SIEMENS

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The Sustainable Way

Grid access solutions from Siemens

Answers for energy.

How do we get power to where it is needed?

The world of energy is changing rapidly. New demands on networks pose new challenges, for which Siemens provides the answers.

More distributed generation, remote renewable energy sources, and shifting patterns of energy usage mean networks must perform like never before. Existing AC networks need to be stabilized and improved and long-distance transmission requires low-loss HVDC transmission. Siemens supplies a comprehensive range of reliable, efficient, and proven grid access solutions that help cope with such challenges.

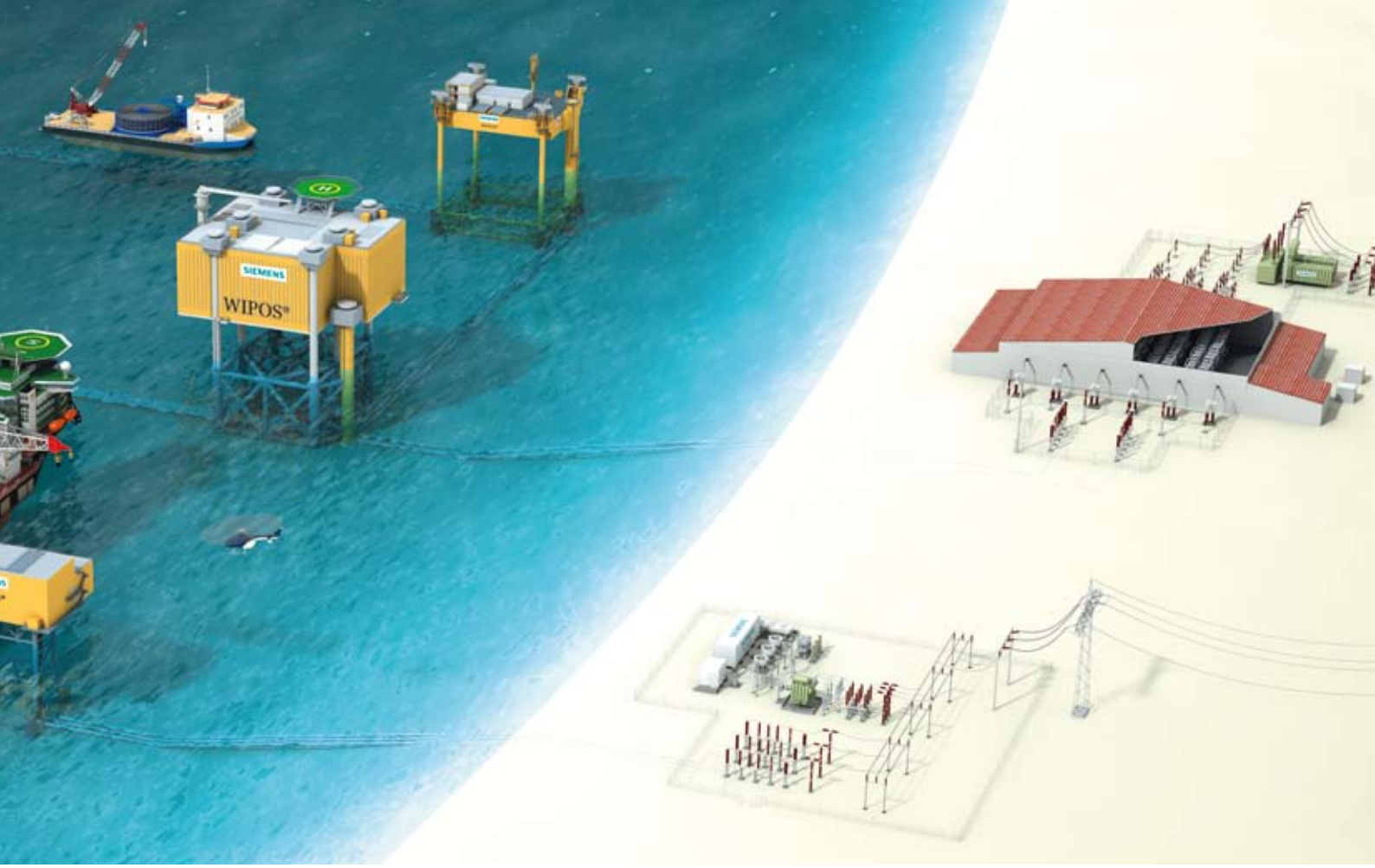
In the emerging world of offshore connections Siemens has taken the early lead. Siemens offers comprehensive turnkey grid access solutions, ranging from first feasibility and power system studies to the engineering, procurement, construction, and commissioning of entire grid connections. Siemens' service departments provide operations and maintenance options, from the wind turbine to the grid. Complemented by wind turbines and financing solutions, Siemens is the only company offering the entire electrical infrastructure required for a fully operational offshore wind farm in order to make sure that the power gets safely to where it is needed.

During the next decades, electric power consumption is expected to increase further in emerging regions in particular, but in the industrialized world as well. One of the main challenges of the 21st century will be to meet this unprecedented energy demand in a cost-effective and sustainable way. Renewable energy will play a highly important role in meeting this challenge.

The contribution of renewable energy within the energy mix is already significant, and worldwide renewable power capacity is expected to dramatically increase, changing the global energy mix. However, most renewable energy resources are usually exploited either by relatively small, distributed power generation units or, on a larger scale, in remote areas often hundreds or even thousands of kilometers away from the centers of consumption.

Effective solutions are vital to connect all the distributed generation to the grid in order to make power available where it is really needed.

Siemens supplies leading HVDC (high- voltage direct current) and FACTS (flexible AC transmission systems) as well as HVAC (high-voltage alternating current) technology plus a comprehensive range of related services based on



long-standing experience in the field of power transmission and distribution. All over the world, Siemens' technology and expertise is much sought after whenever it comes to safe, reliable, and efficient connection of energy resources to the grid. Discover the Siemens grid access solutions and see for yourself how to make the most of renewable energy generation.

Technology

- HVDC PLUS
- HVAC
- SVC PLUS®
- FACTS
- GIL

Services

- Studies
- Engineering
- Installation
- Commissioning
- Operation
- Maintenance
- Training
- Life cycle asset management

Solutions

- Wind farms
- Grid connections
- Onshore and offshore substations and cables
- Financing solutions

Siemens experts provide invaluable practical experience throughout the complete project life cycle.

SVC PLUS from Siemens stabilizes power grids, helps increase the capacity of existing AC networks, and ensures grid code compliance.

Drawing upon unique expertise

Experience

As the world's only integrated energy technology company and spanning the entire energy conversion chain, Siemens provides an unparalleled degree of expertise and practical experience. Over 160 years ago, the three Siemens brothers played a decisive role across Europe in the development of power technology, paving the way for the modern power industry. Siemens has remained at the cutting edge of power generation, transmission, and distribution ever since.

In the 1880s, Siemens generators were powering Berlin. By the 1940s Siemens demonstrated HVDC transmission systems with six mercury-arc rectifiers for +/- 200 kV, 60 MW. In 1964 Siemens introduced the first SF6 circuit breaker – the basis of modern gas-insulated switchgear technology.

The world's first long-distance HVDC transmission system equipped with thyristors was commisioned by the German HVDC working group Siemens, AEG, and BBC in 1977 between Mozambique and South Africa for the Cahora Bassa hydroelectric power station, and in 1992 Siemens put the world's first thyristor controlled three-phase series compensation (TCSC) into operation in Arizona, USA.

Now, in the 21st century, Siemens still is a technology leader, connecting more megawatts of offshore wind than anyone else. Siemens offers market-leading technology such as HVDC PLUS coupled with smart service solutions to deliver the highest availability.

The unique experience, long-standing tradition of innovation, and a global presence in over 190 countries make Siemens the partner of choice when it comes to meeting today's economic and technical challenges in the implementation of grid access solutions. Comprehensive grid design and performance studies, as well as financing support, round out Siemens' scope of products, solutions, and services to ensure maximum return on investment and optimal life cycle costs.

A model of Siemens' wind power offshore substation (WIPOS): Siemens supplies comprehensive offshore grid connection solutions with flexible substation configurations for both AC and DC applications.

Excellent approaches to new challenges

WIPOS®
Siemens' wind power offshore substation (WIPOS) is the optimal solution that ensures long life for offshore substations. With WIPOS, Siemens has created a benchmark for the design, engineering, and installation of offshore platforms for wind farms.

WIPOS serves as an interface between wind turbines and the mainland, whereby power harvested from wind is collected on a WIPOS and then transmitted through high-voltage subsea cables to reach the point of connection onshore. Siemens' WIPOS concept integrates all electrical equipment into a multi-deck corrosion-resistant steel platform in order to deliver an efficient substation solution for both AC and DC transmission.

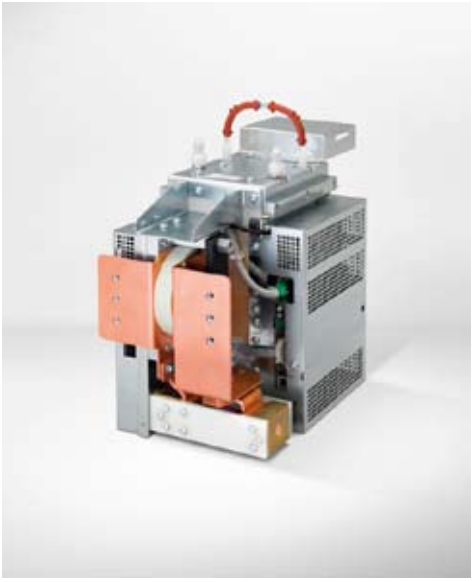
Siemens offers a family of WIPOS designs with the flexibility to meet various offshore weather, tide, and seabed conditions.

WIPOS topside solution (topside/jacket)
In this configuration, the topside and foundation structures are two separate sections.

WIPOS self-lifting solution
As the name implies the platform structure lifts itself. The topside comprises a pontoon with hollow tubular legs that are immersed and fastened on a base frame (foundation), thus allowing vertical suspension. Minimal installation efforts are required for this solution and heavy lift vessels are not necessary.

WIPOS floating solution
The floating solution incorporates a floating facility with excess buoyancy that, depending on water depth, can either be completely floating or held in place by anchors connected to a catenary mooring system on the seabed. This configuration is designed for deep waters.

Implementation



The VSC power module is Siemens' unique technology for power conversion.

The HVDC PLUS and SVC PLUS MMC modules make station design much more flexible than traditional designs.

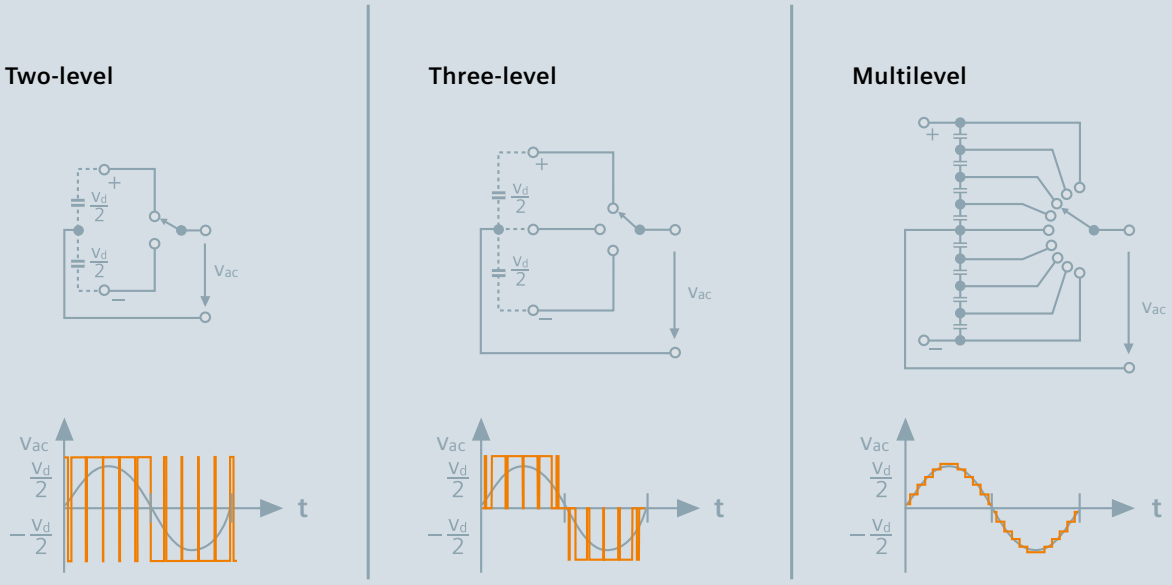
Setting examples in efficiency

Investments in large-scale renewable projects such as offshore wind farms require investors to be sure in advance that their asset can connect to the grid without issues. Siemens' deep understanding of grid codes around the world and the advanced modeling of complete network systems, dynamically and across the frequency domain, means that Siemens can underwrite grid code compliance on design and construction contracts. For AC connections this includes engineering of reactive power compensation and filtering using FACTS devices such as SVC PLUS. For wind farms further offshore HVDC connections are required. Careful modeling is still vital in order to optimize the performance of wind turbines and grid connection.

FACTS
Flexible AC transmission systems from Siemens allow for steady state and dynamic voltage control as well as reactive power control of dynamic loads and active damping of power oscillations, to name just a few. FACTS solutions thus increase the reliability of the system, and improve its stability and voltage quality, offering high flexibility for the integration of various energy sources and strengthening the grid.

SVC PLUS®
Being part of the FACTS product portfolio, Siemens' trendsetting VSC technology with "Modular Multilevel Converter" (MMC) design of SVC PLUS helps provide grid access for the variable output of renewable energy sources. The pretested, standard modular units of ±25, ±35, or ±50 MVAr guarantee fast implementation and can be operated individually or in parallel. SVC PLUS reduces time and resources required for project development. The relatively low number of components simplifies design, planning, and engineering tasks at the same time. Thanks to the modular design with fewer elements than conventional SVC systems, installation and commissioning also requires considerably less time than conventional systems. SVC PLUS is outstandingly compact, and is offered in a containerized solution, featuring great operation and footprint flexibility.

HVDC PLUS
HVDC PLUS is the technology of choice for bi-directional power transmission and whenever black start capability is deemed necessary. With this technology harmonic filters are not necessary, therefore providing tremendous footprint advantages. This modular, and highly reliable, concept is based on VSC technology and the unique MMC design. Specially designed for transmission in the range of up to 1,000 MW and above, it is ideally suited for the connection of offshore wind farms to the grid. HVDC PLUS allows the use of overhead lines as well as cable systems, and can connect and supply even small networks and passive loads.



Introducing the next generation of power conversion

The core of HVDC PLUS and SVC PLUS is voltage-sourced converter (VSC) technology based on a MMC design.

- The MMC provides a nearly ideal sinusoidal-shaped AC waveform and smooth voltage in DC applications. There remain few, if any, requirements for high-frequency and harmonic filtering.
- The VSC offers an independent control of active and reactive power.
- MMC design allows for low switching frequencies, which reduces system losses.
- The modular design of the MMC provides an outstanding degree of flexibility in converter station design.
- HVDC PLUS and SVC PLUS systems utilize robust, proven standard components, such as typical AC power transformers and industrial class IGBTs (insulated gate bipolar transistors) used for traction and industrial drives.

A single-source approach

Turnkey project implementation

Siemens' outstanding experience from HVDC, FACTS, and HVAC projects all around the world is the basis for customized turnkey grid access solutions. Siemens takes over the coordination of the entire project, reducing the number of interfaces between customer and suppliers, and takes responsibility for clearly defined schedules as well as cost and quality covenants. Turnkey projects also reduce the customer's own share in project risks, as Siemens guarantees the delivery of a system ready for operation.

As success relies significantly on careful advanced planning, Siemens sets the course for success through the provision of technical advice and the execution of a series of comprehensive studies.

Starting with feasibility studies at the earliest stages, over grid compliance analysis during design and construction, to analyzing issues that may arise during operation, Siemens provides customized solutions based on core competencies that have been engineered and developed in-house. Leveraging our broad competence and experience in electrical system studies, and using our state-of-the-art software tools of the Power System Simulator PSS® Product Suite, Siemens can offer the full range of consultancy and support for renewable energy projects. Respective studies cover, for example, design and analysis of the complete network of wind farms (including wind turbine generators and compensation equipment), verification of compliance with grid code requirements, investigation of the interconnection to the transmission networks, and assessment of further impacts of the wind farm integration into the power supply system.

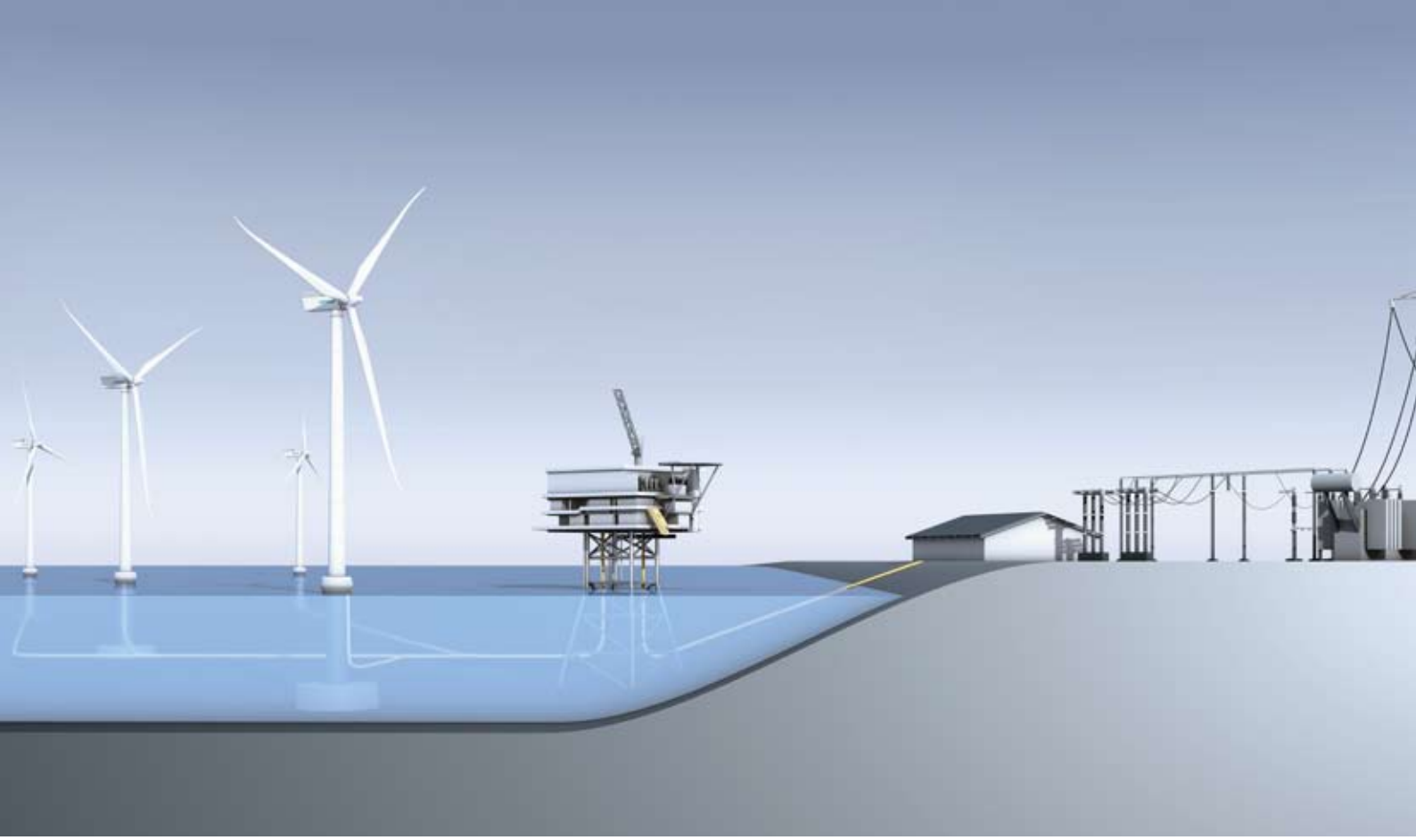
Turnkey grid access solutions from Siemens ensure that demanding project timescales and budgets from the project development phase through to realization are met.

Siemens undertakes techno-economic analyses of projects to assist in determining ideal solutions that satisfy financial expectations and comply with technical regulations. Support is also given in the production of planning and grid applications, including regulatory advice and liaison with network operators.

Siemens offers customized financing solutions and can counsel on arranging the financing. In the current economic environment, tailored project financing is a key success factor in realizing the necessary investment. At the same time, Siemens may also participate as an equity investor following due diligence.

When necessary, Siemens' systematic, professional, and comprehensive project management also includes obtaining planning permission as well as environmental assessment and consents. Siemens ensures the reliable completion of the project within a clear quality, time, and cost framework. Close cooperation with customers guarantees maximum transparency and makes sure that potential problems can be discussed and resolved at the earliest possible stage.

Finally, operation services, proactive maintenance and servicing solutions, remote diagnosis, and tele-maintenance ensure the highest possible degree of availability and reliability throughout the entire life cycle of the asset. This is especially vital for offshore assets, where service management and safety in particular mean aiming to minimize offshore site hours and deliver timely right-first-time interventions.



Value-added services

Expertise all along the way

Wind power plays an increasingly important role in the energy mix and contributes considerably to the reduction of carbon dioxide emissions. Siemens supplies the entire range of products required for efficiently harnessing the power of the wind and getting the energy to the end-consumer. This includes wind turbines and complete grid access solutions as well as monitoring and control solutions and operation and maintenance services.

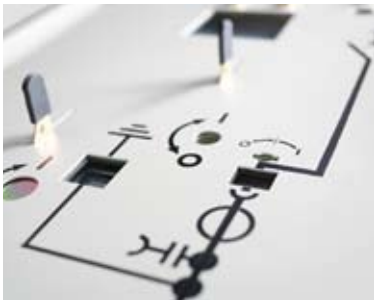
As a leading company in both the manufacture of wind turbines and in the supply of optimal grid access and network integration solutions based on both AC and DC technology, Siemens supplies a complete range of services as well as operation and maintenance options.

Siemens' comprehensive services include the determination of the most economical network within a planned wind farm, the optimal grid connection, the definition and configuration of the required components, and extensive studies and calculations for the entire system.

State-of-the-art high and medium-voltage switchgear and energy automation products and solutions from Siemens ensure a long service life and reliable operation of the entire power grid and make sure that the generated power is available wherever needed.

Siemens is an established service provider for offshore and onshore AC substations as well as for HVDC systems and provides a range of operation and maintenance regimes to meet customer requirements. Siemens can deliver comprehensive lifetime asset services on equipment and structures and offers proven systems for asset management and traceability, remote diagnostics, 24-hour monitoring, authorized employees, and safety management systems.

Linking the electricity grids of Northern Ireland and Scotland, the Moyle Interconnector is one example of Siemens' operations and maintenance offerings. It was built and is operated and maintained by Siemens, and is renowned as the world's most reliable HVDC link. Already fulfilling the second five-year long-term maintenance agreement, Siemens maintains the converter stations to meet world-class availability criteria. Siemens engineers and technicians who are based at the stations work hand in hand with the customer to provide a total service package. Paddy Larkin, executive director of Moyle Interconnector and chief executive of Mutual Energy, confirms, "Siemens is a trusted partner, who for eight years now has played a vital role in driving down cost, increasing efficiencies, and above all ensuring the safety of our equipment and the people who



work with us. The fact that the Interconnector has a world-class record of over 99 percent availability indicates that our service agreement is working very well and ensures we can provide security of supply for our customers. Through Siemens we are also providing the asset care to ensure that our first-class performance continues into the future."

The need to keep up with high standards of health, safety, and environmental protection are Siemens' highest priority. Siemens has implemented effective business management systems, certified to international standards such as ISO 14001 and ISO 9001, for instance, with a structured approach to the identification of hazards and risks and providing operational processes and procedures to identify, control, and eliminate such hazards. Siemens also recognizes that creating customer value and managing risk is essential. "PM@Siemens" is a global initiative that provides a framework for excellence in project management through the development of a consistent project management culture at Siemens, from bid stage to full project execution, by sharing best practice and introducing standard approaches, tools, and processes. As part of this framework, all Siemens project managers are accredited to deliver complex high-value projects. Siemens' experience, capability, technology, and processes provide a reliable basis for the delivery of complex grid connection solutions for today and for the future.

During the accreditation process, the APM (Association of Project Management) assessing team acknowledged:

"When it comes to professional project management and the value of it, Siemens is the benchmark."

Andrew Bragg, APM chief executive:

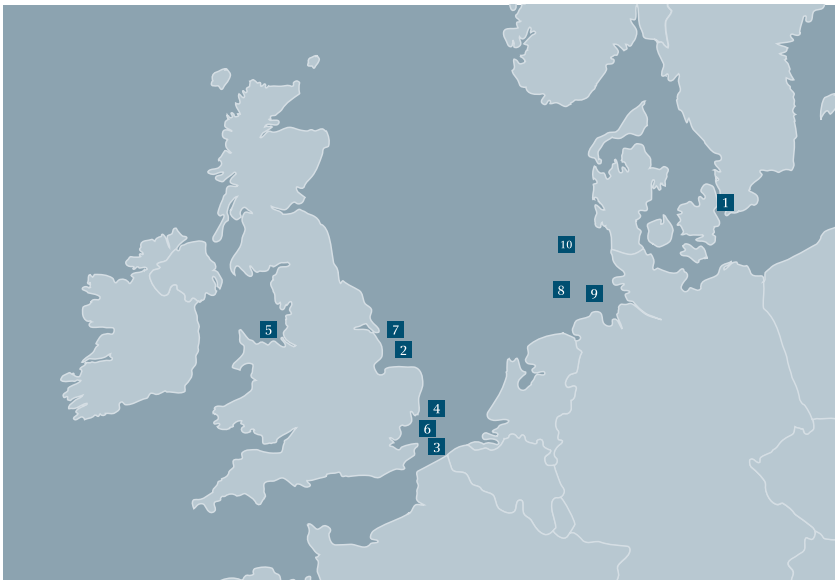
"What Siemens has achieved is impressive."

Paul Coffey, chief operating officer at RWE Innogy, says:

"Siemens has an excellent track record in offshore wind turbines and grid connections. We are working in partnership with them on projects including Gwynt y Môr Offshore Wind Farm and have had good business relationships with the company for many years. I look forward to our continued work together."

Colin Hood, chief operating officer at SSE, agrees:

"They're a trusted partner, and they won't walk away from issues."



Project references

1 **Lillgrund, Sweden**
110 MW

2 **Lynn/Inner Dowsing, UK**
180 MW

3 **Thanet, UK**
300 MW

4 **Greater Gabbard, UK**
500 MW

5 **Gwynt y Môr, UK**
576 MW

6 **London Array, UK**
630 MW

7 **Lincs, UK**
270 MW

8 **BorWin2, Germany**
800 MW

9 **HelWin1, Germany**
576 MW

10 **SylWin1, Germany**
864 MW

110 MW offshore wind farm Lillgrund, Sweden

About seven kilometers off the Swedish coast, 48 Siemens wind turbines, each with an output of 2.3 MW, produce electricity for Vattenfall AB, a leading Swedish power provider.

The 33/138 kV Siemens substation with its 120 MVA transformer is located within the wind farm footprint. Power transmission to the onshore grid is accomplished with a three-phase 138 kV XLPE subsea cable connecting the wind farm with a substation in the town of Bunkerflo. Siemens also performed extensive design and performance studies for the entire project.

180 MW offshore wind farms Lynn and Inner Dowsing, United Kingdom

A few kilometers off the Lincolnshire coast 54 Siemens 3.6 MW wind turbines produce electricity for Centrica Renewable Energy Ltd.

Two 100 MVA transformers are at the heart of the 33/132 kV onshore substation that receives the generated electricity through three 33 kV XLPE subsea cables. Siemens supplied the substation and the onshore cable system as well as grid, design, and performance studies for the wind farm.

300 MW offshore wind farm Thanet, United Kingdom

A project 11 kilometers off the Kentish coast, consisting of one hundred 3.0 MW wind power units, produces electricity for Vattenfall UK.

Siemens supplied the 33/132 kV offshore substation station for this project, equipped with two 180 MVA transformers, and the onshore substation including two SVC PLUS compensation systems. Siemens also ensured compliance with grid code, carried out performance studies, and provided the onshore cable system.

500 MW offshore wind farm Greater Gabbard, United Kingdom

Roughly 25 kilometers off the coast of Suffolk, 140 Siemens wind turbines, 3.6 MW each, will produce carbon-free electricity. Two 33/132 kV offshore Siemens substations with two 90 MVA transformers on one and three 180 MVA transformers on the other will help export the electricity through three three-phase 132 kV XLPE submarine cables. Near the network point-of-coupling to the grid in the village of Sizewell, Siemens is also installing a reactive power compensation device, which allows the wind farm to meet the requirements of the UK grid code.

576 MW offshore wind farm Gwynt y Môr, United Kingdom

The Gwynt y Môr project, situated in the Liverpool Bay area around 18 kilometers off the English northwest coast, will have a generating capacity of 576 MW upon completion. The project will be developed by a joint venture between RWE Innogy, Stadtwerke München, and Siemens. Siemens will be responsible for connecting the wind farm to the grid as well as delivering all 160 Siemens 3.6 MW class wind turbines. The turbines will be installed in water depths between 15 and 30 m. The grid connection of Gwynt y Môr will consist of two offshore substations, each equipped with two 33/132 kV 160 MVA transformers. In order to meet grid code requirements, Siemens will install two ±50 MVAr SVC PLUS systems for reactive power compensation as part of the onshore substation connection.

630 MW phase one offshore wind farm London Array, United Kingdom

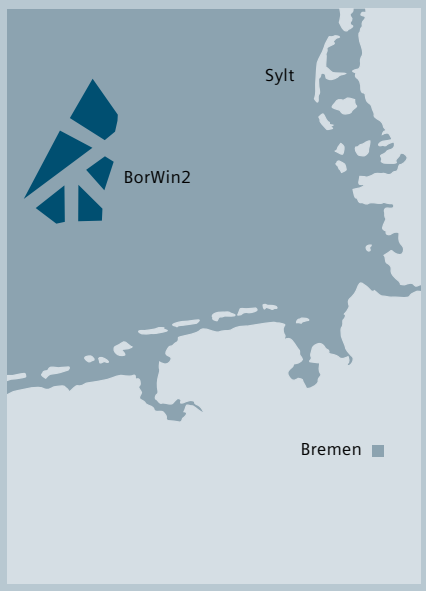
Situated 24 kilometers from Clacton-on-Sea, Essex, the development of this project will upon completion of phase one and two generate 1,000 MW of green power and will be the world's largest offshore wind farm when it is energized in 2012.

In phase one, two offshore substations will be delivered to collect the 630 MW of power generated by 175 Siemens wind turbines before transferring the power to shore via the main 150 kV export cables.

Siemens is the design-build contractor responsible for the overall electrical design of the grid connection providing performance studies, the equipment for two offshore substations, the complete onshore substation, and reactive power compensation.

270 MW offshore wind farm Lincs, United Kingdom

The Lincs project, a wind farm owned by Lincs Windfarm Limited, whose shareholders include Centrica, DONG, and Siemens, will be located in the Greater Wash region approximately eight kilometers from Skegness, Lincolnshire, UK. Lincs will have a generating capacity of 270 MW employing 75 Siemens 3.6 MW wind turbines installed in water depths of between eight and 18 meters. In addition to supplying the wind turbines, Siemens will be providing performance studies and constructing the offshore substation topside housing two 33/132 kV 240 MVA transformers as well as the onshore AC substation for this project. This contract award follows the successful commissioning of Centrica's Lynn & Inner Dowsing offshore wind farms, for which Siemens also provided the grid connection.



800 MW offshore HVDC PLUS link BorWin2, Germany

For the BorWin2 project, Siemens will supply the voltage-sourced converter (VSC) system – using Siemens HVDC PLUS technology – with a rating of 800 MW. The wind farms Veja Mate and Global Tech 1 are designed to generate 800 MW and will be connected through Siemens' HVDC PLUS link to shore. The converter will be installed on an offshore platform, where the voltage level will be stepped up and then converted to ±300 kV DC. The platform will accommodate all the requisite electrical equipment for the HVDC converter station, two transformers, four AC cable compensation reactors and high-voltage gas-insulated switchgear (GIS). The Siemens wind power offshore substation (WIPOS) will be designed as a floating, self-lifting platform. Power will be transmitted via subsea and land cable to Diele close to Papenburg, where an onshore converter station will reconvert the DC back to AC and feed it into the 380 kV AC network. The entire transmission link is expected to begin operation in 2013.

576 MW offshore HVDC PLUS link HelWin1, Germany

For the project HelWin1, Siemens will be supplying a voltage-sourced converter (VSC) system with a rating of 576 MW using Siemens HVDC PLUS technology. The wind farms Nordsee Ost and Meerwind are designed to generate 576 MW and will be connected through a Siemens' HVDC PLUS link to shore. The converter will be installed on an offshore platform, where the voltage level will be stepped up and then converted to ±250 kV DC. The platform will accommodate all the requisite electrical high-voltage AC and DC equipment for the converter station. Similar to the BorWin2 project, the Siemens wind power offshore substation (WIPOS) will also be designed as a floating, self-lifting platform. Energy will be transmitted via subsea and land cable to Büttel, northwest of Hamburg, Germany, where an onshore converter station will reconvert the DC back to AC and transmit it into the high-voltage grid. The entire transmission link and grid connection is expected to be in operation by 2013.

864 MW offshore HVDC PLUS link SylWin1, Germany

Siemens will supply the world's largest voltage-sourced converter (VSC) offshore system with a rating of 864 MW for the SylWin1 project. Siemens' HVDC PLUS link will connect the Dan Tysk wind farm to the German shore. The converter will be installed on an offshore platform, where the voltage level will be stepped up and converted to ±320 kV DC. The platform will accommodate all electrical equipment required for the HVDC converter station: two transformers, four AC cable compensation reactors, and high-voltage gas-insulated switchgear (GIS). Similar to the BorWin2 and HelWin1 projects, the Siemens wind power offshore substation (WIPOS®) will be designed as a floating, self-lifting platform. The energy will be transmitted via subsea and land cable to Büttel, where an onshore converter station will reconvert the DC to AC and feed it into the 380 kV AC grid. The transmission link is scheduled to start operation in 2014.

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Power Transmission Division
Order No. E50001-G610-A109-V3-4A00
Printed in Germany
Dispo 30003, c4bs No. 7504
fb 3986 471709 WS 0711

Printed on elementary chlorine-free
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