

Name	Phase	Seabasin	Location	Location Name	Wind Farm type	Lead	Timeframe	Target species	Target habitat	Technological readiness level	Project description/approach	Monitoring date and methods	Results – lessons learned in project on restoration	Knowledge gaps left / recommendations	Possible negative effect	Sources	Credits
ADD; FaunaGuard	Construction	North Sea	Netherlands, Germany, France, Italy	Multiple offshore wind farm construction sites	Offshore windfarm (bottom fixed)	Van Oord and Ace Aquatec	Since 2017	Fish, Seals, Porpoises, Turtles		Implemented	FaunaGuard is a modular system that uses species-specific acoustic signals to temporarily deter marine fauna from active construction zones, minimizing harm during activities like pile driving.	Monitoring is conducted during deployment to assess effectiveness; specific dates and methods vary by project.	The system has been effective in creating temporary exclusion zones, allowing marine life to avoid harmful noise exposure during construction.	Further research is needed to optimize sound patterns for additional species and to assess long-term habituation effects.	Potential for temporary disturbance to non-target species; importance of careful calibration to avoid unnecessary stress.	Aceaquatec	OCEaN mitigation database
AdBm Noise Mitigation System	Construction	North Sea	Netherlands	Borssele Wind Farm Zone	Offshore windfarm (bottom fixed)	Van Oord & AdBm Technologies	2019-2020	Marine mammals, fish		Implemented	Used AdBm Noise Mitigation System (NMS) with acoustic resonators to reduce underwater noise, combined with a Big Bubble Curtain (BBC).	Continuous noise monitoring during construction.	Successfully reduced noise emissions below regulatory thresholds.	Further testing needed to optimize performance in variable sea conditions.	Potential localized disruption of marine life, though mitigated by noise reduction.	AdBM	OCEaN mitigation database
Avoidance of Anti-Fouling Paint Containing Biocides	Planning/design	North Sea	EU	Multiple offshore wind farm projects	Offshore windfarm (bottom fixed)	Industry-wide		Marine life, benthic organisms		Implemented	Avoid using anti-fouling paints with biocides to prevent chemical contamination in marine ecosystems.	Compliance with EU environmental regulations.	Reduced bioaccumulation of toxic substances in marine species.	Further studies needed on alternative non-toxic coatings.	Potential impact on maintenance cycles and effectiveness of biofouling prevention.	RTE (2022). Parc éolien en mer de Dunkerque	OCEaN mitigation database
Choice of Cable Design to Minimise EMF	Planning/design	North Sea	Netherlands	Dutch part of the North Sea	Grid Infrastructure	TenneT		Marine life (e.g. elasmobranchs, benthic species)	Seabed areas where cables are laid	Implemented	For AC cables, minimize EMF by optimizing twist distance; for DC cables, bundle cables to reduce EMF and minimize trenching. For inter-array cables, bundle and shield AC cables.	Compliance monitoring by Dutch regulatory agencies.	Bundled DC cables are now the norm in Dutch waters, reducing EMF and installation impacts.	More research needed on long-term effects of EMF on marine organisms.	Residual EMF impacts may still occur despite mitigation measures.	TenneT's website - Innovative submarine cable	OCEaN mitigation database
Cable Burial to Reduce EMF Exposure	Planning/design	North Sea	Netherlands, Germany	Dutch & German EEZ	Grid Infrastructure	Industry-wide		Marine life (e.g. elasmobranchs, benthic species)	Seabed areas where cables are laid	Implemented	Cable burial depths reduce seabed area under EMF exposure and lower intensity at the sediment surface. -3m depth mandatory in Dutch coastal areas; -1m further offshore. In Germany, the standard depth is -1.5m in the EEZ, except for traffic separation schemes (-3m).	Compliance monitoring per Dutch Water Act and German EEZ regulations.	Burial depth regulations significantly reduce exposure to marine organisms.	Further studies needed on EMF effects at different depths and sediment types.	Potential habitat disruption during burial process.	Hermans and Schill (2022). Electromagnetic fields and the Marine Strategy Framework Directive Descriptor 11 - Energy	OCEaN mitigation database
Shielding of Cables to Prevent Electric Field Transmission	Planning/design	North Sea	Various	Offshore Wind Farms	Grid Infrastructure	Industry-wide		Marine life (e.g. fish, crustaceans)	Seabed areas where cables are laid	Implemented	Shielding techniques ensure direct electric fields do not radiate into the marine environment.	Compliance monitoring per international best practices.	Effective in eliminating direct electric field emissions.	More research required on optimal shielding materials and costs.	Shielding may increase material costs and installation complexity.	BOEM (2020). Electromagnetic Fields from Offshore Wind Facilities	OCEaN mitigation database
Marine Mammal Observer (MMO) - Umuiden Ver Gamma Offshore Grid	Construction	North Sea	Netherlands	Umuiden Ver Gamma	Grid Infrastructure	TenneT	2021-Present	Marine mammals		Implemented	MMO stationed on installation vessels to monitor for marine mammals before noisy activities begin, ensuring no disturbance or injury.	MMO observations recorded in real-time before pile-driving.	Effective in reducing risk to marine mammals before construction.	Best practices should be generalized for all offshore projects, not just Natura 2000 sites.	Dependent on visibility; effectiveness can be limited in poor weather conditions.	OCEaN mitigation collection	OCEaN mitigation database
Siting Offshore Converter Stations & Cables to Avoid Valuable Habitats	Planning/design	North Sea	Belgium	Princess Elisabeth Energy Island	Offshore windfarm (bottom fixed)	Elia	2023	Marine benthic species, fish	Seabed habitats	Implemented	Micro-siting approach avoids sensitive habitats and ecosystems.	Site-specific habitat surveys.	Protects sensitive seabed ecosystems.	More studies needed on best techniques for precise micro-siting.	Space constraints may limit full avoidance.	Elia Group (2023). Transforming our seas into Europe sustainable economic enging	OCEaN mitigation database
Micro-siting Cables to Avoid Dense Reef-building Organisms & Spawning Areas	Planning/design	North Sea	Netherlands	Offshore Wind Farms	Offshore windfarm (bottom fixed)	TenneT	2020	Reef-building organisms, spawning fish	Seabed habitats	Implemented	Careful cable placement prevents damage to reef-forming species.	Environmental monitoring and mapping.	Protects reef integrity and fish spawning areas.	Research on reef resilience after nearby cable installation.	Minor habitat disturbances still occur.	BERR and Defra (2008).. Review of cabling techniques and environmental effects applicable to the offshore wind farm industry	OCEaN mitigation database
Seasonal Timing to Avoid Sensitive Marine Life Activities	Construction	North Sea	EU	Rampion, Princess Elisabeth Energy Island	Offshore windfarm (bottom fixed)	Ørsted, TenneT, RWE, Elia		Marine mammals, fish	Breeding, nursery, and spawning areas	Implemented	Avoid construction in critical times for feeding, spawning, and nursery habitats.	Seasonal environmental assessments.	Helps protect critical life stages of marine species.	More detailed ecological impact assessments needed.	May restrict project schedules significantly.	Bennun, L., van Bochove, J., Ng, C., Fletcher, C., Wilson, D., Phair, N., Carbone, G. (2021). Mitigating biodiversity impacts associated with solar and wind energy development. Guidelines for project developers. Gland, Switzerland: IUCN and Cambridge, UK;	OCEaN mitigation database
Spawning Time Avoidance	Construction	Baltic Sea	Germany	Baltic 1 Wind Farm	Offshore windfarm (bottom fixed)	50Hertz	2020-2025	Atlantic herring, sandeels, dogfish	Seabed and spawning areas	Implemented	Adjust construction periods to protect Baltic herring spawning grounds during sensitive times	Continuous monitoring during spawning periods	Construction periods adjusted to avoid key spawning seasons	More research on specific seasonal migration patterns of other fish species needed	Possible disruption to local fish populations during non-avoidance times	BERR and Defra (2008).. Review of cabling techniques and environmental effects applicable to the offshore wind farm industry	OCEaN mitigation database
HDD for Cable Laying	Construction	North Sea	Germany	Nordergründe Wind Farm	Grid Infrastructure	TenneT	2022-2027	Various fish and shellfish species	Intertidal and landfall habitats	Implemented	Horizontal Directional Drilling (HDD) used to minimize disruption in sensitive intertidal areas	Annual monitoring of soil and habitat recovery post-drilling	Successful in minimizing impact on habitats and reducing the footprint of cable laying	Further research on HDD impact on deep soil layers and long-term habitat recovery is needed	HDD may disturb seabed layers at the drill entry/exit points, but minimal impact overall	Tennet's website - Horizontal drilling method	OCEaN mitigation database
Sediment-Reducing Cable Burial	Construction	North Sea	Netherlands	Hollandse Kust Zuid Wind Farm	Grid Infrastructure	TenneT	2022-2027	Species sensitive to suspended sediment	Soft and sediment-rich seabeds	Implemented	Cable burial using techniques to minimize sediment suspension and disturbance	Ongoing monitoring of sediment dispersion during cable burial	Effective in reducing suspended sediment levels and minimizing impact on sensitive species	More studies needed on how different sediment types affect local ecosystems	Temporary increases in suspended sediment; mitigation ensures minimal harm	BERR and Defra (2008).. Review of cabling techniques and environmental effects applicable to the offshore wind farm industry	OCEaN mitigation database
Reducing Maintenance Vessel Trips	Operational	North Sea	UK	Galloper Wind Farm	Offshore windfarm (bottom fixed)	RWE	2022-2027	Various marine species		Implemented	Reduced frequency of maintenance vessel trips to minimize disturbance to local ecosystems	Monitoring of maintenance vessel impact on marine life	Reduction in vessel trips has led to lower disruption of marine habitats	Further reductions in vessel operations may be possible with additional research	Still some disturbance from occasional maintenance vessel activity		OCEaN mitigation database