THE COMPLETE CONSULTANCY SERVICE PACKAGE

COWI WIND

COWI

ABOUT COWI WIND

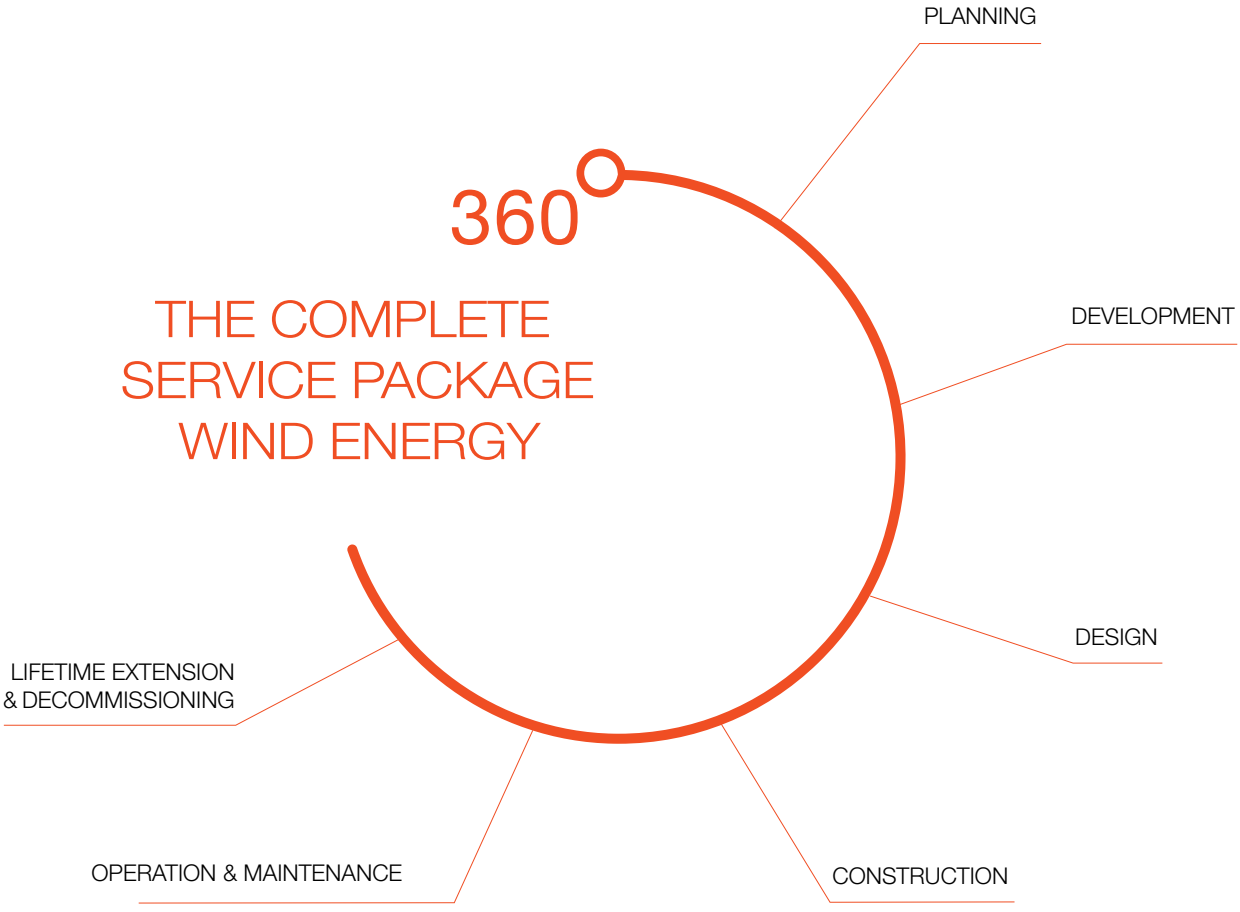
COWI is a leading multidisciplinary consultancy group that creates value for customers, people and society through our unique 360° approach. COWI has more than 80 years' experience in consultancy services and more than 6,200 employees worldwide.

COWI has significant experience within the wind energy sector, and we provide the complete consultancy service package from the identification of project sites to planning and design, contracting assistance, construction services, assistance during operation and maintenance, and decommissioning.

We have jointly worked on more than 800 wind power projects in 68 countries. Our experience in wind energy covers every aspect without exception. Our multi-disciplinary company can assist with everything, as well as issues not specifically mentioned in this brochure, such as establishing policy frameworks or expansion of production facilities.

COWI is a member of Measnet and accredited by DANAK, Danish Accreditation to carry out measurements on wind turbine. COWI is also certified by IECRE as a Danish Testing Laboratory within the IECRE Scope and Standard(s).

COWI provides services to a range of clients, including developers, turbine manufacturers, contractors, international financial institutions, development banks, investors and utility companies.



CONTENT

SITE PROSPECTING

COWI provides a wide range of site investigation services including identifying sites which have the lowest cost of energy. The site prospecting process consists of several phases, which are carried out for both onshore and offshore projects:

- Mesoscale modelling for creating large-scale wind atlases and thereby identifying optimal locations within large areas
- Ranking and selection of sites based on energy potential and overall development costs and constraints (landowner and land use, access conditions, grid connection, etc.)
- Wind measurement strategy for further development of the most promising sites.

The first step in the overall site identification within larger areas is mesoscale modelling. The output of the mesoscale model is maps representing the wind energy potential for a given area. The maps are then integrated in GIS software together with other relevant information such as grid connection possibilities, restricted areas, access roads, etc. Based on this information, COWI provides a ranking of the potential sites.

The final ranking of the sites is based on preliminary feasibility assessments, presenting the technical and economic evaluation of each potential site. This step is carried out in close cooperation with the client.

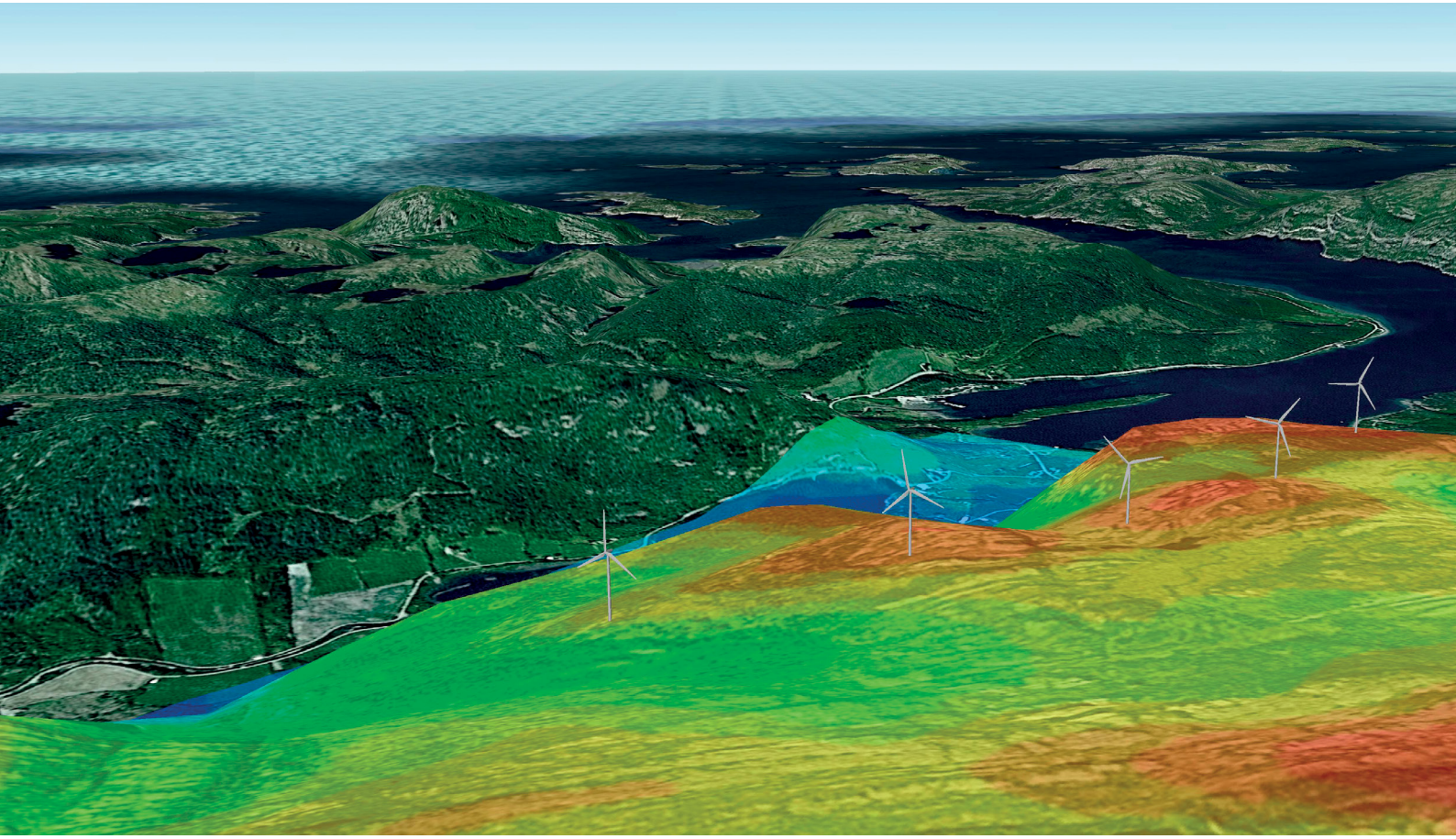
When the client has selected the site(s) for further development, COWI can prepare a wind measurement strategy to provide on-site wind data applicable for a wind study of bankable quality.

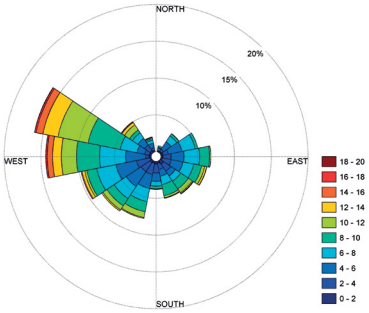
WIND RESOURCE MEASUREMENTS

High quality wind resource measurements are crucial when developing wind power projects. COWI is a co-founding member of MEASNET, and we have more than 35 years of experience in wind resource measurements. COWI can make recommendations on the optimum met mast instrumentation in various climates, as well as identifying the best location for the mast to optimize the site-specific wind resource measurement.

COWI can rent or procure any mast type with or without measuring equipment. From the cold climates of Norway, to the warm climates in the Kingdom of Saudi Arabia, the flat terrain in Latvia and the complex terrain in Bosnia, COWI has installed and monitored more than one hundred met masts worldwide. COWI manages met mast installation, operation, wind data analysis and mast dismantling. We deliver high quality measurements with comprehensive documentation/reporting according to MEASNET recommendations and DANAK accreditation.

In addition to traditional wind resource measurements from met masts, COWI also offers remote sensing measurements with Lidar.





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Measuring Network of Wind Energy Institutes
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WIND STUDIES

COWI has carried out several hundred wind studies of bankable quality worldwide for onshore as well as for offshore wind projects. COWI offers both first-hand assessment for financing and second opinions for due diligence.

COWI wind studies are accredited by DANAK according to MEASNET guidelines.

COWI has a team of dedicated experts working full time with screening and analyses of wind data, wind resource assessments, micro-siting of turbines and Annual Energy Production (AEP) calculations. The team is using state-of the-art software like the WAsP/WindPro linear flow models, and for more complex terrain the CFD flow modelling software WindSim and WAsP-CFD is used. For offshore projects, the FUGA wake loss model is used.

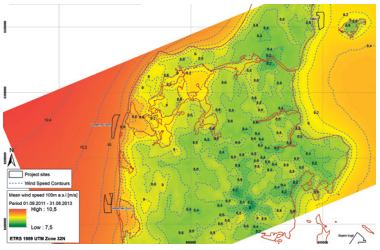
COWI also provides mesoscale wind data when on-site measurements or long-term reference data are not available. COWI has developed a method of using mesoscale data for the determination of the wind resource at offshore wind projects, which has been validated against measurements and has been certified by an independent third party. The mesoscale data is furthermore used for preparation of large-scale wind atlases and for general assessment of the wind resource potential and planning of on-site measurements.

SITE CONDITIONS & WTG SUITABILITY

In addition to the wind studies, COWI carries out site condition studies in accordance with the IEC 61400-1 Ed. 3 standard and DANAK accreditation. The important parameters such as extreme wind conditions and ambient and effective turbulence are analyzed in order to assess the wind class throughout the site. The design load driving parameters such as inflow angles and wind shear are also analyzed and assessed. Once the parameters have been identified the optimum wind turbine class can be selected; in particular the optimum rotor/generator ratio in order to extract as much yield as possible from a given site.

Other site condition parameters such as risk of lightning, probability of earthquake and estimation of seismic ground acceleration are also assessed.

In harsh climatic conditions, either in cold or hot climates, the suitability of wind turbines for the specific conditions is extremely important. In cold climates the effect of ice formation on wind turbines and the consequence on energy production is assessed as well as different heating systems to select the optimum wind turbine. In hot climates, for instance in deserts, both heat and sand are taken into account when selecting the optimum wind turbine.



OFFSHORE WIND RESOURCE ASSESSMENT

For the assessment of offshore wind resources, COWI uses an approach that differs from onshore assessments. The main reason for this is the difficulty and costs related to carrying out on-site wind measurements. Traditionally, the wind resource has been measured with offshore met masts, but as projects are moving into deeper waters and further offshore, alternatives to offshore met masts such as floating Lidars have been deployed and tested in recent years.

As a least cost alternative, COWI has developed a mesoscale-based approach to establish wind data at offshore wind farm sites. The mesoscale model is validated against existing met mast measurements, located both on and offshore which can be found within the mesoscale domain area. The COWI approach makes it possible to assess the bias and the uncertainty of the mesoscale wind data. An independent third party, DEWI, has verified the approach and the obtained results.

For Danish nearshore and offshore project sites, the method has resulted in no bias between the met mast measurements and mesoscale wind data. Furthermore, the obtained uncertainties are acceptable and thus, the mesoscale wind data can be used for wind resource assessments of bankable quality.

COWI also assists with traditional offshore measurements using met masts or Lidar.

METOCEAN

COWI has substantial experience with carrying out met-ocean studies for offshore wind farms and obtaining upfront certification of met-ocean design parameters (e.g. wind, water levels, waves, currents, and sea ice) from accredited certifying agencies.

Using our in-house numerical modelling capabilities, we conduct state-of-the-art numerical modelling studies of waves and hydrodynamics (water levels and currents) to establish long-term time series of met-ocean conditions at various locations within the offshore wind farm site. Subsequently, advanced statistical analyses are conducted to establish the relevant extreme conditions for design.

The met-ocean studies are generally conducted and reported in accordance with the international standard IEC 61400-3.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WIND SUPPORTER
SEISER

FEASIBILITY STUDIES

Selection of an appropriate site and a suitable turbine are key issues for the economy of a wind power project. However, many other issues also influence the development of a project significantly. These issues include for instance environmental impacts, transportation challenges, and regulatory framework.

COWI has significant experience with project specific assessments, and undertakes feasibility studies for a wide range of clients including developers, utilities, and international financing institutions. The feasibility studies generally cover the following, but they can of course be tailor-made to meet the client's specific requirements and needs:

- Wind resource assessment and calculation of the estimated annual energy production (AEP)
- Site conditions and wind turbine suitability
- Assessment of the geotechnical conditions
- Grid impact assessment
- Environmental impact assessment
- Transportation assessment
- Regulatory framework and permits/licenses
- Estimation of CAPEX and OPEX
- Financial analysis
- Assessment of the project organization.

LIFETIME EXTENSION (LTE) AND DECOMMISSIONING

Turbine owners and investors have become aware of Lifetime extension as a way to boost the value of their investment. A significant number of MW turbines installed in Europe is now reaching the design life and a decision on lifetime extension or decommissioning has to be taken.

COWI is able to support wind park and wind turbines owners in all aspects of LTE. LTE on a specific wind turbine is challenged by the standard design lifetime of 20 years dictated by certification requirements. Based on turbine logs, inspections, measurements and detailed information about actual site conditions COWI can verify the actual damage accumulation for a specific turbine. Based on this information the impact from LTE can be evaluated and a financial model including additional service cost can be developed.

The LTE study is a core element in a wind farm decommissioning strategy. COWI can support or manage the decommission strategy on a specific wind farm which will ensure optimum return of investment.

The LTE service requires utilization of many of the COWI key competences comprising advanced load calculations, load and wind measurements, data analysis, inspections and experience from more than 800 wind power projects in 68 countries.

DUE DILIGENCE

In relation to due diligence of wind power projects, COWI assists with transaction management to minimize the risks through identification and assessment of technical, environmental and financial issues. Our vast pool of experts within every relevant discipline ensures that we have the necessary experience and knowledge to assess and evaluate any kind of challenge.

The core of our services in a due diligence context is to assess different types of uncertainty related to the average annual energy production (AEP), and how these uncertainties affect the financial situation of a given project.

We also assess the suitability of the chosen turbine for the specific site, and we undertake technical assessments of the turbine supply agreement including the provided guarantees.

Finally, we assess the related service and maintenance agreement including the OPEX estimate.

Over the years we have performed due diligences for numerous banks, financial institutions, development agencies, multilateral development banks and investors counting among others Pension Danmark, BNP Paribas, Nordea, and Arctas Capital Group, Danida, IFC, ADB and EIB.

OWNERS / LENDERS ENGINEER

COWI provides owner's engineering services to wind farm developers and owners, and lender's engineering services to investors and financing institutions.

As owner's engineer we prepare tender documents including micro-siting of wind turbines, road and foundation design and design of substation, electrical network and overhead lines. Furthermore, we have specialists within commercial conditions, and provide advice on contract format, structuring of guarantees etc. During the construction phase we commence with a review of the supplier's design where our experts' decades of experience as well as our multi-disciplinary line of work ensure that all types of design can be handled. We have extensive experience in dealing with contractors, and through our work we always ensure the optimal solution for the project and thereby the project owner(s). Special attention is given to the procedure at the time of Taking Over of the project but equally if not more important at the End of the Defects Liability Period.

COWI has a vast record of acting as a lender's engineer, with numerous clients counting development agencies, institutional investors and financial institutions. As lender's engineer we emphasise and pay special attention to our role as it is quite different from the role of an owner's engineer. We make use of all of our competencies to ensure the interests of the investor/lender and keep focus on the viability of the investment.

ENVIRONMENT AND PERMITTING

COWI's environmental services cover the entire process from site finding through to construction supervision. COWI's expertise includes experience from numerous wind farm projects both onshore and offshore.

COWI's long term experience with project management in the EIA process covers every aspect including shadow flicker, noise, visual impact, ecology, ornithology, marine biology and habitats.

The visual impact of wind farms is assessed through the use of a landscape assessment, using GIS and high-resolution remote sensing.

In terms of mitigating measures, our broad in-house competencies allow us to find suitable and cost-effective solutions, which are in line with the requirements given by engineers, socio-economists and environmentalists and also accepted by neighbours and other stakeholders.

For the construction phase COWI offers management of permits, licenses and consents. All mitigating measures, necessary permissions and site supervisions are handled in full accordance with regulation and policies.

HEALTH AND SAFETY

For COWI, health and safety plays a key role in all of our projects. COWI's health and safety specialists are internationally recognized for their comprehensive and thorough work and for the practical results they achieve. Continuous client involvement and efficient communication ensure that the results are ready for implementation.

Our general health and safety policy is based on the idea of integration of health and safety management within the client's overall management system. Early implementation of health and safety procedures are crucial especially in relation to general staff awareness.

CIVIL WORKS

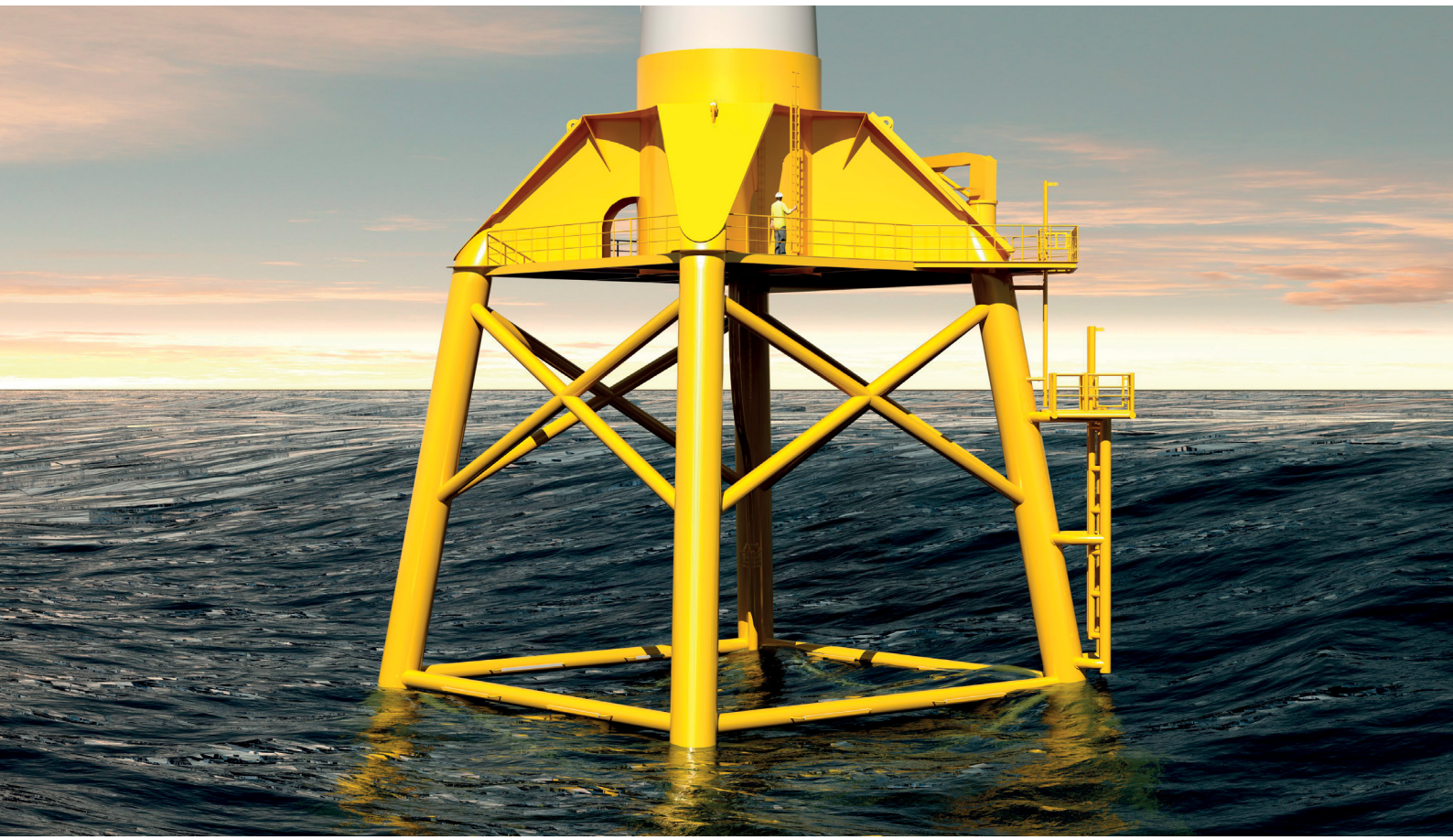
COWI provides the full balance of plant package for civil works including foundations, crane pads, lay-down areas and roads (electrical services are described in a later section in the brochure).

We have designed foundations for more than 12,000 onshore wind turbines over the past 35 years, and we provide fully certified designs including all required and verified documentation. Optimizing the design of foundations is all about being fully acquainted with the wind climate, soil conditions, turbine loads and structural design potential. The challenge is to provide the client with the optimum design with regard to both feasibility, cost and robustness.

Geotechnical investigations are one of the key parameters when optimizing foundations, roads etc. COWI provides full geotechnical investigations including planning, implementation and interpretation of results. We also offer second opinions on geotechnical investigations already carried out.

Gravity based, piled, rock-anchored and rock-adaptor foundations – we have designed all variants, and we take a pride in balancing size and strength to ensure a cost-effective design with the required design life.

COWI is also involved in the development of concrete, steel and hybrid towers for wind turbines with hub heights up to 130 meters in Europe, USA and Asia. We have designed in-situ cast concrete towers with sliding form, post-tensioned elements, and concrete-steel hybrid towers.



OFFSHORE FOUNDATIONS

COWI undertakes structural design for offshore wind foundation projects through all phases of a project. We develop the foundation designs from the initial conceptual stages, where the optimal foundation type is determined, through to the detailed design phase to the supervision and monitoring of the installed and completed structures.

Detailed designs of monopile, jacket, and gravity based foundations have been undertaken for a series of contractors and utility companies.

For London Array Offshore Wind Farm, COWI designed 175 monopile foundations in 0-25 meter water depths and different soil conditions. Piles in diameter of 4.7 or 5.7 meter and foundations in lengths of up to 85 meter were designed for the 3.6MW Siemens turbines.

COWI has designed jacket foundation structures carrying Areva 5MW turbines in 40 meter water depths to withstand the ice forces of the Baltic Sea. As part of the project, the development of a new optimized transition piece with strong emphasis on ease of construction was carried out for Wikinger Offshore Wind Farm.

COWI is a world leader in design of concrete gravity offshore wind turbine foundations with experience in offshore wind farms including Kaarehamn in Sweden, Nysted and Rødsand 2 in Denmark as well as Thornton Bank in Belgium.

GRID STUDIES

Grid studies are offered by COWI to identify technical issues at early stages of the wind farm development. Such issues can be extremely costly later in the project if not recognized and dealt with in due time.

Studies are prepared in transmission system and other major parts of electrical infrastructure, including other power plants. The studies reveal if the wind farm output can be exported through the network without restrictions. Typical studies cover load flow and fault level analysis, contingencies, transient and dynamic analysis.

Major electrical and grid connection components for wind farms are identified and sized in studies forming a basis for budget estimates, technical specifications and procurement.

Grid code compliance for a wind farm is verified for owners and investors. PQ and UQ capability diagrams, dynamic and transient stability, fault ride through capability, voltage and frequency regulation and harmonic analysis are studied.

Additional studies and services are offered such as insulation coordination studies, development and validation of simulation models for wind farms, and grid code compliance by on-site test and measurements.

Simulation software such as DigSILENT PowerFactory, NEPLAN and EMTP can be applied.

ELECTRICAL SERVICES

COWI provides a wide range of electrical services for both onshore and offshore wind farm projects, and has cooperated closely with many manufacturers, developers and operators worldwide. Our electrical experts have extensive knowledge and experience in the electrical disciplines related to on and offshore wind farms.

COWI's electrical experts are up to date with the latest developments in technology and technical requirements to the electrical components and market demands, and have focus on bringing down the cost of energy by optimizing design, installation and operation, and by implementing new solutions. COWI's electrical engineers are experienced in working in small project groups, as well as in large and complex project organizations either as project managers or as specialists.

COWI provides all electrical services:

- Basic, conceptual and detailed design
- Array cable systems
- Export cable systems
- Electrical substation design
- Onshore cable connection
- Onshore substation
- Power system integration
- Preparation of tender documents and tender review
- Procurement assistance.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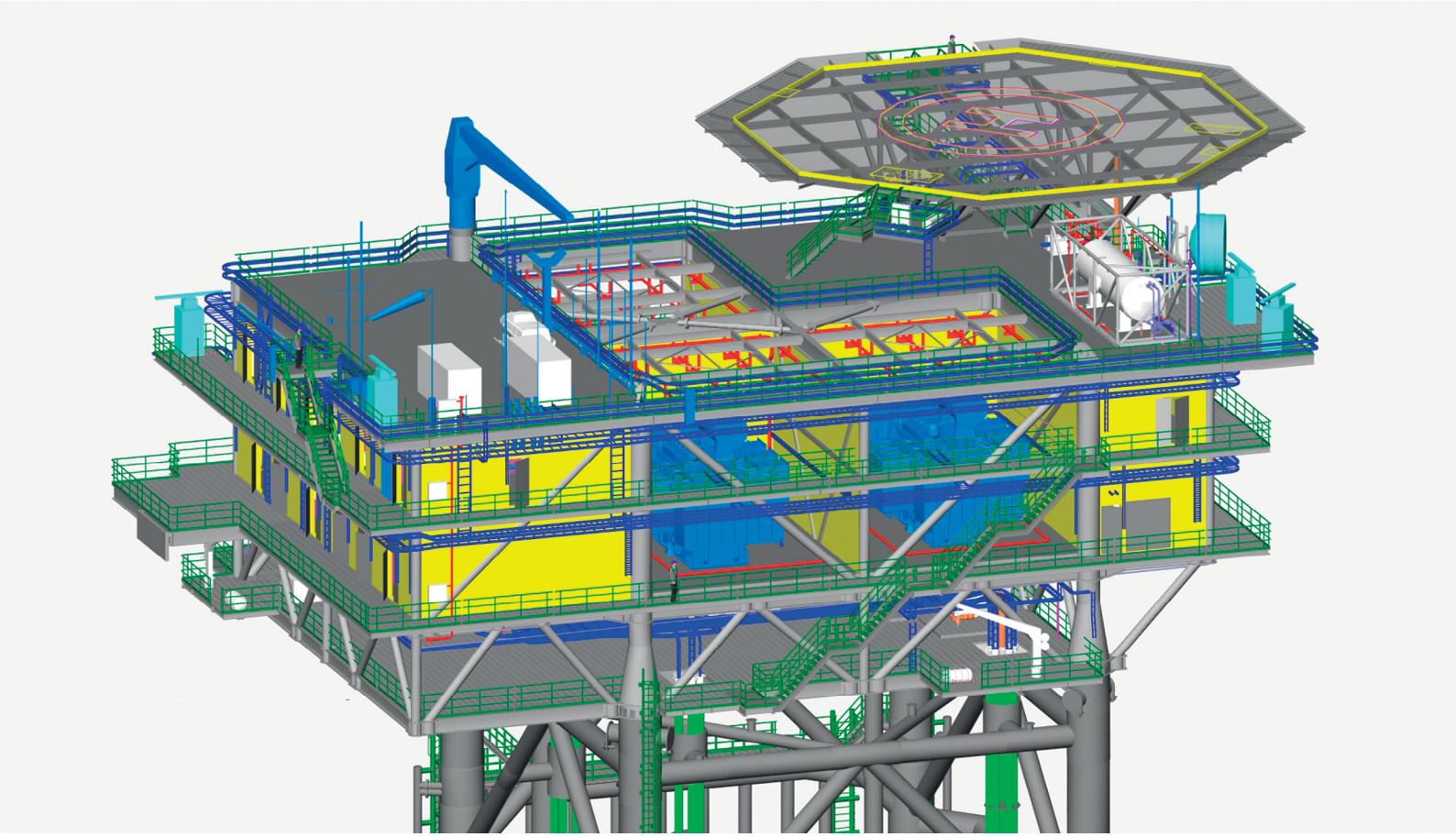


OFFSHORE SUBSTATIONS

COWI carries out both conceptual and detailed design of entire offshore substations. We have in-house expertise in designing all components, both electrical and structural. COWI has designed both jacket and gravity foundations. In relation to platforms, COWI has extensive experience in designing the topside and secondary steel structures including boat landings and helicopter landing deck. The electrical design includes transformers, switchgears, auxiliary transformers, earthing resistors, and SCADA system.

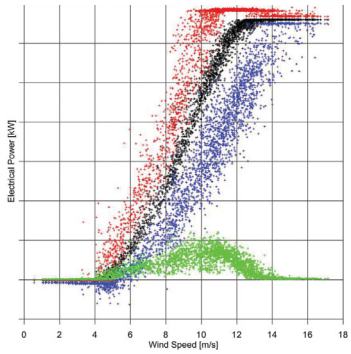
In addition to this, firefighting systems, HVAC systems and sewage systems are included in the design. COWI has the necessary capabilities and experience in-house to prepare either a full detailed design of the entire substation or specific components if that is requested by the client.

COWI also assists clients with technical tender documents, supervision and inspections.

3D-MODEL OF TRANSFORMER PLATFORM

The above illustration is a stand still image from the Autodesk Software (AutoCAD Plant and Navisworks), which enables designers and the Client to "walk around" at the offshore platform and inspect all details and locations.

The model is designed and developed in close cooperation with a corresponding structural model. Combining the two models enables simultaneous creation of the detailed design for the structure, as well as the mechanical and electrical design.



POWER CURVE VERIFICATION

COWI acts as a neutral and independent third party, providing power curve verifications to wind turbine suppliers or project owners to verify contractual warranted power curves.

The warranted power curve is the starting point for selecting a specific turbine and is a central parameter in determining the economy of the project. An accredited measurement of the power curve after installation of the project proves whether or not the turbine conforms to the warranty issued by the manufacturer.

We are accredited by DANAK according to the requirements stipulated in DS/EN ISO/IEC 17025 to carry out power curve measurements on wind turbines and site calibration in accordance with the IEC 61400-12-1 and MEASNET procedures. COWI is certified by IECRE as a Danish Testing Laboratory within the IECRE Scope and Standard(s).

We own a range of masts and have an in-house laboratory for the calibration of measurement instruments. COWI provides the full package, including rent or procurement of masts and equipment, installation, data analysis, reporting, mast maintenance, and dismantling. Furthermore, COWI offers power curve measurements based on nacelle Lidar, nacelle anemometer and ground based Lidar.

MEASUREMENTS ON TURBINES

COWI has more than 35 years' experience in conducting measurements and calculations for design and approval of wind turbines.

The measurements provided by COWI cover the requirements for a type test needed for the approval of wind turbines including power curve, structural loads, functional and safety tests and noise. All tests are accredited by DANAK according to IEC standards. COWI is also certified by IECRE as a Danish Testing Laboratory within the IECRE Scope and Standard(s).

The calculations provided by COWI include full set of design loads using recognized aeroelastic software according to IEC standards and design calculations of all turbine sub-elements, e.g. blades, steel parts and concrete towers using detailed FE analyses.

We provide services to manufacturers in assessing their wind turbine design and sub-elements with respect to strength, lifetime and dynamic behaviour etc. COWI's in-house expertise in both load measurements and load calculations makes us specialists in comparing and verifying calculated and measured loads in connection with certification and/or calibration of load modelling software.

Furthermore, COWI has thorough experience with certification institutions and provides all necessary design documentation for the type approval of wind turbines.

COWI OFFERS THE FOLLOWING ACCREDITED MEASUREMENTS:

- Power curve
- Site calibration
- Nacelle lidar calibration
- Structural loads
- Noise
- Determination of mechanical properties:
  - Measurement of yaw efficiency
  - Determination of natural frequencies
  - Turbine operational conditions
  - Wave loads
- Functional and safety test.

COWI OFFERS THE FOLLOWING CALCULATION SERVICES:

- Aeroelastic load simulations according to IEC
- Strength calculation of turbine components, including FEM calculations
- Design calculations of foundations.

COWI is a member of Measnet and accredited by DANAK, Danish Accreditation to carry out the measurements. COWI is also certified by IECRE as a Danish Testing Laboratory within the IECRE Scope and Standard(s).

DANAK has evaluated and confirmed that COWI is impartial, in possession of the required technical know-how and operates under a quality control system in accordance with the DS/EN ISO/IEC 17025:2005 criteria.

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IECRE

MORE THAN 800 WIND POWER PROJECTS IN 68 COUNTRIES

African Continent:	Egypt, Eritrea, Kenya, Malawi, Morocco, Somalia, South Africa, Swaziland, Uganda.
Asia:	Malaysia, China, India, Japan, Pakistan, South Korea, Philippines, Sri Lanka, Thailand.
Middle East:	Oman, Jordan, Saudi Arabia.
Australasia:	Australia.
Central and South America:	Bolivia, Brazil, Colombia, Costa Rica, Dominican Republic, El Salvador, Grenada, Guatemala, Jamaica, Nicaragua, Peru, Uruguay.
Europe:	Belgium, Bosnia, Bulgaria, Croatia, Denmark, England, Estonia, Faroe Islands, Finland, France, Georgia, Germany, Greece, Ireland, Italy, Latvia, Kosovo, Lithuania, Macedonia, Netherlands, Norway, Poland, Portugal, Romania, Russia, Scotland, Serbia, Spain, Sweden, Turkey, Wales.
North America:	Canada, Mexico, USA.

ADDRESS COWI A/S
Parallelvej 2
2800 Kongens Lyngby
Denmark
PHONE +45 56 40 00 00
FAX +56 56 40 99 99
EMAIL cowi@cowi.com
WWW cowi.com

CONTACT PERSON:
NAME Jan Behrendt Ibsø
POSITION Vice President
DEPARTMENT Wind Energy and Renewables
PHONE +45 56 40 32 60
EMAIL jbis@cowi.dk

COWI