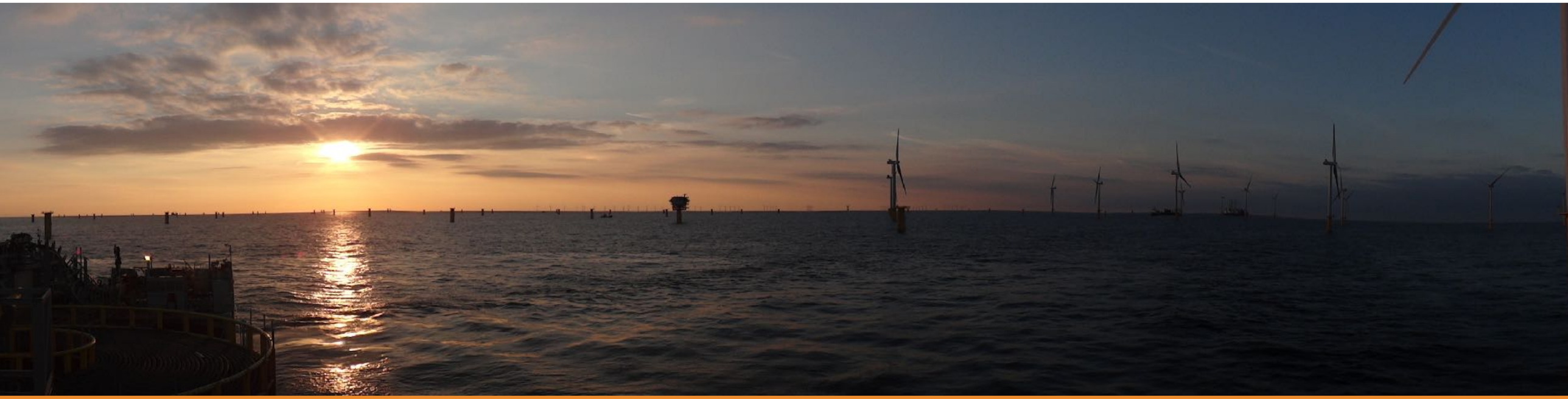


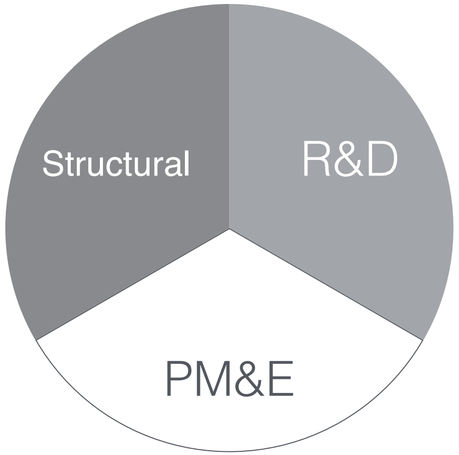
Engineering | Consultancy | Equipment

Offshore Cable Repair Operations

Reinier Nagtegaal, Managing Director

Who are we?

Team of 12 engineers
Innovative & hands-on approach
Located in Wateringen (The Hague)



Presentation Content

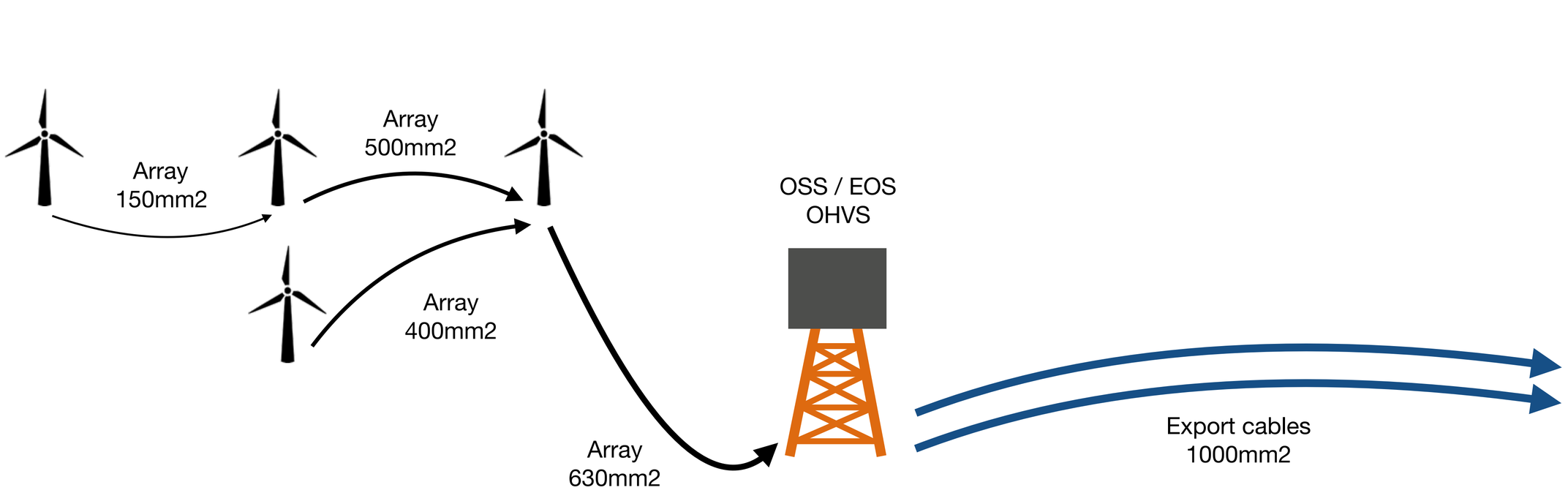
- A brief overview of OWF cable installation
- Cable repair operations:
  - Fault finding
  - Removal
  - Jointing / re-installation

Me at Rampion Export Cable Repair

Presentation contents

Revision: 0
Date: 28-09-2017
Classification: Confidential

ECE offshore



INFIELD / ARRAY

String of array cables
Typically 34kV -> upgrade to 66kV
Burial: 0.60cm - 1.50m
Length: 600m to 3 kilometres

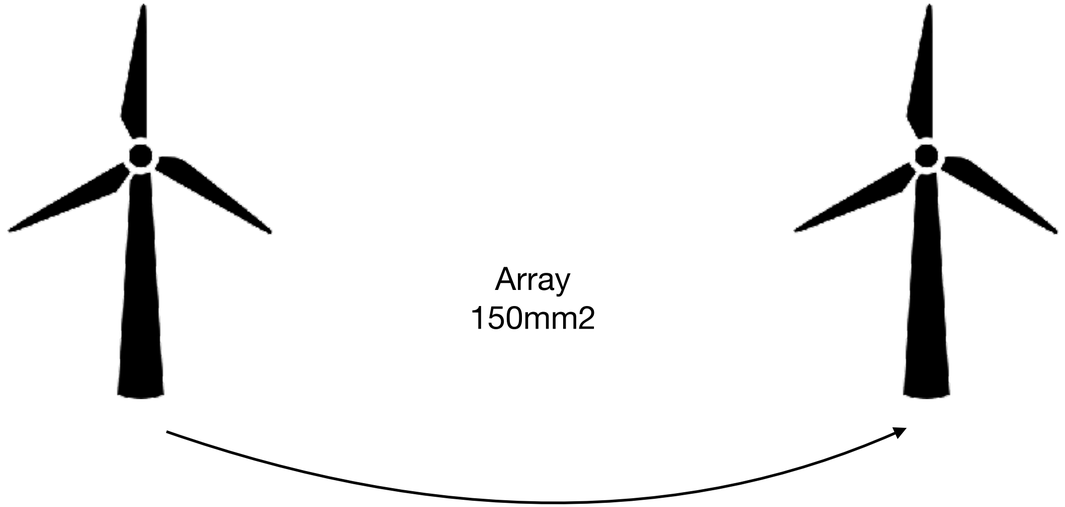
EXPORT / INTERCONNECTOR

One or two export cables
Core size: 800-1600mm2
Typically 132kV / 150kV or higher
Burial: 1.50m or deeper (shipping lanes)
Length: usually longer than 15km

Typical layout of an offshore wind farm

Revision: 0
Date: 24-10-2018
Classification: Public

ECE offshore



Pre-lay survey	Identify objects, bathymetry, geometric sampling
UXO survey	Identify magnetic objects and check if it is a bomb or refrigerator
Route clearance / PLGR run	Remove existing cables, lines etc
Boulder clearance	Remove boulders and other obstacles that can't be avoided
Route design	Design the best route, taken everything above into account
Decide on burial strategy	Pre-lay trenching or post-lay burial
Cable installation	Install the cable between A and B
Burial	Post lay burial or trench back filling
Commissioning	Connect the cores and fiber optics to the switch boxes inside the turbines

Scope of Work: cable installation

Revision: 0
Date: 24-10-2018
Classification: Public

ECE offshore

OASYS
CABLE

STEMAT SPIRIT ON KRIEGERS FLAK

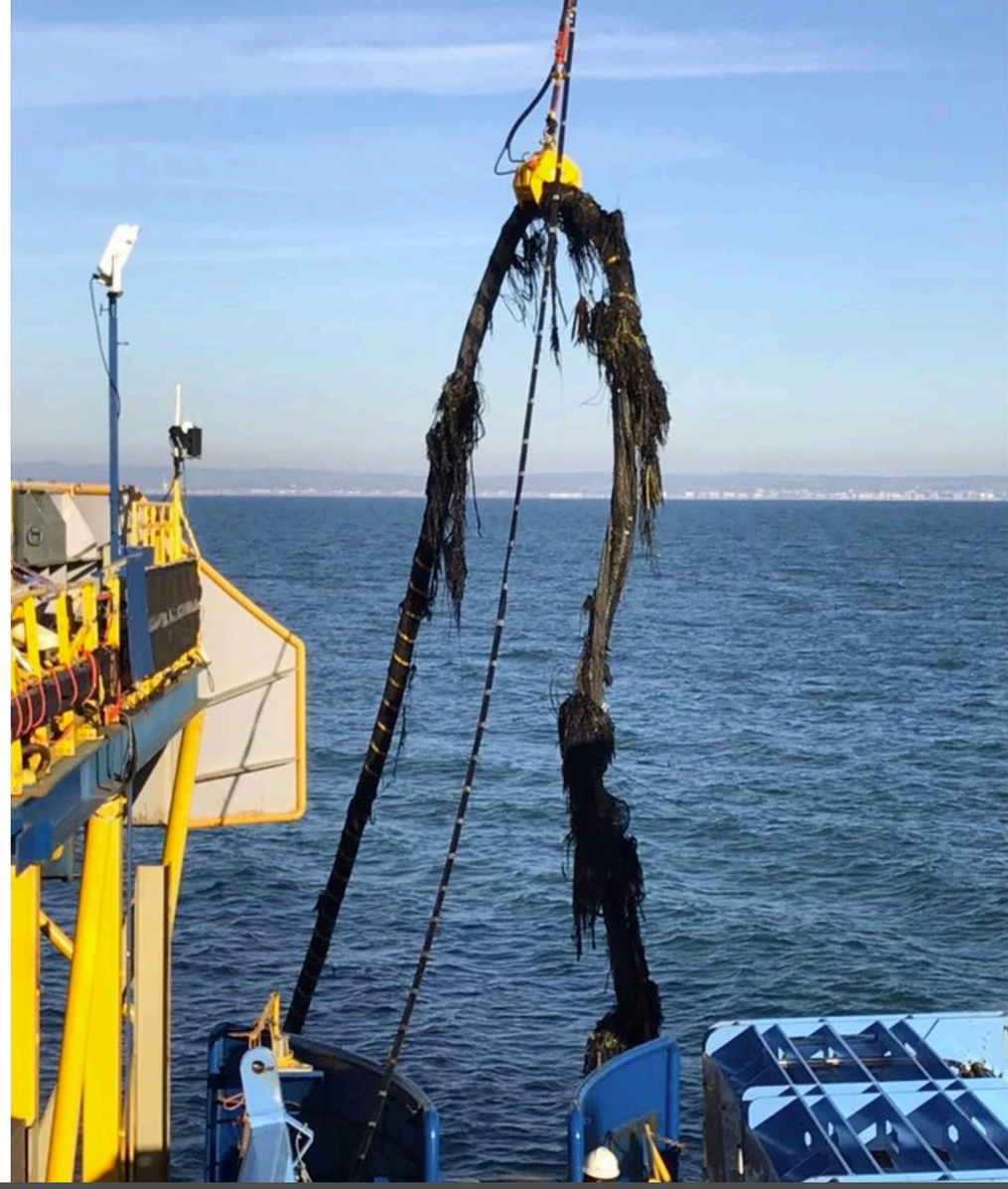

offshore

Yearly fault estimation: 1 cable per 1000km

Average cable length per installed GW: 300km

Source	2020 (GW)	2030 (GW)
Ernst & Young	23.5	44-68
Renewable UK	35	
EWEA	40	150

GW installed	2015	2021	2030
Minimum	2	10	16
Average	**5**	**15**	**24**
Max	7	19	56



Estimated faults per year

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Date: 24-10-2018
Classification: Public

ECE offshore

83% insurance claim costs are cables

	Gemini	Anholt	Dogger Bank A
Wind park capacity	600 MW	400 MW	1200 MW
Amount of turbines	150	111	200
Average turbine capacity	4 MW	3,6 MW	6 MW
Turbine efficiency	43 %	43 %	43 %
kWh sell price	0,03 EUR	0,03 EUR	0,03 EUR
Cable failure	**Loss per day (EUR)**	**Loss per day (EUR)**	**Loss per day (EUR)**
1 – Infield cable	1.224	1.102	1.836
2 – Infield string (6)	7.344	6.612	11.016
3 – ½ Export cable	91.800	61.200	183.600
4 – Export cable	183.600	122.400	367.200

Loss of income due to faults

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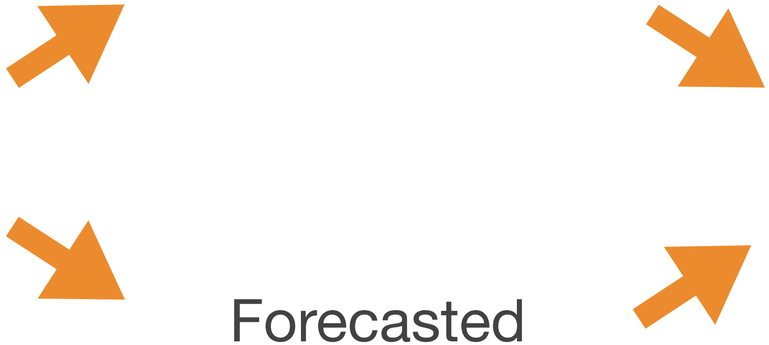
Classification: Public

ECE offshore

Cable repair



Incidental

Usually dragged anchors

Forecasted

Fatigue damage during installation

Temperature hotspots
Failing fiber optics

Fault localisation

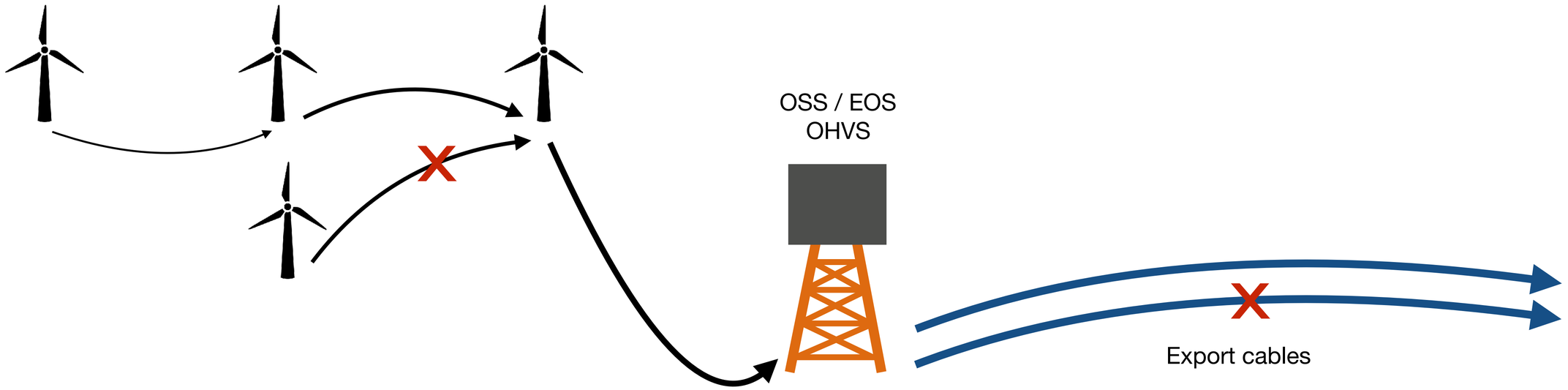
Optical Time Domain Reflector (OTDR) on the fiber optics
Time Domain Reflector (TDR) on the electrical cores
DC resistance measurement on the electrical cores

OTDR is quite accurate, TDR less accurate and electric resistance measurement less accurate due to dispersion and loss of propagation

Accuracy of fault localisation: 10 - 100m

A typical cable repair

Revision: 0
Date: 24-10-2018
Classification: Public



INFIELD / ARRAY

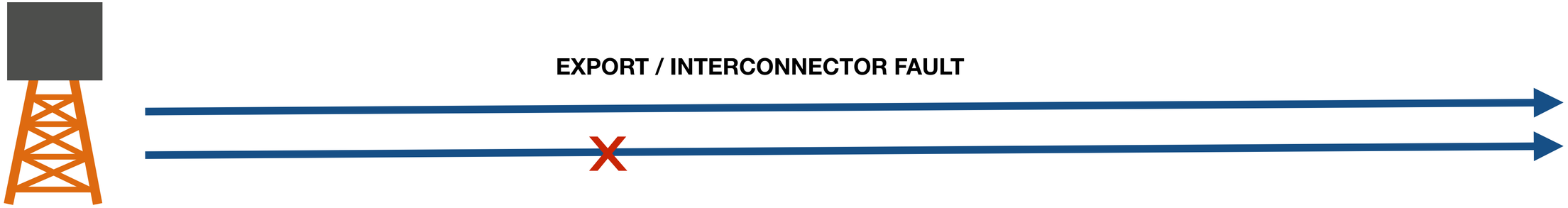
Replacement is more cost efficient than repair

EXPORT / INTERCONNECTOR

Replace a section of approximately 1km

A typical cable repair

Revision: 0
Date: 24-10-2018
Classification: Public

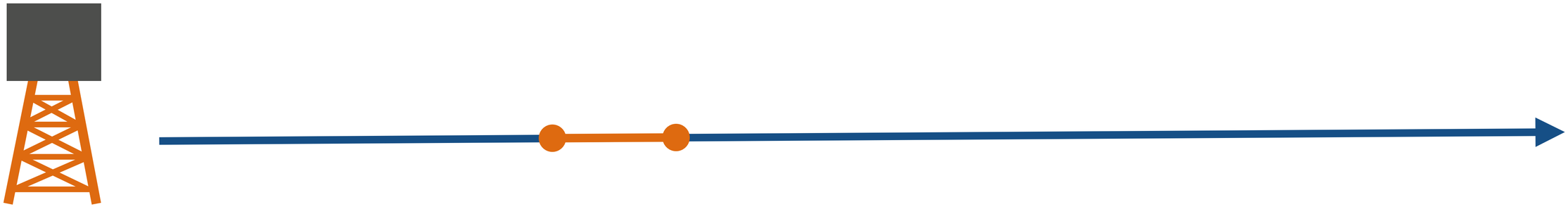


1. Localise approximate fault location using OTDR/TDR or resistance measurements
2. Estimate local burial depth (using historical burial depth measurements)
3. Mobilise cable repair vessel
4. Load spare cable, deck equipment, joints

A typical cable repair - onshore activities

Revision: 0
Date: 24-10-2018
Classification: Public

Repair methodology: replace a section that includes the fault with a spare cable section. Cable ends are joined together by means of a ‘joint’



A typical cable repair - how do they do it?

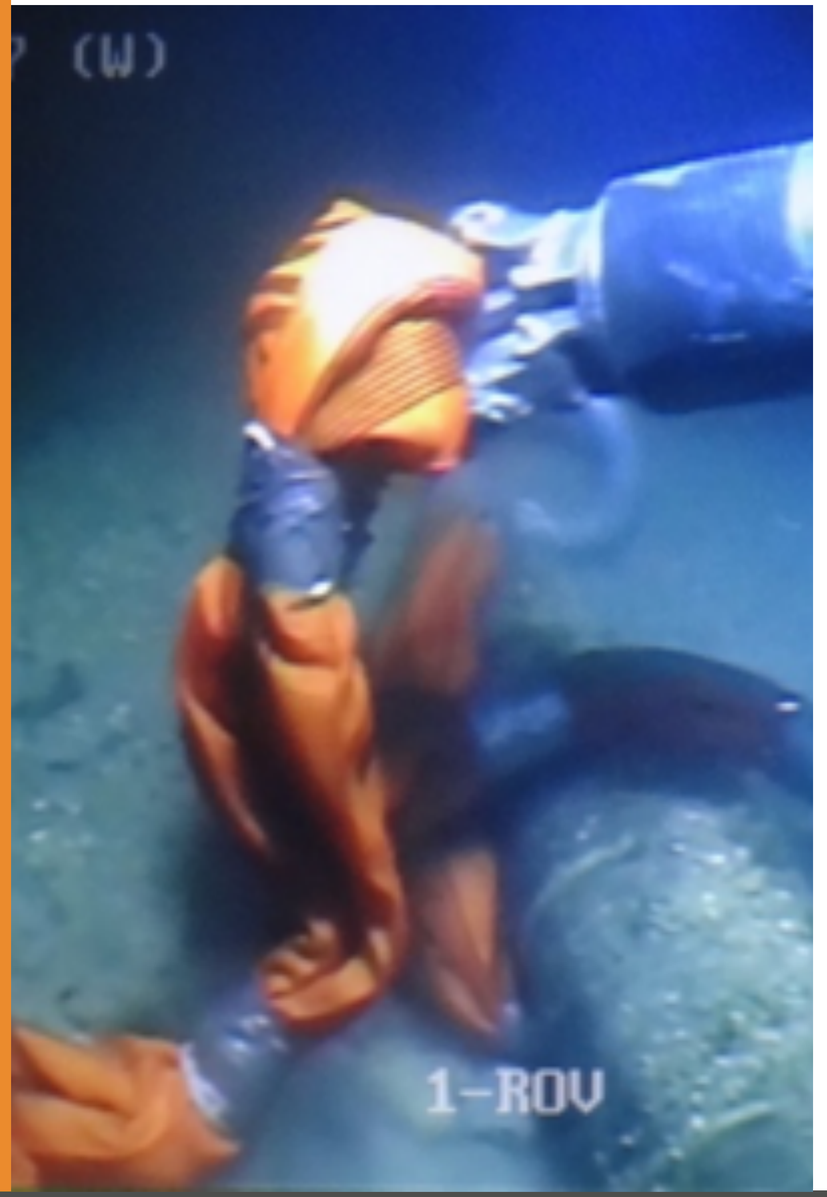
Revision: 0
Date: 24-10-2018
Classification: Public

- Lower mass flow tool on the location of the cable
- Remove sand until the cable is exposed

Mass Flow Excavator: ‘fan-in-the-can’

Revision: 0
Date: 24-10-2018
Classification: Public

Use ROV to install soft strops around the cable

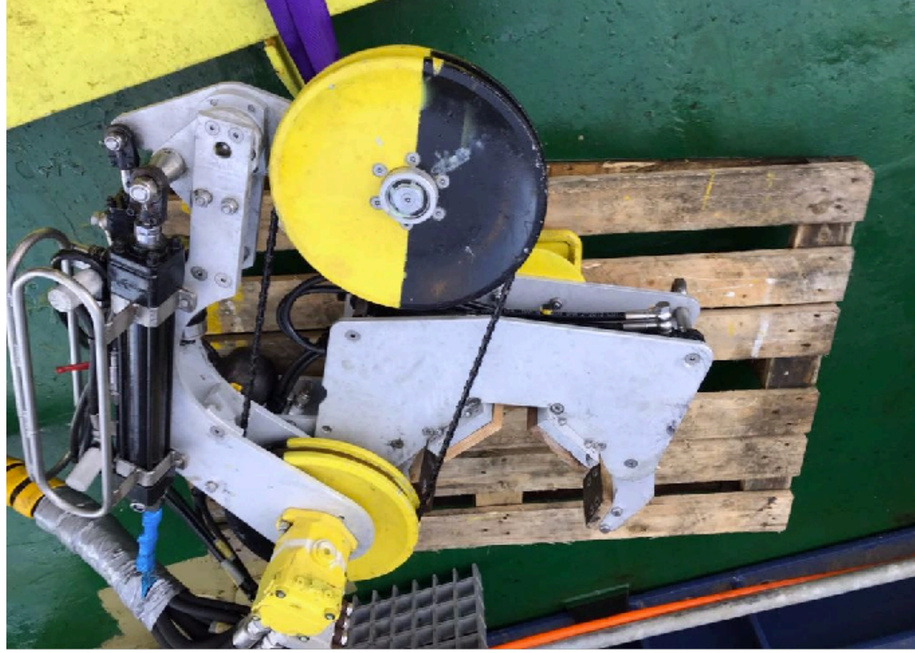


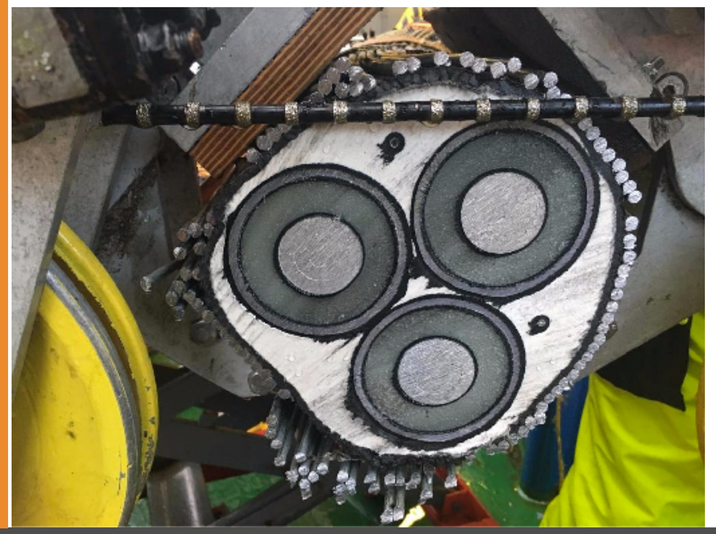
Prepare for cable recovery: lacing shoes for professionals

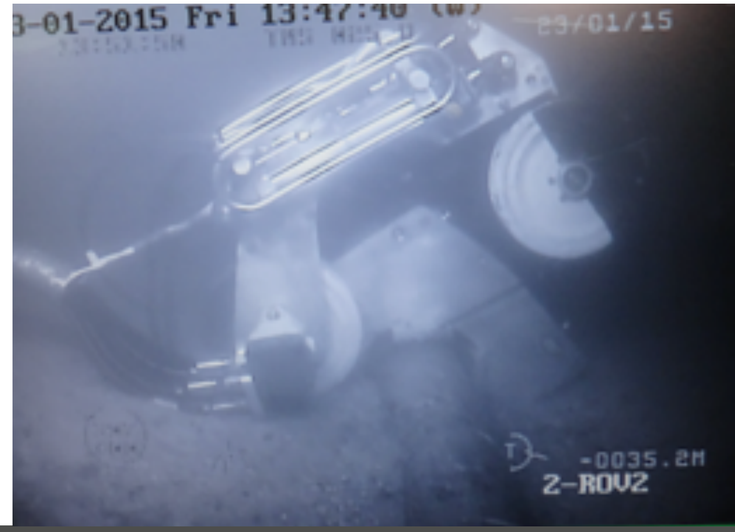
Revision: 0
Date: 24-10-2018
Classification: Public

offshore

- Lower diamond wire cutting tool using deck crane
- Position on cable using ROV
- Cut the cable (30 minutes)



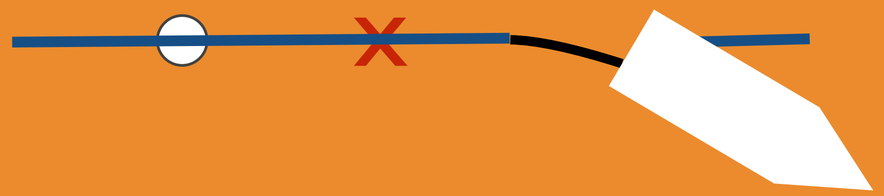




Cutting the cable subsea

Revision: 0
Date: 24-10-2018
Classification: Public

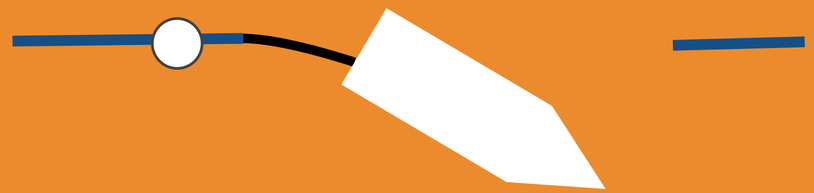
- Connect crane or winch wire to subsea rigging
- Recover cable end to deck



Recover the cable to deck

Revision: 0
Date: 24-10-2018
Classification: Public

- Continue to recover the cable
- Stop at the second joint location
- Cut the cable
- Test if the fault has been contained



Repairs can be smelly

Revision: 0
Date: 24-10-2018
Classification: Public

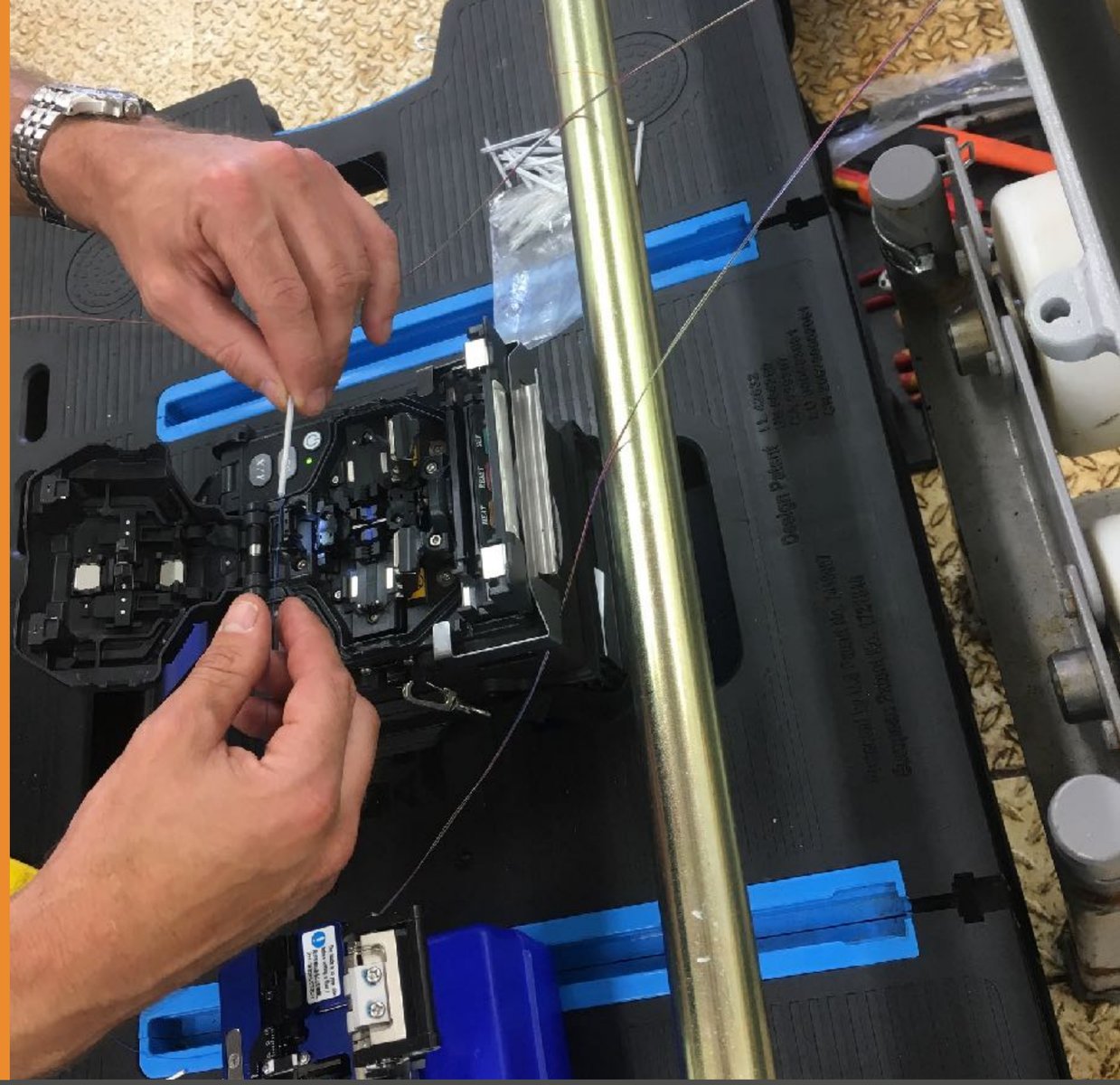
offshore

Align the recovered cable section with the new section on board and prepare for jointing

Prepare for jointing

Revision: 0
Date: 24-10-2018
Classification: Public

- Jointing team works 24h/day to joint two cable ends together
- Usually a fiber-optic team and a high-voltage team
- It takes 3-10 days to complete a joint



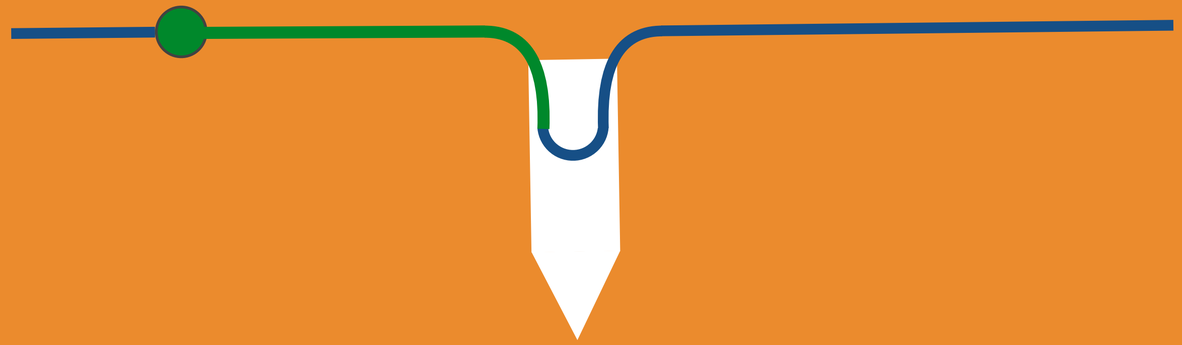
Joint cores and fibre-optics

Revision: 0
Date: 24-10-2018
Classification: Public

Prepare for joint deployment

Deploy joint over the chute

- Lay cable all the way up to the wet stored cable end
- Recover the cable end to deck and align up with the new section
- Create the second joint



Move to second joint location

Revision: 0
Date: 24-10-2018
Classification: Public

- Lay cable all the way up to the wet stored cable end
- Recover the cable end to deck and align up with the new section
- Create the second joint
- Deploy the joint by moving sidewards

Deploy the second joint

Revision: 0
Date: 24-10-2018
Classification: Public

Use a ‘quadrant’ to deploy the bight

- Bight has been laid down on the seabed
- Use mass flow to bury the exposed cable to depth
- Re-commission power and fibre-optics

Cost and time implications:

- Array: EUR 5m and 2 months
- Export: EUR 20m and 6 months

Final result

Revision: 0
Date: 24-10-2018
Classification: Public

OASYS Demonstration

Stand 2.562

Thank you!

r.nagtegaal@eceoffshore.com
info@eceoffshore.com

Visit us for an extensive OASYS demo at stand 2.526

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Date: 24-10-2018
Classification: Public

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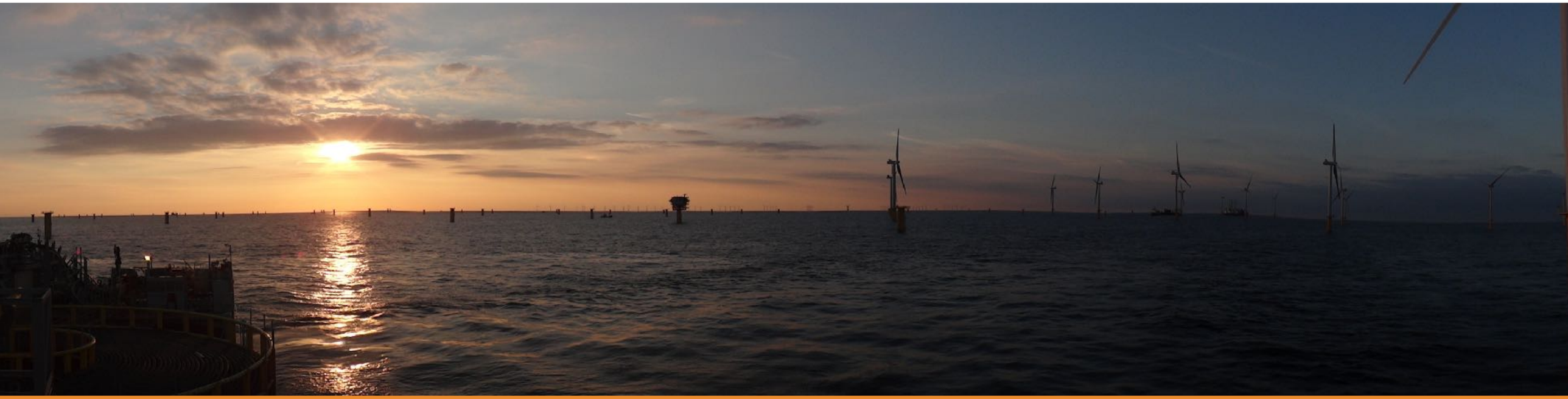

Engineering | Consultancy | Equipment

Corporate Information

Other projects

Northwind OWF

Bel wind OWF

Qatar Cable Installation

Galloper Export

Rampion Export

Walney 03+04 OWF

Hohe See OWF

Nordsee One OWF

Gwynt-y-Mor Cable Repair

Egmond Cable Repair

RAVN Umbilical Installation

Ndurance Conversion

Racebank OWF

Normandie 1 interconnector

Dudgeon Export

Borkum West OWF

Sandbanks OWF

Galloper Infield

London Array Cable Repair

Ormonde Cable Repair

Rampion Cable Repair

Rampion EC3 Installation

Hornsea One Export Cable Installation

Borkum Interconnectors

Blyth Demonstrator

Norther

Horns Rev 3