The Installation of Offshore Wind Farm Inter-Array Cables

Stuart Duncan

Presentation
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Inter-Array Cable (IAC) Installations

- Introduction
- Offshore Wind Farms
  - Power Generation / Current Status / Future Plans
- Wind Farm Construction
  - WTGs / Onshore and Offshore Connection / Inter-Array Cables
- Inter-Array Cable Installation
  - Installation Process
  - Operational Considerations (Geology, Survey, Field Layout, Environmental) / Equipment
- Summary & Questions

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Inter-Array Cable (IAC) Installations

- **Offshore Wind Farms**
  - Power Generation

- 1 x nacelle = 3.6 MW ➔ 140 turbines generates 504 MW
- 1 x nacelle annual output = 16,793 MWh (at 9m/s) ➔ 140 turbines annual output = 2.351 GWh (at 9 m/s)
- 140 turbines ➔ 480,000 homes
- Electricity to 480,000 homes ➔ prevents the release of approximately 2 million tonnes of carbon

As long as the wind blows at 9m/s!

Inter-Array Cable (IAC) Installations

- **Offshore Wind Farms**
  - Current Status

- Europe is the word leader
- UK has the largest capacity
- London Array (630MW) is the largest in the world

	Wind Farms	MW
United Kingdom	20	3681
Denmark	13	1271
Belgium	-	571
Germany	6	520
Netherlands	5	247
Sweden	5	212
Finland	-	26
Ireland	-	25
Spain	-	5
Norway	-	2

Inter-Array Cable (IAC) Installations

- **Offshore Wind Farms**
  - Future Plans

- By 2020, European wind farm capacity will be at 40GW (4% of EU's demand for electricity)
- Dogger Bank (7200 MW / 7.2 GW)
- Irish Sea (4200 MW / 4.2 GW)
- Dudgeon (560 MW)
- USA starting soon (Cape Wind)
- China targets 5GW by 2015 / 30GW by 2020

- Dogger Bank:
  - 1000 Turbines
  - Forewind Consortium (Statoil and Statkraft – 50%)
  - 125km from shore

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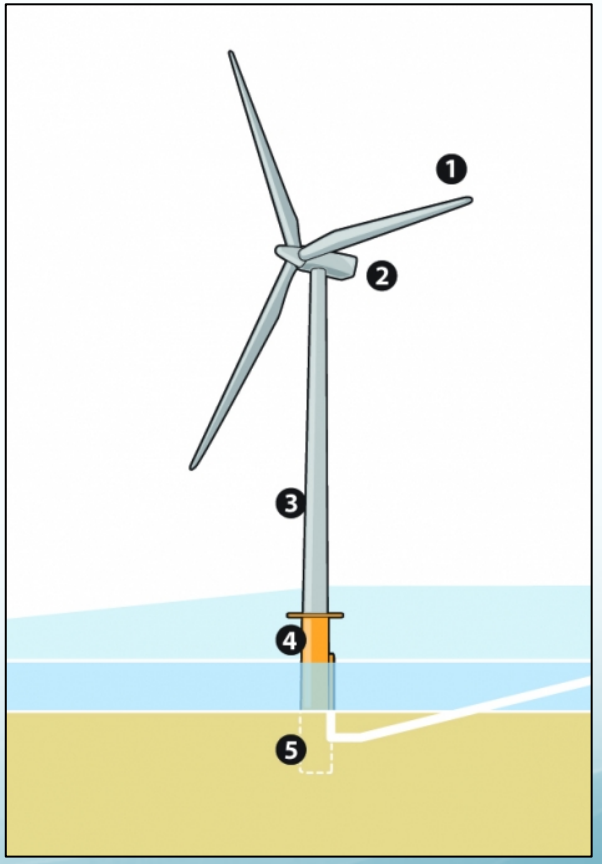
Inter-Array Cable (IAC) Installations

- **Wind Farm Construction**
  - Wind Turbine Generators (WTGs)
  - Onshore and Offshore Connection
  - Inter-Array Cables

Inter-Array Cable (IAC) Installations

- **Wind Farm Construction**
  - Wind Turbine Generator (WTGs)

- One WTG comprises of five parts (in order of installation):
  - Monopile (5)
  - Transition Piece (4)
  - Tower (3)
  - Nacelle (2)
  - Blades (1)



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5

4

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  - Blades (1)

3, 2 and 1

Inter-Array Cable (IAC) Installations

- **Wind Farm Construction**
  - Onshore & Offshore Connection

- Other import aspects of the Offshore Wind Farm construction are the following:
  - Export Cable Installation
  - Onshore substation
  - Offshore substation(s)
  - IAC Installation

90% of wind farm subcontractors are topside operators

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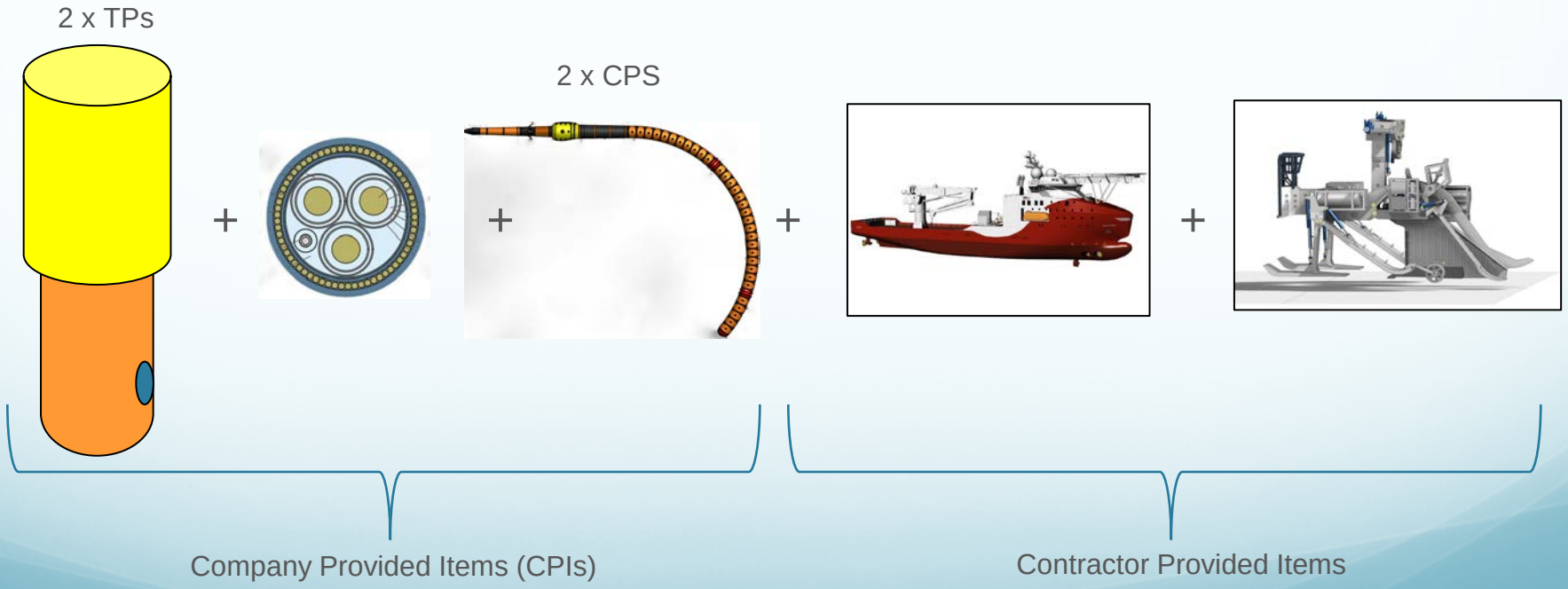
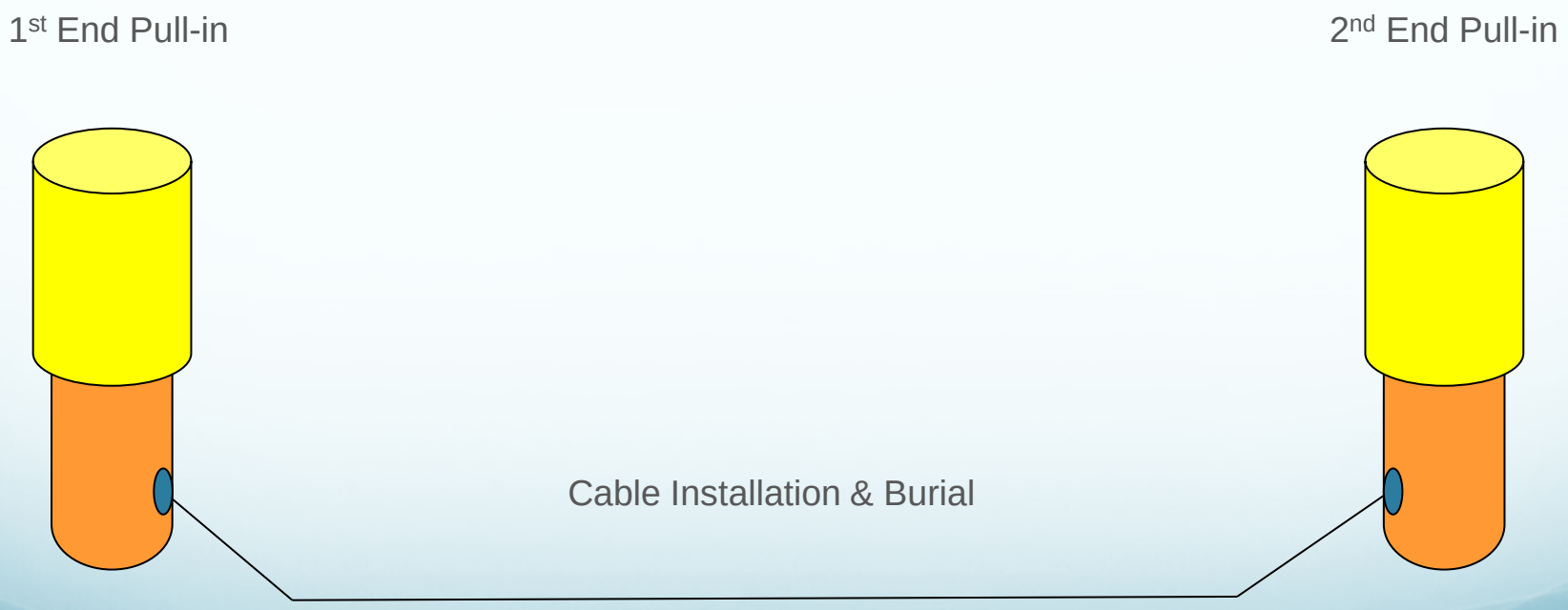
- **Wind Farm Construction**
  - Inter-Array Cable Installation – Essential Ingredients



Inter-Array Cable (IAC) Installations

- **Wind Farm Construction**
  - Inter-Array Cable Installation – Installation Process



Inter-Array Cable (IAC) Installations

- **Wind Farm Construction**
  - Inter-Array Cable Installation – operational characteristics

- Challenging conditions - difficult seabed
- Shallow water - invariably < 35m
- Short installation distances - nominally < 1200m
- Repetitive operation - 20, 140, 160 or 1000 times
- Environmentally sensitive - wind, current, tide, sea state, visibility
- Equipment challenges - positioning, durability, spares
- Simultaneous Operations - big projects require a lot of subcontractors

Inter-Array Cable (IAC) Installations

- **Inter-Array Cable Installation**
  - Operational Considerations
    - Pre-engineering surveys
    - Cable Protection System (CPS)
    - Product
    - Equipment
    - Geology & Route Engineering
    - Survey & Positioning
    - Environmental
    - Field Layout

Inter-Array Cable (IAC) Installations

- **Inter-Array Cable Installation**
  - Operational Considerations
    - **Pre-engineering Surveys**

- Numerous surveys are undertaken:

1. Bathymetry surveys
2. Geophysical surveys
3. Geotechnical surveys
4. Borehole testing
5. Core sampling
6. UXO surveys

Undertaken before any subcontractor arrives in field

Inter-Array Cable (IAC) Installations

- **Inter-Array Cable Installation**
  - Operational Considerations
    - **Cable Protection System (CPS)**

- Various different CPS solutions exist:

1. Tekmar TEKLINK
2. Seaproof Solutions

- Purpose: to ensure the integrity of the product (cable) for the lifespan of the installation (approx. 25 years)

Inter-Array Cable (IAC) Installations

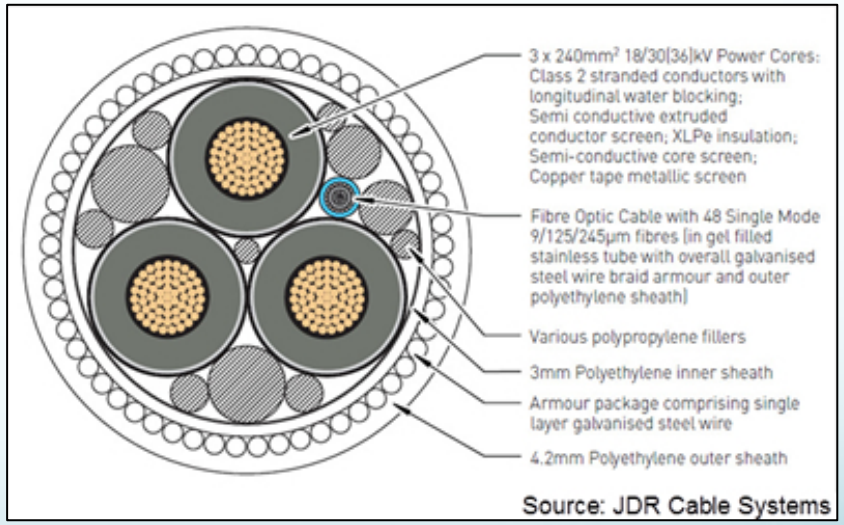
- **Inter-Array Cable Installation**
  - Operational Considerations
    - **Product**

Typical Inter-Array Cable Manufacturers include:

- JD Cables
- Nexans
- Draka (Prysmian)
- General Cable

Of particular concern during installation:

- Minimum bend radius (MBR)
- Temperature
- Nature of seabed



Inter-Array Cable (IAC) Installations

- **Inter-Array Cable Installation**
  - Operational Considerations
    - **Equipment**

The combination of installation vessel and burial plant is chiefly driven by soil type.

- Subsea ploughs
- Trenchers

Furthermore, two types of vessels are preferred:

- DP vessels
- Barges

All vessels will have at least one ROV and most likely support from a dive spread

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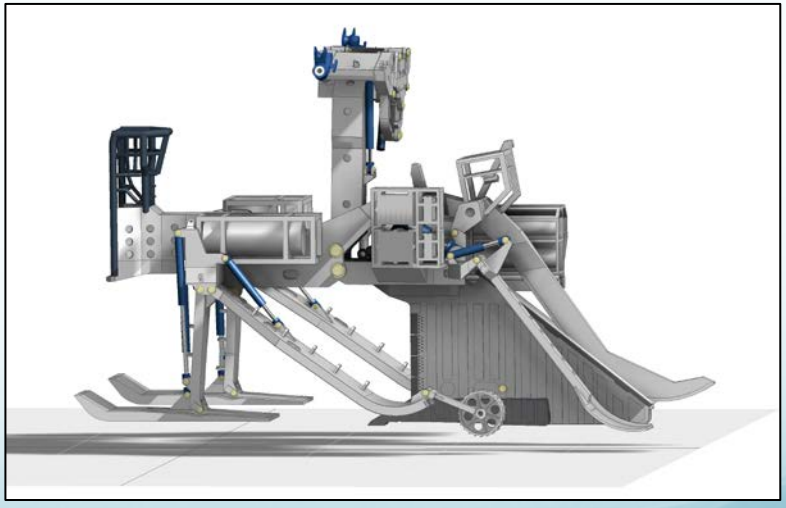

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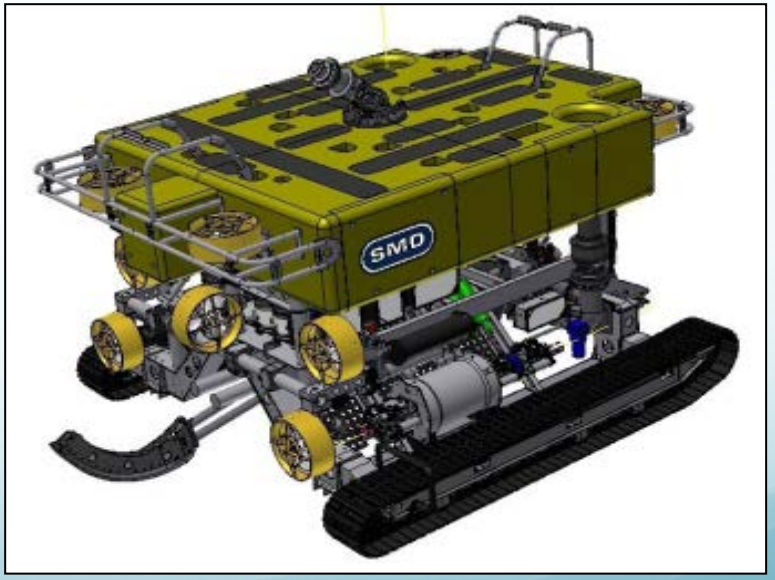

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Courtesy: CTOffshore

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Inter-Array Cable (IAC) Installations

- **Inter-Array Cable Installation**
  - Operational Considerations
    - **Geology & Route Engineering**

IACs are expected to be installed in different types of seabeds:

1. Sand
2. Clay
3. Glacial till

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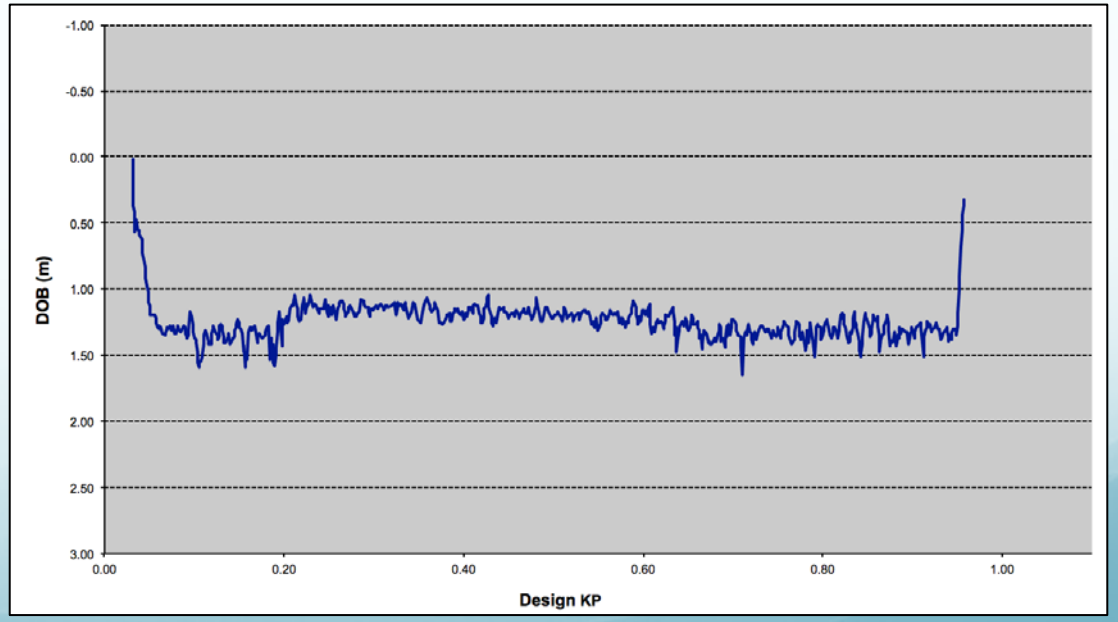

IAC installed in sand

Inter-Array Cable (IAC) Installations

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For glacial till and complex areas, a comprehensive understanding of the field geology is essential:

1. Estimating realistic Depth of Burial
2. Understanding what the burial operation can expect
3. Ensuring product is not compromised during simultaneous lay and burial
4. Safe operations during installation

A Cable Package **should** produced for each IAC

Inter-Array Cable (IAC) Installations

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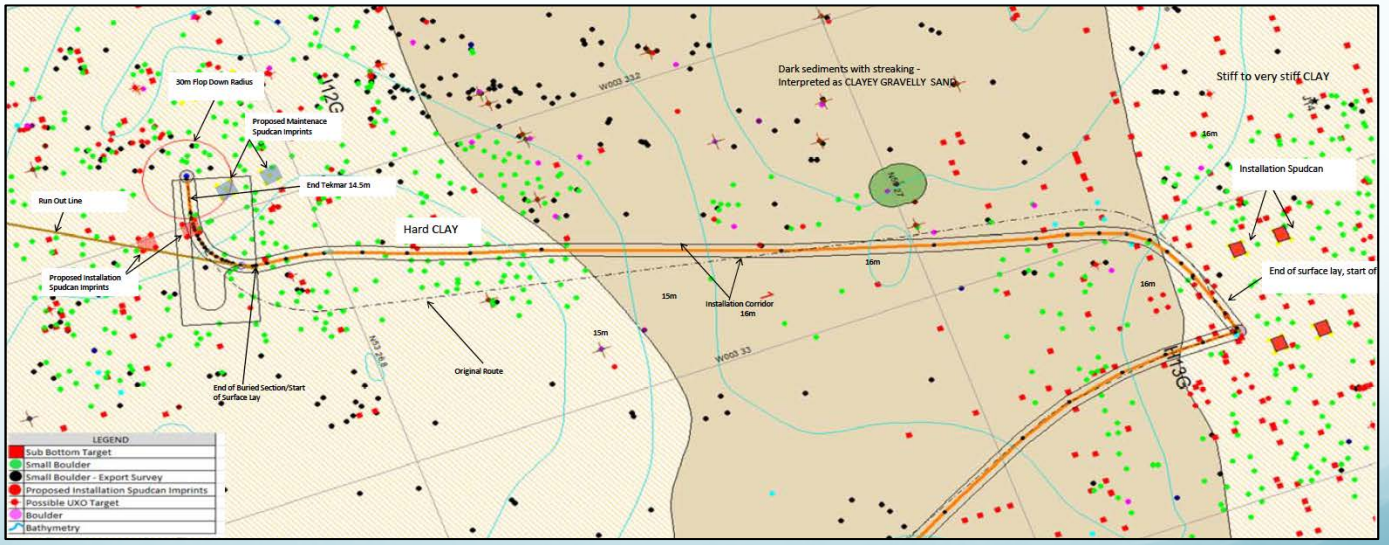

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Inter-Array Cable (IAC) Installations

- **Inter-Array Cable Installation**
  - Operational Considerations
    - **Survey & Positioning**

Typical Installation Parameters:

- Horizontal accuracies in the region of +/- 0.5m
- Depth of Burial (DOB) from as many as three different sources

Challenges:

- Shallow water (cavitation from vessel's thrusters)

Inter-Array Cable (IAC) Installations

- **Inter-Array Cable Installation**
  - Operational Considerations
    - **Environmental**

Of particular concern during installation:

- Shallow water – less than 35m
- Strong currents – Up to 4 knots
- Soil conditions – sand and/or clay
- Water column visibility – can be often close to zero
- Wind! – reliable forecasting

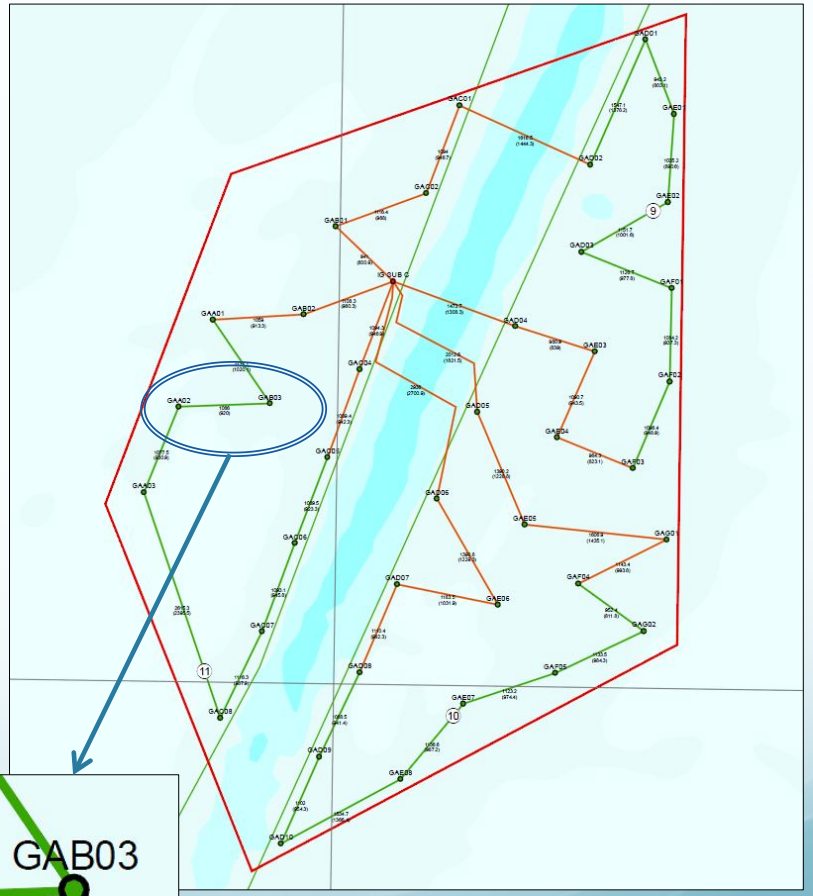
The planets must align!

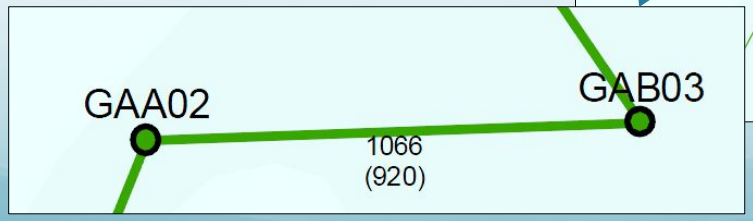
Inter-Array Cable (IAC) Installations

- **Inter-Array Cable Installation**
  - Operational Considerations
    - **Field Layout & Readiness**

Of particular concern during installation:

- Currents – prevailing directions affect vessel
- Aperture orientation during 1st End Pull-in
- Distance – for vessel operations
- Status of WTG installation
- Tower preparedness
- Lock-offs, yawing
- Environmental
- Lay-downs
- SIMOPs





Inter-Array Cable (IAC) Installations

- **Summary**

Much like any oil and gas project, the success of a IAC installation is a result of the following:

- Sufficient lead time for engineering,
- Thorough geotechnical understanding of the area,
- Wind farm pre-engineering cooperation with cable subcontractors
- Good cooperation with other in-field subcontractors during project execution
- Comprehensive and thorough cooperation with client
- Sound equipment choice with sufficient spares
- Personnel competency

Thank you

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Any questions