

OFFSHORE WIND FARMS

SELECTED PROJECT REFERENCES



COWI

SELECTED TURBINE FOUNDATION DESIGN PROJECTS

COUNTRY
Germany

PERIOD
2015-2016

CUSTOMER
DEME GeoSea NV

RECIPIENT
EnBW

MERKUR OWF - DETAILED DESIGN - MONOPILES

Offshore wind farm in the German part of the North Sea with up to 80 ALSTOM Haliade 150 turbines. COWI's services comprised detailed design of monopile foundations for offshore wind turbines, viz. design of primary steel design for monopole and transition piece, geotechnical design, hydrodynamic load calculation, scour protection, corrosion protection, low voltage design, and ship collision friendliness analysis.

COUNTRY
Germany

PERIOD
2015-2016

CUSTOMER
GeoSea NV

RECIPIENT
EnBW

HOHE SEE OWF - DETAILED DESIGN - MONOPILES

71 Siemens 7 MW turbines on monopile foundations. Water depth is 38.6-40.1 m. Detailed design of foundations: Geotechnical design. Calculation of wave loads for the integrated load analysis. Individual monopile design for all locations. Pile drivability assessment. Design of internal and external secondary structures, external and internal LV equipment, impressed current corrosion protection. Grouted connections. Ship collision analysis.

COUNTRY
Belgium

PERIOD
2015-2017

CUSTOMER
DEME/Geosea

RECIPIENT
Rental NV

RENTEL OWF - DETAILED DESIGN - MONOPILES

Rental NV is developing an offshore wind farm, approximately 32 km off Zeebrugge and 42 km from Ostend, located between Northwind OWF on the Lodewijkbank and Thornton OWF on Thornton Bank, with water depths between 22 and 32 m LAT and sand dunes of 5 m in height. The farm will have a capacity of 288 MW to 550 MW with turbines with a capacity of 4 MW to 10 MW. COWI carried out the detailed design of the monopile foundations.

COUNTRY
Taiwan

PERIOD
2014-2015

CUSTOMER/RECIPIENT
Swancor Enterprise Inc.

FORMOSA I OWF - DETAILED DESIGN - MONOPILES

Foundation design for Taiwan's first offshore wind farm, Formosa 1. Taiwan is aiming at 600 MW offshore wind capacity by 2020 and 3 GW by 2030, and this project is the beginning of the offshore wind industry in Taiwan. During 2014-2015, COWI developed the detailed design of the first two monopile structures, to be equipped with 4.0 MW turbines and a FEED (front end engineering design) study for tendering a design-build contract for another 34 locations.

HORNS REV 3 & KRIGERS FLAK AC OFFSHORE SUBSTATION

Horns Rev 3 and Krigers Flak, viz. 2x400 MW substations and 1x200 MW substation. Concept study of 400 MW and 200 MW topside structure, detailed design of 400 MW and 200 MW substation, detailed design of foundations and structures, design review, equipment layout and 3D design, project management, tendering. The design further considered transport and installation design, process design, supply systems and mechanical installation as well as piping, HVAC, accommodation, electrical installations, instrumentation and SCADA, fire and safety, communication.

COUNTRY
Denmark

PERIOD
2013-2014

CUSTOMER
Energinet.dk

RECIPIENT
Energinet.dk

KÅREHAMN OWF - DETAILED DESIGN - GBF

COWI carried out the detailed design of 16 wind turbine gravity foundations of up to 1.800 tons in 8 m to 21 m water depth in the Baltic Sea off Oeland. The foundations are founded at 8.2 to 20.5 m MSL depth. Jan de Nul is the foundation design-build contractor. COWI prepared the geotechnical and structural design of the primary foundation structures. Vestas supplied the sixteen 3 MW wind turbine generators type V112 to E.ON.

COUNTRY
Sweden

PERIOD
2012-2013

CUSTOMER
Jan De Nul NV

RECIPIENT
E.ON

WIKINGER - DETAILED DESIGN - JACKETS

Offshore wind farm with 70 jacket foundations for 5 MW turbines installed in the German sector of the Baltic in water depths of 36 to 42 m. COWI A/S in joint venture with IMS carries out the design of the foundations and transition pieces. Services rendered by COWI: Project management, geotechnical engineering, detailed design of foundations and transition pieces incl. secondary steel. Also ship collision analyses, HSE management, risk management, interface management, quality management, and options for fabrication and installation support services.

COUNTRY
Germany

PERIOD
2012-2017

CUSTOMER/RECIPIENT
Iberdrola Renovables Offshore
Deutschland GmbH

DANTYSK OWF - DETAILED DESIGN - MONOPILES

The DanTysk offshore wind farm is located in the German North Sea 75 km from the island of Sylt. 80 Siemens 3.6 MW turbines are installed on monopile foundations at depths ranging from 17 to 31 metres. It was one of the first full-scale commercial OWF's approved under the German BSH approval system. The monopiles have a diameter of 5.8 metres, and a grouted cylindrical connection to the transition pieces with shear keys. The monopiles are equipped with internal cabling, steel working platforms and scour protection.

COUNTRY
Germany

PERIOD
2012-2013

CUSTOMER
Aarsleff Bilfinger Berger JV

RECIPIENT
DanTysk

COUNTRY

Belgium

PERIOD

2010-2011

CUSTOMER

OWEC Tower

RECIPIENT

C Power

THORNTON BANK OWF - DETAILED DESIGN - JACKETS

The 2nd and 3rd phase of the Thornton Bank project are the industrial phases following the first, pilot phase. Phase 2 and 3 consisted of 48 5 MW Senvion turbines, 24 in each concession sub-area. The wind turbines are installed on jacket foundations. COWI's services comprised detailed design of the 48 jacket foundations for REpower 6 MW turbine. The services included structural design of foundation primary and secondary steel.

ALPHA VENTUS OWF - DETAILED DESIGN - JACKETS

Alpha Ventus was first German offshore wind farm. The construction phase was just 12 months, a pioneering feat in a location with a water depth of about 30 m and a distance from the coast of 60 km. Alpha Ventus operates two types of wind turbines with two foundation designs, jackets and tripods. The output of the wind farm is 60 MW. COWI's services involved detailed structural design of six jacket foundations. The jacket foundations are designed for the REpower 5 MW turbine and based on BSH regulations.

COUNTRY

Germany

PERIOD

2007-2009

CUSTOMER

OWEC Tower

RECIPIENT

DOTI

COUNTRY

United Kingdom

PERIOD

2010-2012

CUSTOMER

Aarsleff | Bilfinger Berger JV

RECIPIENT

London Array Limited

LONDON ARRAY OWF - DETAILED DESIGN - MONOPILES

With 175 monopile, designed to carry the Siemens 3.6 MW turbines, totally 630 MW, London Array is the largest operational offshore wind farm in the world. Monopiles of 4.7 m and 5.7 m in diameter were installed in water depths between 0 m and 25 m. With a total length of up to 85 m, these foundations range among the largest ever built. The contractor Aarsleff Bilfinger Berger Joint Venture (ABJV) engaged COWI as lead in a joint venture with IMS GmbH to carry out the detailed design of the steel foundations. COWI's services comprised detailed structural design of 175 monopiles with appurtenances, detailed geotechnical design for 175 locations and detailed hydraulic design.

THORNTON BANK OWF PHASE 1 - DETAILED DESIGN - GBF

Detailed design of six offshore gravitational foundations for 5 MW RePower wind turbines, set in 21 to 27 m of water depth some 30 km from the coast. COWI's detailed design of foundation structures and appurtenances comprised structural, geotechnical and hydrodynamic design as well as installation analysis, programming and analyses of mathematical and physical modelling of shear leg movements and sling forces during transport and installation.

COUNTRY

Belgium

PERIOD

2006-2007

CUSTOMER

Dredging International

COUNTRY

Denmark

PERIOD

2008-2011

CUSTOMER

Aarsleff - Bilfinger-Berger Joint Venture

RECIPIENT

EON Vind Sverige

RØDSAND II OWF - DETAILED DESIGN - GBF

An offshore wind turbine park with 90 wind turbines has been built with turbines placed on ballasted caissons in 5 to 12 m water depth. COWI's services comprised establishing a design basis on the basis of the owner's design basis, basic design of the foundation structure to the level defining concrete dimensions, detailed structural design of the 90 gravitational foundations, structural design - construction and installation forces (IBDAS model), geotechnical design determining bearing capacity, overturning capacity, sliding capacity and foundations, and soil reaction, hydraulic design including hydrodynamic loads and design, determination of ice forces, scour protection design and detailed design of appurtenances.

RØDSAND B GBF TRANSFORMER PLATFORM FOUNDATION

Detailed design of the transformer platform for a 215 MW extension of the Rødsand OWF south of the island of Lolland. The platform by a 1200 t concrete gravity-based foundation in 6 m water depth. COWI's services comprised design of the entire offshore platform - including all mechanical, electrical and structural components - and the foundation. Follow-up on equipment contractors and yard fabrication as well as offshore transport, installation and commissioning was included in COWI's scope of work at a later stage.

COUNTRY

Denmark

PERIOD

2007-2008

CUSTOMER

Energinet.dk

RECIPIENT

Energinet.dk

COUNTRY

United Kingdom

PERIOD

2008-2009

CUSTOMER

OWEC Towe

RECIPIENT

Vatenfall

ORMONDE OWF - DETAILED DESIGN - JACKETS

Ormonde is an offshore wind farm located in the Irish Sea, around 10 km from the coast at Barrow-in-Furness in the north-west of the UK. It is innovative in many respects:

- › First commercial deployment of one of the world's largest 'market-ready' wind turbines, the 5 MW REpower
 - › First commercial use of steel jacket foundations fabricated in Scotland
 - › Longest 'single-pull' electricity export cable installation in UK waters (42 km)
- COWI's services comprised detailed structural design of 30 jacket foundations.

NYSTED OWF - DETAILED DESIGN - GBF

Detailed design of gravity foundations for 72 wind turbines and one transformer (OSS) located 9-10 km from the coast in the southern part of Denmark. The total production capacity of the wind farm is about 480 GWh. The wind turbines are 68.5 m high and founded at 7.5 m - 12.75 m depth. COWI carried out the structural design, geotechnical design, design of scour protection and evaluation of limiting wave conditions for the operation of placing the foundations on the seabed. Hydraulic model testing was carried out in connection with scour design and evaluation of the motion of the laying barge exposed to waves. Project follow-up in the construction phase.

COUNTRY

Denmark

PERIOD

2000-2001

CUSTOMER

Per Aarsleff A/S

SELECTED TENDER DESIGN

OTHER SERVICES

BORSSELE III & IV - TENDER DESIGN

COUNTRY, PERIOD: Netherlands, 2016-2017

CUSTOMER: DEME

680 MW in total capacity. The scope of work includes: Design basis, primary steel design including load iteration with turbine supplier, secondary steel design, geotechnical design, scour protection design including analyses of sand waves, corrosion protection strategy, design of low voltage systems.

NORTHER OWF - FEED

COUNTRY, PERIOD: Belgium, 2015-2016

CUSTOMER: Dredging International & GeoSea

DEME bid for the design build contract for the Norther offshore wind farm, with 44-58, 6-8 MW turbines (150 m rotor diameter) on monopole foundations on 20-35 m water depth off the coast of the Vlanderen region in Belgium. A joint venture of Technum (lead), COWI A/S and TDA carried out a FEED for DEME. The contract was eventually awarded to DEME's competitor.

ST. NAZAIRE & COURSEULLES OWF - TENDER DESIGN

COUNTRY, PERIOD: France, 2015-2017

CUSTOMER: Eiffage Construction Métallique

Two offshore wind farms off the coast of France: Courseulles-sur-Mer comprises 75 Alstom Haliade 150 6 MW wind turbines on monopile foundations. Saint-Nazaire OWF comprises 80. COWI's services comprised tender design of monopile foundations for the two offshore wind farms.

FÉCAMP GBF - TENDER DESIGN

COUNTRY, PERIOD: France, 2015-2016

CUSTOMER: VCGP-SDI

GBF for 83 Alstom Haliade 6 MW turbines at water depths from 26 to 33 m. COWI supplied a review of geotechnical background data, establishment of own soil parameters, geotechnical and structural design, gravel bed and scour protection design, corrosion protection design of foundation and appurtenances, assessment of temporary phases and concept study of jacket alternative.

WIKINGER OSS - TENDER DESIGN

COUNTRY, PERIOD: Germany, 2012-2013

CUSTOMER: Iberdrola Ingeniería y Construcción

Conceptual structural and electrical design of offshore substation for the Wikinger Offshore Wind Farm, located in the German sector of the Baltic Sea. The capacity is in the 400-600 MW range. The conceptual design is carried out in joint venture with IMS, with COWI as the lead partner.

COWI's services comprised conceptual structural design of topside and electrical design comprised conceptual design layout, mechanical systems, main electrical equipment, communication systems, electrical low voltage systems, and conceptual design safety.

KENTISH FLATS PHASE 2 - TENDER DESIGN

COUNTRY, PERIOD: UK, 2012-13

CUSTOMER: Per Aarsleff A/S

Phase 2 is an extension of Kentish Flats OWF located in the outer Thames Estuary. It is planned to include 16 or 17 Vestas 3.0 MW V112 generators installed on monopiles. Water depths range between 3.8 m and 5.0 m LAT. Soil conditions are relatively uncomplicated and show a consistent trend below 8 m corresponding to London Clay. Mobile sand banks are present. Tender design of monopile foundation structures. The tender design included primary structural steel and secondary steel, such as boat landing structure, work platform and transition piece. Two alternative monopile concepts were considered; one with a bolted transition piece and one without a transition piece.

ARCADIS OST 1 - PRELIMINARY DESIGN

COUNTRY, PERIOD: Germany, 2012-2012

CUSTOMER: KNK Wind GmbH

60 Nordex 6 MW wind turbines at 40-46 m water depths. COWI, in JV with IMS, prepared the feasibility and preliminary design of two types of jacket foundations for both the wind turbines and the offshore substation (OSS) including OSS topside structure. COWI conducted the metocean study for the park area and a joint probability analysis of wind speed vs. wave height, wind speed vs. water level and wave height vs. water level.

KRIEGER'S FLAK OWF - GEOTECH STUDY

COUNTRY, PERIOD: Denmark, 2014-2014

CUSTOMER: Per Aarsleff A/S

Offshore Wind Farm located 15 km east of the Danish coast in the southern part of the Baltic Sea with a capacity of 600 MW. The number of turbines will be between 60 and 200. The site area of 250 km² encircles the bathymetric high called "Kriegers Flak" with water depth between 16 and 30 m. The options are driven monopiles, gravity base structures, jackets or suction buckets. COWI's services comprised preliminary review and assessment of available geotechnical data to determine suitability of ground conditions for gravity base foundations.

WIKINGER YARD HANDLING

COUNTRY, PERIOD: Denmark/Germany, 2015-2016

CUSTOMER: Bladt Industries A/S

The four-legged jacket foundations for Iberdrola's Wikinger offshore wind farm have been fabricated at Bladt's site at Lindø and are to be upended and loaded onto barges for transport to the site. The foundations are approximately 65 m tall and weigh 650 tons each. COWI supported Bladt Industries during fabrication of the jacket foundations, which were designed by COWI. COWI has verify the structural integrity of the jacket during the upending operation and the structural integrity of the existing support pipes.

SCOUR ENGINEERING SERVICES FOR OFFSHORE WIND PROJECTS

COUNTRY, PERIOD: Denmark, 2013-2015

CUSTOMER: DONG Energy Wind Power A/S

On a staff secondment basis, support of all offshore wind projects under development by DONG Energy Wind Power, as well as existing offshore wind farms owned by DONG Energy Wind Power. COWI's services comprised scour engineering services: Establishing design basis, design methodologies and detailed design of scour protection for WTG foundations, offshore substations and cables crossings. Establishing design basis and design methodologies for prediction of scour depths around unprotected offshore foundations depending on soil conditions.

ENERGINET, NEARSHORE WINDFARMS

COUNTRY, PERIOD: Denmark, 2013-2015

CUSTOMER: Energinet.dk

The Danish Ministry of Climate, Energy and Building has appointed Energinet.dk (ENDK) to conduct pre-investigations at six nearshore wind farm sites in Danish seas towards the tendering process of the operational licenses as well as to conduct environmental impact assessments for each of the proposed six sites: Vesterhav Nord, Vesterhav Syd, Bornholm, Sæby, Sejerø Bugt and Smålandsfarvandet. Energinet.dk has contracted COWI A/S as metocean consultant to carry out the meteorological and oceanographic studies for each location. Additionally, Energinet wished COWI to study and emit a second opinion on the wave conditions at a seventh location, Horns Rev 3, for a 400 MW farm 15 km of the west coast of Denmark.

STORGRUNDET OWF

COUNTRY, PERIOD: Sweden, 2012-2013

CUSTOMER: Storgrundet Offshore AB

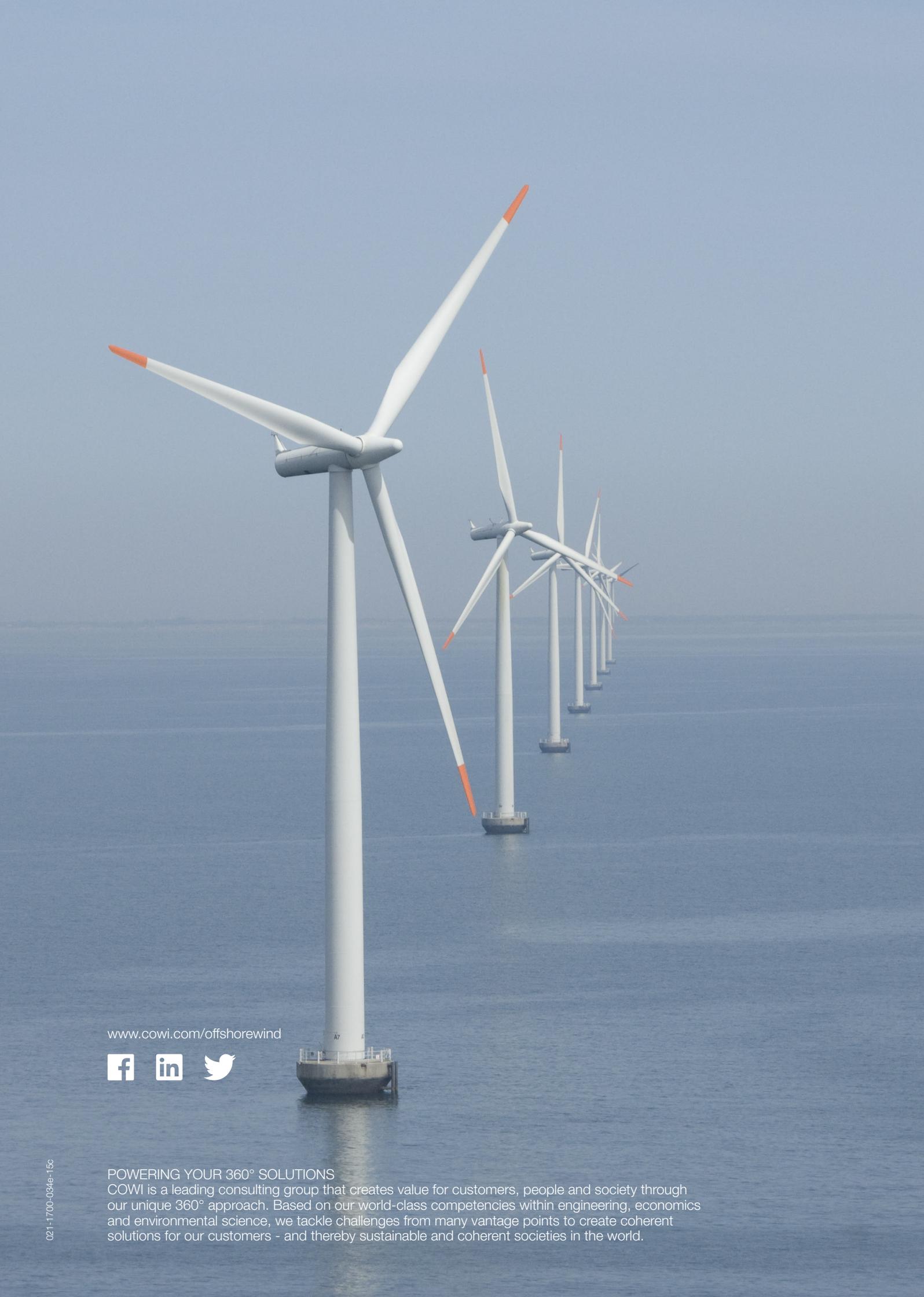
Offshore AB is developing an offshore wind farm east of the island Storjungfrun located southeast of the town Söderhamn in Sweden. COWI's services comprised preliminary design basis, specifying applicable standards, wave, wind and current climates, water levels, ice conditions, soil conditions, environmental conditions and ship impacts for the design of the foundations.

SUURHIEKKA OWF

COUNTRY, PERIOD: Finland, 2012-2013

CUSTOMER: Suurhiekkä Offshore Oy

The Suurhiekkä Offshore wind farm is located in the Bothnic Bay, Finland, in an ice prone region in 3-15 m water depth exposed to breaking waves. The wind farm comprises 80 3 MW offshore wind turbines and two substations totalling 240 MW installed power. COWI's services comprised preparation of metocean study and preliminary design basis. The metocean study included MIKE21 wave and current modelling with subsequent analysis of results. External description of wind conditions, ice conditions and geotechnical conditions were included in the preliminary design basis.



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POWERING YOUR 360° SOLUTIONS

COWI is a leading consulting group that creates value for customers, people and society through our unique 360° approach. Based on our world-class competencies within engineering, economics and environmental science, we tackle challenges from many vantage points to create coherent solutions for our customers - and thereby sustainable and coherent societies in the world.