MCEDD

DEEPWATER DEVELOPMENT

28 - 30 March 2023 | Millennium Gloucester Hotel | London, UK

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GULF QUEST

Quest Offshore

World Oil

Subsea Anchoring Corporation

The Renewable Energy Technology

Transforming Wind Farm Anchoring with Oilfield Technology

Ken Kotow, President/COO

Subsea Drive
Well Engineering Innovation

Presentation Outline

1. Subsea Anchoring Introduction & Background
2. Floating Wind Energy Global Forecasts
3. Anchoring Types
4. Subsea Anchoring
5. Subsea Anchoring Engineering
6. Riserless Casing Drilling

Subsea Anchoring Corporation

Offshore technology company

- Subsea Drive Corporation have patented technology:
  - ✓ Deepen the deepwater structural casing according to prevailing PP/FG to decreases well costs while increasing the reliably of attaining more well objectives; mitigate shallow wellbore instability and shallow hazards with riserless casing drilling
  - ✓ Cost effective & robust anchoring systems for floating wind turbine & oilfield structures
- Own 2 U.S. Patents
  - ✓ No.8,229,671 B2 July 24, 2012, Method and System for RiserlessCasing Seat Optimization
  - ✓ No.11,542,791 Jan 3, 2023, Systems & Methods for Casing Drilling Subsea Well & anchoring
- Completed conceptual design of installation drive system
- Based in Houston, Texas
- Technology partners: Blade Energy & Frontier Oil Tools

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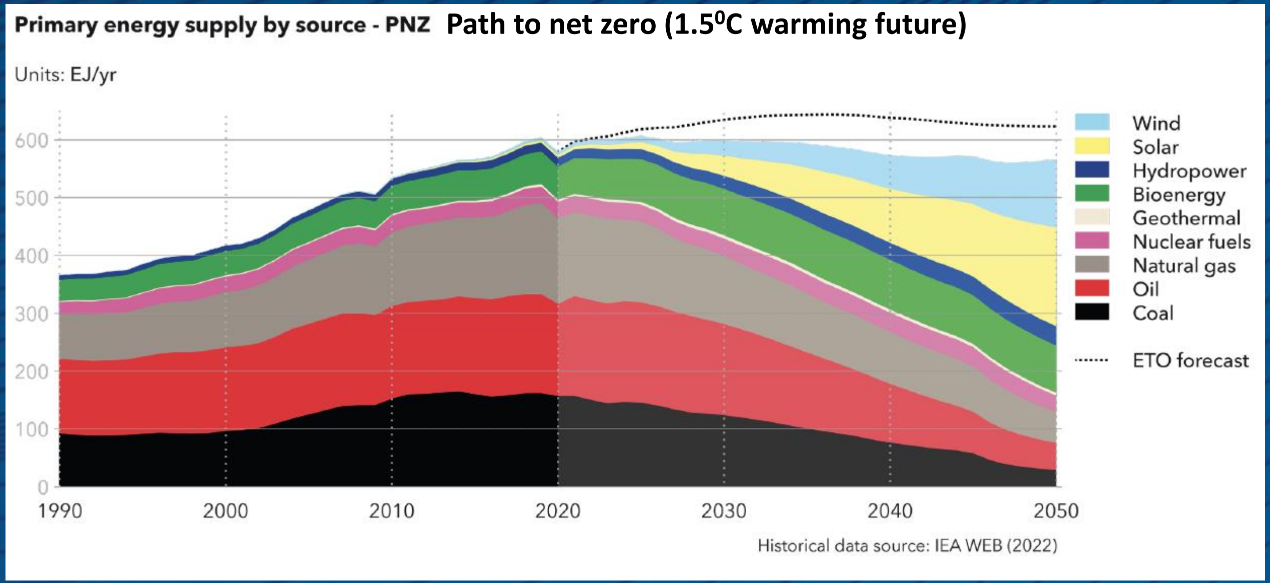
Global Wind Power Forecast

Growing market creating opportunities for anchoring systems

- Electrification the main engine for transition with positive impact on “clean” energy
- Electricity demand will grow at 3%/yr, with half of this demand being for road transportation
- In 28 yr electricity will rise from 27 to 62 Peta GWh/yr
- Global fossil fuel supply of energy demand decreases from 80% to 50% by 2050
  - ✓ 2020 oil consumption 75, peak at 86 reduce to 56 MMbbl/d
- Wind electricity increase 1.6 to 19 Peta GWh/yr by 2050
- Offshore floating wind electricity costs forecasted to decrease 84% by 2050 due to:
  - ✓ New & bigger turbines (15 KWh), larger blades & storage to increase capacity factors 38% to 43%
  - ✓ Decrease construction costs:
    - smaller floating structures (high capacity Subsea Anchoring)
    - more efficient anchoring (Subsea Anchoring)

Forecast only Wind & Solar to increase energy supply



DNV Energy Transition Outlook (ETO) 2022 Executive Summary
Global & Regional Forecast to 2050

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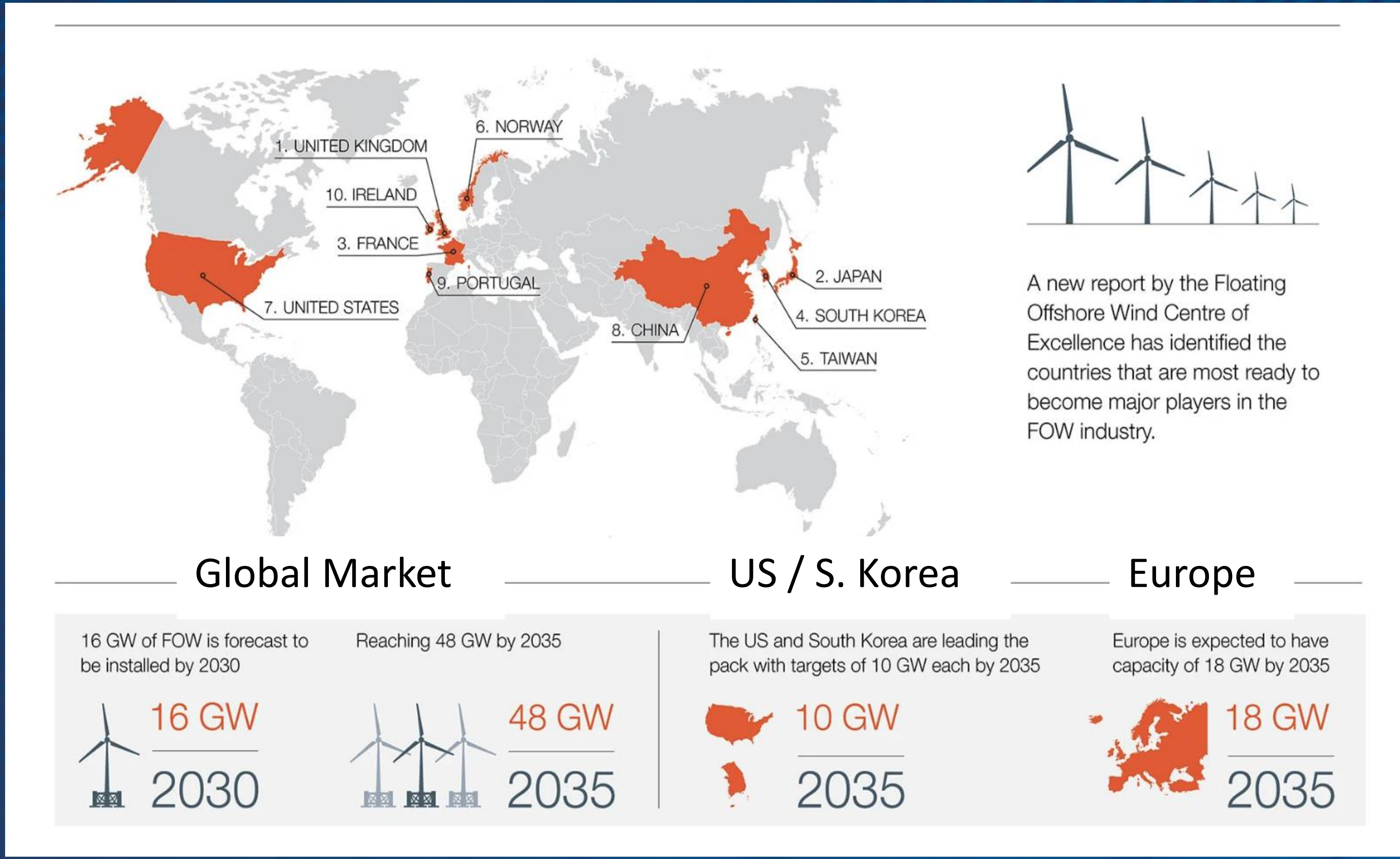
Global Wind Energy Generation Forecast

Growing market requires large number of anchoring systems



Forecasted Wind Turbine Capacity ~ 15 MW

Capacity	Anchors (3 - 4 anchor/turbine)
16 GW	3,200 to 4,300
48 GW	9,000 to 12,800

1 GW = 1 million KW

The Floating Wind Forecast: Mostly Sunny with a Chance of Showers: Oct 12, 2022, COWI Holdings A/S

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Subsea Anchor Alternatives

Suitable in all soil conditions / design for required load resistance

ANCHOR TYPES FOR FLOATING WIND

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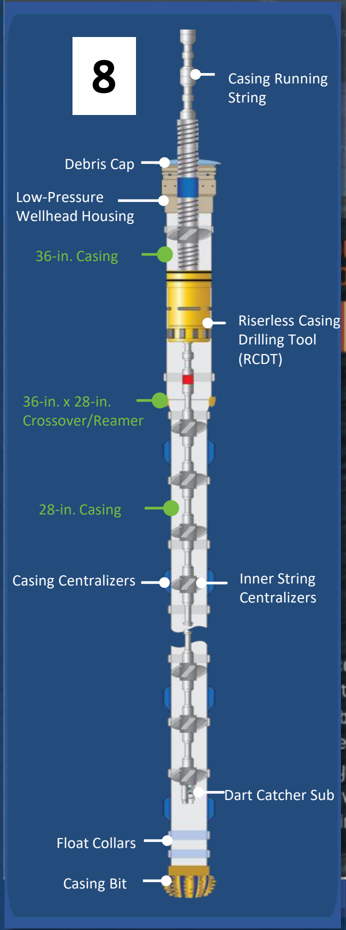
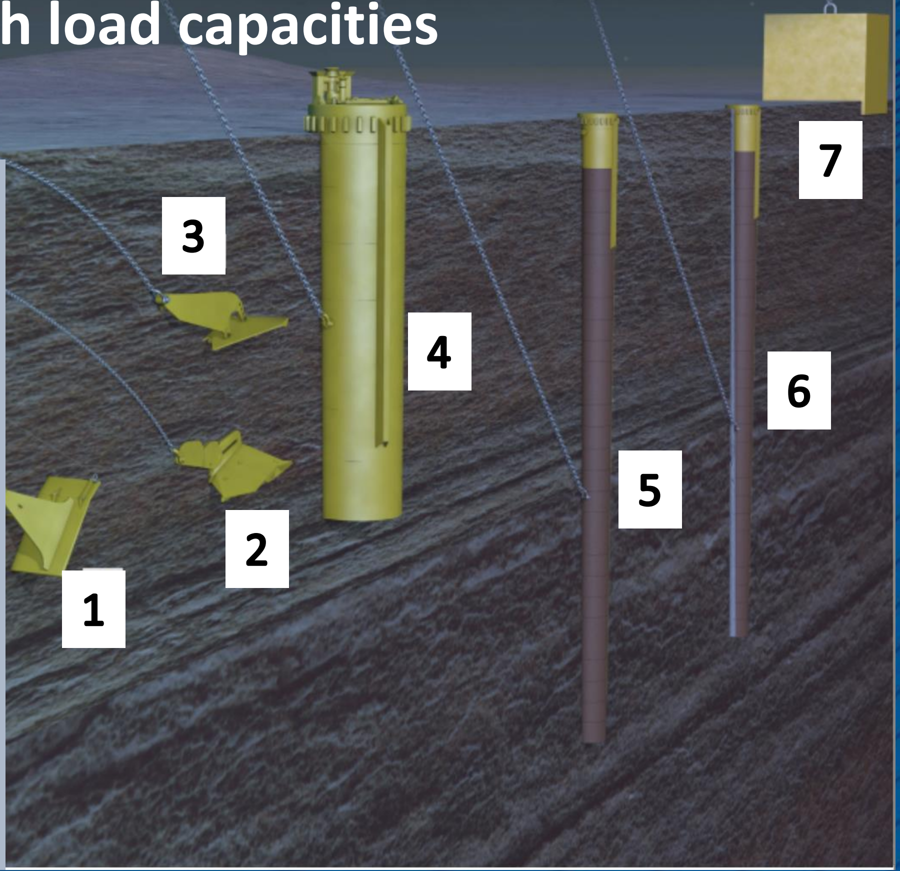


Subsea Anchors versatile: all soil types, all water depths, high load capacities

Anchor Type

1 Suction embedded plate
2 Drag vertical load anchor
3 Drag Anchor
4 Suction Anchor
5 Driven Anchor
6 Drilled & Grouted Anchor
7 Gravity Clump Anchor
8 Subsea Anchoring



Current anchoring practice information from Acteon Floating Winds Solutions Houston Tx June 2021

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Application Subsea Anchor

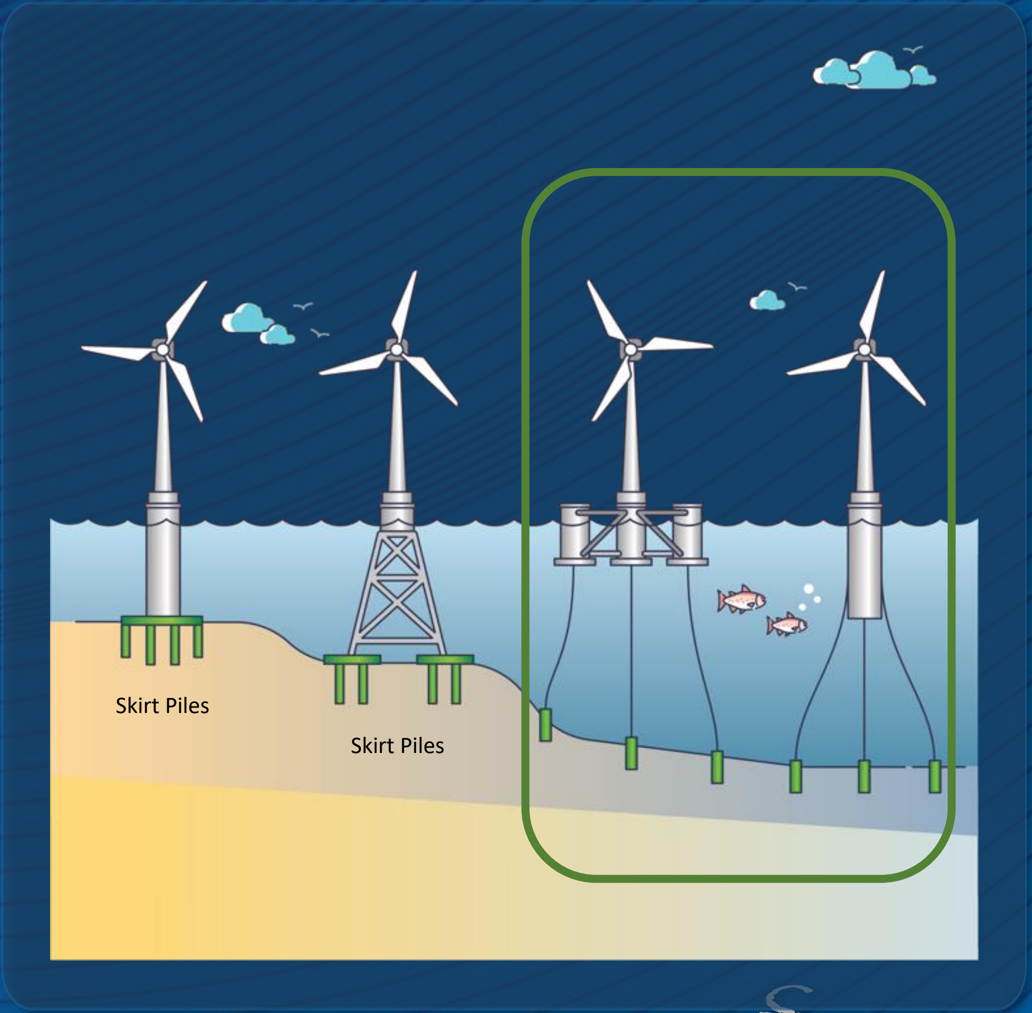
Versatile anchoring system

Features & Benefits:

- Very high axial load capacities
- Install in any type formation (hard rock, soil or even sub mudline boulders)
- Install with oilfield technologies
  - ✓ Casing drilling w/ NOV XLW conn. & cementing
- Less environmentally intrusive (noise)
- Smaller diameter casing
  - ✓ Fewer logistics issues, less steel cost & less welding
- Install anchors at any water depth
- Operates in most sea conditions

Commercial Model:

- Turnkey drilling: fit-for-purpose rig
- Potential high global anchoring demand



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Subsea Anchoring "Sweet Spots"

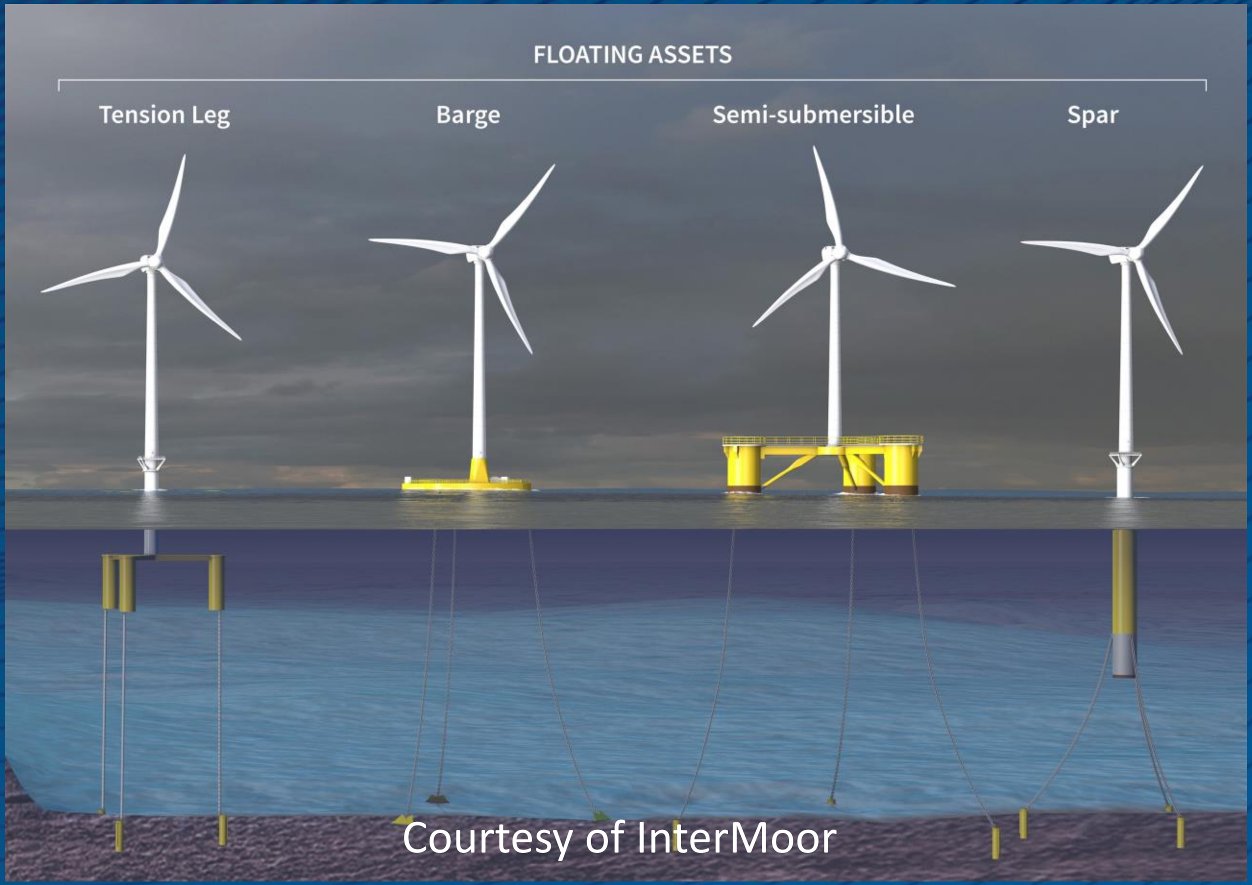
Most versatile anchoring system

Harder rock type formations

- Oilfield drilling technology

Tension Leg Platforms

- Requires high axial loading
- Minimize floating structure costs (TLP/Spar)
- Minimize seafloor disturbance
- Less expensive mooring system, less anchors
- No water depth limit



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Subsea Anchoring Engineering: Axial Capacity

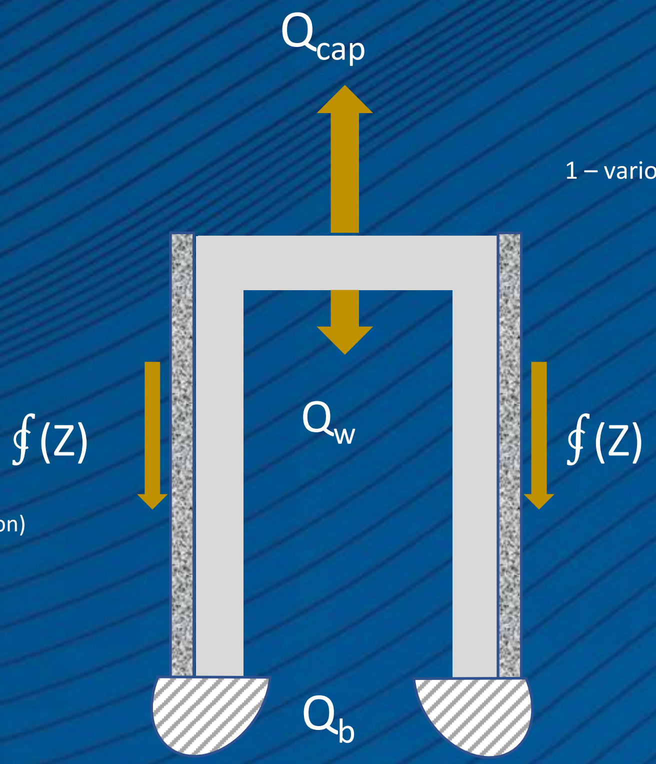
Comparative evaluation of current anchors vs Subsea Anchors

Axial Load Capacity

- Based on API RP 2GEO grouted & drilled piles
- Cement/soil shaft friction
  - ✓ 0.4 BP GOM, improved with casing drilling
- Drilled anchors axial capacity based upon
  - ✓ surface area, reversed end bearing & pile weight
- Casing drilling improves cement/formation contact
- Increasing surface area improves capacity
- Increased depth increases max. lateral strength

Ultimate Axial Pile Capacity[1]

$$Q_{cap} = Q_t + Q_b + Q_w = \oint(Z)A_s + Q_b + Q_w$$



1 – various methods

Q_t – shaft friction capacity (external friction)

Q_b – reversed end bearing capacity

Q_w – wgt of anchor

A_s – surface area of anchor

$\oint(Z)$ – unit shaft friction, in stress units

Q_b – reversed end bearing capacity = $\frac{1}{4} \times \pi \times N_c \times D^2 \times S_u(L)$

N_c – reverse end-bearing capacity factor
9 to 12 – undrained shear strength

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Subsea Anchoring Engineering: Lateral Capacity

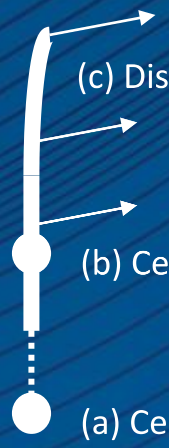
Subsea Anchoring creates greater horizontal loading capacities

Lateral Resistance Capacity

- Lateral resistance increases with:
  - ✓ installation depth
  - ✓ casing diameter/spec
  - ✓ soil shear strength
- Deeper installation for given contact area of soil and pile increase the max. lateral displacement of the pile top before failure, i.e., increasing horizontal loading capacity
- Subsea Anchor adapts casing diameter/spec. & depth for required lateral capacity
- Subsea Anchoring attachment point is at top, or below tapered casing

Failure mechanism for horizontally loaded anchors:

- Translational movement (a)
- Rotational movement (b)
- Fatigue failure of pile, bending (c)



$\Delta H = P \times D \times \Delta Z$

$P = N_{ps} \times S_u(Z)$

$H_u = \Sigma \Delta H$

ΔH – lateral resistance of length increment
D – diameter of cylinder
ΔZ - depth of length increment
N_{ps} – lateral bearing capacity factor of length increment
S_u – shear strength of length increment
H_u – ultimate lateral capacity

Aubeny & Murff (2005)

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Subsea Anchoring Axial Capacity Comparison

Subsea Anchoring greater vertical loading capacities

Subsea Anchoring

Anchoring System	Casing Dia (in)	General Description	Set Depth (m bsb)	Undrained Shear STR, avg (kPa)	Unconfined Stress (kPa)	Pullout Capacity		
						(kN)	(lbf)	(SF*2 - lbf)
Drilled / Grout (Rock)	50	Soft rock	12	6,000	3,000 to 12,000	795	179,000	89,500
Impact Driven (Medium Clay)	79	Very soft soil	56	11.6	N/A	9,086	2,000,000	1,000,000
Impact Driven (Sand / clay)	144	Soft soil	39	N/A	N/A	53,400	12,000,000	6,000,000
Drilled-in / Cmt (DW GOM)	22	Very soft soil	91	146.3	N/A	23,279	5,200,000	2,600,000
Drilled-in / Cmt (Soft sand / clay)	22		100	236.3	17 to 600	41,428	9,300,000	4,650,000
Drilled-in / Cmt (Soft sand / clay)	22		50	236.3		21,653	4,800,000	2,400,000
Drilled-in / Cmt (Soft sand / clay)	36		130	251.0		91,211	20,500,000	10,250,000

Pullout capacity increases with deeper higher shear strengths and larger surface area

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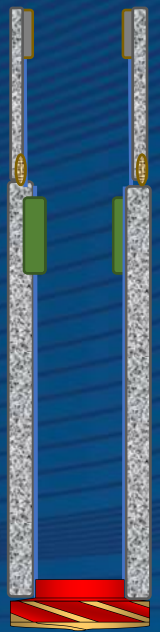
Subsea Anchoring Configurations

Various concepts for seafloor types & required loading requirements

Taught leg buoy (inclined taught mooring lines)

Higher spec. top section



Rock / Gravel Seafloor

Sandy / Clay Seafloor

Tension leg platform (vertical tethers)

Conn NOV XLW

25,000 kips tension yield str.
15,900 ft-kips bending yield str.

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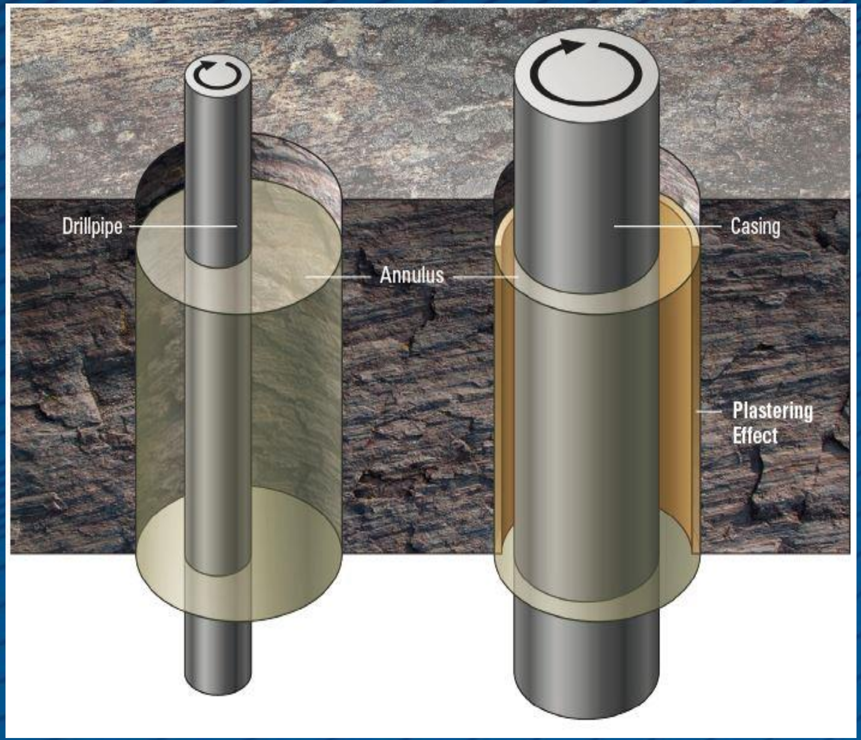
Riserless Casing Drilling

Technology enables single trip drilling/casing

- Drilling conventionally shallow subsea formations is problematic:
  - ✓ Difficult to maintain hole open to run casing
  - ✓ Problematic cementing (loss circulation)
  - ✓ Shallow hazards (water flows, loss circulation)
  - ✓ Time consuming
- Casing rotation creates gauge hole hardening formation to strengthen wellbore
- Mitigates shallow wellbore instability to install casing (anchor) at required depth
- Improves cement formation bonding; improved loading resistance
- Installed with connector



Plastering Effect of Casing Drilling

Source: SPE 208793

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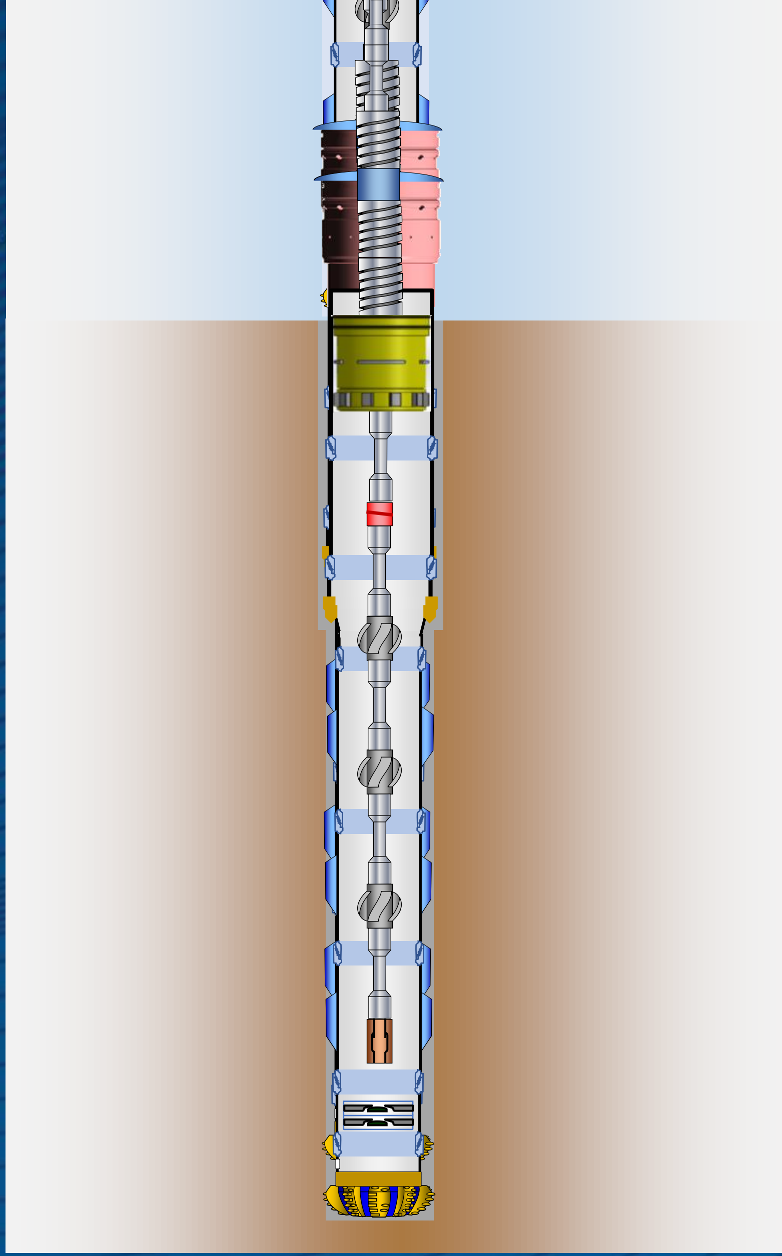
Riserless Casing Drilling

36" x 28" conductor/anchor installation procedure



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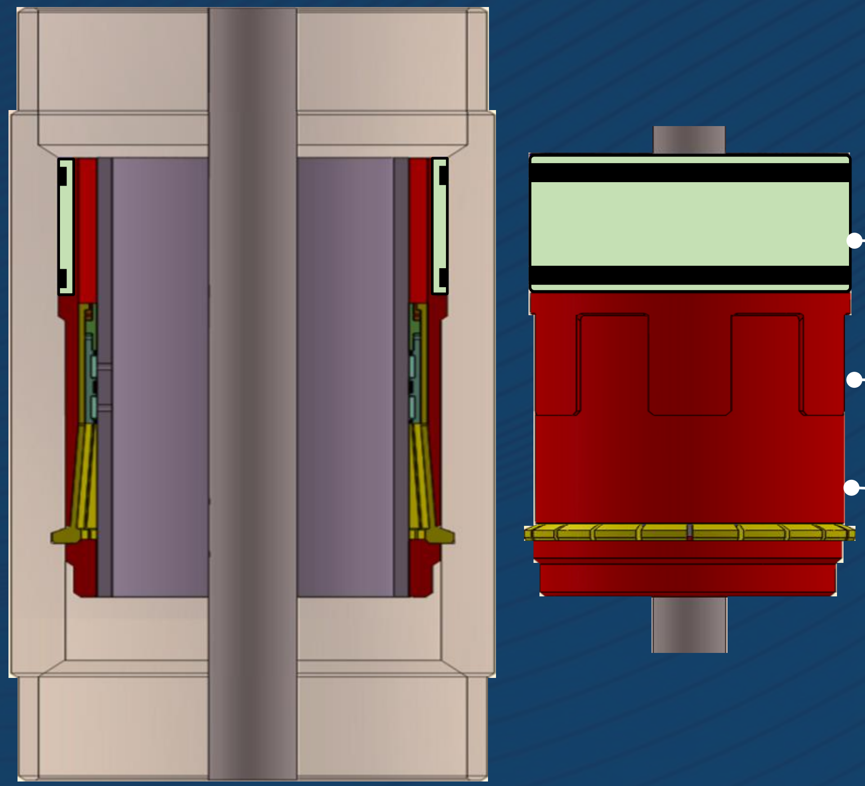
Subsea Drive Tool

Patented concept schematic

Proprietary technology delivered under license

- Hydraulically balanced
- Functions in neutral, compression or tension
- Secondary release option
- Releasable prior to cementing
- Rotation capability while cementing



Conceptual Design Only
Patent Pending

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Subsea Anchoring

The perfect Floating Wind Turbine anchor?

- Tried & proven oilfield technology (casing drilling, semi-sub rigs, drill bits, OCTG)
- Installation costs comparative to existing systems
- Provides the highest anchor load capacities
- Allows less costly floating structures with tension leg anchoring, decreasing the cost of offshore electricity energy
- Oilfield drilling vessels allows installation in wide range of weather conditions

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Thank You

Questions? Comments?

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