SeeOff Conference on Technologies for Offshore Wind Decommissioing, May 10th, 2021

Research Project SeeOff

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SeeOff

Strategieentwicklung zum effizienten Rückbau von Offshore-Windparks

Development of efficient strategies for offshore wind farm decommissioning

Supported by:

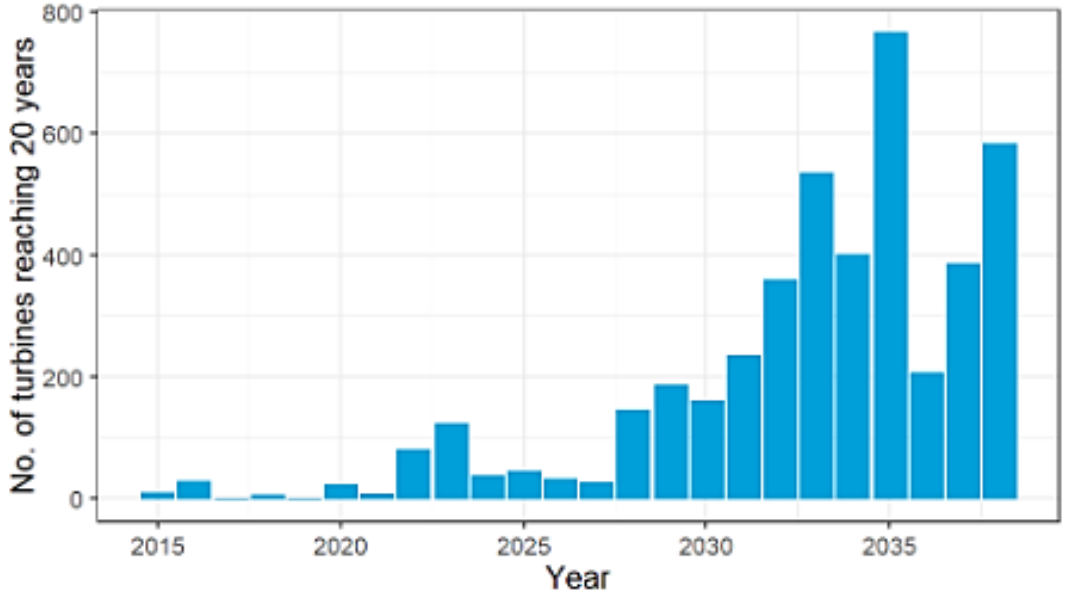
Federal Ministry for Economic Affairs and Energy

on the basis of a decision by the German Bundestag

Decommissioning – Experience vs Demand

Wind farm	Country	Capacity (number of WTGs, MW)	Foundation type	Years of operation	Decom. year
Yttre Stengrund	SWE	10 (5 x 2MW)	Monopiles	15 (2001-2015)	2015
Lely	NL	2 (4 x 0.5MW)	Monopiles	20 (1994-2014)	2016
Vindeby	DK	4,95 (11 x 0.45MW)	Concrete Gravity	26 (1991-2017)	2017
Utgrunden	SWE	10.5 (7 x 1.5MW)	Monopiles	18 (2000-2018)	2018
Blyth	UK	4 (2 x 2MW)	Monopiles	13 (2000-2013)	2019

Source: 4C offshore



Number of wind turbines reaching 20 years of operation annually in Europe [1]

29 offshore WTG's decommissioned so far.

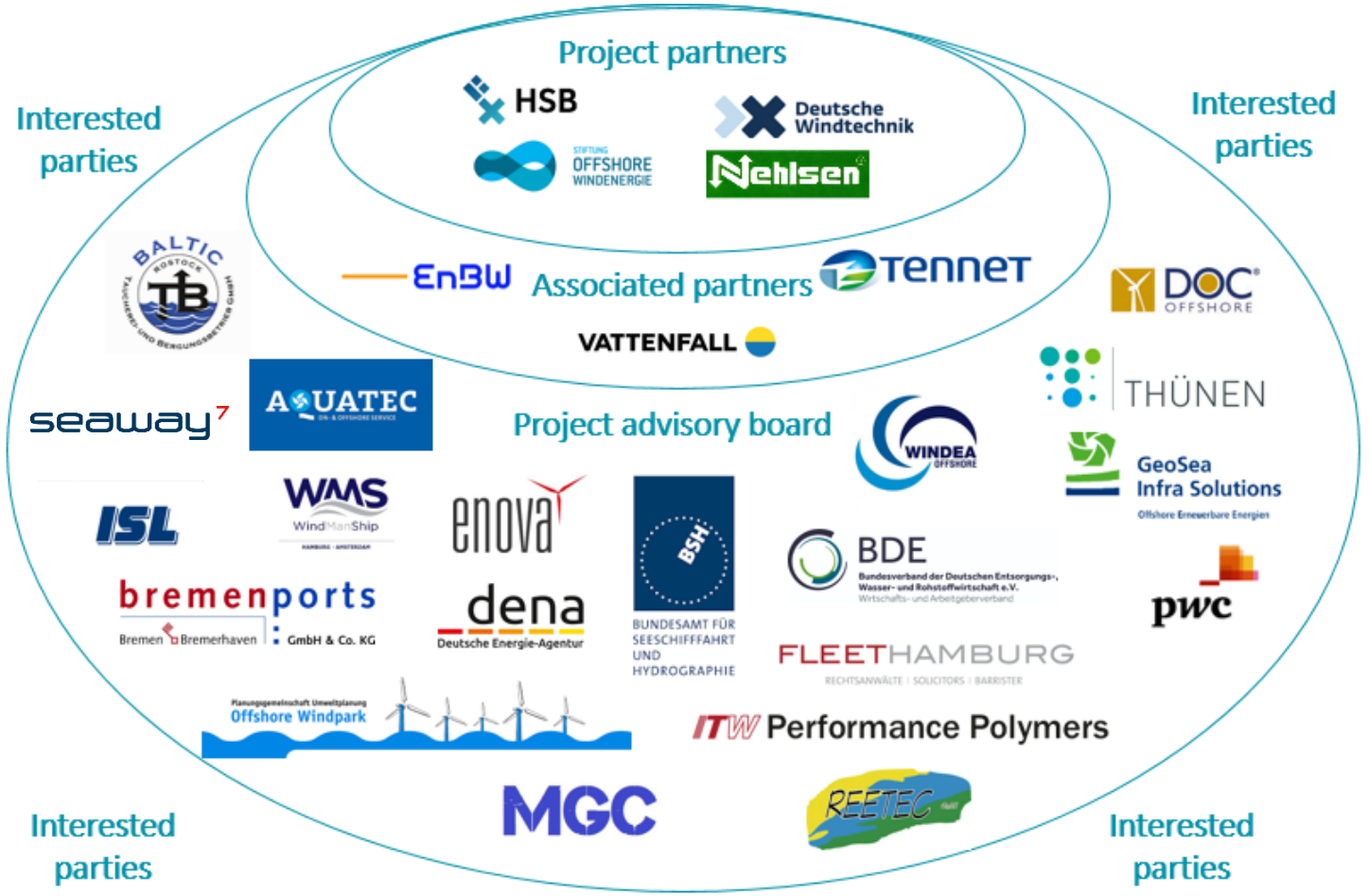
Between 2020 and 2030, decisions on lifetime extension, repowering or decommissioning needed for over 1,800 offshore wind turbines in Europe. [1]

[1] Eva Topham, Elena Gonzalez, David McMillan, Elsa João (2019) J. Phys.: Conf. Ser.1222 012035

SeeOff – Project Description

SeeOff — *Development of efficient strategies for offshore wind farm decommissioning*

- **Project funding:**
  The project is funded by the Federal Ministry of Economics and Energy (BMWi) within the framework of the 6th Energy Research Program
- **Funding body:** Projektträger Jülich
- **Project duration:**
  3 years (November 1st 2018 – October 31st 2021
  prolongation for additional 6 months requested)
- **Project coordination:** Prof. Dr.-Ing. Silke Eckardt
  City University of Applied Sciences Bremen



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SeeOff – Project Objectives

- Development and assessment of efficient **Decommissioning Strategies**
- Such strategies shall
  - comply with **legal requirements**,
  - be **cost efficient**,
  - ensure **safety at work**,
  - ensure **environmental protection, low GHG emissions** and **sustainability/resource efficiency** (covering entire process including recycling and recovery of secondary raw material)
  - be **publicly accepted**.

Quelle: Deutsche Windtechnik AG

SeeOff – Project Scope

- Compilation of a **requirement catalogue** (legal, technical, logistical, HSE and acceptance requirements)
- Development of **decommissioning scenarios**
- Development of methods for **analysis and evaluation**
- Identification of potential **improvement measures** (planning, technology, logistical, design)

- Output: a **decommissioning handbook** which shall enable stakeholders to develop project specific decommissioning strategies

Quelle: Deutsche Windtechnik AG

Decommissioning – Open questions

Legal

Do cables have to be removed?

Must scour protection be removed?

How to handle soil from inside the MP?

How much time is allowed for decommissioning?

....

Planning

Will WTG or major components be reused / refurbished?

Does grouted connection between TP and MP allow for lift?

Is the industry ready for „serial cutting“ (instead of cutting off single structures in oil&gas)?

....

Costs

Which logistic will be available?

How will charter rates evolve especially for vessel of 1st / 2nd generation?

Could any revenue be earned by selling raw material?

Will the required securities be sufficient for potentially higher requirements?

Recycling / Disposal

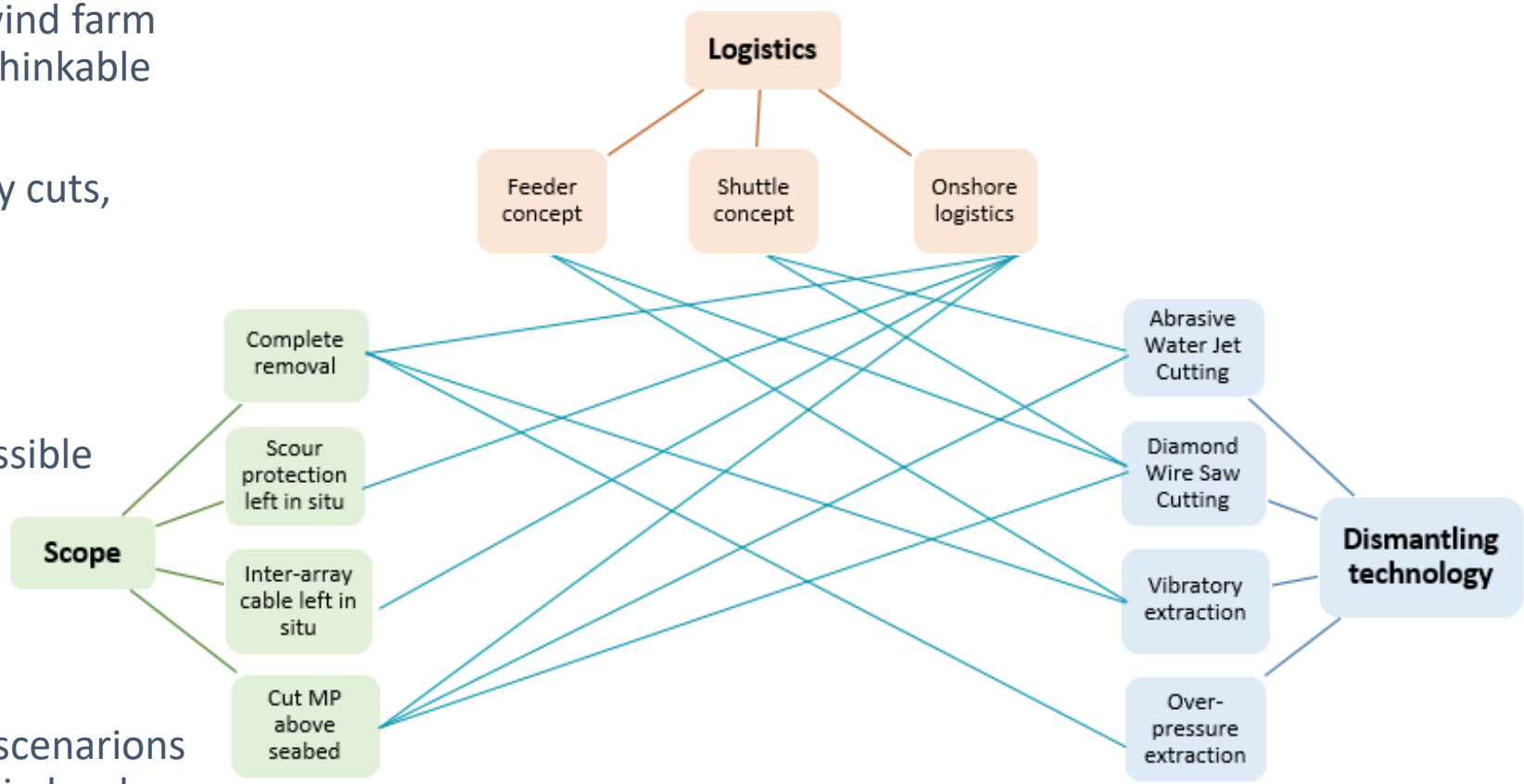
Will there be specialised harbours for handling special material (e.g. blades or stones)?

Or for the deconstruction of the OSS?

Will there be any recycling methods available for blade material?

SeeOff – Decommissioning Scenarios

- Due to open questions and different wind farm specifics (e.g. foundation type) many thinkable combinations possible of
  - concepts (e.g. where and how many cuts, scour protection removal or not...)
  - technologies
  - logistics (e.g. shuttle or feeder)
- No “one scenario fits all” approach possible



- In order to compare and evaluate the scenarions (e.g. time and cost wise) a base scenario has been defined.

SeeOff – Base Scenario

<u>Reference Windfarm</u>

WTG:	80 x SWT 3.6 120
Foundation:	Transition Piece (TP) with grouted connection to Monopile (MP) MP: 680 t, length 65 m, diameter max. 6 m, wall thickness max. 126 mm TP: 250 t, length of 27 m
Water Depth:	between 20m and 30m
Inter Array Cable (IAC):	33kV (length approx. 100 km)
Scour Protection:	2 layer (Filter: 20 - 200mm, Armour: 350 - 550mm)
OSS:	Weight approx. 3,000 t Jacket foundation, approx. 850 t
Harbour:	Bremerhaven (for a better comparability just one harbor assumed)


Quelle: Deutsche Windtechnik AG

SeeOff – Scenarios WTG

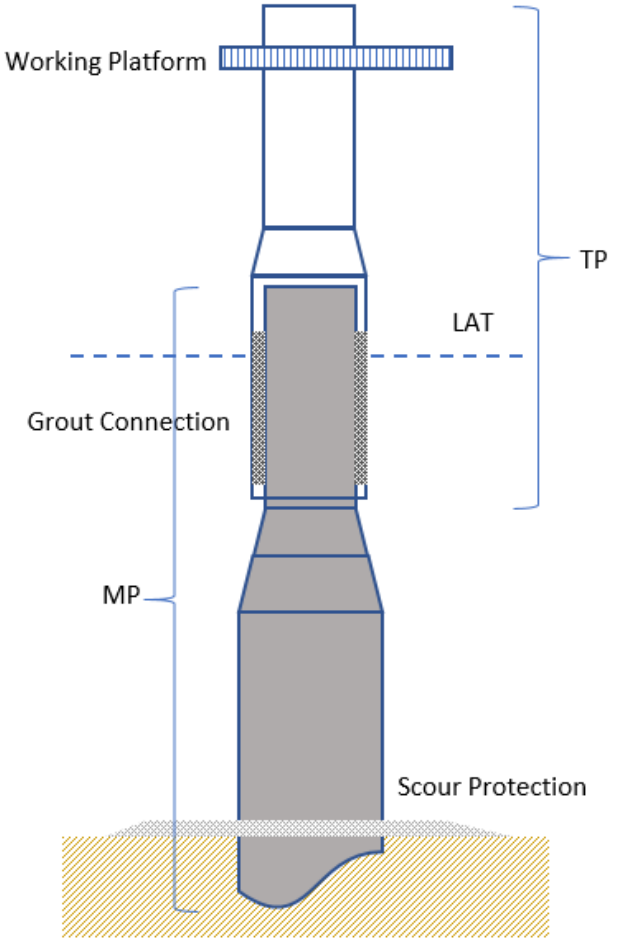
	Base Scenario	Alternative Scenarios
Concept	„Reverse Installation“ Dismantling in reverse installation order, interface is tower/TP flange	./.
Logistic	Jack-Up Vessel (JUV) for both dismantling and transport	JUV for Dismantling Feeder concept for transport

(Quelle: www.windcarrier.com)

SeeOff – Scenarios FOU

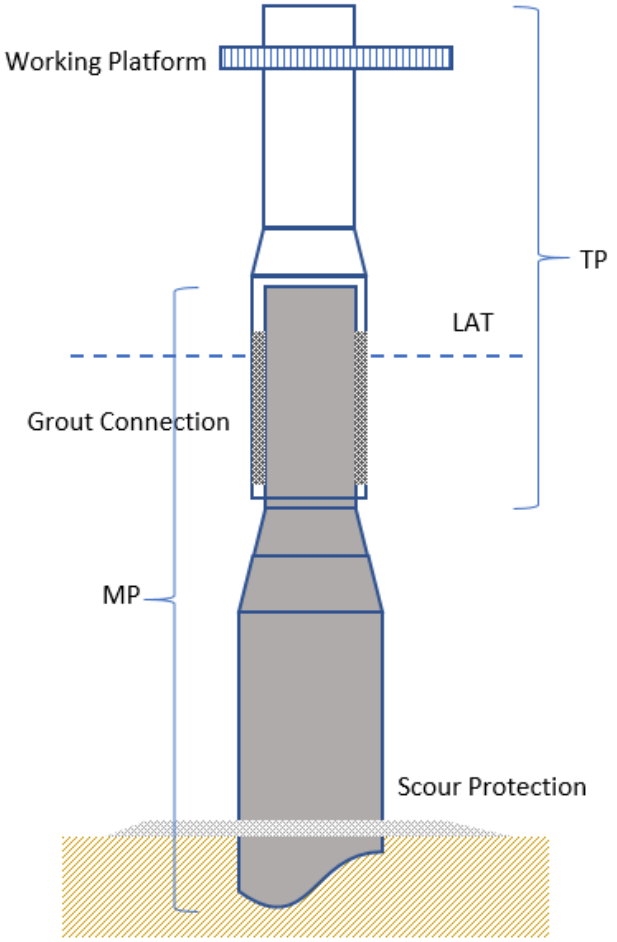
SeeOff *Development of efficient strategies for offshore wind farm decommissioning*

	Base Scenario	Alternative Scenarios
Concept	2 cuts: TP internal cut below TP, AWJ technology MP internal cut, AWJ technology, min. 1 m below seabed	2 cuts: TP internal cut below TP, AWJ technology MP internal cut, AWJ technology, above seabed
		2 cuts: TP internal cut below TP, AWJ technology Vibratory extraction for complete removal
		Alternative Cutting with DWCM
Logistic	Shuttle concept with JUV	JUV for Dismantling Feeder concept for transport



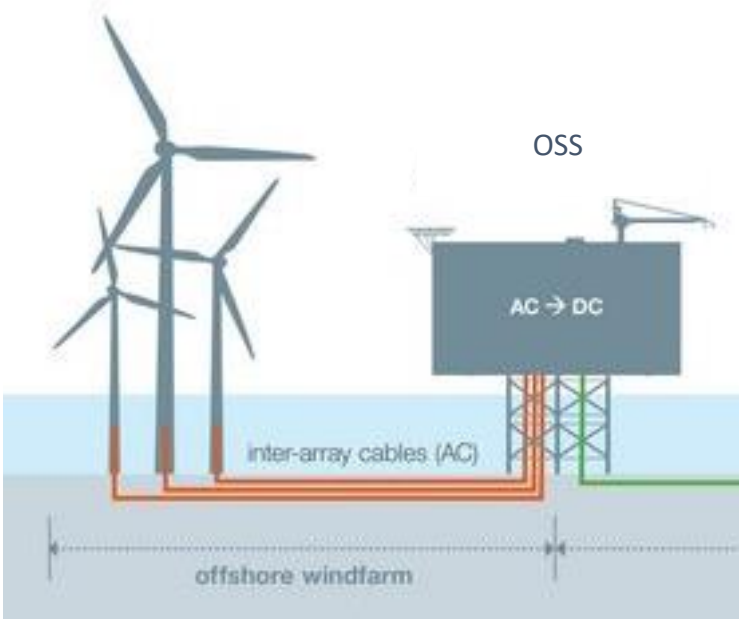
SeeOff – Scenarios Scour Protection

	Base Scenario	Alternative Scenarios
Concept	Removal of stones with cable dredger	No removal of scour protection
Logistic	Cable Dredger (Barges for transport)	./.



SeeOff – Scenarios IAC

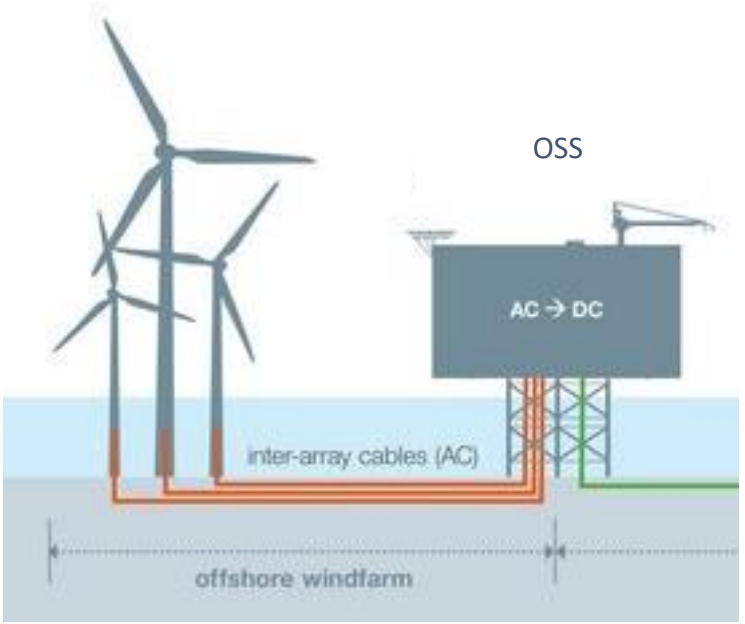
	Base Scenario	Alternative Scenarios
Concept	Complete removal of all cables	Removal of cables around FOU, burial of cable end and no removal of buried cables
Logistic	W2W Vessel and Cable Lay Vessel	./.



(Quelle: https://www.tennet.eu/news/detail/tennet-develops-innovative-submarine-cable-with-suppliers/)

SeeOff – Scenarios OSS

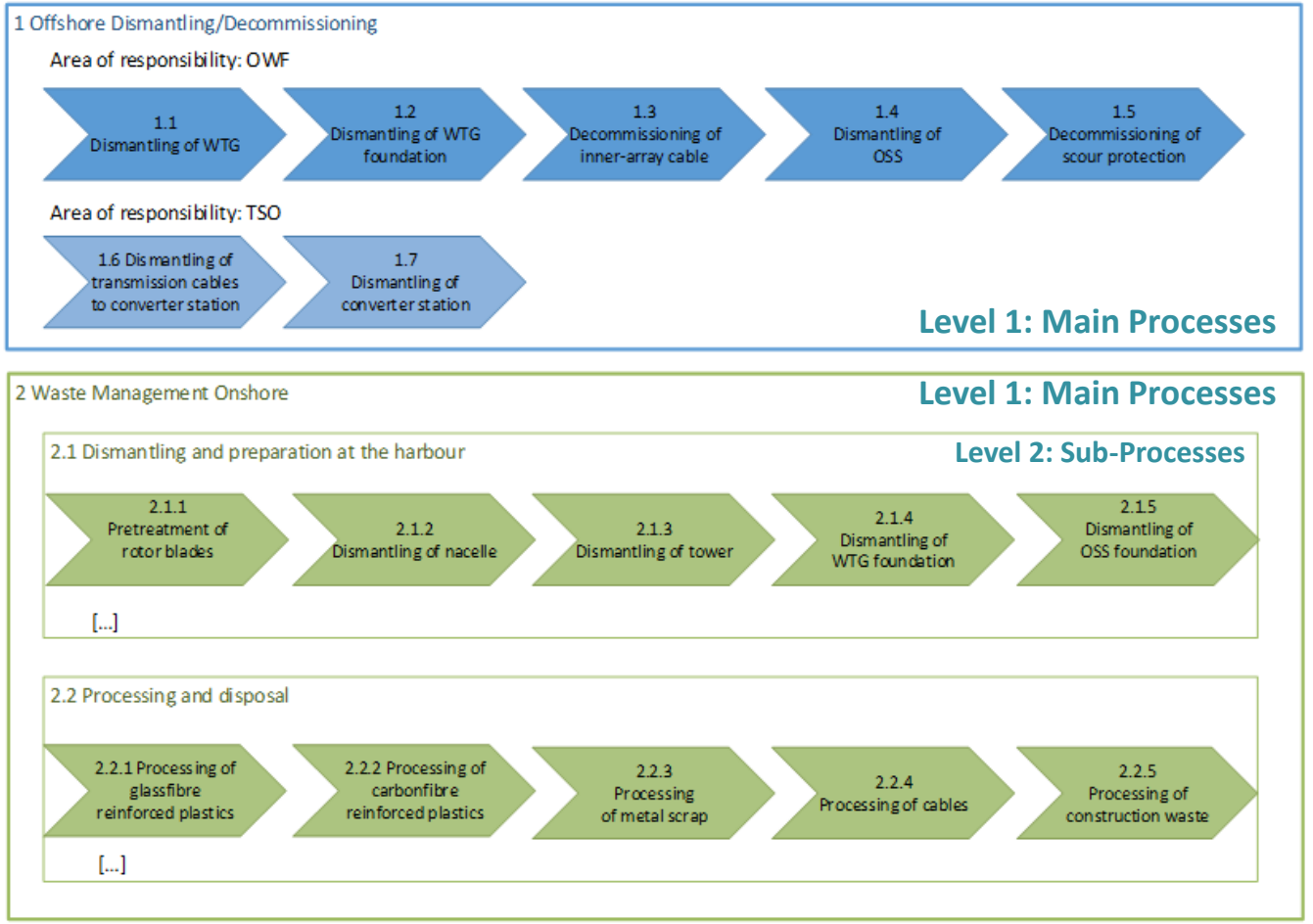
	Base Scenario	Alternative Scenarios
Concept	Topside: Oxy fuel cutting Jacket piles: AWJ technology inside, min. 1 m below seabed	Jacket: Cut piles with DWCM
Logistic	HLV + Flat-top Barge, Unloading with HLV	HLV + Flat-top Barge, Unloading with SPMT



(Quelle: https://www.tennet.eu/news/detail/tennet-develops-innovative-submarine-cable-with-suppliers/)

Process Chain

- The different scenarios will be transfered into chronological process chains and parameterized.
- The parameterisation constitutes the basis for further calculations.
- Parameter have to be defined for the different objectives, for example:
  - Hazard level
  - CO_2 emissioins
  - costs
  - Acceptance level
  - Recycling rate



Summary ... so far

- Each decommissioning project needs specific engineering and planning.
- The real life time for an average OWF still unknown.
- Technology for decommissioning mostly available, most offshore processes already proven.
- Especially for new technologies (e.g. vibration/over pressure extraction) still a significant need for research.
- And for known technology still unknown: Which technology / method is best for scaling?
- Still uncertainty with regards to environmental impact (and the assessment of the impact) and thus legal requirements (e.g. removal of cable, scour protection).
- Improvements on decommissioning technologies will mainly depend on experiences made and, based on that, improvements in design (e.g. to allow for better cutting, removal, lifting etc).

Thank you very much for your attention

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