



OFFSHORE WIND CAPABILITY

Up to 90GW of offshore wind capacity could be installed by 2024, nearly tripling current global capacity. Now more than ever, offshore wind projects require specialist expertise and global insight to succeed.

PSC supports the global offshore wind market with independent services in specialized technical advisory, engineering and project management consulting. Using PSC's expert technical and owner's engineer services in the power sector, our clients build projects to their requirements, save on costs, optimize availability and mitigate risk. With our international resources, extensive technical knowledge and experience in offshore wind, power system studies, power networks engineering, and HVDC technology, PSC is well equipped to support any offshore wind project.

KEY CAPABILITIES

Lender's and/or Owner's Engineer and Technical Advisor

- ▶ Technical due diligence
- ▶ Techno-economic feasibility studies
- ▶ Power system and grid connection studies
- ▶ Concept design and FEED
- ▶ Technical specifications and tender management
- ▶ Specialist technical and regulatory advice
- ▶ Grid connection applications
- ▶ Factory acceptance testing
- ▶ Asset Management, O&M plan reviews

Substation Primary Layout and Engineering

- ▶ Single line diagrams
- ▶ Switchgear and transformer specification
- ▶ Onshore and offshore substation layout and optimization
- ▶ Protection & Control philosophy, concept and engineering
- ▶ Protection relay settings and co-ordination (Grading) Studies

Offshore Wind Farm Optimization

- ▶ Optimization assessment of the HV electrical components
- ▶ Inter-array cable layout design
- ▶ Cable design and losses optimization
- ▶ Offshore substation platform conceptual design of HV/ MV Equipment
- ▶ Export cable arrangement and voltage level selection
- ▶ Onshore substation detail design

Power System Analysis

- ▶ Grid code compliance studies
- ▶ Steady state load flow, reactive compensation and fault studies
- ▶ Harmonic assessment, switching and transient studies (PSCAD, EMTP)
- ▶ Insulation co-ordination studies
- ▶ Arc flash studies
- ▶ Earthing and lightning protection studies



HELPING YOU POWER
THE WORLD



PSC RELEVANT PROJECTS

A selection of projects which demonstrate our offshore and wind generation experience is shown below:

TDD and LTA Services for OFTO Assets, UK*

Technical due diligence for UK offshore transmission assets under Ofgem's tender rounds TR4, TR5 and TR6 (on-going). Our services included full technical due diligence at ITT Phase and PB Phase, providing confirmatory due diligence and advice to the Client and Lenders through to Financial Close. After Financial Close, we continued as the Lender's Technical Advisor providing regular reports to the Lenders on the OFTO's technical and operational performance including an assessment of factors such as availability, incidents that affect availability, and O&M strategy and exceptional costs, including seabed inspection and burial regimes. TDD has been undertaken for Westermost Rough, Dudgeon, Burbo Bank, Rampion, Galloper, Race Bank, Walney Extension, Beatrice and Hornsea.

DolWin1 and DolWin2 HVDC Offshore Wind Farms, Germany

PSC personnel were contracted to assist with the installation and commissioning of two ABB offshore HVDC links. The 800MW and 916MW Voltage Source Converters connect new offshore windfarms in the German Bight. PSC provided five staff responsible for onsite construction management, overall HVDC commissioning management and engineering support. PSC also provided design and project management of the telecommunications aspects of Dolwin 1. Staff have been based in Dubai, Germany and Sweden as they have followed this project through manufacturing, installation and commissioning.

DolWin5, Germany

ABB has contracted PSC personnel as Lead Engineer for the HVDC scope of this sizeable offshore HVDC link which will deliver 900 megawatts of zero-carbon electricity – enough to power around 1 million homes - from three wind farms some 100 km off the German coast. PSC's contribution includes guiding the engineering activities for the main circuit, auxiliary systems, control and protection, valve cooling, mechanical and civil engineering, as well as the interface to the offshore platform, DC cable, and the offshore AC grid and wind turbines. It is scheduled for completion in 2024.

Concept design of the HV/MV equipment and grid connection for Binhai H2 400MW OFWF, China*

This work included the optimization of inter-array and export cables and the specification and design assurance of HV and MV equipment. The power system studies included load flow, fault level, energization and reactive compensation analysis for grid code compliance. Following a fire on the OSP resulting from the failure of electrical cables, further services were provided to assess the root cause of the failure.

Inch Cape OFWF FEED, Scotland*

PSC was engaged to deliver front-end engineering (FEED) design services for Inch Cape offshore windfarm. The FEED included the OSP HV/MV equipment layout and specification, array cables and onshore grid connection. The wind farm optimization included the array layout and voltage level, platform location optimization, offshore substation single line diagram, export cable optimization and grid connection.

System Studies for Kilgallioch 240MW Onshore Wind farm, UK*

This work included optimization of the grid connection, and grid connection assessments comprising load flow, fault level and reactive compensation analysis for grid code compliance. PSC performed a dynamic and transient stability analysis to assess the wind farms ability to remain connected (Fault Ride Through) during fault conditions. Our services provided confirmation of technical compliance with the connection of renewable generation (CC.6.3.8 and CC.6.3.15) of the UK Grid Code.

Western Isles, Scottish & Southern Electricity, UK

PSC was engaged to write an Information to Tender (ITT) for SSE as well as provide specialist advice regarding the specification of a proposed 600MW VSC offshore HVDC link. This ITT has since been used to go out for tender.

Borwin 1 HVDC Light® Project, Germany

Borwin 1 is a 400MW HVDC Light® project to transfer power from the Borkum 2 Offshore Windfarm to the German Power Network. This included an HVDC Light® platform located offshore with the windfarm. PSC provided the Factory Test Manager and Control System Coordinator for this project and other PSC technical specialists provided factory testing and commissioning services. The scope of work included many diverse auxiliary systems unique to offshore platforms, such as a seawater cooling system, navigational aids, radios, telecommunications and data networks including satellite backup communications and complex backup generator changeover systems. PSC also provided staff to assist with the design and implementation of the telecommunications infrastructure.

Harmonic Assessment Study, Offshore Wind Project, US

PSC personnel were contracted to provide harmonic distortion assessment studies. This work involves establishing a utility-side system model and then checking harmonic compliance at multiple onshore points against the US-standard IEEE 519-2014 protocol. PSC is also developing mitigation measures for the identified non-compliance issues.

Massachusetts Clean Energy Centre Offshore Wind Transmission Study, US

PSC participated in a joint study to review both AC and HVDC transmission options to connect offshore wind farms in the Massachusetts and Rhode Island lease areas to 345kV points of interconnection within ISO-NE. Various build-out scenarios were considered to achieve 500MW to 3,000MW of offshore wind development into strategic 345kV points of interconnection. The evaluation included high-level physical sites and cable routes, main circuit configurations, capital cost estimates, and selection of 345kV points of interconnection.

New York area Offshore Wind Transmission Options, US

PSC partnered with an environmental firm to study options to transmit offshore wind in the New York lease areas to strategic points of interconnection on Long Island and New York City. The study reviewed submarine and underground cable route options, physical space, and available main circuit capacity at points of interconnection, provided load flow screening analysis, and capital cost estimates.

*Experience gained at Ramboll Energy UK Power Systems prior to acquisition of the group by PSC.