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
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 eolien 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 Schilt (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
Cable Burial to Minimise Heat Emissions	Planning/design	North Sea	Germany	German EEZ & Wadden Sea	Grid Infrastructure	Industry-wide		Marine life (benthic species, infauna)	Seabed areas where cables are laid	Implemented	Cable burial required to limit seabed heating to 2 Kelvin at 20 cm depth (EEZ) and 30 cm depth (Wadden Sea).	Compliance monitoring by German regulatory bodies.	Regulation ensures minimal thermal impact on benthic ecosystems.	Need for further studies on long-term thermal effects of subsea cables.	Localized thermal hotspots possible if burial depth is inadequate.	Kümpel (2014): Subsea power cable operations - Accuracy investigation of the Teledyne TSS 350. In: Hydrographische Nachrichten 99. Rostock: Deutsche Hydrographische Gesellschaft e.V.. S. 17-20.	OCEaN mitigation database
Siting Away from SPAs, MPAs, and Valuable Habitats	Planning/design	North Sea	UK	Thanet Offshore Wind Farm	Offshore windfarm (bottom fixed)	Vattenfall	2014	Marine protected species	Biogenetic reefs, spawning and nursery grounds	Implemented	Avoids designated areas, micro-siting to protect Sabellaria spinulosa reefs.	Repeated reef mapping & monitoring.	Effective in preserving biogenic reef integrity.	If full avoidance is not possible, comprehensive baseline assessment and careful micro-siting are required.	Some unavoidable disturbances still occur.	Pearce et al. (2014). Repeated mapping of reefs constructed by Sabellaria spinulosa Leuckart 1849 at an offshore wind farm site	OCEaN mitigation database
Siting Offshore Converter Stations Away from Sand Waves to Reduce Dredging	Planning/design	North Sea	Netherlands	IJmuiden Ver Gamma Offshore Grid	Offshore windfarm (bottom fixed)	TenneT	2022	Marine benthic species	Sand wave areas	Implemented	Siting offshore converter stations outside sand wave regions to avoid excessive dredging.	Environmental Impact Assessment (EIA) monitoring.	Reduces seabed disturbance from dredging.	Need to assess long-term impact of sand wave avoidance on infrastructure placement.	Dredging may still be required in unavoidable cases.	Ijmuiden Ver Gamma Offshore Grid - Summary of EIA report (2022)	OCEaN mitigation database
Minimizing Inter-array Cabling by Optimal Offshore Converter Station Siting	Planning/design	North Sea	Netherlands	Offshore Wind Farms	Offshore windfarm (bottom fixed)	TenneT	2021	Various		Implemented	Strategic placement of converter stations reduces cable lengths and vessel trips.	Compliance monitoring.	Reduced seabed disturbance and lower cable costs.	Future assessments on optimal station layouts for minimal cabling.	Potential constraints in highly congested maritime zones.		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
Micro-rerouting Cables to Avoid Silty Deposits & Peat (Preventing Turbidity Issues)	Planning/design	North Sea	Netherlands	IJmuiden Ver Gamma Offshore Grid	Offshore windfarm (bottom fixed)	TenneT	2022	Marine benthic species	Silty seabed, peat deposits	Implemented	Avoiding silty deposits and peat reduces turbidity risks and need for sediment replacement.	Environmental Impact Assessment (EIA) monitoring.	Helps maintain seabed stability and reduces sediment plumes.	More research needed on long-term seabed changes from micro-siting.	Potential cost increases due to added surveying efforts.	Ijmuiden Ver Gamma Offshore Grid - Summary of EIA report (2022)	OCEaN mitigation database
Defining Exclusion Zones for Anchoring to Protect Sensitive Habitats	Planning/design	North Sea	Netherlands	Offshore Wind Farms	Offshore windfarm (bottom fixed)	TenneT	2019	Sensitive benthic species	Seabed habitats	Implemented	Anchoring restrictions prevent damage to valuable seabed habitats.	Regular monitoring of exclusion zone compliance.	Reduces direct anchor impacts on sensitive areas.	More research needed on potential for dynamic anchoring zones.	Enforcement challenges if anchoring rules are not respected.	BERR and Defra (2008). Review of cabling techniques and environmental effects applicable to the offshore wind farm industry	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	https://www.tennet.eu/nl-en/about-tennet/innovations-tennet/horizontal-drilling-method	OCEaN mitigation database
Narrow Blade Ploughing	Construction	North Sea	Germany	Nordsee One Wind Farm	Grid Infrastructure	TenneT	2022-2027	Various benthic species	Seabed habitats	Implemented	Conventional plough technique used to minimize disturbance and allow natural seabed recovery	Post-burial monitoring of seabed recovery	Effective at reducing benthic disturbance, allowing for natural recovery	Long-term monitoring needed to assess full recovery and effectiveness in deeper seabed areas	Slight temporary disturbance to the seabed; recovery is generally fast	BERR and Defra (2008). Review of cabling techniques and environmental effects applicable to the offshore wind farm industry	OCEaN mitigation database
Frond Mattress Usage	Operational	North Sea	Germany	Borkum Riffgrund 2 Wind Farm	Grid Infrastructure	TenneT	2022-2027	Various benthic species	Soft seabed areas	Implemented	Frend mattress used for additional cable protection in soft sediments	Monitoring during cable laying and post-installation	Not currently used by TenneT in shallow waters, but effective in deeper areas	Frond mattress technique has shown benefits in deeper seabeds, but effectiveness in shallow waters requires more research	Frond mattress may not be viable in shallow seabed conditions	BERR and Defra (2008). Review of cabling techniques and environmental effects applicable to the offshore wind farm industry	OCEaN mitigation database
Backfill with Nature-Based Materials	Construction	North Sea	UK	Gwynt y Môr Wind Farm	Offshore windfarm (bottom fixed)	TenneT, RWE	2022-2027	Various benthic organisms	Seabed habitats	Implemented	Backfilling using sustainable, nature-based materials to minimize environmental impact	Monitoring of backfill material effectiveness	Successful use of sustainable materials to protect seabed habitats	Continued use of sustainable materials; research needed on material compatibility in different seabed types	No major negative effects; successful mitigation of seabed disruption	BERR and Defra (2008). Review of cabling techniques and environmental effects applicable to the offshore wind farm industry	OCEaN mitigation database

Backfill with Nature-Based Materials	Construction	Mediterranean Sea	Spain		Offshore windfarm (bottom fixed)	Red Eléctrica	2023-2028	Various marine species	Rocky seabed areas	Implemented	Backfilling using sustainable, nature-based materials to minimize environmental impact	Monitoring of backfill material effectiveness	Successful use of sustainable materials to protect seabed habitats	Continued use of sustainable materials; research needed on material compatibility in different seabed types	No major negative effects; successful mitigation of seabed disruption	BERR and Defra (2008). Review of cabling techniques and environmental effects applicable to the offshore wind farm industry	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
Seabed Recovery Backfilling	Construction	North Sea	Netherlands	Borssele Wind Farm	Offshore windfarm (bottom fixed)	TenneT	2022-2027	Various benthic organisms	Seabed habitats	Implemented	Backfilling displaced material to reduce sediment remobilisation and support habitat recovery	Post-burial monitoring of sediment stability	Backfilling has helped in stabilizing the seabed and supporting benthic recovery	Further research on specific backfilling materials and techniques is required	Some sediment displacement during cable burial can temporarily affect local benthic organisms	BERR and Defra (2008). Review of cabling techniques and environmental effects applicable to the offshore wind farm industry	OCEaN mitigation database
Jet Ploughing for Soft Seabeds	Construction	North Sea	UK	Hornsea One Wind Farm	Offshore windfarm (bottom fixed)	Ørsted	2022-2027	Various benthic species	Soft seabeds	Implemented	Jet ploughing technique used to minimize disturbance in soft seabed areas	Monitoring of benthic recovery after jet ploughing	Effective at minimizing benthic disturbance in soft seabed areas	Long-term monitoring needed to evaluate full impact on benthic organisms	Jet ploughing can still cause minor seabed disruption, but disturbance is lower than conventional methods	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
Bury and Forget – Subsea Cables	End of Life	North Sea	Germany	TenneT Grid Infrastructure	Grid Infrastructure	TenneT	2025-2030	Various marine species	Seabed habitats	Implemented	Subsea cables are buried at appropriate depths and left in place during decommissioning to avoid seabed disturbance	Post-decommissioning monitoring of seabed stability and cable status	"Bury and forget" is effective in minimizing disturbance, but the practice has raised questions about circularity and material use for future subsea cables	Further research on the relationship of buried cables with future materials demand and understanding environmental impact of this practice	Regulatory uncertainty and lack of full removal may lead to confusion and inconsistency in decommissioning practices	Al-Sallami (2021). Cables decommissioning in offshore wind farms: environmental and economical perspective	OCEaN mitigation database