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# Geotechnical Challenges for OSW in Australia

## (and how not to repeat history!)

**Damon Sunderland**

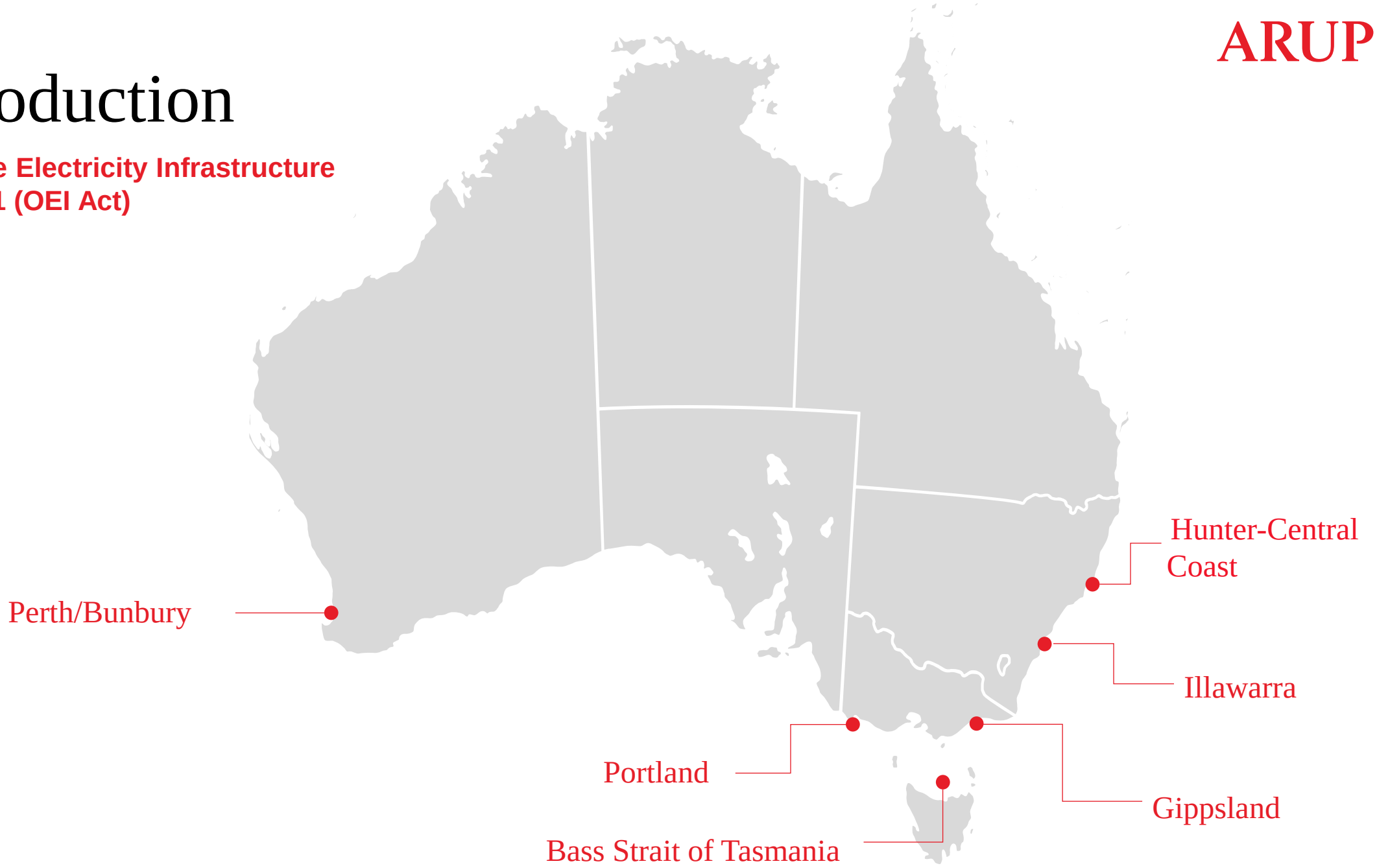
05 April 2023

# Contents



# Introduction

**Offshore Electricity Infrastructure Act 2021 (OEI Act)**



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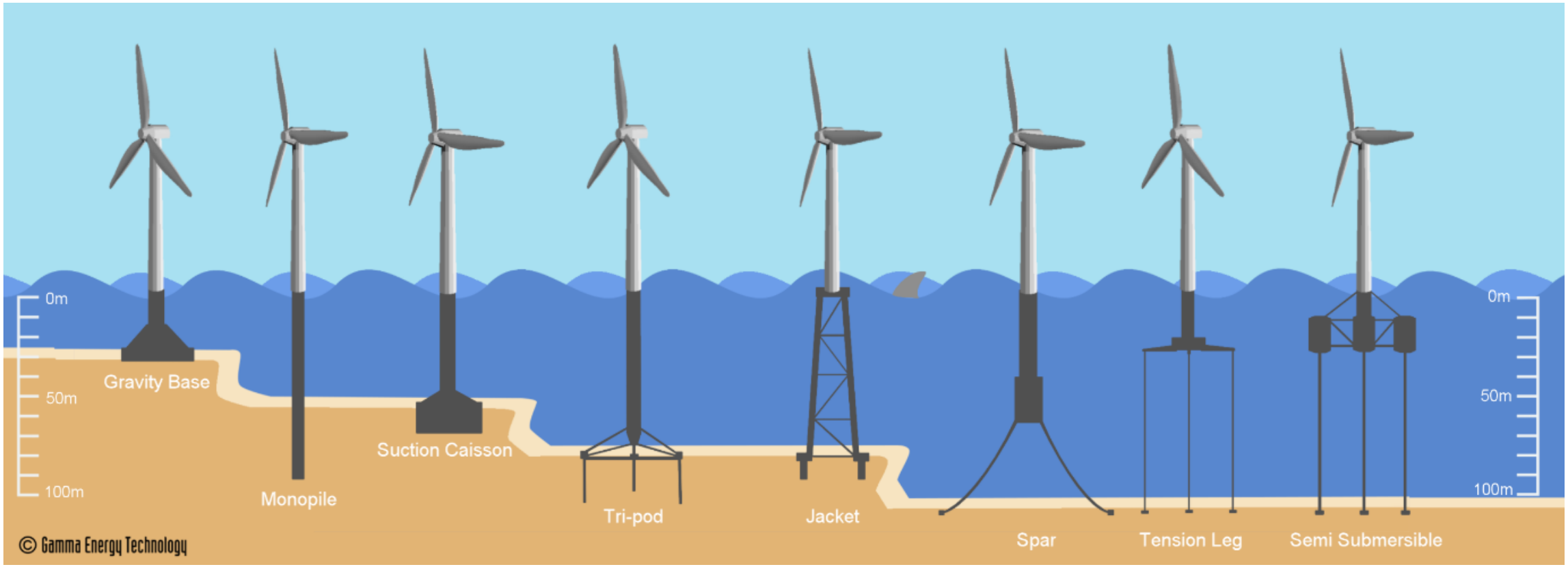
# Offshore Wind Turbine Generators (WTGs)

## Fixed and Floating Foundation Systems



# Offshore Sub-Stations (OSSs)

## Fixed and Floating Foundation Systems


*Triton Knoll OWF, UK (Innogy)*

*Wikinger OWF, Germany (Iberdola)*

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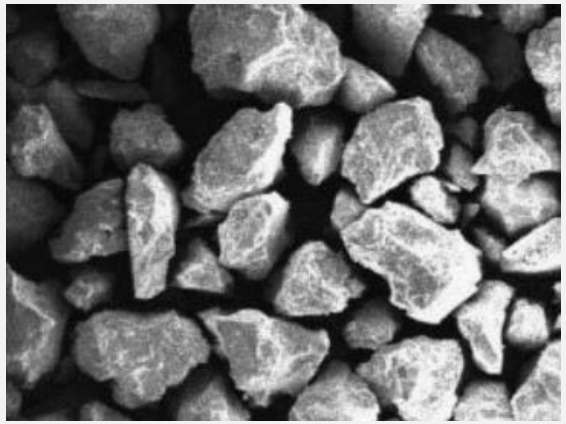
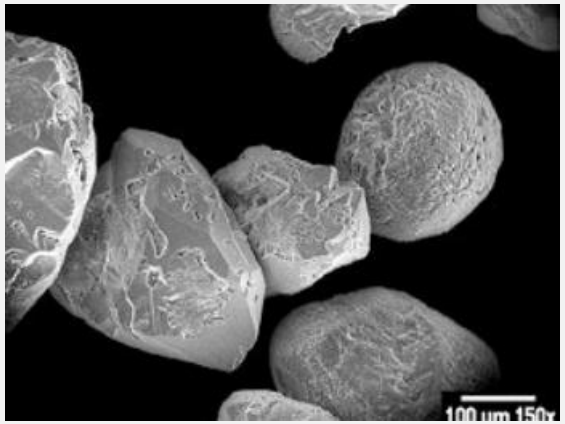
# Soil Properties

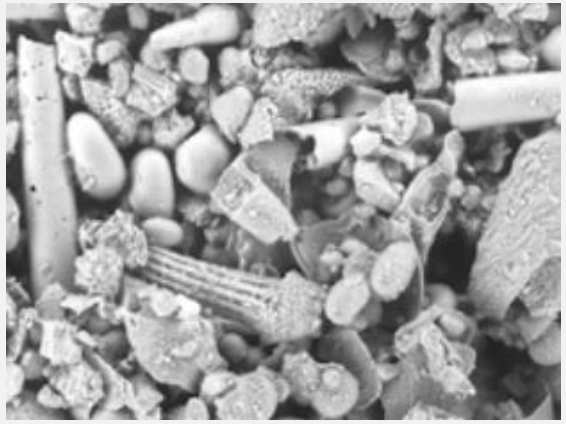
## Silica Soils vs Carbonate Soils

Silica Sand






Carbonate Sand



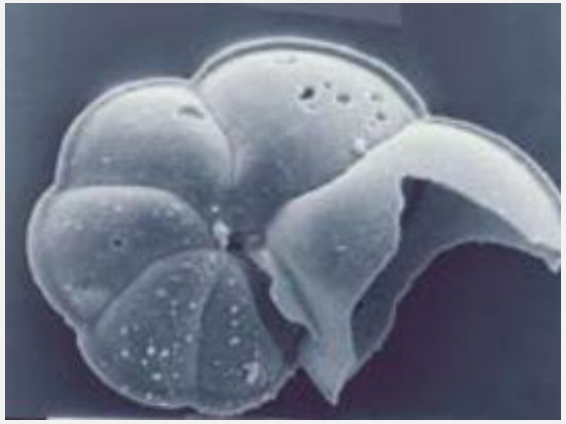


*Image courtesy: Senders et al, 2013*

# Offshore WTG Installation

## Taiwan Projects

### Yunlin Offshore Wind Farm Project Suffers Delay as Monopile Lost During Installation

**Bartolomej Tomic,** Editor
*Bartolomej Tomic is managing editor of Offshore Engineer....*

*July 13, 2022*

*Source: https://www.oedigital.com/*

"A dropfall is an incident in which the pile goes into sudden freefall during pile hammering due to layering in the soil. The snap loads following a pile drop can be very high and exposes both personnel and equipment to high risk, says specialist equipment provider Crane Master."


*Source: https://www.projectcargojournal.com/*

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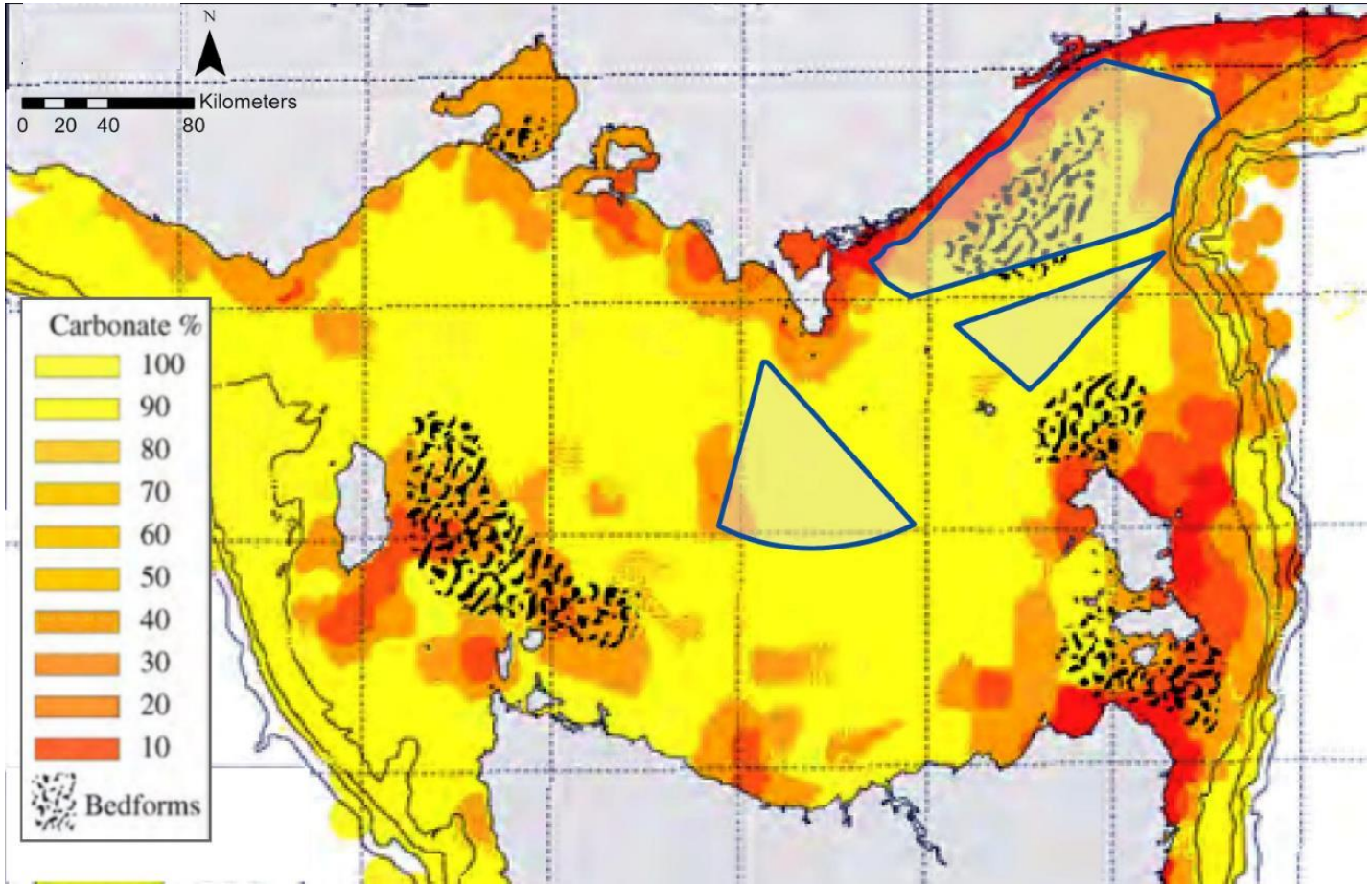
# Carbonate Soils

## Surficial Sediments of the Bass Strait

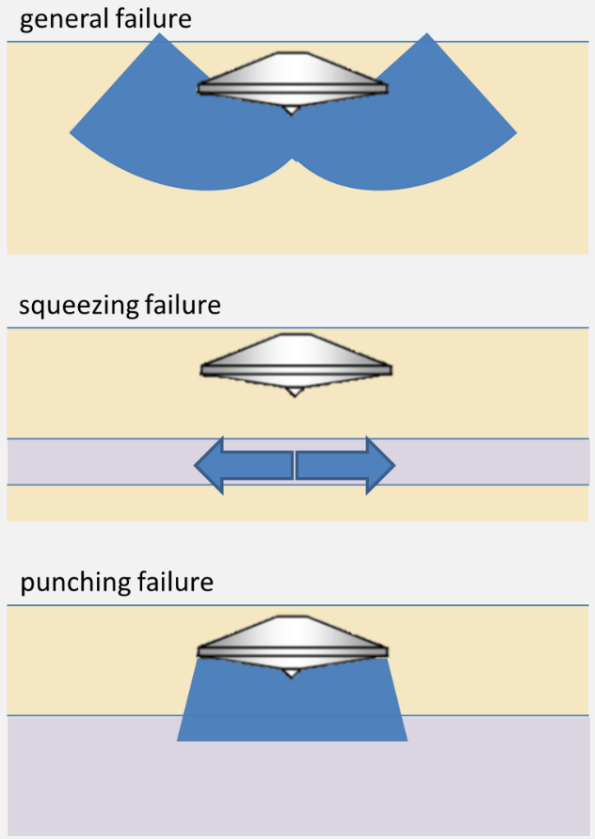



OEI-01-2022

*Source: © Harris and Heap 2009*

# Jack Up Rigs

## Jack Up Rigs

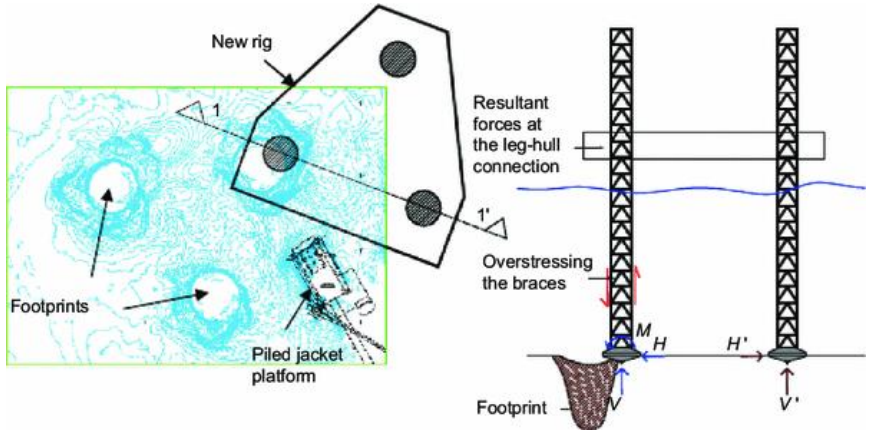



Failure mechanisms:

- Punch-through
- Bearing failure and settlement
- Sliding failure
- Footprints
- Rack Phase Difference – relevant for rack and pinion jacket leg types (i.e. Scylla, Voltaire etc.)
- Liquefaction

Site specific assessment (SSA) for specific location and loading condition, i.e. jack-up configuration and environmental loading.
In accordance with:
- SNAME, ISO 19905-1 by DNVGL or equivalent body.

© *Bladt*



# WTGs and OSSs

**Geotechnical Risks / Geohazards**

### Soil – sand, silt, clay (often carbonate)

Scour, sensitivity, settlement, liquefaction, strength degradation under cyclic load, pile free fall

### Rock (often layered calcarenites/ calcretes)

Skirt/ pile refusal, or punch through risk for JUBs

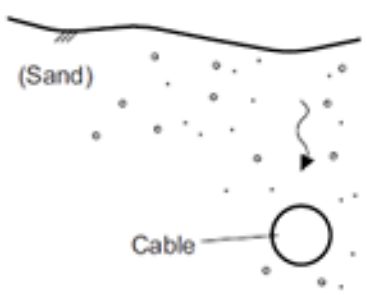
### General

High lateral and vertical variability in material types

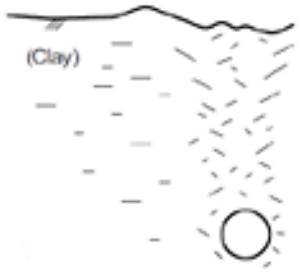
# Subsea Cabling

## Installation Techniques

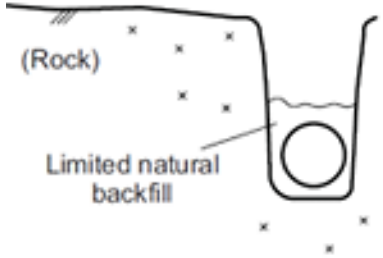
Below the seabed:



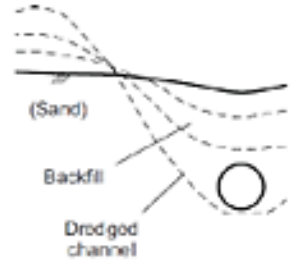

Sand – Jetting / Fluidisation




Clay - Ploughing

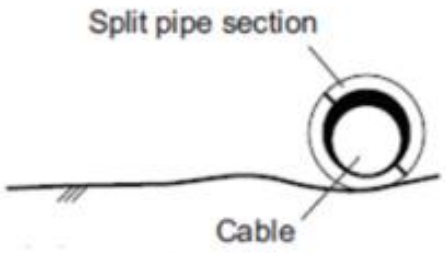



Rock - Mechanical Cutting

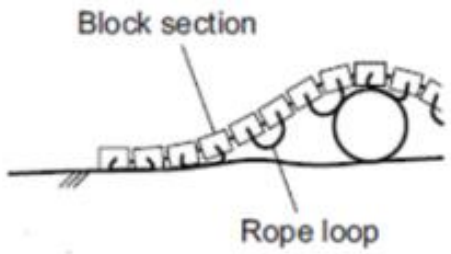



Sand / Clay – Open Trench Dredging

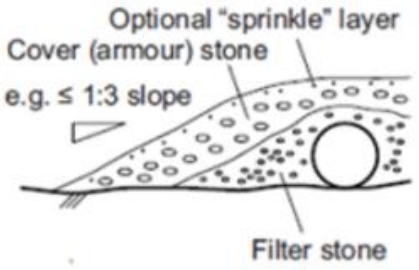
On the seabed:




Tubular Product




Mattress




Rock placement

# Why Subsea Power Cables Fail

**Principle Reasons**

- Fishing Activities and Anchors
- Poor Installation
- Electrical Faults
- Environmental Factors
- Thermal Errors
- Mechanical Faults
- Manufacturing Errors
- Unknown Reasons
- Ageing

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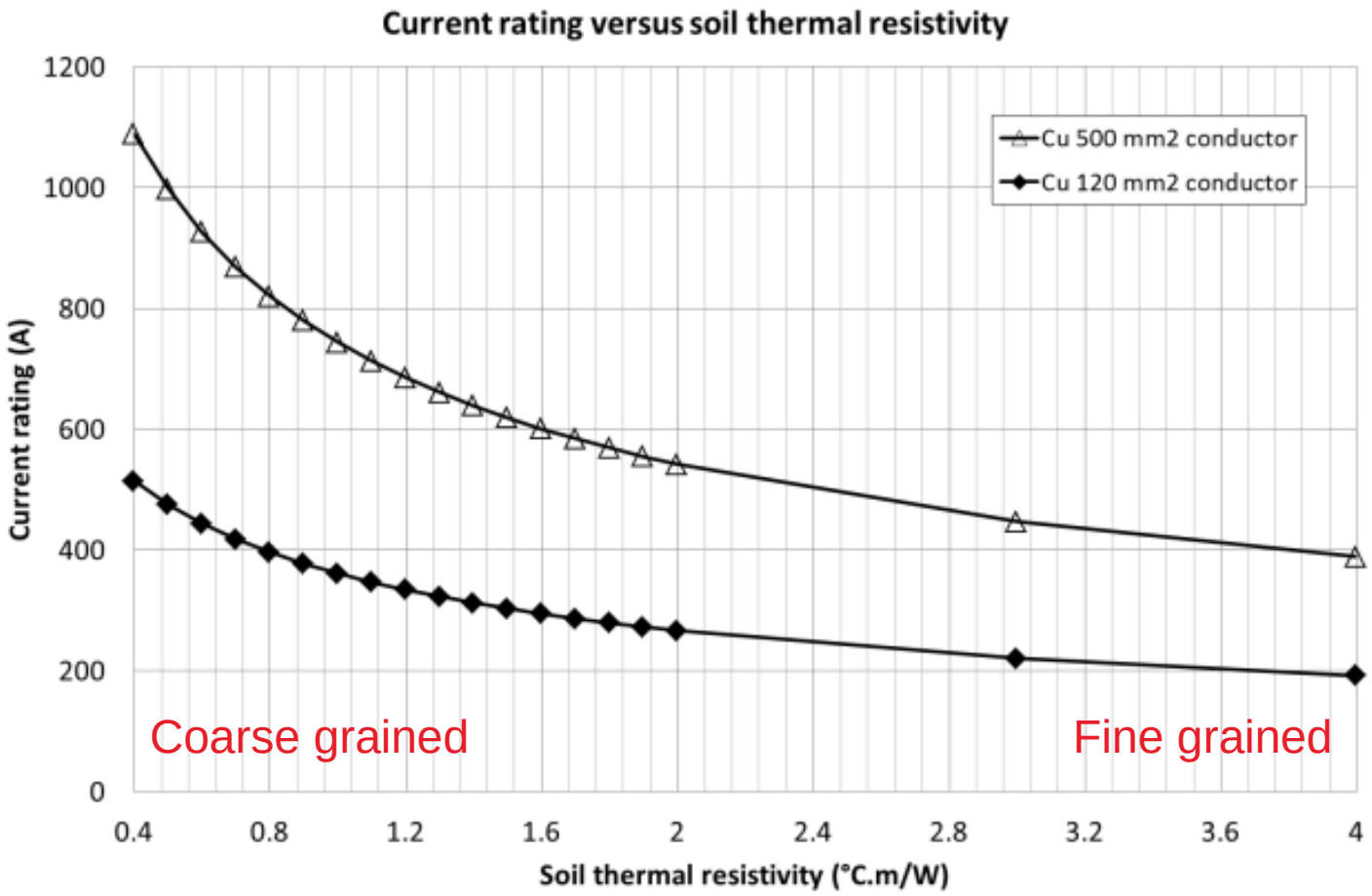
# Subsea Cabling

## Geotechnical Risks / Geohazards

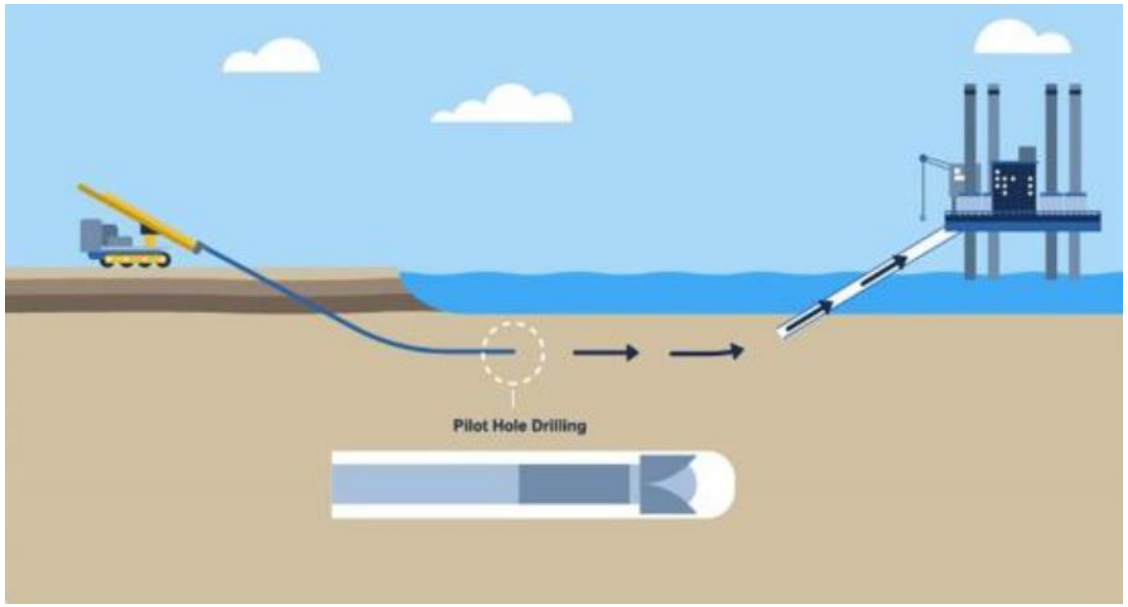
- Thermal resistivity of soil (ability to dissipate heat)
- Presence of rock
- Cable Settlement in soft soils
- Sediment deposition
- Sediment scour



# Shore Crossings (Landfall)

## Techniques

### Horizontal Directional Drilling (HDD)




*Source: © Arup*

### Direct Pipe

*Source: https://www.herrenknecht.com/*

# Shore Crossings (Landfall)

**Common Pitfalls**

- Incorrect sizing or land take
- Ground modelling does not focus on the details
- Contractors not familiar with plant
- Poor quality drilling mud return and control
- Thermal derating/drill depth imbalance
- Trenchless options not all considered

# Shore Crossings (Landfall)

**Case Study**

- Ground variability
- Faulting
- Permeability
- Voids/ cavities
- Boulders/ cobbles
- Swelling clays


*Source: © Arup*

# Ports and Harbours

## Background – Quayside Loading

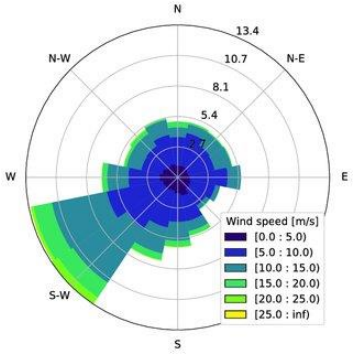
Two main types of quay loading:

### SPMT

Ro/Ro Operations [Foundation or Nacelle Load-in/ Load-Out] - load distributions will be dependent on the trailer configurations, i.e. number of axles, number of trailer lines etc. Tend to be limited to **10-20t/m2** given the limited individual axle loads (depending on the models).

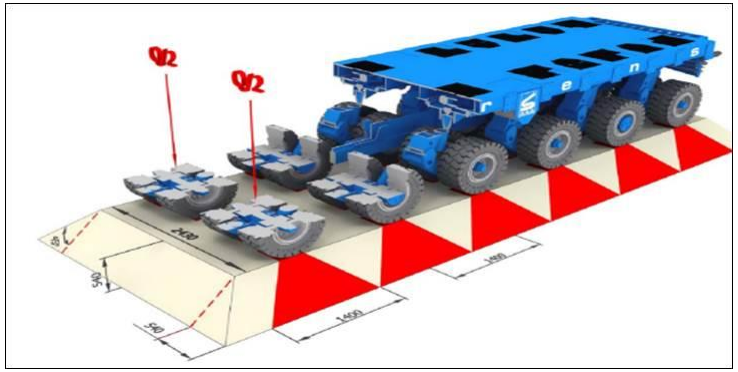
### Crane Lifting Procedure

[Pin-Pile, Tower, Blade load-in, Tower pre-assembly]
Crane operations likely requiring temporary load-spreading – depending on the quay capacity.




Weather Downtime:
u >10m/s

### Ro/Ro



*© Sarens*

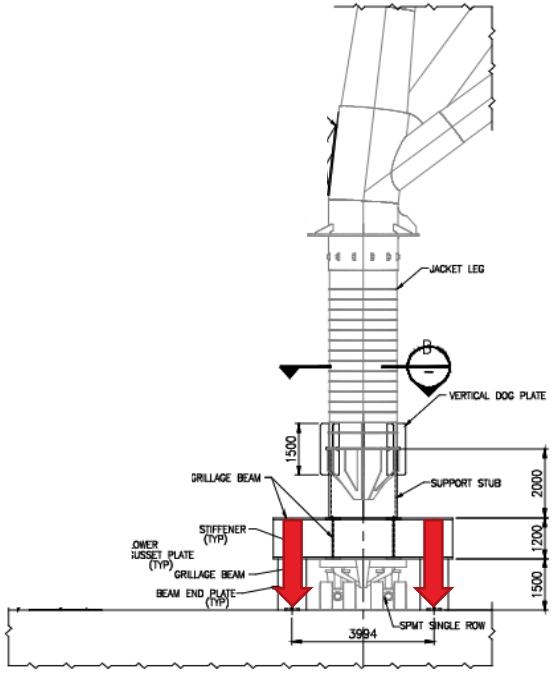
### Lo/Lo

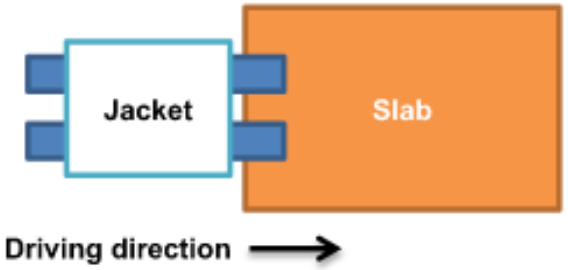
*© Port of Esjberg*

*© PSG Marine*

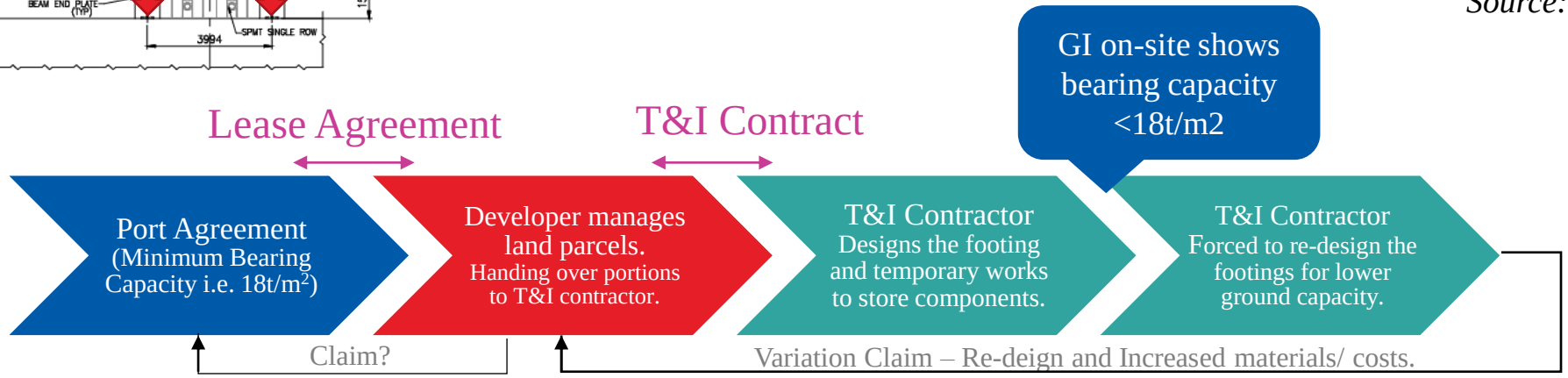
# Ports and Harbours

## Case Study




*Source: © Arup*



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# SUT OSIG Guidance Notes

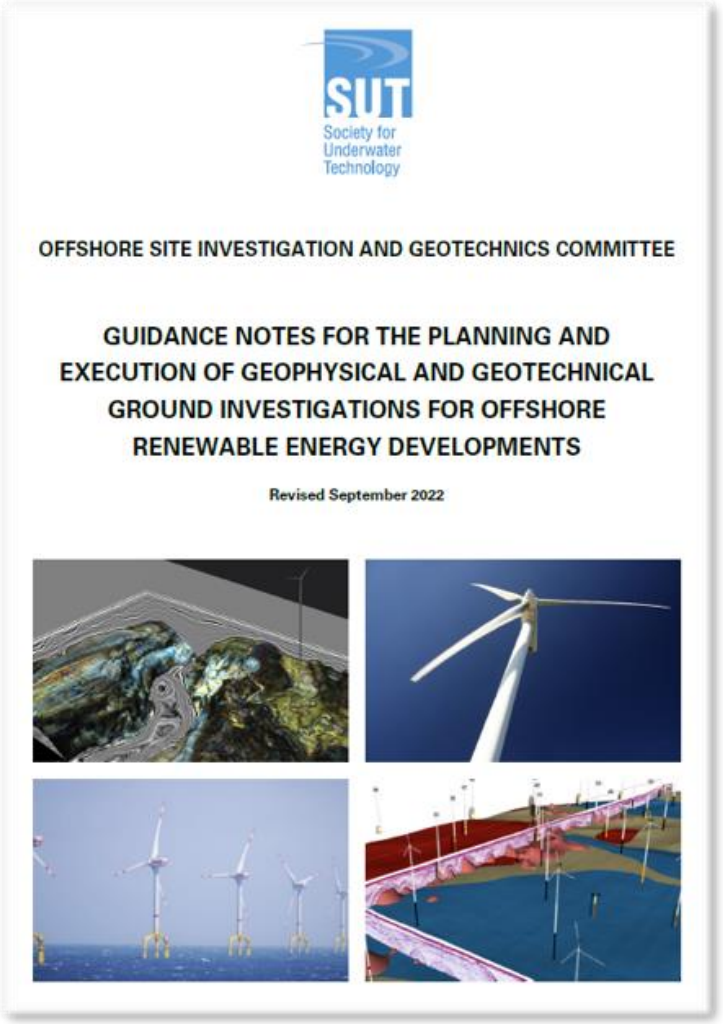
**Planning and Execution of G+G Surveys for Offshore Renewables**

## Planning

- Managing Geological and Geotech Risk
- The Ground Model
- Competent Personnel
- Planning an Offshore Ground Investigation

## Execution

- Health and Safety
- Developers Offshore Representation
- Contractor/Vessel/Equipment Selection
- Geophysical
- Geotechnical
- Positioning
- Data Integration, Interpretation and Reporting



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Questions?

Find out more about our work
in offshore wind