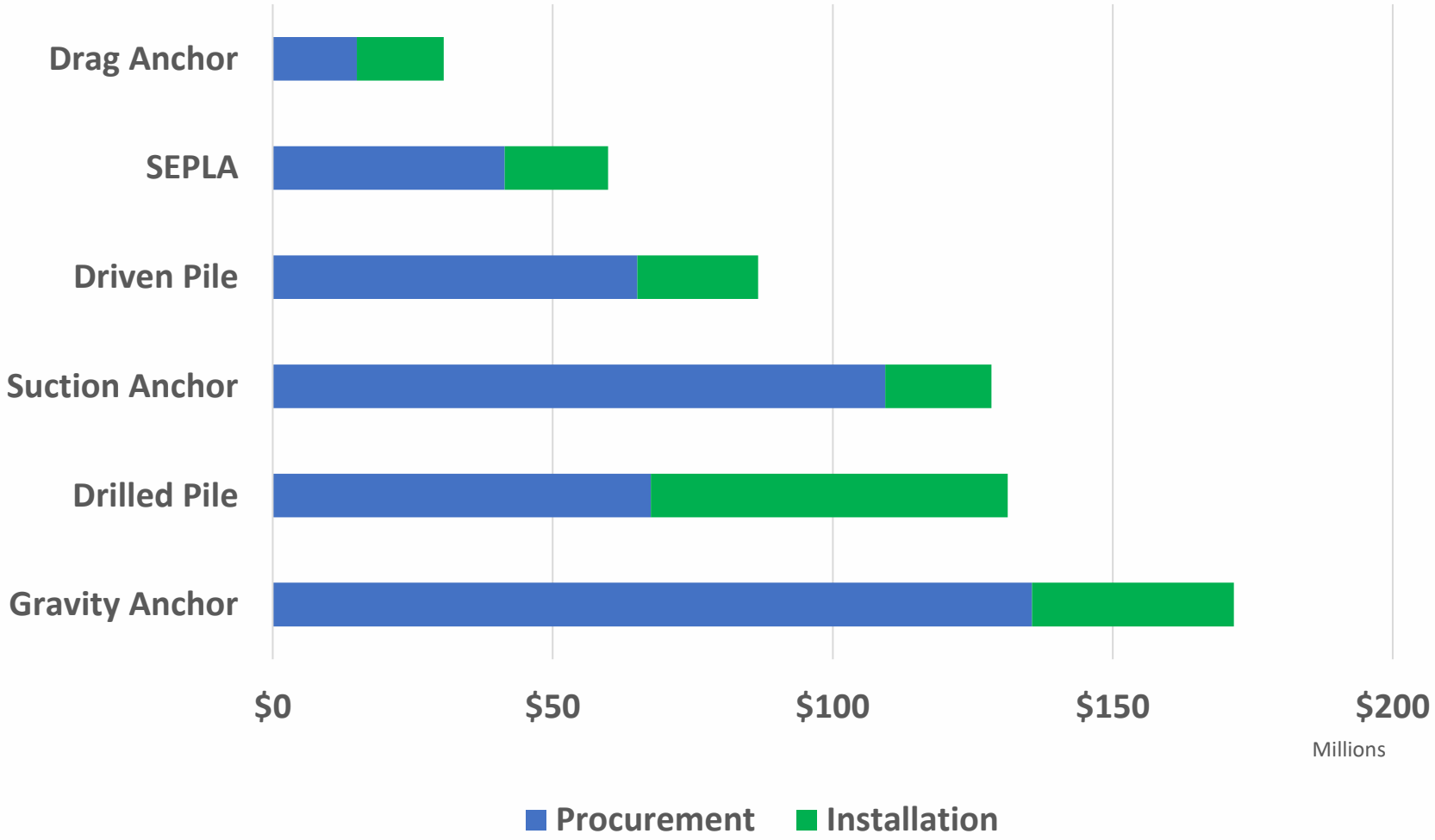
Installation Time for 150 anchors (days)



- Installation can take a considerable amount of time
- Depends greatly on:
  - Distance from port
  - Anchor size
  - Vessel deck space
  - Can anchors be transported and transferred by supply vessels?
  - Can anchor be towed?

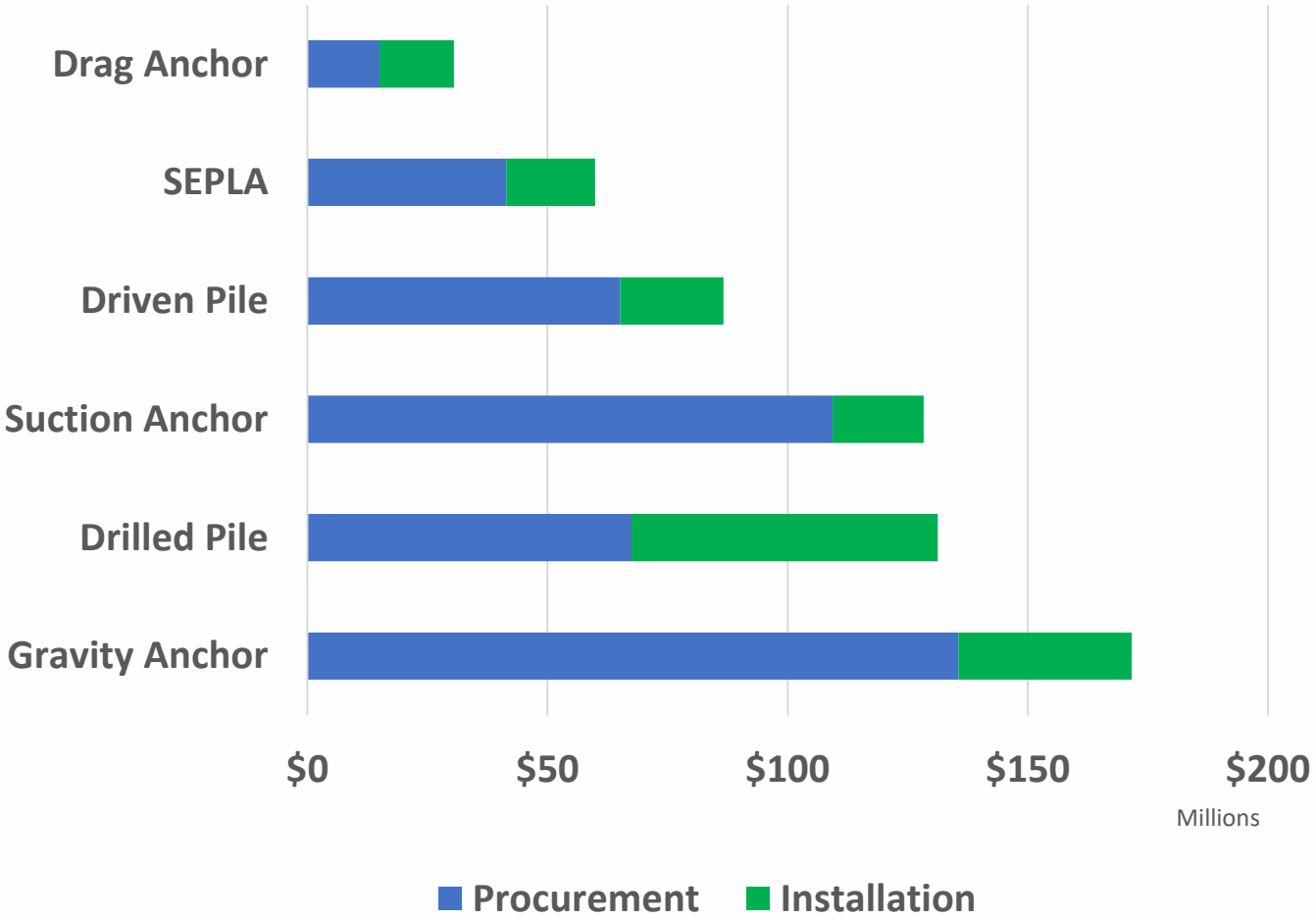
Total Costs for 150 anchors



Main assumptions:

- Use for comparative purposes only!
- No base port costs included
- No engineering included
- Cost assumes 1 non-stop installation campaign
- Site 100mn from base port

Total Costs for 150 anchors

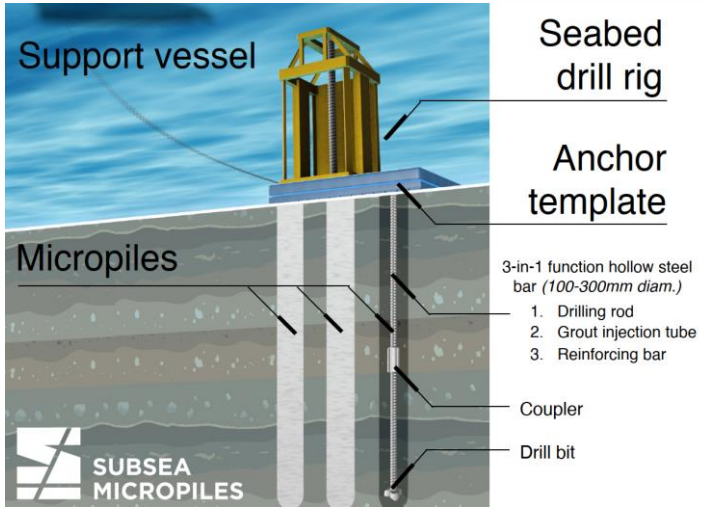


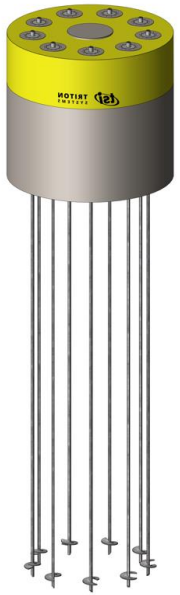
SOME COMMENTS

- Drag anchor tensioning needs subsea tensioner (such as Bruce tension) and temporary reaction anchor
- Drag anchors cannot withstand vertical loading (some allowed in soft clays)
- Drag anchors, SEPLAs, and Suction Anchors are recoverable
- Drilled and driven piles have installation noise
- Gravity anchors cost can vary significantly due to materials used and volume needed for ballast

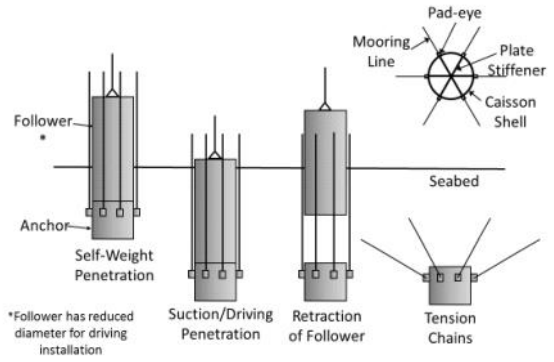
New Anchor Concepts

- Subsea micropiles (drilled)
- Triton Systems Helical Anchor Group Installation System (HAGIS) – rotation
- Texas A&M Deeply Embedded Ring Anchor (DERA) – (suction/driven)
- Oceanetics/Aubin Liquid Anchor (gravity anchor with dense liquid)
- Olav Olsen AS OO Anchor (vibratory embedded)

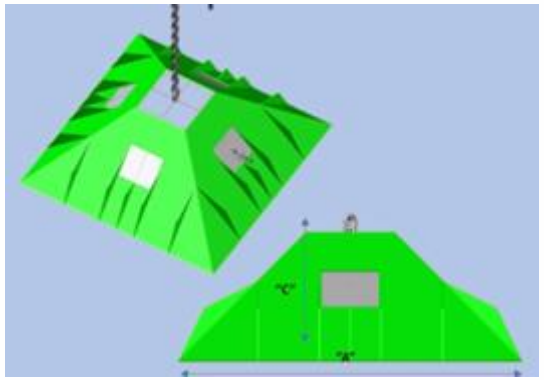




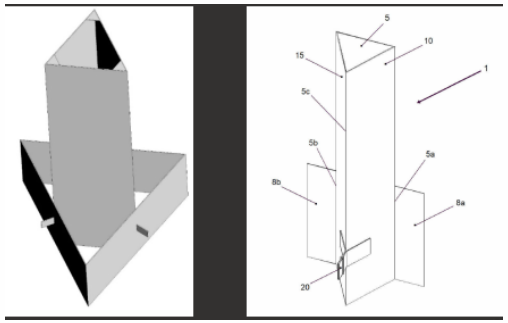
HAGIS



DERA



Liquid Anchor



OO Anchor

Take Aways

Anchor selection is important!

- Study options early
- Driven by local seabed conditions

More than one anchor type could be efficient across a wind farm

Make sure design, procurement, installation and risk are all considered

Logistics is critical due to space constraints and time

Anchors are a significant portion of overall mooring cost

For any questions, please contact:

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