



grow

Hydraulic Pile Extraction – Scale Tests (HyPE-ST)

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Challenges of decommissioning offshore wind farms

- Almost 30% of the total installed wind turbine capacity in Europe will be older than 15 years by 2020
- By the end of this 20-year service life, wind farm operators need to decide between the **extension of the asset lifetime, repowering or decommissioning** the site
- Nevertheless, regardless the final service life of a wind turbine, **decommissioning will always happen**
- Between 2020 and 2030, decisions between lifetime extension, repowering or decommissioning will be needed for over **1,800 offshore wind turbines**
- From 2030 to 2040, almost **>3,000 offshore wind turbines** will be facing their end-of-life scenarios in Europe

Source: Eva Topham et al 2019 J. Phys.: Conf. Ser. 1222 012035

Regulatory framework

- OSPAR Convention for the Protection of the Marine Environment of the North-East Atlantic.
- OSPAR has produced guidance documents on offshore wind-farms, incorporating ideas on their decommissioning. In particular, the paper 'Problems and Benefits Associated with the Development of Offshore Wind-Farms, Biodiversity Series, OSPAR Commission 2004' proposes some aspects to be taken into consideration in developing guidance for the removal/disposal of offshore wind-farms. This paper says that: “when decommissioning wind energy installations (end of operational life-time use or premature termination of the project), the wind energy installations (**including foundation**) and cables should **be removed completely** and disposed of (recycling) on land. In order to avoid hindrances for e.g. fisheries, **the piles should at least be cut off far enough beneath the seabed** to ensure that the remaining parts will not be exposed by natural sediment dynamics”

Regulatory framework

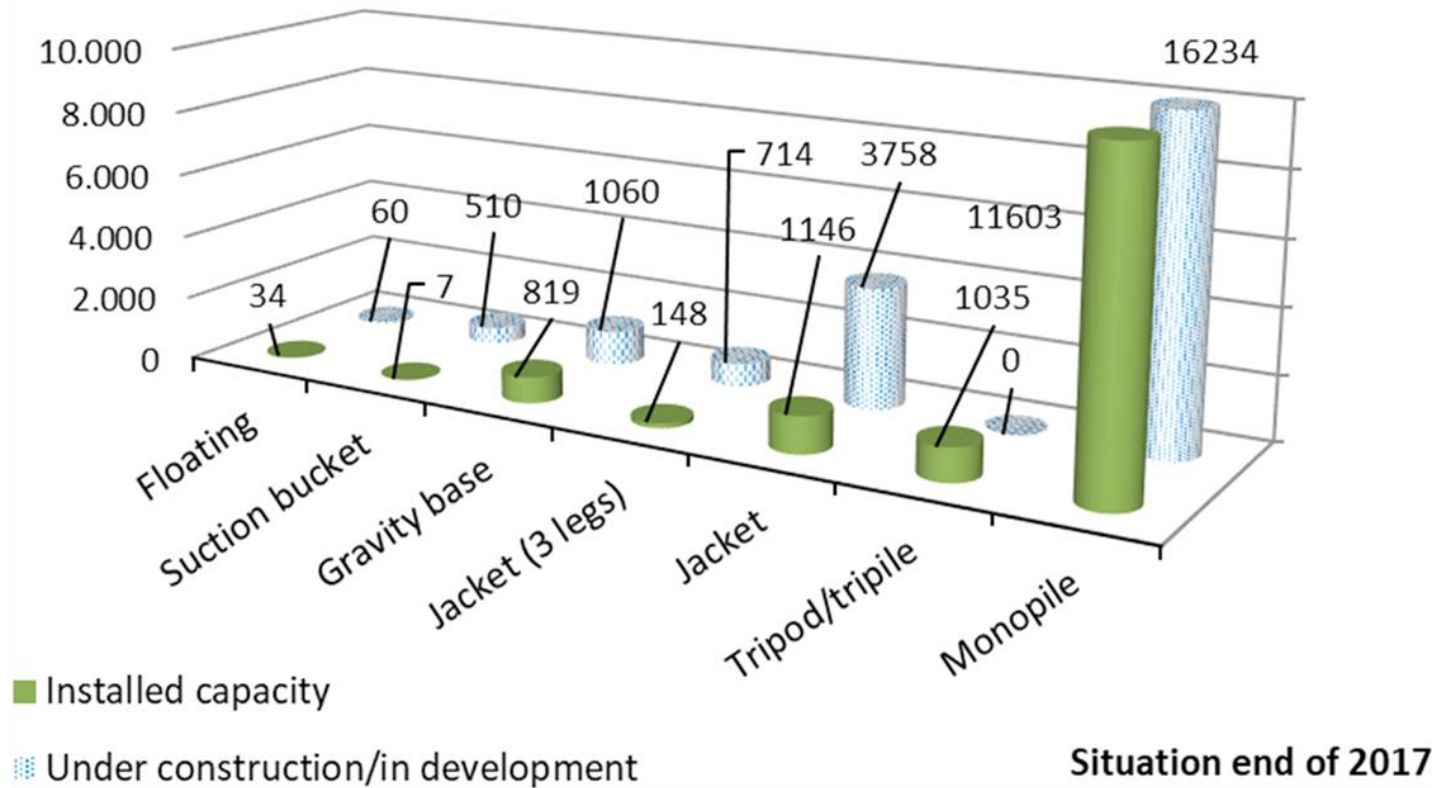
- In terms of how the structures should be removed, the OSPAR paper says that:
“techniques which minimise impacts on the environment (e.g. benthos, fish) including re-suspension of the sediment should be applied for the removal.”



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Monopiles

Breakdown of foundations by type (EU) in MW

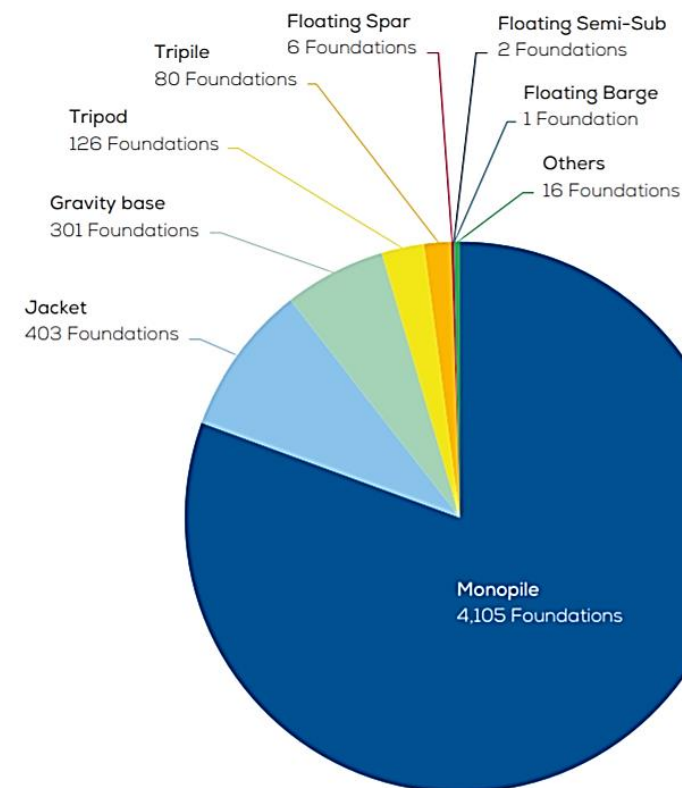
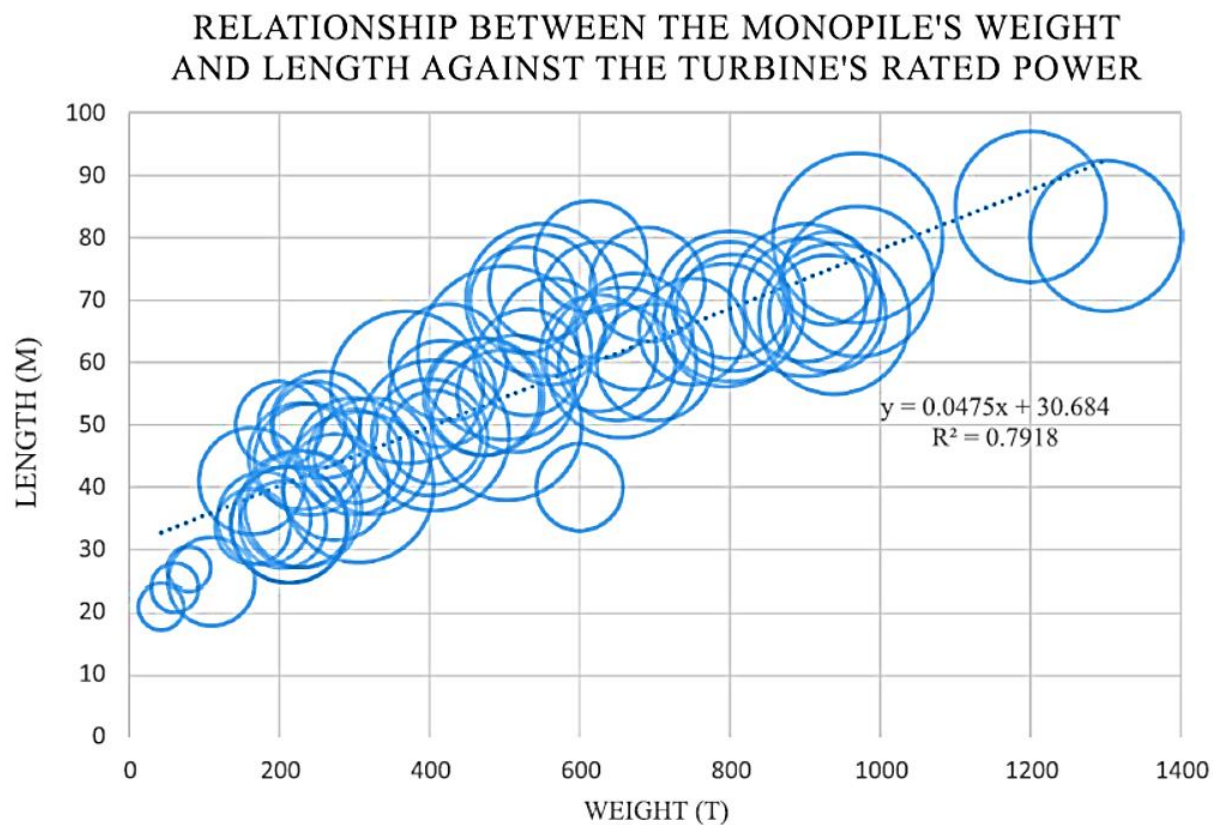


Source: Lacal-Arántegui et al., 2018



Photographer Ulrich Wirrwa

Monopiles XXL



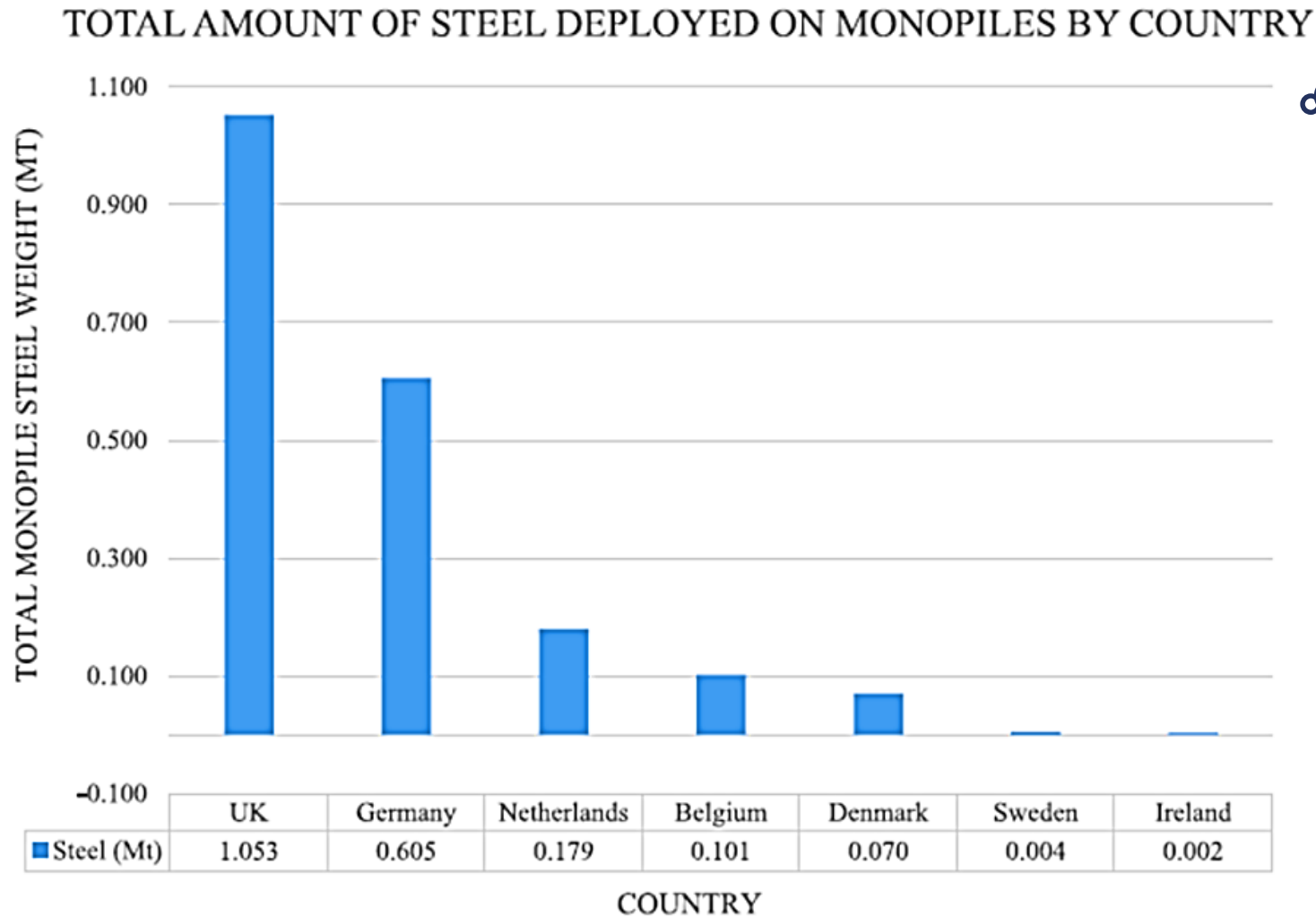
Source: WindEurope

E. Topham, et al. Energy Policy 129 (2019) 698–709

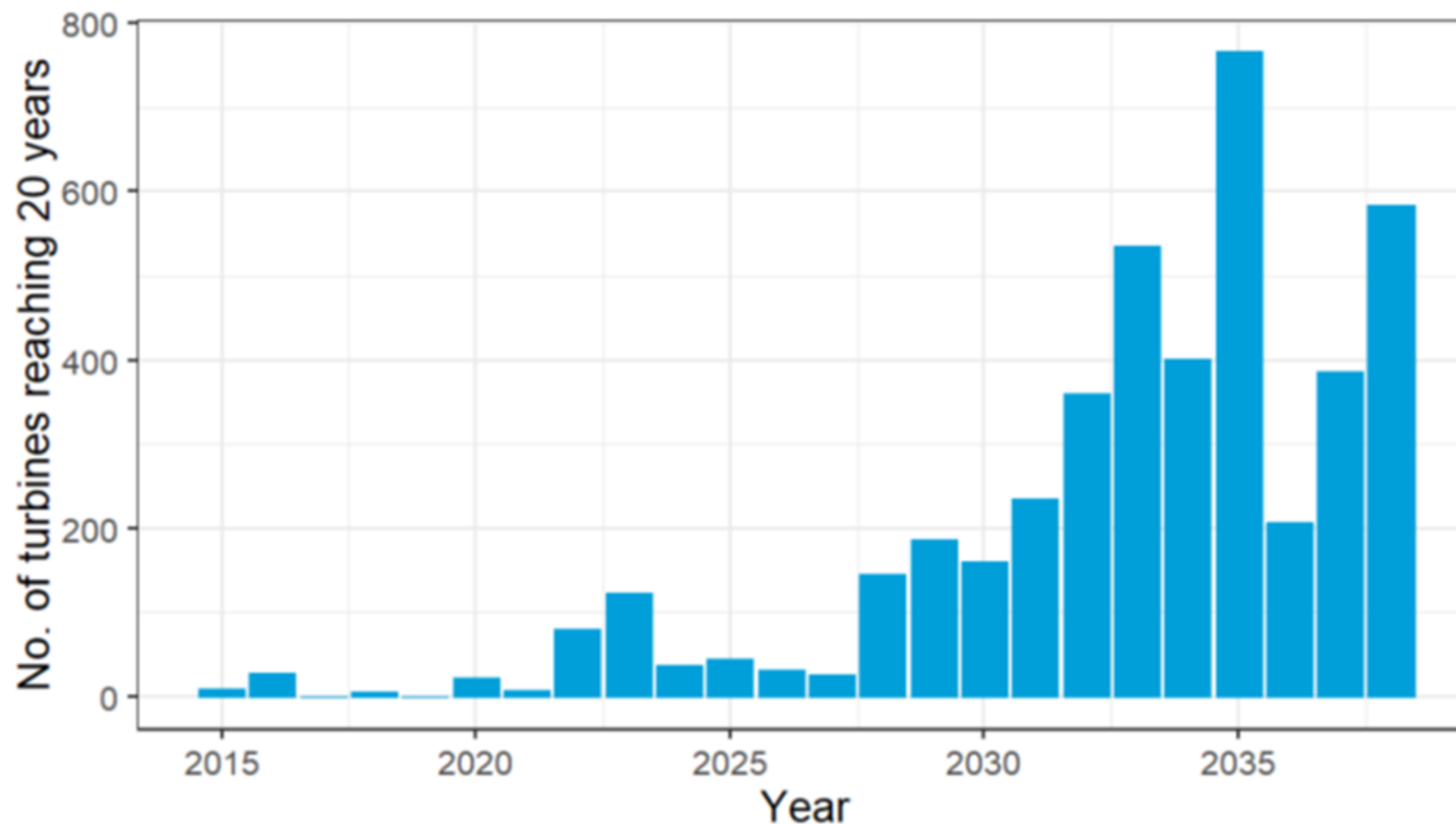
Amount of steel (Monopiles in Europe)

Deltares

~2Mt



Number of offshore wind turbines reaching 20-years of operation annually in Europe



Decommissioning of Monopiles

Monopile average specifications.

Monopile specification	Weight (t)	Length (m)	Diameter (m)	Length to be removed (m)
Average	577.3	58.8	5.6	22.3



- Excavating / Dredging
- Cutting the monopiles
 - abrasive waterjet
 - diamond wire tool

Estimation on the recoverable costs from monopiles.

Recycling monopiles	Methodology	Value
Total available steel (t)	Weight of removed monopile × Total no of monopiles	782,795
Estimated value from recycling steel (£)	Total amount of steel × Scrap value	109,591,247
Estimated total (£/Monopile)	(Total amount of steel × Scrap value) / Total no of monopiles	31,402
Estimated total (£/MW)	Estimated total / Average rated power	8010

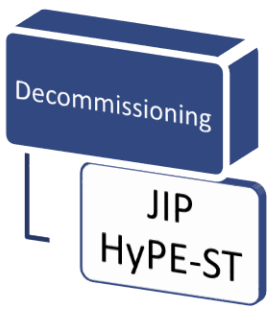


Full monopile extraction ~ 2X value => removal cost saving (4-8%)

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JIP HyPE-ST

=> sustainable decommissioning of monopiles



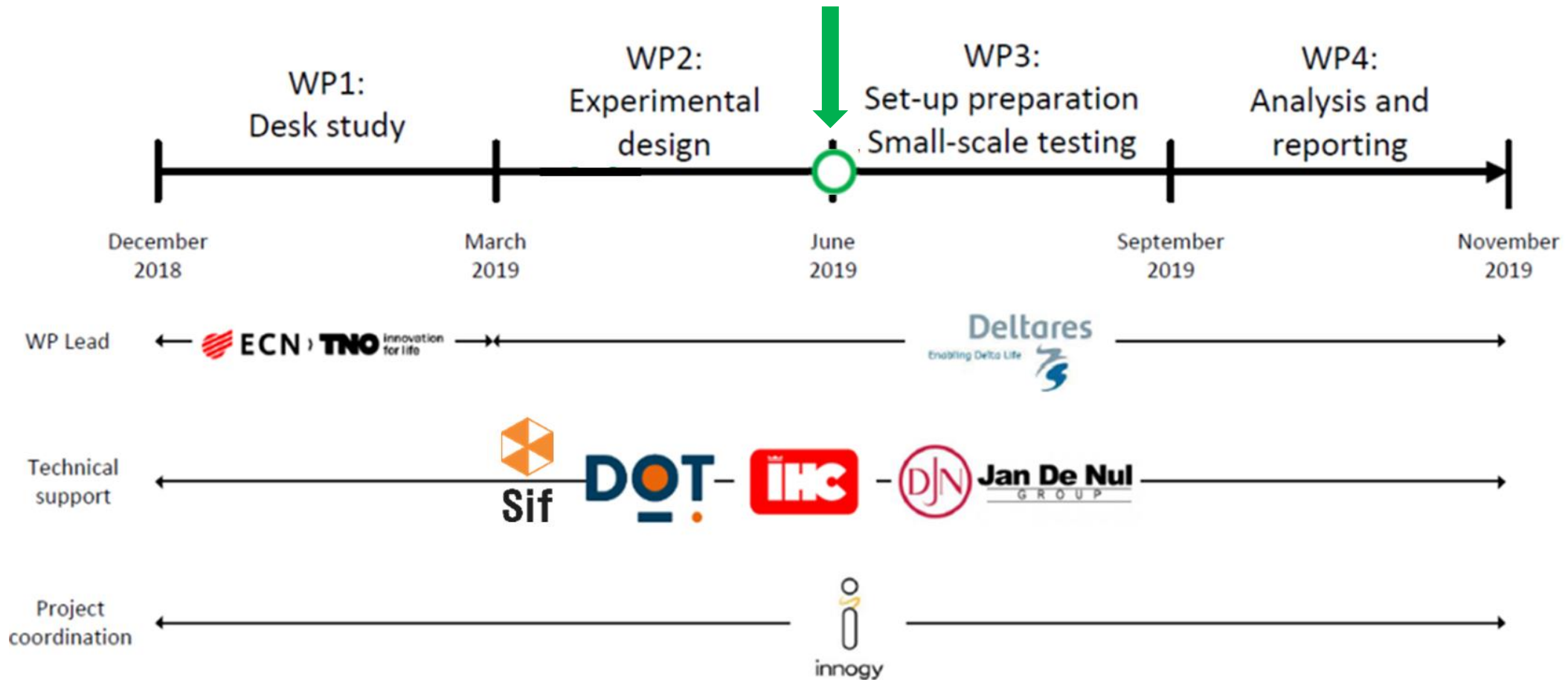
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Netherlands Enterprise Agency



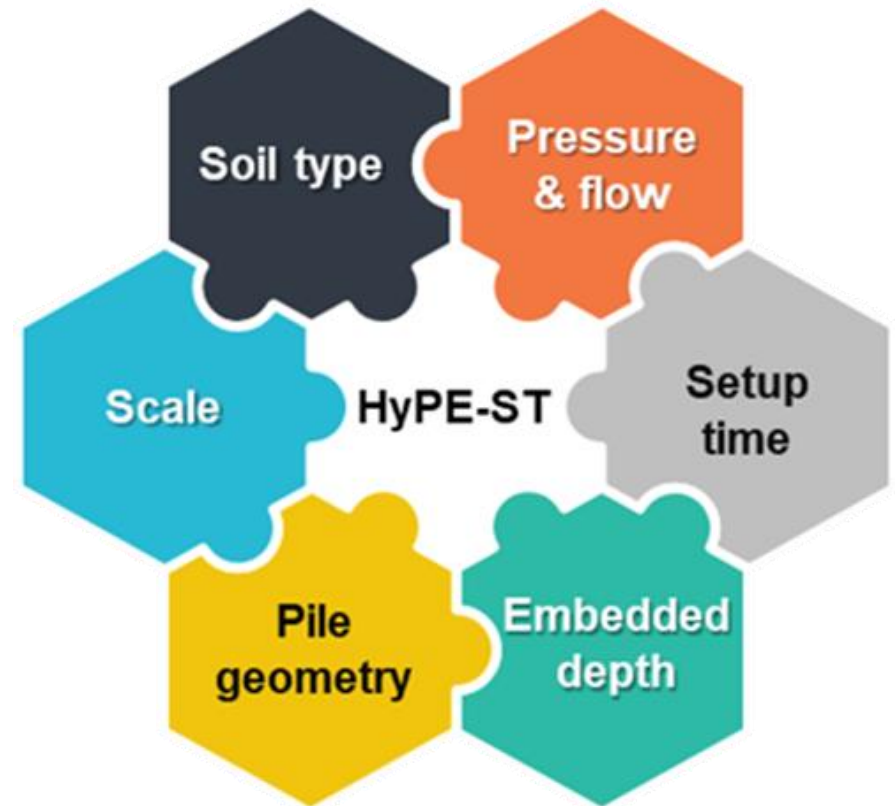
HyPE-ST: Project schedule and organization



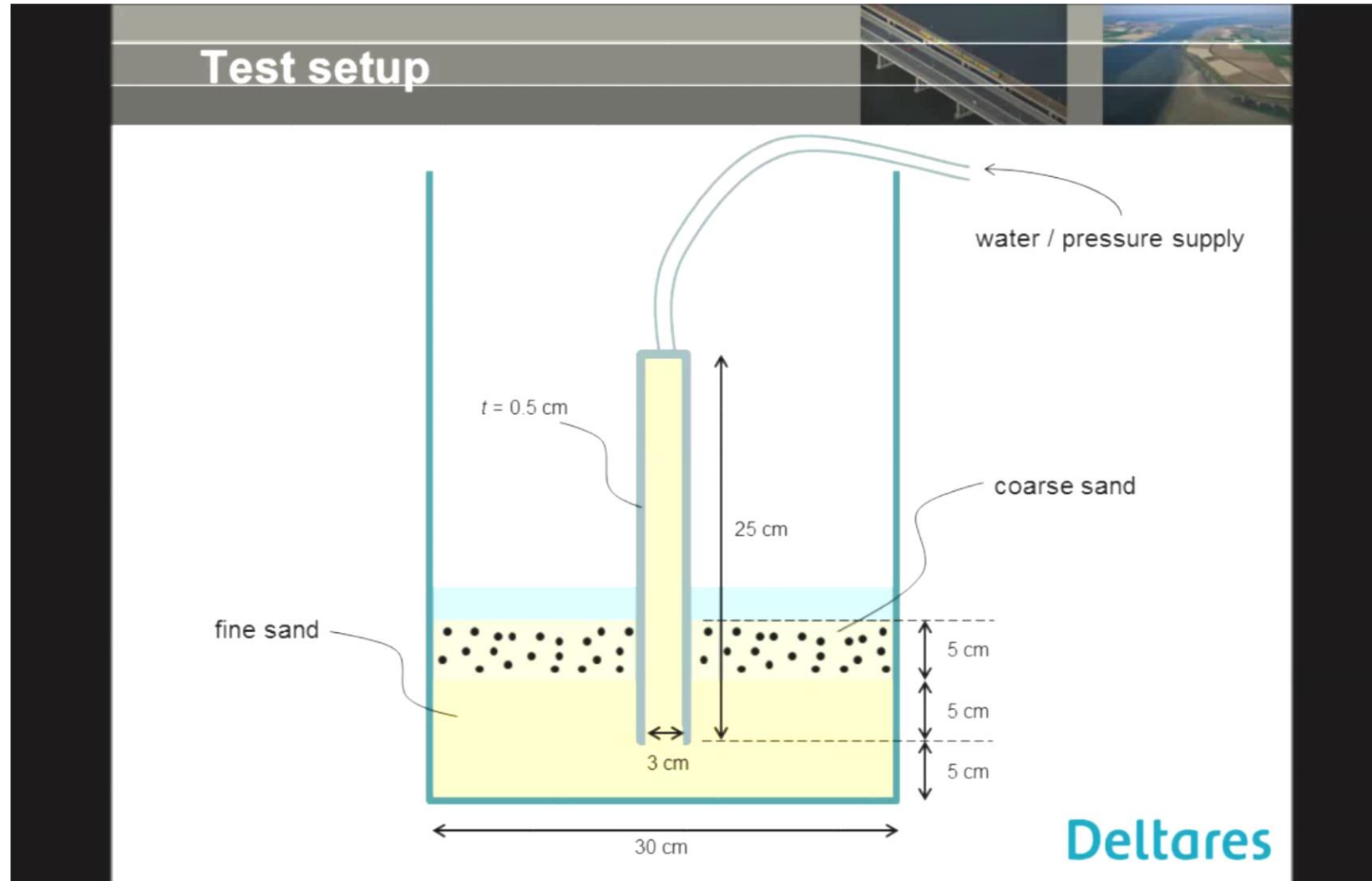
HyPE-ST

=> sustainable decommissioning of monopiles

- Identify, understand and quantify **soil-pile-interaction mechanisms** during application of **hydraulic overpressure** to extract a (mono)pile under different boundary conditions in a controlled environment (small-scale).
- Important research questions:
 - Maximum required pressure to initiate pile extraction (break-up pressure)
 - Flow and extraction rate patterns, including leakage
 - Development of friction forces along the pile shaft



HyPE-ST: Concept (Look & Feel test)



HyPE-ST: Experimental design

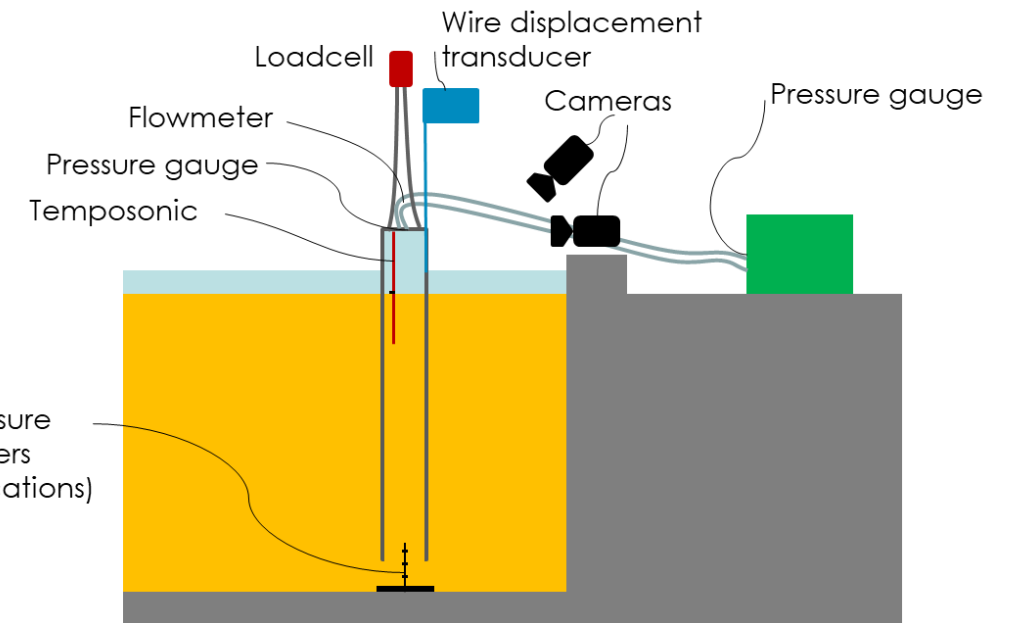
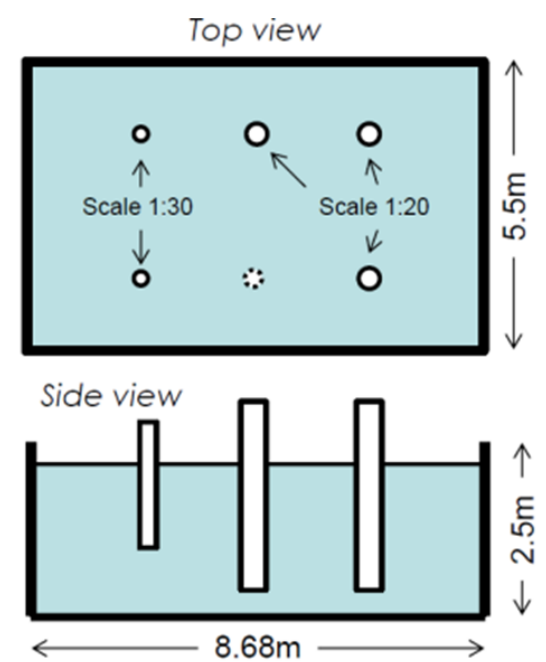


Batch 1: medium dense sand

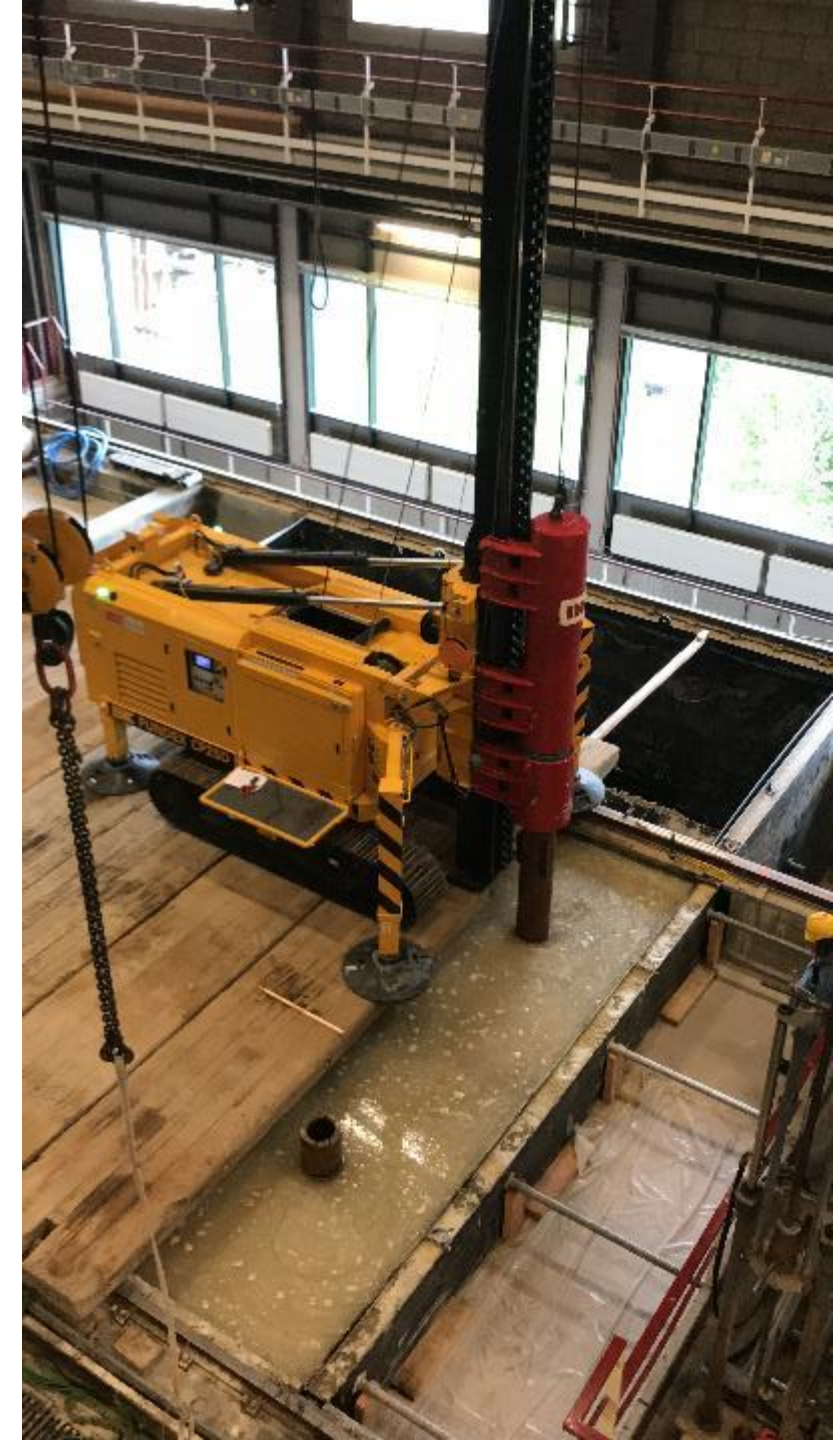
Batch 2: dense sand

Batch 3: medium stiff clay

Batch 4: a) soft clay OR
b) layered soil



HyPE-ST: Pile Driving



Key takeaways

- To date, nearly 115 European offshore wind energy projects have been installed or are currently under construction (> 5000 OWT).
- As decommissioning will always be the final stage of an offshore wind energy project, efforts must be attempted on making it as sustainable as possible by means of enhancing the recycling of the removed components
- Hydraulic extraction could offer a sustainable full removal option of monopiles
- Savings on removal cost from recovering full monopiles is ~4-8% (scrap price)
- Additional savings on vessel operations, crane capacity, risk for divers, noiseless, i.a., are all of added (financial) value.

Thank you

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