FULL CIRCLE SOLUTIONS FOR
OFFSHORE WIND FARMS
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INTRODUCTION

COWI is a highly versatile and multidisciplinary company operating worldwide from more than 35 international offices.

COWI’s expertise within offshore wind farm projects stands on the shoulders of our experience developed since 1930 within foundations for large bridges, offshore oil and gas developments, power systems and marine structures.

COWI offers multidisciplinary and diversified consultancy and we draw on in-depth expertise for the wide range of disciplines required, which have successfully been applied to a wide range of offshore wind farm projects.

COWI offers a broad range of services within every project phase involved in an offshore wind development. Our 360° approach takes lots of expertise. Fortunately, we have the people to back it up.

The purpose behind this full-circle solution is to minimize the project risk by offering a simple and coherent approach by which we support our clients in achieving the expected high quality results within budget and on time.
Technical installations chart for the feasibility studies of offshore wind farms in the Øresund area in Denmark.
SITE SCREENING AND FEASIBILITY STUDIES

SCREENING PROCESS
The purpose of the screening process is to identify sites where locations for offshore wind farms would be feasible and have the least possible environmental impact on nature and humans. The following issues have to be taken into consideration:
- Wind energy resources
- Grid connection
- Hydrography
- Environment and raw materials
- Sea cables
- Navigation
- Visual impact.

CONCEPTUAL DESIGN
The conceptual design phase aims at selecting the best suited technical foundation solution for each wind farm location and characteristics. A basis for the economic assessment of an offshore wind power plant is established and the costs are divided into:
- Construction costs for foundations, wind turbines, power system and grid connection
- Operating and maintenance costs.

FEASIBILITY STUDY
The purpose of the feasibility study is to assess the economic feasibility of an offshore project based on the conceptual design and the available wind energy resources. The results of the feasibility study include calculation of the production costs per kWh and assessment of economic and technical risks during implementation and operation.

SELECTED REFERENCES
- Screening of offshore sites in the Øresund area in Denmark for 300 - 400 MW offshore wind farms
- Site identification for 100 MW offshore wind farm in Bohai Bay in China
- Assessment of the potential for offshore wind farms along the Portuguese coast
- Conceptual design of 300 MW offshore wind farm in Øresund in Denmark
- Identification of potential offshore wind farm in the Danish territorial waters
- Development of wind farm layout, wind power calculations, conceptual design of foundation structures and cable grid. In addition, estimate the total wind farm cost for two offshore areas in the Øresund area in Denmark and calculate the unit cost per kWh.
COWI carries out offshore wind measurements with standard equipment such as anemometers on lattice towers and Lidar’s. We are one of the Measnet founders and one of the few companies accredited for IEC61400 and Measnet quality measurements.

We supply high quality analysis and combine measurements with wind resource studies. We also supply site specific wind data input for the design basis for wind turbines and foundations.

Our services include:
› Initial evaluation of wind energy resources
› Planning and execution of site-specific wind energy resource investigations.
› Analyzing site-specific data and preparing detailed wind energy resource studies
› Micro-siting using state of the art software packages
› Calculation of energy production
› Second opinion on wind studies and micro-siting.

We offer measurements of movements and loads of grout-connections between monopiles and transition pieces for offshore wind turbines. We base our advice on 30 years of experience with structural measurements on wind turbines, and load calculations with aeroelastic wind turbine codes.
We provide high quality analysis of our measured data or of client’s data. This is at times a requirement by a certifying body, and sometimes a comforting means of control for the operator and owner of a wind farm.

COWI has been involved in offshore wind farm layout configuration from the very beginning. Offshore wind farms are fundamentally different from onshore in the sense that there is no terrain and roughness.

From a wind perspective the challenge is to make the optimum grid (layout) and spacing in order to optimize losses due to wakes. Offshore wind farms consist of multiple rows and estimation of deep array losses is crucial for a reliable AEP estimate. Virtual roughness, where appropriate, is modelled when estimating the deep array losses. COWI has gained expertise in modelling deep array losses and using wake models to optimise specific locations. The relevant economic optimisation when preparing layout for offshore wind farms combines foundation costs, cable-costs, electrical losses in cables and lifetime value of electrical output. Non-economic issues like sailing routes, visual impact and environmental concern also need to be considered.

**SELECTED REFERENCES**
- Met mast installation to gather data for optimising the foundation design of the 500 MW Greater Gabbard Offshore Wind Farm off the coast of Suffolk in UK.
- Measurement equipment including strain gauges on the foundation have been installed on an offshore wind turbine at Nysted Offshore Wind Farm in Denmark and several analyses have been carried out in order to determine the loads on the turbine caused by waves and wind.
ENIRONMENTAL SERVICES

IDEA

ASSESSMENT
› Fact-finding, incl. plans and regulations
› Surveys
› Baseline studies
› Mapping
› GIS & data management
› Socio-economy.

DESIGN

FEASIBILITY
› Strategic environmental assessment (SEA)
› Environmental impact assessment (EIA)
› Environmental indicators
› Mitigation and compensation measures
› Due diligence
› Cradle-to-cradle
› Environmental law and economics.

CONSTRUCTION

MONITORING
› Environmental management and monitoring plan EMP
› Training and capacity building
› Health, safety and environment (HSE)
› Environmental monitoring.

OPERATION AND MANAGEMENT

EVALUATION
› Environmental management and monitoring plan EMP
› Management planning
› Training and capacity building
› Health, safety and environment (HSE).

DECOMMISSIONING

ASSESSMENT AND MONITORING
› Fact-finding, incl. plans and regulations
› Environmental management and monitoring plan EMP
› Training and capacity building
› Health, safety and environment (HSE).

“Seabirds constitute one major environmental risk, particularly in the shallow seas where offshore wind farms are being constructed. Often, seabirds migrate and feed exactly at those sites, which are technically attractive for wind farms – and conflicts may arise.”

Photo: Petri & Betz
ENVIRONMENTAL IMPACT ASSESSMENT

A thorough environmental impact assessment (EIA) is a mandatory component in any offshore wind farm project. Based on our extensive experience COWI applies comprehensive EIA procedures according to contemporary international standards and the environmental standards of the funding entity.

A specific EIA may be preceded by a strategic environmental assessment (SEA) for a regional offshore wind power development plan. COWI has wide experience of conducting SEAs for planning authorities by deploying planners as well as environmental and regulatory specialists. Our strong international network with partners, institutions and organisations enables us to obtain complete data and information of importance for conducting a comprehensive EIA.

A thorough mapping of environmental sensitivity is essential as a part of securing a complete environmental baseline.

COWI can develop environmental risk models, which take into account hydraulic features and oceanographic parameters necessary for creating a trustworthy picture of the dynamic environment at a given wind farm site.

An integrated and important element in our approach to environmental assessments is the attention we give to interdisciplinary solutions. Due to our broad in-house competencies we can challenge possible technical and environmental problems and find suitable and sustainable solutions, which can be approved by engineers, socio-economists and environmentalists – and meet the needs of our clients. Typical interdisciplinary issues comprise sustainability schemes (inclusive of cradle-to-cradle analysis), health, safety and environment (HSE) issues at construction sites and at the operating wind farms.

“Also, fish spawning areas and the occurrence of marine mammals are environmental elements of very high significance – and candidates for potential conflicts when locating and establishing wind farms.”

SELECTED REFERENCES

- Environmental impact assessment of the field development of the Nini and Cecilie and 10 prospects in the North Sea. Our services included technical descriptions of the facility during the extension, production and dismantling/removal phases, a description of the environment in the affected area, and environmental consequence assessments for each phase of the project.
- Update of environmental impact assessment of further development of existing oil and gas fields in the North Sea.
- Performance of marine monitoring around the development of the artificial island in Qatar (the Pearl of the Gulf) to evaluate the effects according to authority requirements.
COWI offers the complete service with respect to metocean studies for offshore wind developments. We analyse meteorological and oceanographical data and use numerical wave and hydrodynamic modelling state-of-the-art-software to define design water levels and wave conditions at each site.

Site specific metocean studies are performed to establish hydraulic design conditions for offshore wind farms. The studies are presented in report form providing a general description of the area in question including seawater properties, such as salinity, temperature and density variations. Baseline data for the study are presented. Such data typically comprise measured or hind-casted wind, waves, water levels, currents and atmospheric pressure.
Hydrodynamic modelling of waves, current and water levels forms a key part of the metocean study. COWI applies the state-of-the-art DHI MIKE hydrodynamic modelling suite. Wave conditions are modelled by use of MIKE21 SW, typically for durations of 10 to 20 years to allow full statistical analysis of design conditions. Normal and extreme current speed as well as tidal levels and storm surges are derived from hydrodynamic modelling MIKE21 HD for periods covering a full year and selected storm events.

Statistical analysis forms the second major part of the metocean study. This analysis includes extreme statistics, scatter tables and joint probability analysis directly applicable to the load cases of the IEC-61400-3 standard.

COWI applies time and spatially distributed wind and pressure fields as forcing of the models. Wave boundary conditions are provided from regional/global wave models. Model bathymetry is derived from the global sea chart database MIKE C-MAP combined with site specific surveys. In combination, the global availability of such data allows us to perform metocean studies for any site, typically within 3 months from receipt of client-specific data.

SCOUR AND SCOUR PROTECTION
Seabed/structure interaction in terms of scour, backfilling and scour protection is presently an area of intense research. COWI maintains very close contact with universities and research institutions within this field and contributes to development of design approaches. COWI has extensive experience of both desk designs of scour protection and planning and supervision of physical model tests.

SELECTED REFERENCES
- Analysis of metocean conditions including wind, waves, currents and water levels and preparation of the preliminary design basis for the gravity based foundation for the Storgrundet Offshore Wind Farm located in Swedish territorial waters in the southern part of the Gulf of Bothnia. For the given site three layouts of turbine positions, comprising 46, 56 and 70 wind turbine generators located in water depths from 10.5 m to 27.5 m are envisaged with 3 MW to 5 MW wind turbines.
- The metocean study for the offshore wind farm ARCADIS Ost 1 in Germany included salinity, temperature, density, seasonal variations, wind, wave, water level time series, misalignment plots and extreme analysis.
- Metocean study and preliminary design basis for Suurhiekka Offshore Wind Farm in Finland.
The results of the geophysical survey together with the geotechnical investigations give the geological information needed to design the most cost effective solution for the foundations.

COWI reviews the existing information in order to prepare a comprehensive invitation to tender (ITT), introducing the basic requirements, best practices and legal terms, to allow an efficient contractor selection process, in which we also assist our clients. COWI distributes the ITT to qualified bidders, reviews proposals, gives advice on the contractor selection and starts managing the relationship with the client-selected contractor.

After the contract award COWI manages the relationship between client and contractor, reviews and ensures the quality of all project preparation documentation such as quality and health, safety and environment (HSE) plan and documentation.
COWI optimises the survey proposed by the contractor in order to minimise the survey time (i.e. optimising the number of lines and turns) while maximising safety and data gathering performance by supporting the simultaneous acquisition of all required data, which normally comprise bathymetry (multibeam echosounder), acoustic imaging of the sea bed (side scan sonar), vertical layering of the seabed (sub-bottom profiles) and detection of possible metallic obstruction on the seabed (magnetometer).

Acting as the client’s consultant during calibrations, data acquisition and with operational safety assistance, COWI adds value to the survey performance.

After the survey COWI manages the relationship between the client and the contractor and deals with all required negotiations.

Finally, COWI checks the data processing, charting and reporting in order to guarantee that final deliverables meet the required quality. The deliverables will be focused on:
- Supporting the selection of a minimum number of locations to perform geotechnical investigations and characterise the area
- Supporting the creation of a geological report.

UNEXPLODED ORDNANCE (UXO) SURVEY
COWI offers support on managing the risk of potential UXO in relation to jack-up rigs and cable installation operations. Our services include:
- Comprehensive risk assessment as a basis for possible UXO surveying and to comply with local legislation and the client’s HSE requirements
- Design, survey and mitigation (if needed).

SELECTED REFERENCES
- Preparation of invitation to tender for marine geophysical survey to support decision making on the route selection for the export cable and detailed post-processing of magnetometer survey results for unexploded ordnance detection for the Anholt Offshore Wind Farm in Denmark.
- Planning and survey design, CPT investigations for export cable for the West of Duddon Sands Offshore Wind Farm in UK.
- Client’s consultant and representation before, during and after the survey for the Wikinger Offshore Wind Farm in Germany.
- Quality check and assurance of survey data (regular seabed mapping) and UXO-assessments on the London Array Offshore Wind Farm in UK.
JACK-UP RISK ASSIGNMENTS
COWI has carried out risk evaluation regarding the sea bed conditions for jacking up on a number of offshore wind turbine sites. The risk assignment focuses on: Existence of objects on the seabed surface or metallic objects in the sub-surface, which could compromise the operation, sea bed conditions, bearing capacities and penetration of footings, risk of punch through of softer layer below footing, and other ground related risks in conjunction with jacking up operations. All the previous assessments are carried out with geophysical (i.e. AUV) and geotechnical solutions.
COWI supplies all necessary geotechnical engineering services:
- Preparation of tailored tender documents for investigation programmes
- Proposal evaluation
- Supervision of geotechnical investigations
- Specification and interpretation of field and laboratory tests, including CPTU, triaxial tests and consolidation tests
- Preparation of design bases for foundation design
- Conceptual and detailed design of all types of foundations for offshore wind turbines and transformers
- Advanced analysis, including 2D and 3D finite elements modelling.
- Leg penetration analyses for jack-ups including punch-through analyses (in combination with geophysical results)
- Preparation of tender documents for construction
- Follow-ups on project execution.

COWI has a vast experience working with gravity foundations and monopiles using in-house design tools to ensure optimal design. COWI has also a broad experience, obtained in the oil and gas sector, designing jacket foundations. These are increasingly expected to be the preferred foundation type for deeper waters.

COWI carries out advanced 2D and 3D finite elements modelling of foundations to clarify the complicated interaction between soils, foundation and wind turbine in operation.

Additionally COWI is continuously gathering information on new foundation types, which might provide the appropriate solution for our client’s developments (i.e. bucket foundations).

SELECTED REFERENCES
- Supervision assistance to soil investigation for foundations for 23 offshore wind turbines for Thornton Bank phase 2 in Belgium
- Supervision assistance to soil investigation for 12 locations to characterise the area for Wikinger Offshore Wind Farm in Germany
- Supervision assistance to soil investigation for foundations for more than 100 wind turbines for Wikinger Offshore Wind Farm in Germany
- Supervision of the detailed soil investigations for the West of Duddon Sands Offshore Wind Farm including 140 wind turbines and one substation in UK
- Supervision of geotechnical investigations containing boreholes and CPTs from jack-up for the offshore wind farm just east of Frederikshavn with 5 wind turbines. COWI is acting as client's representative.
FOUNDATION DESIGNS

Together with our clients, COWI participates in the development of offshore wind farm foundation projects from the outset and through all phases of the project. We develop the foundation designs from the initial conceptual stages, where the optimal type of foundations for the project are determined, through the detailed design phase and supervision and monitoring of the installed and completed structures. Our services include assessments of foundation types in the context of overall project returns based on wind resources, make of turbine, geotechnical and hydraulic conditions etc. to ensure that each project foundation is optimized to the site and requirements of our clients.

Our design experience within offshore wind farm foundations has been obtained over many years since the early start of the offshore wind farm industry in the 1980s. Our concepts and designs have set the standard over the years. Our design experience for detailed design of offshore wind farm foundations includes:

- Steel monopile foundations
- Concrete gravity based foundations for shallow water depths
- Concrete gravity based foundations for deep water depths.

For tender, concept and preliminary designs our experience includes:

- Jacket structures
- Tripod foundations
- Bucket foundations.

The early stage design projects are based on our comprehensive design experience from the marine offshore industry of both terminals and oil & gas.

The key to a successful offshore wind farm design project is always the actual and comprehensive project experience. Only through actual and comprehensive project experience can the proper handling of the complex interfaces between the contractors, clients and third parties be obtained. This is where a designer’s input can be the key to the early handling of decisions that will later prove decisive for optimal project execution and hence optimal project returns.

It is also the actual project experience in combination with the necessary level of qualifications that ensures that an optimal design solution is found for contractors and clients alike within the constraints of time and resources.

COWI can provide the experience, the competence and the necessary flexibility in staff resources to ensure that our projects are undertaken carefully, diligently and with an optimal outcome for our clients.

COWI uses state-of-the-art numerical FEM programmes for the analysis and design of foundation structures. We have established an integrated platform for an expedient execution of our calculation models and hence we can execute large and comprehensive design projects efficiently.

For concrete structures, we use our in-house FEM program IBDAS, which provides advanced modelling features for pre-stressed concrete structures, taking into account fatigue in both reinforcement and concrete.
COWI carried out the detailed design of the foundations for Thornton Bank phase 1, which comprises 6 turbines, totalling, 30 MW.

The wind turbines are founded at -21.5 m to -27 m TAW and soil conditions are generally sand of medium grain size. The pre-stressed concrete foundation structure is composed of a cylindrical shaft on top of a conical base transferring the loads from the wind turbine directly to the base slab.

The base diameter is 23.5 m and the shaft diameter is 6.5 m, matching the diameter of the turbine tower.

The foundation structures are prefabricated on land, and installed at sea by a heavy lift crane, on a pre-installed gravel bed. The weight of the concrete structure is about 2,700 tonnes.
LONDON ARRAY

FOUNDATION DESIGN

With 175 monopiles, designed to carry the Siemens 3.6 MW turbines, the London Array will be the largest offshore wind farm in the world, when completed in 2012. Monopiles of 4.7 m and 5.7 m in diameter are being installed in water depths between 0 m and 25 m. With a total length of up to 85 m, these foundations will be amongst the largest ever built.

A consortium of DONG, E.ON and Masdar has commissioned Aarsleff Bilfinger Berger Joint Venture (ABJV) as contractor to undertake fabrication and installation of the steel foundations. To carry out the detailed design of the steel foundations, ABJV has engaged COWI as lead in a joint venture with IMS GmbH, COWI-IMS JV.

The offshore wind farm is located on and between the sandbanks of Kentish Knock and Long Sand representing depth variations of up to 25 m. The soil includes both sand profiles, stiff London Clay profiles and mixtures including also gravel layers. With layers potentially prone to liquefaction, also the soil represents a challenge to the design.

The project will be one of the first to introduce a new design of grouted connections and improvements in the geotechnical calculations of soil structure interaction to allow for an optimised design.

The present project constitutes the first phase of a two-phased set-up and is expected to deliver 630 MW of electricity.
MARINE STRUCTURES RISK AND PROBABILISTIC ANALYSES

Planning, design, construction, operation and decommissioning of marine structures opens up a vast field of different risk sources. These can be analysed and handled accordingly with help of probabilistic analysis. COWI is experienced in risk assessment and mitigation in all project phases.

An indispensable part of the metocean study is evaluation of extreme values and joint probabilities of environmental conditions, providing a basis for design and further allowing evaluation of the structure’s reliability. COWI’s expertise can be seen at the leading edge of current developments and application of extreme and joint probability analysis, and is already applied in different projects all round the world.

One of COWI’s specialties is the ship risk analysis. Based on studies of the ship traffic pattern in a certain region the risk due to ship collision with any kind of marine structure can be evaluated at a sophisticated level. This is essential not only to evaluation of damage or collapse risk of marine installations, but also to the risk of environmental impact due to ship cargo spills. Further, re-/routing of ship traffic and navigational risks should be emphasized in the variety of risk analysis performed by COWI in relation to ship risk.

Already during the design phase it is essential to gain knowledge on the construction and the operational risk. This not only guarantees a reliable structure with acceptable risks to users and third party, but also allows for an economic optimization of the design taking further life cycle risks into account. COWI has extensive experience in construction and operational risk analysis and incorporation of the these results during the design phase. This has allowed COWI to build and maintain all different types of marine structures in a very economic and efficient way.

End-of-life decisions involving decommissioning options are another specialist area in which COWI has extensive experience. Recommendations for decommissioning options are based on technical feasibility and related risks, risk to personnel and to the surrounding environment which can be systematically modeled for all options to achieve a transparent decision basis.

As any kind of risk analysis strongly involves the needs and requests from the client, COWI is very open to adapt and develop risk analyses fulfilling our client’s needs and capturing the marine structure’s specialties on a high, sophisticated level.
CABLE ENGINEERING AND ROUTING

INTER CONNECTION CABLE DESIGN
COWI designs medium voltage cables, and 36 kV array cabling and provides related electrical design - conceptual as well as detailed.

EXPORT CABLE ENGINEERING
COWI prepares detailed designs of export cable solutions up to 400 kV. We also carry out conceptual design starting from the choice between offshore substation and high-voltage cable and the alternative onshore substation plus one or several 33-66 kV cables from wind turbines to shore. Trenching and cable burial is a core element in our assistance and experience.

HORIZONTAL DIRECTIONAL DRILLING (HDD)
Often, cables cannot be laid in open trenches in some areas (i.e. legal or environmental restrictions), or it is not the best solution (i.e. soil formations, high water level, etc). In these cases directional horizontal drilling can be the solution to, for example, establish casings used to pull in the cables.

Our services include:
› In the planning phase - finding the optimal trace and taking authorities, soil conditions etc. into consideration
› Preparation of tender documents
› Interface review
› Contracting work
› Review of the contractors’ design documents
› Supervision under the construction phase
› Trenching and cable burial.

In relation to offshore cables and pipes, COWI presents relevant geological and geophysical data as 2D profiles for assessment of burrial and protection options. At the landfall locations COWI uses the 2D geological profiles to evaluate feasibility of horizontal directional drillings and investigation of suitable installation depths.
SELECTED REFERENCES

- Detailed electrical design for substation for 207 MW for the Rødsand 2 Offshore Wind Farm in Denmark
- Offshore substation detailed electrical design of 34 kV and 132 kV equipment as well as protection relays. Design, procurement, supervision and commissioning and onshore grid connection for 300 MW Walney 1 and 2 in UK
- Offshore substation detailed electrical design of 33 kV and 138 kV equipment. Design, procurement, supervision and commissioning for 110 MW Lillgrund Offshore Wind Farm between Denmark and Sweden
- Offshore substation detailed electrical design of 34 kV and 132 kV equipment as well as protection relays and SCADA. Design, procurement, supervision and commissioning and onshore grid connection for 165 MW Nysted in Denmark.
- Crossing the Limfjord near Aggersund in North Jutland in Denmark with 5 x 1.500 m cable conduits by using HDD
- Crossing the Limfjord near Vester Hassing in North Jutland in Denmark with 3 x 1300 m cable conduits by using HDD
- Crossing the Limfjord near Hals in North Jutland, Denmark with 2 x 1000 m sewage pipes
- Several crossings by HDD in the gas pipeline project from Egåved to Ellund in the south of Denmark.
Detailed electrical design for offshore substation for the Walney 1 project in UK.
OFFSHORE SUBSTATIONS

COWI designs platform topsides and their concrete foundations. The platform itself houses the main transformer with associated cables and panels, internal power supply, an emergency generator, a fire-fighting unit, a workshop and monitoring and control system. The whole operation will be controlled and monitored from the shore.

RØDSAND 2
The wind farm comprises 90 offshore wind turbines with a total output of 207 MW, enough to supply 200,000 households for a whole year. Rødsand 2 also offers the opportunity to build three trial wind turbines with a capacity of 15 MW in total. The transformer platform will collect electricity from these wind turbines and transform it from 33 kV to 132 kV for transfer via a powerful marine subsea cable to the shore, benefiting domestic consumers and companies alike.

The platform topside weights approximately 800 tonnes, not counting its concrete foundation. The transformer alone weighs 280 tonnes. The ground plan will be 30 m x 16 m. The platform will be placed at a depth of six metres on a so-called “gravity-based” foundation, which retains its stability on the sea bed in all weather conditions by virtue of its own weight.
Once an offshore wind farm is under production, monitoring and inspection of the submerged section is a key task in order to assure the proper production of the facility in the years that it is commissioned for.

Depending on the country the legal requirements for the inspections will change, but COWI, being present in about 40 countries, being among the main players of the offshore wind industry, will know what it is required in each individual case to minimise the cost of the inspection while maximising the results (i.e. governmental requirements might vary from the ones required by the client’s insurance company).

COWI has a broad experience in underwater inspection services, support rehabilitation and new structures design. COWI can undertake the required tasks from different approaches by indirect and direct observations.

At the moment, COWI is already in dialogue with some main offshore wind turbine producers, survey companies and autonomous unmanned vehicles producers in order to assess the most cost-effective way to undertake such tasks.
Indirect observations are based on hydroacoustic geophysical tools. Depending on the scope of work, the most suitable equipment will be selected to achieve the requested technical needs in a minimum time (i.e., existence of debris, status of cables - exposure, free spam, status of foundation - sediment scour, structural damage. These works can be developed from either a vessel or vessels (depending on the required scope) or by means of autonomous unmanned vehicles (AUV).

COWI will also select the best contractor to undertake the work on behalf of the client, making sure that all tasks will be carried out on time and within budget while deliverables comply with the agreed quality.

Additionally, COWI also provides client representation (resident engineer and/or geoscientist) services for all kinds of marine project, including assessing a contractor’s progress and conformance with contract specifications.

Our services include:
- Remote underwater investigation of marine structures using hydroacoustic instrumentation
- Direct underwater investigation of marine structures by engineer divers
- Structural evaluation of deterioration due to corrosion, chemical attack and marine borers
- Calculation of load capacity and remaining service life
- Rehabilitation design of steel, concrete and timber structures
- Waterfront construction quality control
- Client representation and consulting for any kind of marine project.
COWI A/S is a leading Northern European consulting group. We provide state-of-the-art services within the fields of engineering, environmental science and economics with due consideration to the environment and society. COWI is a leader within its fields because COWI’s 6,100 employees are leaders within theirs.

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