SIEMENS

The Sustainable Way

Grid access solutions from Siemens

siemens.com/energy/grid-access-solutions

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 transmission systems (grid access solutions) that help to cope with such challenges.

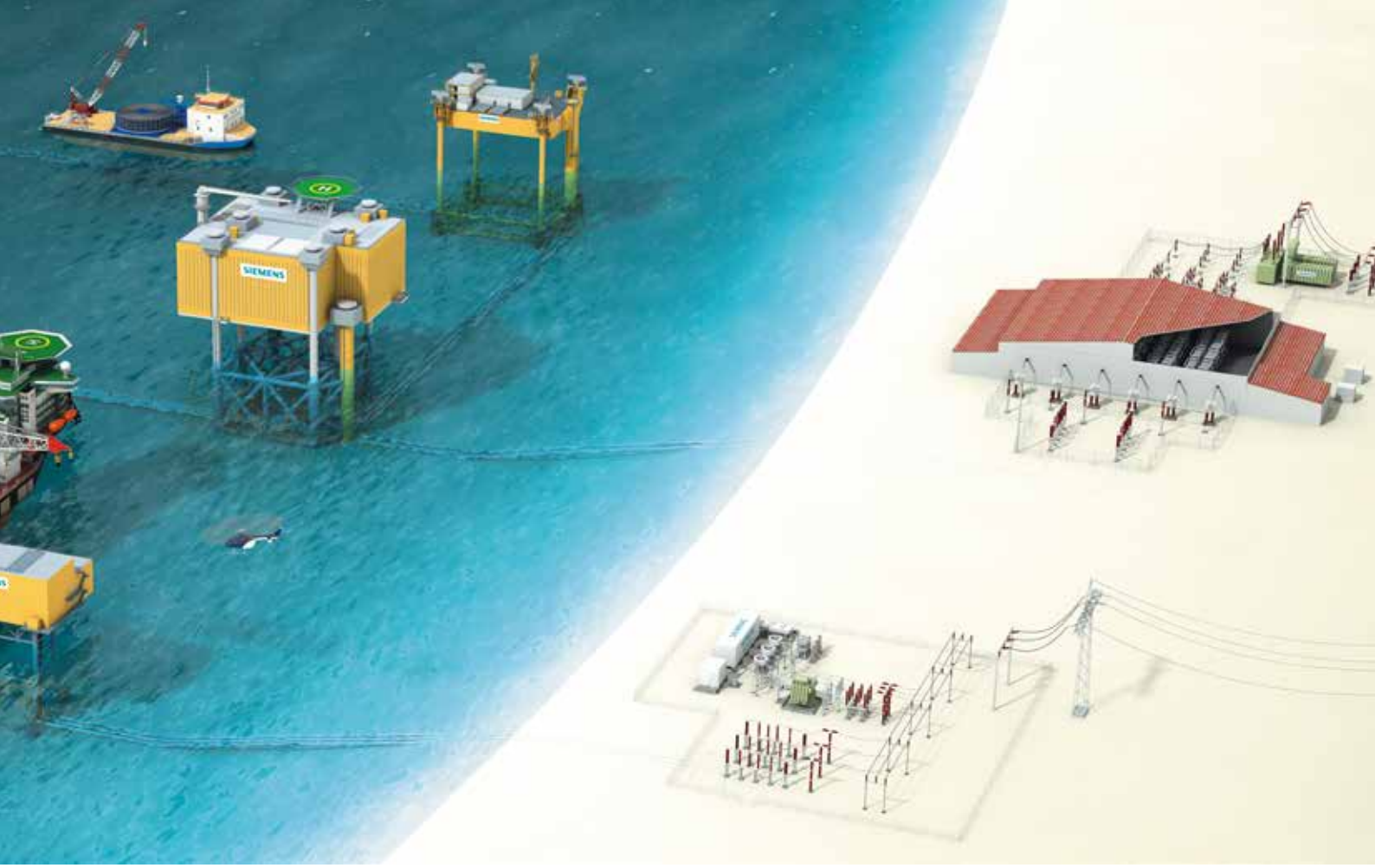
In the emerging world of offshore connections Siemens has taken the early lead. Siemens offers comprehensive turnkey grid access solutions, ranging from first feasibility and power system studies to the engineering, procurement, construction, and commissioning of entire grid connections. Siemens' service 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 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 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
- DC Compact Switchgear (DC CS)
- Compact and modular offshore modules

Services

- Studies
- Engineering
- Installation
- Commissioning
- Operation
- Maintenance
- Training

Solutions

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

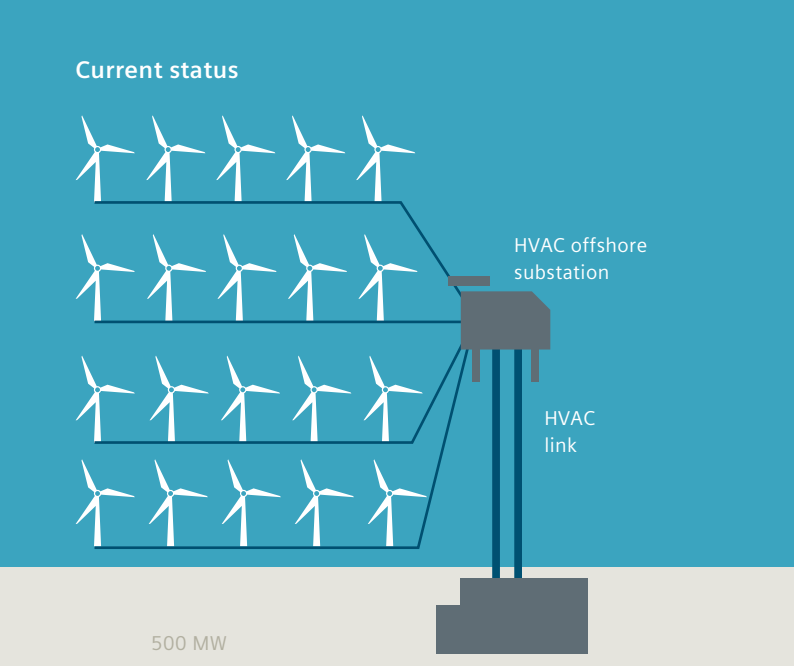
AC Grid Access Solutions – Compact and modular offshore modules

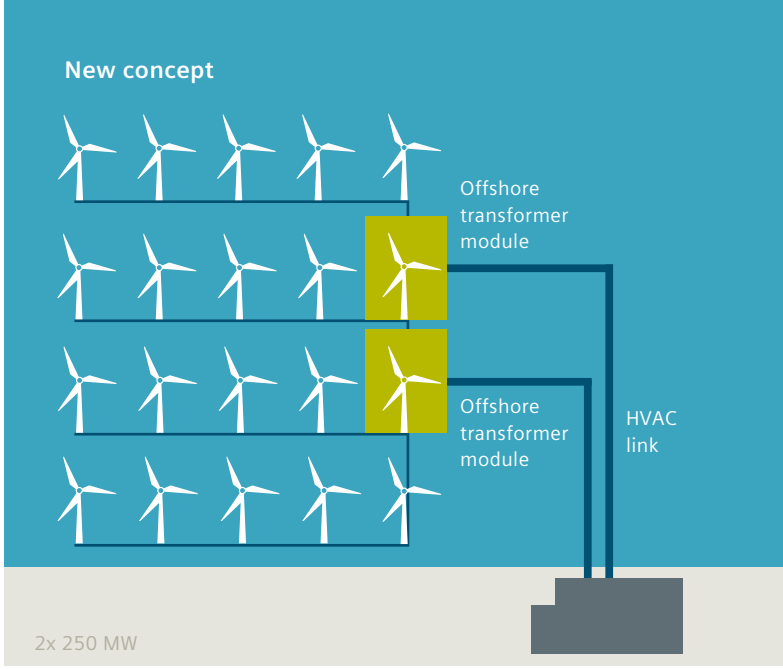
AC transmission is the most widely deployed technology for the connection of offshore wind farms. Since 2008 10 Siemens offshore platforms have been contracted for, and those completed have been successfully delivered. Unlocking the potential for offshore wind power within the wider energy mix remains dependent upon being able to innovate and reduce the levelized cost of energy.

Siemens has taken the lead in utilizing its experience in generation and grid access to innovate its portfolio. This innovation enables the reduction of both capital and operational expenditure, meaning it helps customers achieve the goal of reducing the levelized cost of energy to €0.10/ kilowatt hour by 2020.

Siemens' new innovative solution is based on the concept of two smaller and significantly lighter platform modules to replace the single large platforms currently deployed. The solution allows for the connection of the same rated power in total. It also offers high flexibility by allowing the modules to be installed and integrated with the wind turbine foundation or independently based on customer's requirements.

The solution has various options to suit the needs of each project while maintaining the optimized price level required by the market.





The new solution has been designed by considering the wind farm as a holistic asset. By doing so Siemens can exploit synergies to significantly reduce the grid access solution costs. By fully utilizing the potential of the wind farm as an integrated system, it is possible to leverage the following:

- Using the wind turbines to provide reactive power, thus eliminating the need for offshore reactors
- Using end-of-array connections to provide flexibility and remove the need for diesel generators
- Using wind turbine tower emergency refuge and heli-hoist to reduce equipment and servicing requirements

New AC grid access solution – saving weight, space, and costs by:

- ability to integrate with the turbine foundation or to be deployed separately
- installation by foundation/turbine installation vessels
- using MIDEL technology to make it fire safe and environmentally friendly
- simple and rugged design
- using electrical components optimized from our accumulated lifecycle experience
- modular approach to enhance operational performance, maintenance, and availability

AC grid access, general data	
Rated power (MW)	250
Rated HVAC voltage (kV)	220
Rated MVAC voltage (kV)	33 or 66
Platform weight (t)	650

The containerized FACTS device SVC PLUS supports the grid to offer grid access for the variable output of renewable energy sources.

HVDC PLUS converter technology at the offshore platform

Setting examples in efficiency

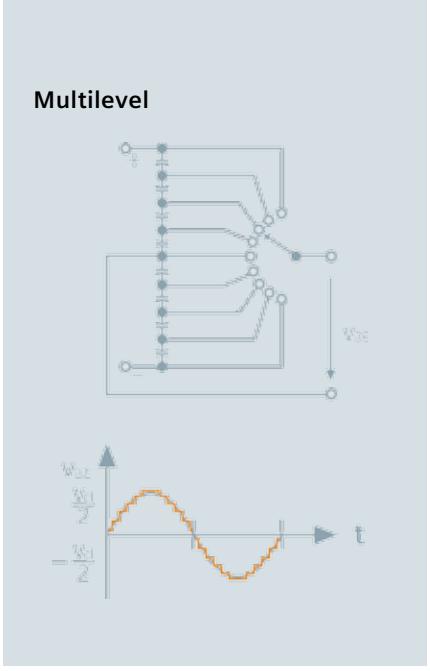
Investments in large-scale renewable projects such as offshore wind farms require investors to be sure in advance that their asset can connect to the grid without issues. Siemens' deep understanding of grid codes around the world and the advanced modeling of complete network systems, dynamically and 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 to optimize the performance of wind turbines together with the 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, among others. 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®
As part of the FACTS product portfolio, Siemens' trend-setting VSC technology with "Modular Multilevel Converter" (MMC) design of SVC PLUS helps to 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 bidirectional power transmission and whenever black start capability is required. 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.

DC compact switchgear for 320 kV



Concept of the Siemens Modular Multilevel Converter (MMC) topology

Introducing the next dimension in compactness

The core of HVDC PLUS and SVC PLUS is voltage-sourced converter (VSC) technology based on the MMC design offering a flexible station layout with a small footprint.

- The MMC provides a nearly ideal sinusoidal 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.

DC compact switchgear (DC CS)
As in AC substations, switching devices are also needed in the HVDC converter stations. The latest innovation from Siemens, the compact 320 kV DC switchgear, is the space-saving solution for HVDC cable connections to remote offshore wind farms using gas as the insulating medium instead of air. Gas-insulated substations utilized for AC applications are a proven technology for decades. Until now it was not possible to construct compact gas-insulated systems for use with direct current, because it is very difficult to control an electrical field under DC voltage conditions. The recent development from Siemens is an insulator with resin-impregnated paper (RIP) technology capable of durably withstanding high-voltage direct current under long-lasting application. This has enabled us to develop a new design (with smaller equipment geometries) for gas-insulated 320 kV switchgear for direct current. As a result, our new systems require 90 percent less space in comparison to air-insulated predecessors!

50-year service life
Since all live components are completely encapsulated, this equipment can be sited safely and reliably at any location irrespective of adjacent installations, and also be erected in outdoor settings. Based on long-term tests conducted jointly with the Technische Universität München (TUM), the service life of these switchgear is assessed to be up to 50 years.

In the near future, DC compact switchgear and transmission solutions will facilitate the realization of multiterminal arrangements or DC grids, backing up the existing AC networks.

Onshore HVDC PLUS converter station in Germany to reconvert the DC voltage into AC for power infeed into the grid

A single-source approach

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, and including grid compliance analysis during design and construction, and 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.

Onshore AC substation with the FACTS device SVC PLUS for grid access of the generated wind power

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 provided in the production of planning and grid applications, including regulatory advice and liaison with network operators.

Siemens offers customized financing solutions and can offer counsel on financing arrangements. In the current economic environment, tailored project financing is a key success factor in realizing the necessary investment.

When necessary, Siemens' systematic, professional, and comprehensive project management also includes obtaining planning permission as well as providing support with 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 ensures that potential problems can be discussed and resolved at the earliest possible stage.

Finally, operation services, proactive maintenance and servicing solutions, remote diagnosis, and telemaintenance ensure the highest possible degree of availability and reliability throughout the entire lifecycle 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.

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.

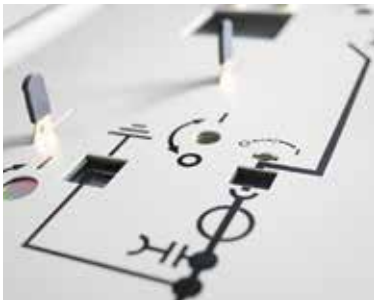
As a leading company in both the manufacturing of wind turbines and in the supply of optimal grid access and network integration solutions based on both AC and DC technology, Siemens supplies a complete range of services as well as operation and maintenance options.

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 ensure that the generated power is available wherever needed.

Siemens is an established service provider for offshore and onshore substations and provides a range of operation and maintenance regimens 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 services. It was built 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 employees 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 that 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 that 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 is Siemens' highest priority. Siemens has implemented effective business management systems, certified to international standards such as ISO 14001 and ISO 9001, with a structured approach to identify and to avoid hazards and risks. Siemens also recognizes that creating customer value and managing risk is essential. The initiative PM@Siemens provides a framework for excellence in project management, from bid stage to full project execution, by sharing best practices and introducing standard approaches, tools, and processes. In addition, 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."

BorWin2: the first North Sea grid connection using HVDC technology

Following the installation of HelWin1, Siemens' first converter platform, off Helgoland in August 2013, the BorWin2 offshore platform was installed in the North Sea northwest of the island of Borkum in April 2014 and successfully handed over to the German-Dutch network operator TenneT in January 2015. BorWin2 was the first offshore grid connection worldwide to begin commercial operation with efficient high-voltage direct-current technology, and its installation marked a crucial milestone in the German grid connection projects.

The transmission capacity of BorWin2 is 800 megawatts – enough to meet the power demand of about one million average households. The platform accommodates an HVDC converter station, two transformers, four AC cable compensation reactors, and high-voltage gas-insulated switchgear. For low-loss power transmission to the mainland, the voltage level of the alternating current generated by the wind turbines of the Veja Mate and Global Tech 1 wind power plants is stepped up and then converted to ±300 kV DC by a voltage-sourced converter (VSC) system using Siemens HVDC PLUS technology. Near the village of Diele close to Papenburg, an onshore converter station reconverts the DC back to AC and feeds it into the German 380 kV AC mainland grid.

BorWin2 platform was built by Nordic Yards in Warnemünde, Germany. The so-called topside, the visible part of the platform, is 72 meters long and 54 meters wide – more than half the size of a soccer field. It weighs 12,000 tons and has seven decks spanning a total height of 25 meters. These decks house the HVDC system as well as living quarters for maintenance and servicing staff.

The topside was too large for the passage through the Kiel Canal. So three tugboats towed it into the North Sea around the northern tip of Denmark after construction work had been completed in the shipyard in Wismar.

The topside reached its final destination after covering about 1,000 kilometers and was finally positioned directly above the base frame that Siemens had previously anchored in the North Sea, which is 39 meters deep at that point. This substructure consists of six steel pilings of up to 2.5 meters in diameter and a wall thickness of 8 centimeters and is anchored around 50 meters deep in the seabed. With a length of up to 83.5 meters, these pilings are only ten meters shorter than the Statue of Liberty in New York, including its base.

After the topside was aligned above the base frame, the two parts were combined. This is the most critical part of such an installation sequence, as it calls for a very calm sea. Then the platform was raised using a hydraulic jack-up system. The platform is installed 20 meters above sea level to protect it against giant waves and is designed for decades of operation in the rough North Sea.

Numerous commissioning tasks, at times requiring up to 100 employees to work simultaneously on the platform,

The BorWin2 platform implemented in the German North Sea is a milestone in the short history of offshore grid access solutions.

followed the successful installation of the topside. The platform is fully automated now and can be monitored and controlled from shore, with cameras and sensors providing a complete overview of the current operating status. The crews' quarters on the platform are only used when maintenance work is required. Siemens has been contracted by TenneT for maintenance of the grid connection for an initial period of five years.

HVDC PLUS systems, based on modular multilevel voltage-sourced converters, are ideally suited for the transmission of offshore power to the mainland. Other than conventional HVDC systems, which can only be used in networks with sufficient short-circuit capacity, systems using HVDC PLUS enable island networks to start up from scratch – an important prerequisite for the operation of an offshore network. Siemens' modular VSC technology, developed in 2007, enabled the use of HVDC systems on the high sea for the first time ever. It reduces complexity and the footprint of the installations, which proves a great advantage when space is limited, as is the case on offshore platforms. Moreover, HVDC PLUS ensures a nearly ideally sinusoidal AC voltage curve and a smooth voltage in the DC circuit, which eliminates the need for harmonic filters that would require additional space.

"The BorWin2 link is a major contribution to the energy transition. The connection's capacity of 800 megawatts is equivalent to the capacity required for supplying one million private households."

Lex Hartman, member of the managing board of TenneT TSO GmbH

"This is the first offshore grid connection worldwide to take up commercial operation with efficient high-voltage direct-current technology. We are proud that we have mastered and completed this demanding and challenging project, despite the many difficulties that working far out at sea presented."

Jan Mrosik, CEO of the Siemens Energy Management Division

Siemens experts provide invaluable practical experience throughout the complete project lifecycle.

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

Drawing upon unique expertise

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 of 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, a 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 lifecycle costs.

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

11 **HelWin2, Germany**
690 MW

12 **Dudgeon, UK**
402 MW

13 **BorWin3, Germany**
900 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 coast of Kent, 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 Liverpool Bay around 18 kilometers off the north coast of Wales, will have a generating capacity of 576 MW upon completion. The project was developed by a joint venture between RWE Innogy, Stadtwerke München, and Siemens. Siemens was responsible for connecting the wind farm to the grid as well as delivering all 160 Siemens 3.6 MW wind turbines. The turbines were installed in water depths between 15 and 30 m. The grid connection of Gwynt y Môr consists of two offshore substations, each equipped with two 33/132 kV 160 MVA transformers. To meet grid code requirements, Siemens has installed two ±50 MVAr SVC PLUS systems for reactive power compensation as part of the onshore substation connection.

630 MW phase 1 offshore wind farm London Array, United Kingdom

Situated 24 kilometers from Clacton-on-Sea, Essex, this project, after completion of phases 1 and 2, is now generating 1,000 MW of green power and is the world's largest offshore wind farm.

In phase 1, two offshore substations were 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 was 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.

©TenneT

270 MW offshore wind farm Lincs, United Kingdom

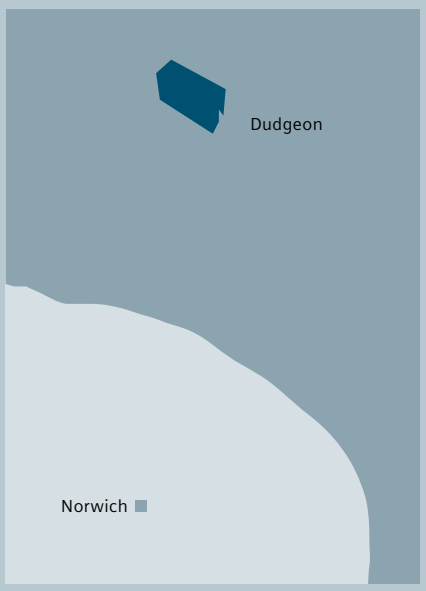
The Lincs project, a wind farm owned by Lincs Wind Farm Limited, whose shareholders include Centrica, DONG, and Siemens, is located in the Greater Wash region approximately eight kilometers from Skegness, Lincolnshire, UK. Lincs has a generating capacity of 270 MW and employs 75 Siemens 3.6 MW wind turbines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

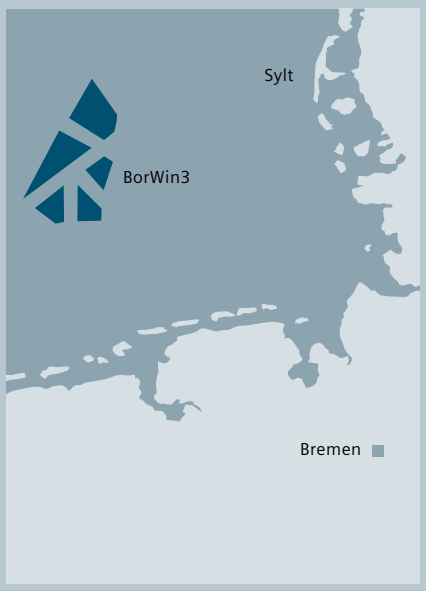
576 MW offshore HVDC PLUS link HelWin1, Germany

For the HelWin1 project, Siemens supplied a voltage-sourced converter (VSC) system with a rating of 576 MW using Siemens HVDC PLUS technology. The Nordsee Ost and Meerwind wind farms are designed to generate 576 MW and are connected through a Siemens HVDC PLUS link to shore. The converter was installed on an offshore platform, where the voltage level is stepped up and then converted to ±250 kV DC. The platform accommodates 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 is designed as a floating, self-lifting platform. Energy is transmitted via subsea and land cable to Büttel, northwest of Hamburg, Germany, where an onshore converter station reconverts the DC back to AC and transmits it into the high-voltage grid.

864 MW offshore HVDC PLUS link SylWin1, Germany

Siemens supplied the world's largest voltage-sourced converter (VSC) offshore system with a rating of 864 MW for the SylWin1 project. Siemens' HVDC PLUS link connects the Dan Tysk wind farm to the German shore. The converter is installed on an offshore platform, where the voltage level is stepped up and converted to ±320 kV DC. The platform accommodates 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 is designed as a self-lifting platform. The energy is transmitted via subsea and land cable to Büttel, where an onshore converter station reconverts the DC to AC and feeds it into the 380 kV AC grid.





690 MW offshore HVDC PLUS link HelWin2, Germany

Siemens erected HelWin2, the link between the Amrumbank West North Sea offshore wind farm and the onshore grid. The customer is TenneT TSO GmbH of Bayreuth, Germany.

The grid connection is designed as an HVDC transmission link in voltage-sourced converter technology for power transmission at 320 kV DC over a distance of 130 km. With a power rating of 690 MW it can supply approximately 700,000 homes with renewable wind energy. Amrumbank West is built about 55 kilometers from the mainland, 35 kilometers north of Helgoland, and 37 kilometers west of the North Frisian island of Amrum. Together with the Meerwind and North Sea East offshore wind farms, it is part of the HelWin North Sea cluster and feeds into the 380 kV AC onshore grid in Büttel, Germany.

402 MW offshore AC link Dudgeon, United Kingdom

The 402 MW Dudgeon Offshore Wind Farm will be located 32 km off the coast of Cromer in North Norfolk in a water depth of 18–25 m. The electricity it generates will be brought to shore via a seabed cable at Weybourne Hope, some 5 km west of the town of Sheringham. From there an underground cable will be laid to carry this electricity to Necton, near Swaffham, where a dedicated substation will enable the electricity to be transmitted into the National Grid.

In September 2014, Siemens was awarded the Contract for the electrical system infrastructure, which includes the engineering, procurement, construction and offshore hookup of the 400/132kV onshore substation and 33/132kV offshore substation, including jacket foundation. Siemens will have the overall system responsibility to connect the offshore wind farm to the 400 kV National Grid network in Necton.

900 MW offshore HVDC Plus link BorWin3, Germany

The BorWin3 grid connection is the fifth order that Siemens has received from the German-Dutch transmission grid operator TenneT for connection of offshore wind farms in the North Sea. With a transmission capacity of 900 MW it is the world's largest offshore DC power transmission system. Siemens will provide the HVDC PLUS technology and serve as the leader of the consortium with Petrofac, the firm in charge of constructing and installing the offshore platform. This 160-kilometer-long grid connection will convert the 155 kV AC of the wind power plants into 320 kV DC for power transmission to the mainland, where it will be converted back to AC and fed into the 380 kV AC grid near Emden, Germany. The estimated date of completion is 2019.

Published by and copyright © 2015:
Siemens AG
Energy Management Division
Power Transmission Solutions
Freyeslebenstrasse 1
91058 Erlangen, Germany

For more information, please contact
our Customer Support Center.
Phone: +49 180 524 70 00
Fax: +49 180 524 24 71
(Charges depending on provider)
E-mail: support.energy@siemens.com

Power Transmission Division
Order No. EMTS-B10004-00-7600
Printed in Germany
Dispo 30003
fb 6627 473222 WS 0915